Emotion recognition problems after brain injury:

Development of the Brief Emotion Recognition Test (BERT)

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ABSTRACT

Difficulty recognising emotion can have a major impact on psychosocial outcome following acquired brain injury. Current measures are time consuming and outdated. The need to have an easily administered screening test which enables clinicians to quickly assess this ability has been identified. In this thesis, the development of the Brief Emotion Recognition Test (BERT) is described. The test consists of 14 short video clips of actors portraying positive, negative and neutral emotions. After watching each video clip viewers are asked to choose which emotion is being portrayed from a list of six emotions (happy, sad, surprise, anger, fear, disgust) and neutral. Half of the clips include facial expressions only ("no phrase") and the other half include facial expressions and congruent vocal cues in the form of neutral carrier phrases ("with phrase"). The performance of 92 neurologically healthy adults was compared with that of 20 adults who had sustained moderate-to-severe acquired brain injury (ABI). Performance on the BERT was found to be correlated with an existing measure of emotion recognition (Emotion Evaluation Test - EET). Correlations were higher in the ABI group than the neurologically healthy group. Test retest reliability in the ABI group was good, and moderate in the neurologically healthy group. Overall the ABI group's performance on the BERT was impaired relative to the neurologically healthy group. Both groups performed worse on the "with phrase" BERT, with the ABI participants finding this part of the test particularly difficult. In the neurologically healthy group, intelligence was not found to be associated with performance on the BERT. However, it was found to be associated with the ABI group's performance on the "with phrase" BERT. The groups differed in education and intelligence. Education was not found to be a significant predictor of group differences, intelligence was. The neurologically healthy group were more accurate regarding five clips in the 'no phrase' condition; two of the seven in the 'with phrase' trial; and in the total overall score. Overall, findings for this pilot study suggest the BERT provides a useful means of rapidly screening for emotion recognition difficulties after brain injury. Further research is needed establish the new test's psychometric properties. Evaluation of the findings, relevance to counselling psychology, implications for practice and areas for further investigations are outlined.

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Chapter 1: Literature Review

1.1 Acquired brain injury

Acquired brain injury (ABI) is brain damage that occurs after birth. There are many types of ABI including those resulting from external traumatic events such as accidents and physical assaults and those resulting from internal events such as strokes, brain tumours and brain infections.

Incidence

ABI is a major health issue affecting approximately 10 million people worldwide (Langlois, Rutland-Brown & Wald, 2006). It will be one of the major causes of death and disability by the year 2020 (Hyder, Wunderlich, Puvanachandra, Gururaj & Kobusingye, 2007). Brain injury is the most common cause of death and disability in people aged 1–40 years in the UK and each year 1.4 million people attend emergency departments in England and Wales with a recent head injury (NICE 2014; Clinical Guidance 176).

Personality and behavioural changes after ABI

Cognitive and neuro-physical impairments are common after ABI. Depending on factors such as the location and extent of damage; age (brain plasticity); premorbid functional and intellectual level; medical and emotional health; and the support system that exists, physical and cognitive recovery can often occur within the first few months after injury (Zillmer, Spiers & Culbertson, 2008). As well as cognitive and physical impairments, individuals can suffer a range of personality and behavioural changes such as becoming self-centred, insensitive to others needs, slowness, poor memory and irritability (Brooks, Campsie, Symington, Beattie & McKinley, 1986). These are evident shortly after injury and long-term (Langois et al., 2006; Milders, Ietswaart, Crawford & Currie, 2006; Oddy, Coughlan, Tylerman & Jenkins, 1985; Rosenberg, McDonald, Rosenberg & Westbrook, 2016). The research suggests that these changes in personality and behaviour do not dissipate over time (Marsh, Knight & Godfrey, 1990; McKinlay, Brooks, Bond, Martinage & Marshall, 1981; Oddy, Humphrey & Uttley, 1978) without intervention. Most people rely on their partners or families to support them after an ABI (Wood, Liossi & Wood, 2005). The consequence of this is that the impact of ABI is not just on those who have suffered the injury but also on their partners and families (Anderson, Parmenter & Mok, 2002; Endberg & Teasdale, 2004; Hoofian, Gilboa, Vakil & Donovick, 2001; Harris, Godfrey, Partridge & Knight, 2001; Kreutzer, Gervasio & Camplar, 1994). Changes in family and social relationships and overall quality of life are often reported (Teasdale & Endberg, 2005).

Early studies identified that a lot of families complain about personality, behavioural and emotional changes in the person who has experienced a brain injury. For example, Thomsen (1974), in a study of 40 severely brain injured individuals and their families found that 84% of families complained of changes which included behaving in socially inappropriate ways, egocentricity, self-centeredness, being argumentative, disinterested and insensitivity to others. In a follow up study, Thomsen (1984) found that the psychosocial consequences of brain injury, namely, emotional problems and personality change were more debilitating than physical disabilities and increased the risk of social isolation, caregiver distress and unemployment. Thomsen's work highlighted how psychosocial changes after ABI have a significant impact on individuals and the importance of addressing these in order to improve outcome.

Brooks et al. (1986) carried out a one year and five year follow up of a group of 55 severely brain injured individuals. At the five year follow up they managed to contact

42 of the original participants and assessed that these were a good representation of the original sample. Using structured interviews, a close relative of each brain injured patient was asked about the patient's physical and mental state, behaviour, self-care abilities and personality. Relatives were asked to report any changes in the patient which had emerged after the injury and were still present. Relatives were also asked to report any strain or distress experienced as a result of the changes. This was measured using a seven point self-report scale ranging from the low point "I feel no strain as a result of changes in my spouse/relative", to the maximum of "I feel severe strain…" Seventy four percent of relatives reported personality change at the five year follow up (up from 60% at one year follow up) and personality change was found to be related to high levels of distress in the relatives.

Research shows ABI has a significant impact on family functioning and levels of psychological distress (for example: Hoofian et al., 2001; Kreutzer et al., 1994; Kreutzer, Marwitz, Hsu, Williams & Riddick 2007; Livingston, Brooks & Bond, 1985). After ABI there is a high likelihood of depression, family burden and loneliness and this is associated with difficulties the ABI person has in social situations (Hoofian et al., 2001; Testa, Malec, Moessner & Brown, 2006). Families are confronted with dealing with many changes including cognitive, behavioural and neuro-physical changes. Anxiety and depression is evident in 25-30% of relatives and 60-80% report some emotional distress (Kreutzer et al., 1994; Livingston et al., 1985).

ABI severity

ABI severity is usually defined as 'mild', 'moderate' or 'severe' according to the amount of altered consciousness experienced after the injury (Saatman & Duhaime, 2008). The Department of Defense and Department of Veterans Affairs (2008), measures levels of ABI severity by three factors: the Glasgow Coma Scale (GCS; Teasdale & Jennet, 1974); duration of post trauma amnesia (PTA) and the duration of loss of consciousness (LOC) after the injury. The GCS is used to assess the central nervous system status of a patient. It has three elements; eye response, verbal response and motor response. These elements are scored out of five and summed up. The maximum score is 15 which indicates a fully awake patient and the minimum score is three which indicates deep coma or a brain-dead state (Jennet & Bond, 1975). Table 1 illustrates how levels of ABI severity are defined by the Department of Defense and Department of Veterans Affairs (2008). The current study has used this table to categorise ABI severity.

Table 1. Levels of ABI severity (Department of Defense and Department of Veterans Affairs, 2008)

	GCS	Duration of PTA	Duration of LOC
Mild	13-15	< 1 hour	< 30 minutes
Moderate	9-12	30 minutes – 24 hours	1-24 hours
Severe	3-8	< 1 day	>24 hours

Reduced social contact and loneliness

Research has established that the number of relationships and frequency of social contact decreases after ABI and there is a tendency to rely on family for social contact (Elsass & Kinsella, 1987; Thomsen, 1974). People with ABI have reported loneliness as being a main problem for them (Oddy et al., 1985). Difficulty maintaining relationships including established relationships built up over many years occurs and there is evidence that even when the number of acquaintances before and after injury remains constant the number of close friends decreases (Endberg & Teasdale, 2004). A correlation has been found between relatives' reports of personality changes and the number of friends that the person with ABI has maintained contact with (Weddell, Oddy & Jenkins, 1980). It has been suggested that reduced social contact and high levels of loneliness may be as a result of the difficulties people with ABI have in social situations (Hoofian et al., 2001).

Therefore, after ABI people often have reduced social contact. The social contact that does occur is different to what it was before the ABI in terms of frequency and type and loneliness and social isolation are problems for people after ABI.

Breakdown in marital relationships

Divorce and separation rates are higher than average after ABI. Marital breakdown after a "severe" outcome been assessed as up to 78% (Thomsen, 1984) and 42% in those with "good" outcomes (Tate, Lulham & Broe, 1989; Wood & Yurdakul, 1997). Deterioration in marriages following ABI has been found to be directly associated with loneliness and altered interpersonal skills of the ABI individual (Wedcliffe & Ross, 2001).

Gosling and Oddy (1999) reported poor marital dissatisfaction and lack of emotional responsiveness and expressed affection in couples 1-7 years following ABI. They also found that partners were more dissatisfied with the relationship than the person who had had the ABI. This may suggest that sometimes after ABI individuals are not aware of the impact their behaviour is having on relationships (Koskinen, 1998; Wood, 2001).

Research shows that difficulties engaging and interacting socially is a particular problem after brain injury (Greenwood, 1999). There is evidence that after brain injury, behaviour can appear to be lacking in empathy, be inappropriate and self-centred and this can make it difficult to maintain social relationships (McDonald & Saunders 2005;

Wood & Williams, 2008). Despite these difficulties being well documented, there is a lack of literature on how neuro-behavioural problems affect the relationships that people with ABI have (Wood et al., 2005).

1.2 Emotion recognition problems after ABI

Psychosocial functioning problems often pose greater problems to adjustment after injury than cognitive or physical functioning (Gratton & Ghahramanlou, 2002; Yates, 2003). The impairments that contribute to psychosocial problems are not well understood (MIlders, Fuchs & Crawford, 2003). They are likely to be multifactorial and include cognitive, physical and emotional factors as well as external factors such as reduced social and financial opportunities (Bornhofen & McDonald, 2008a). The occurrence of emotion recognition problems after ABI has been identified. Research has shown that a substantial number of people are impaired in their ability to recognize emotional facial expressions after ABI (McDonald & Flanagan, 2004; McDonald & Saunders, 2005; Radice-Neumann, Zupan, Babbage & Willer, 2007; Rosenberg et al., 2016).

Studies investigating the proportion of people who have emotion recognition problems after ABI have reported various figures, some as high as 51% (Biszak & Babbage, 2014). In a meta-analysis of 13 studies involving 296 adults with moderate-to-severe ABI and 296 matched controls (Babbage et al., 2011) it was reported that there was a relatively large effect size (1.1 *SD)* differentiating people with ABI from matched controls. This meta-analysis estimated that up to 39% of people with ABI experience problems recognising facial emotions from static photographs.

Brain injuries, especially those that result from traumatic impact such as in motor accidents, often result in damage to particular areas of the brain including the prefrontal, temporal and parietal lobes, the amygdala and other structures which have connections within and to the limbic system (Radice-Neumann et al., 2007). These areas are associated with emotion and so it is perhaps not surprising that problems with emotion recognition often occur after ABI.

Emotions are communicated largely through facial expressions (Jackson & Moffat, 1987). Difficulty recognising facial emotion can interfere with a person's ability to interpret how others are feeling and is likely to be related to the communication problems and difficulties in social relationships that are often reported after ABI (Radice-Neumann et al., 2007). Negative consequences of not being able to interpret facial emotional expressions may include not responding appropriately to others; not being able to gauge the appropriateness of their own behaviour; and not fully understanding the communication of others (McDonald, 2003). Despite the fact that emotion recognition is a critical aspect in the development and maintenance of social relationships (Radice-Neumann at al., 2007) and problems in relationships after ABI have been recognised for some time, it is only relatively recently that research into impairments in emotion recognition following ABI has been carried out (McDonald, 2013).

In a recent study, May et al. (2017), found there was an association between poor post-injury behaviour (including community integration) and emotion recognition after ABI. They also found that this association could not be explained fully by injury severity, time since injury or education. This finding supports the suggestion that emotion recognition is an important factor in aiding and maintaining good social functioning. We know that post injury social behaviour is related to social outcome (Struchan, Pappadis, Sander, Burrows & Myszka, 2011), and that changes in social behaviour can contribute to caregiver burden and distress (Katsifaraki & Wood, 2014).

Emotion recognition problems present shortly after injury

Research has investigated whether emotion recognition problems are present shortly after injury in order to try to establish whether the deficits are caused by the injury itself or secondary factors. Research comparing emotion recognition problems in participants who were an average of just 2.6 months post injury (Green et al., 2004) and during first 60 days of injury (Borgaro, Prigatano, Kwasnica, Alcott & Cutter, 2004) with matched controls found that the ABI participants were significantly less accurate than controls identifying emotions. In other words, the findings of these studies suggest that deficits in emotion recognition exist shortly after injury and are therefore caused by the injury itself rather than environmental changes or from secondary factors such as depression or anxiety which often occur after ABI. As well as there being evidence that emotion recognition deficits exist shortly after ABI, longitudinal research has demonstrated that without intervention emotion recognition impairments in facial and vocal expressions do not change over time (Ietswaart, Milders, Crawford, Currie & Scott, 2008; Milders et al., 2003).

As a significant proportion of individuals with ABI have impairments in emotion recognition and research shows these problems are as a result of the injury rather than secondary factors such as anxiety or depression, it makes sense for these impairments to be screened for shortly after injury. Indeed, Borgaro et al. (2004) have highlighted the importance of screening for emotion recognition deficits during rehabilitation and have suggested that the availability of a brief screening measure would be particularly useful, especially in an acute setting where patients' ability to endure extensive assessment may be limited.

Emotion recognition research using photographs

One of the first studies to report emotion recognition problems after ABI was that of Prigatano and Pribram (1982). They used the Ekman and Friesen (1971) black and white photographs of facial expressions. These photographs portray the six basic emotions (happy, sad, fear, anger, surprise, disgust) and neutral that have been demonstrated by Ekman and Friesen (1971) to be universal across cultures. A substantial number of subsequent studies using photographs have reported findings of emotion recognition impairments after ABI (for example, Borgaro et al., 2004; Green, Turner & Thompson, 2004; Jackson & Moffatt, 1987). In addition these studies have established that emotion recognition problems after ABI are common and have drawn attention to how emotion recognition problems are likely to adversely affect social and emotional behaviour.

Vocal emotion recognition

Emotion in voices is portrayed in the meaning of the vocal content (the *what*) and also in prosody (the *how*) (Dimoska, McDonald, Pell, Tate & James, 2010). The term prosody includes the intonation pattern (pitch contour) of speech, word stress (a complex subjective variable based on timing, pitch, and loudness) and pauses that sometimes occur at the ends sentences (Wingfield, Lahar & Stine, 1989).

Research has established that a significant number of individuals with ABI have difficulties recognising emotion from vocal expressions (Braun, Baribeau, Ethier, Daigneault & Proulx, 1989; Hornak, Rolls & Wade, 1996; Marquardt, Rios-Brown, Richburg, Seibert & Cannito, 2001; McDonald & Flanagan, 2004**;** McDonald, Flanagan, Martin & Saunders, 2004; Milders et al., 2003; Spell & Frank, 2000; Zupan, Neumann, Babbage & Willer, 2009). Some of these studies have investigated both vocal and facial emotion recognition (Knox & Douglas 2009; McDonald & Saunders 2005; Milders et al., 2003; Spell & Frank 2000; Zupan, Babbage, Neumann & Willer, 2014) and have found that individuals with ABI perform less well on both types of tasks compared to matched controls without brain injury, though impairment has been found to be greater for vocal emotion than facial emotion recognition (Spell & Frank, 2000).

Whilst deficits in interpreting facial emotion recognition has been widely explored, difficulties interpreting vocal cues of emotion has received much less attention (Zupan et al., 2009). Accurate interpretation of vocal emotion cues is important, particularly when facial cues are absent or ambiguous because these cues contribute to more accurate identification of emotion (Zupan et al., 2009). One of the first studies to compare face and vocal emotion recognition (Braun et al., 1989) reported that ABI participants were impaired in facial emotion recognition but were not impaired identifying emotions from verbal narratives with the exception of narratives portraying anger where there was significant impairment. However, subsequent research has established that difficulties recognising vocal emotion is not limited to the emotion anger and that individuals with ABI have difficulty recognising vocal expressions of all emotions (for example; Ietswaart et al., 2008; McDonald & Saunders, 2005; Milders et al., 2003).

Taken together the studies have established that as well as there being facial emotion recognition problems after ABI there are also vocal emotion recognition problems. The studies have also highlighted how vocal emotion recognition deficits after ABI contribute to social communication problems (Spell & Frank, 2000; Zupan, et al., 2009) and these problems are likely to adversely affect social integration and social functioning (McDonald & Flanagan, 2004; McDonald & Saunders, 2005; Orbelo, Testa & Ross, 2003; Zupan et al., 2009).

Dynamic multi-modal displays of emotion

Static displays of emotion in photographs are simple to use and allow the viewer time to view a fixed emotional expression. However, in everyday communication we use verbal cues, facial expressions, context, past experience and other non-verbal information cues to make sense of social interactions (Bornhofen & McDonald, 2008a). In other words recognising emotions displayed in photographs or audio recordings (unimodal displays) is arguably different to recognising emotions in real life social interactions as they fail to provide the viewer with all the cues and information which are present in most normal interpersonal exchanges (Bornhofen & McDonald, 2008a).

In the last decade or so, progress has been made in developing tests of emotion recognition that are dynamic (moving) and multimodal making them more ecological. The Awareness of Social Inference Test (TASIT; McDonald, Flanagan, Rollings & Kinch, 2003) is one test that simulates real life settings in the form of videoed vignettes. The TASIT has three parts. The first part is the Emotion Evaluation Test (EET). This consists of 28 video vignettes of professional actors portraying one of the six standard emotions and neutral. All the scripts are ambiguous monologues or dialogues devoid of specific emotional content. The video vignettes are used to emulate real emotional expressions and viewers have to identify the emotional expression being portrayed by the designated actor in the vignette by choosing an emotion from a list of the six standard emotions and neutral. Responses are recorded on a sheet and scored manually.

McDonald and Saunders (2005) used the EET in a study involving 34 adults with severe ABI and 28 adults without brain injuries. Four different media were used: still images; moving facial displays; audio only; and audio visual media (EET). The study found that individuals with ABI performed more poorly than individuals in the control group in all of the four different media. McDonald and Saunders (2005) discovered that the ABI group were significantly impaired recognising emotions in both the audio and audio-visual displays and eight of the thirty four were significantly impaired recognising the emotions in the photographs whilst only one of the thirty four was impaired in the recognition of the moving visual displays with no sound. The ABI group was most impaired in the dynamic audio visual task. The findings led the authors to suggest that recognition of emotion in visual moving displays involves different brain systems (for example the parietal cortices), to recognising emotions in still displays.

Knox and Douglas (2009) compared the performance of 13 individuals with ABI and 13 matched controls on emotion recognition of static stimuli (Ekman photos) and dynamic displays (18 items from the EET presented without no sound). The study found that the ABI group were impaired interpreting facial expressions in both static and dynamic displays, though performed significantly worse on the dynamic display task. The control group's performance was similar in both the tasks. The finding in this study that dynamic displays of emotion were more difficult for individuals with ABI to identify than static photographs is different to the findings of McDonald and Saunders (2005).

Knox and Douglas (2009) suggest the reason why individuals in the ABI group performed worse on the dynamic stimuli task may be that the dynamic displays demanded more executive functioning than the static stimuli (photographs). They suggest that when viewing dynamic displays the viewer has to focus on a greater number of cues and information and the performance of individuals with ABI is affected by their ability to process these cues, impaired information processing speed or working memory deficits. Further, the authors point out that static images allow the viewer to look at a single image for a longer time and do not require the viewer to rely as much on their working memory, therefore they minimise the impact of slowed information processing or attention deficit.

Damage after ABI is diffuse so deficits in facial emotion recognition with vocal content may be due to difficulty processing cues in the visual and/or auditory modality or how the cues in the two modalities are integrated (Madigan, DeLuca, Diamond, Tramontano, & Averill, 2000). Zupan et al. (2009) argue that information from the visual and auditory channels are automatically integrated during the interpretation of emotion. They suggest that when both facial and vocal cues are available, an emotion can be more confidently identified if what is seen and heard are perceived to be consistent with one another (e.g both sad). They argue that perception of emotion is a bimodal process and that social interactions rely on the interpretation and integration of facial and vocal emotion cues. This explains why congruous facial and vocal expressions are easier to understand than incongruent ones (Marquardt et al., 2001). It has been suggested that emotional processing is dependent on emotional control (Pessoa et al., 2002) and that problems in emotional recognition may be due to insufficient resources such as attentional control (Ridout et al., 2007) being available to process all the information.

Williams and Wood (2010a) replicated the study of McDonald and Saunders (2005) to investigate if different media presentation affected emotion recognition. They expected individuals with ABI to find dynamic displays more difficult than static displays, on the basis that audio visual media (dynamic displays) requires the individual to process conversational content as well as emotion and prosody and this is a complex dual processing task which is often impaired after ABI (Williams & Wood, 2010a). Williams and Williams (2010a) asked 64 participants with ABI and matched controls to complete an audio visual test (the EET) and a static photograph test (the Ekman 60 faces test). The study found that the ABI group was significantly impaired on both the audio visual test and the static photographs test compared to the control group. Moreover, it was found that both groups were more accurate in recognising emotions displayed in audio visual format, though the difference was more marked in the ABI group. The authors suggest that this finding may be explained by the fact that the audio-visual test provided more clues than static photographs and these cues help us to recognise emotions. They also point out that the static photographs used in the study were black and white and visually outdated.

Williams and Wood (2010a) concluded from their study that mode of stimulus is an important factor influencing emotion recognition abilities. They suggested that their findings provide evidence that emotion recognition is affected by type of media presentation and that their findings may give support to Adolphs (2002), and Adolphs, Tranel and Damasio (2003) suggestion that different neural pathways process different types of emotional stimuli. Adolphs et al. (2003) suggest that dynamic emotional media is processed by the parietal cortical systems, whereas still emotional media is processed by other neural pathways including the limbic system, bilateral inferior and anterior temporal lobe and medial frontal cortices.

Subsequent research by Zupan and Neumann (2014) supports Williams and Wood's (2010a) finding that individuals with ABI find it easier to recognise emotions from context rich dynamic stimuli than static photographs. The reason may be as Williams and Wood (2010a) suggest, namely that there are more cues available in dynamic stimuli. Further, if visual and auditory information is combined when interpreting emotion (de Gelder & Vroomen, 2000; Zupan et al., 2009) then the more information and cues available the easier it is to recognise the emotion (Williams & Wood, 2010a). However, Zupan et al. (2009) acknowledge that more research is needed on the integration of facial and vocal emotion cues of emotion in static versus dynamic stimuli.

Therefore, the majority of the research comparing emotion recognition of static stimuli and dynamic audio visual stimuli has found that individuals with ABI find dynamic audio visual displays easier.

Valence - Negative and positive emotions

Research suggests that some emotions are generally easier to recognise than others. Happy facial expressions have been found to be identified more accurately, earlier and faster than other facial expressions (Calvo & Lundqvist, 2008). Identification of negative emotions (i.e. sadness, anger, disgust and fear) has been found to be more difficult and slower to recognise after ABI (Adolphs et al., 1999; Calvo & Lundqvist, 2008; Croker & McDonald, 2005; McDonald et al., 2003; Jackson & Moffat, 1987; Williams & Wood, 2010a). Also, research has shown that those with ABI are poorer at judging neutral expressions than matched controls (McDonald et al., 2003). However, whilst there appears to be increased difficulty in identifying neutral items, neutral items are not mistakenly identified as any particular emotion by individuals with ABI (Williams & Wood, 2010a).

Are particular neural structures involved in recognising different emotions and different media?

The fact there is a valence difference has led some to propose that this is because there is independent cognitive processing of specific emotions (Parry, Young, Saul & Moss, 1991). Research findings suggest that particular neural pathways are involved in processing different emotions (Adolphs, 2002; Wang et al., 2002). There is evidence that the amygdala is involved in recognising fear (Adolphs, Baron-Cohen & Tranel, 2002; Calder, Young, Rowland, Perrett, Hodges & Etcoff, 1996; Adolphs, Tranel, Damasio & Damasio, 1994). The amygdala has also been associated with recognising sad expressions (Adolphs & Tranel, 2004). It has been estimated that approximately 50% of patients with amygdala damage have impaired ability to recognise sad facial expressions (Fine & Blair, 2000).

There is also research suggesting that the ventral striatum is involved in recognising anger (Calder, Keane, Lawrence & Manes, 2004). Further, it has been reported that functional neuroimaging demonstrates that the facial expressions associated with disgust engage different regions of the brain (insula and putamen) than other facial expressions (Calder, Keane, Manes, Antoun & Young, 2000; Sprengelmeyer, Young, Calder, Kamat, Lange & Homberg, 1996).

The temporal structures of the brain have been identified as being important in emotion recognition by Rankin, Kramer and Miller, (2005). Facial emotion recognition has been associated with the right superior temporal sulcus and the amygdala and orbitofrontal cortex (Iidaka et al., 2001; Narumoto et al., 2001; Rosen et al., 2002; and Winston et al., 2002). Voice prosody has been associated with the right superior temporal sulcus and the amygdala (Adolphs, 1999; Scott, Morris, Scott & Dolan, 1999, Young & Calder, 1997).

The literature demonstrates that different modes of stimuli affects emotion recognition performance in individuals with ABI (McDonald & Saunders, 2005; Wood & Williams, 2010a, Zupan et al., 2009). Evidence that different neural pathways may be involved in processing different emotions and different modes of stimuli comes from studies involving individuals with brain lesions (Adolphs et al., 2003; Tolmeo et al., 2016; and Wang et al., 2002)

Adolphs et al. (2003) found that a patient who had extensive bilateral brain lesions could only recognise happiness from static images or single verbal labels but could recognise all basic emotions except disgust from dynamic displays and stories. The authors suggest dynamic emotional media may be processed via the parietal cortical systems whereas the limbic system, bilateral inferior and anterior temporal lobe and medial frontal cortices may be involved in processing still emotional media**.**

Wang et al. (2002) in their study of a schizophrenic patient with bilateral anterior cingulate gyrus lesions and a lesion in right amygdala found that this patient was significantly worse at recognising fear compared to three groups of controls (normal control group; brain injured group with lesions that did not include the amygdala, hippocampus or cingulate gyrus and a schizophrenic group). Recognition of the other five basic emotions was not significantly different from that of the controls. The authors concluded that their finding that this patient was worse at identifying fear but not the other basic emotions supports the view that the brain has separable networks for processing different emotions and that the cingulate gyrus and amygdala are involved in the recognition of fear. Moreover, Ridout et al. (2007) reported that patients with lesions to the anterior cingulate cortex (ACC) demonstrated impaired facial emotion recognition performance (as measured by the EET) than those without ACC lesions.

Further evidence comes from the study of Tolomeo et al. (2016). They compared emotion recognition in patients who had treatment resistant depression and who had undergone bilateral anterior cingulotomy, with patients who had treatment resistant depression who had not received surgery and healthy controls. They found that patients who had the surgery were worse at recognising the negative emotions of fear, disgust and anger and had no impairment in recognising the facial expressions of surprise, happy or sadness. They also found that larger volume lesions predicted more impairment in identifying fear, anger and disgust but did not predict identification of happy or surprise. The research findings of Tolomeo et al. (2016) provides some evidence that the anterior mid-cingulate cortex is part of a network associated with the experience of negative emotion and pain and engages cognitive control processes for optimising behaviour in the presence of negative emotion and pain. This finding supports the existing evidence that the anterior cingulate has a causal role in recognising negative emotions.

Taken together these studies have implications for individuals with ABI. They provide evidence that different neural systems are involved in the recognition of different emotions and different types of media. The implication is that in the future it may be possible to identify the type of emotion recognition deficits an individual has from the location or type of injury sustained or the location or type of injury from the emotion recognition deficit.

Subjective emotional experience

Reduced emotional experience has been reported after ABI. Hornak, et al. (1996) obtained self-reports of participants' ability to experience the emotions of sadness, enjoyment, anger, fear and disgust since sustaining their injury. They found that several of the participants with ABI reported blunted affect, particularly for negative emotions such as sadness. In another study investigating subjective emotional experience, Croker and McDonald (2005) found that the majority of participants with ABI reported some change in the post-injury experience of every day emotion, although the pattern of changes differed greatly between individuals. They found that reduced subjective experience, especially of sadness and fear was associated with poor emotion matching but not emotion labelling. Other research has reported that damage to the prefrontal cortex results in a decreased ability to experience one's own emotions and this may make it difficult to perceive emotion in others (Hornak et al, 2003).

Alexithymia

Alexithymia is difficulty differentiating feelings and body sensations and difficulty identifying and describing one's own emotions (Bird & Cook, 2013). Those who have alexithymia usually have externally orientated and concrete style of thinking (Taylor, Bagby & Parker 1997) and tend to reflect less on their emotions as well as others' emotions than those without this trait (Lane et al., 1996).

The incidence of alexithymia in the general population is estimated to be between 10 and 14.8% (Berthoz, Pouga & Wessa, 2010; Koponen, et al., 2005; Wood & Williams, 2010b). The majority of research investigating the relationship between alexithymia and deficits in emotion recognition in neurologically healthy populations has found that there is an association (Lane et al., 1996; Parker, Taylor, & Bagby, 1993; Parker, Prkachin & Prkachin, 2005; Prkachin, Casey & Prkachin, 2009). Alexithymia appears to be a contributor in behavioural and psychiatric disorders including disordered eating, somatoform disorders and depression and anxiety (Connelly & Denney, 2007; Pedrosa-Gil et al., 2008; Ridout, Thom & Wallis, 2010). It has been linked to poor self-awareness (Allerdings & Alfano, 2001), anxiety and depression (Wood, Williams & Kalyani, 2009).

The Toronto Alexithymia Scale (TAS-20; Parker, Taylor & Bagby, 1993) has been used in the ABI literature to measure alexithymia. Using this measure it has been found that there are high levels of acquired alexithymia following ABI (Henry, Phillips, Crawford, Theorodou & Summers, 2006; Koponen et al., 2005; Williams & Wood, 2010b). For example, Williams and Wood (2010b) found that 60.9% of individuals in their ABI group had alexithymia compared to 10.9% in the control group. It has been suggested that what appears to be poor emotion recognition (or empathy) may be due to alexithymia (Bird & Cook, 2013).

There is a paucity of literature looking at the link between alexithymia and emotion recognition problems after ABI (McDonald, Rosenfeld, Henry, Togher & Bornhofen 2011). McDonald et al. (2011) investigated levels of alexithymia (using the TAS-20) and emotion recognition performance on two tasks (matching and labelling photos of the 6 basic emotions) in 20 individuals with ABI and 20 adults without brain injuries. The study found that the association between alexithymia symptoms and emotion perception deficits was generally limited. The only correlation they found between alexithymia and emotion perception in the ABI group was between the labelling of positive emotions and the TAS-20 (measure of alexithymia) subscale "Externally Orientated Thinking". The authors reported that this was surprising because most of the participants including the ABI participants in the study found the positive emotions easy. Consistent with existing research (such as Henry et al., 2006; Kopenen et al., 2005; Williams & Wood, 2010b), the study found that the ABI participants had a higher incidence of alexithymia and were more impaired in the recognition of negative emotions than the neurologically healthy controls, but that these scores were not associated with the TAS-20 scores. The findings led the authors to conclude that deficits in emotion recognition in ABI are not part of a broader disorder of acquired alexithymia as measured by the TAS-20.

One of the most recent studies to look at the relationship between alexithymia and emotion recognition problems in people with ABI was conducted by Neumann, Zupan, Malec and Hammond (2014). In this study 60 individuals with ABI and 60 age and gender matched controls were evaluated for alexithymia (using the TAS-20); facial and vocal emotion recognition using Diagnostic Assessment of Non-verbal Accuracy 2- Adult Faces and Voices (DANVA2-Faces; Norwicki & Duke, 1994); and empathy using the Interpersonal Reactivity Index (IRI; Davis1980). The study found that the participants with ABI had significantly higher alexithymia; poorer facial and vocal emotion recognition; and lower empathy scores. For the ABI participants, facial and vocal emotion recognition variances were significantly explained by alexithymia (12% and 8%, respectively); however, the majority of the variances were accounted for by one of the subscales of the TAS-20, externally-oriented thinking. The authors concluded that people who have a tendency to avoid thinking about emotions (externally-oriented thinking) are more likely to have problems recognizing others' emotions and assuming others' points of view.

Other studies using the TAS-20 with ABI populations (Henry et al., 2006; Wood & Williams 2007; Wood, Williams & Kalyani, 2009) suggest that alexithymia and emotion recognition are associated. It has been suggested that acquired alexithymia in ABI is a generalised deficit in processing emotional stimuli which includes emotion recognition problems (Wood & Williams, 2007). Further, there is evidence that acquired alexithymia in individuals with ABI may be linked to the development of somatoform disorders and poor self-awareness (Allerdings & Alfano, 2001; Wood, Williams & Kalyani, 2009).

However, the use of the TAS-20 with its three subscales has not been properly investigated in ABI samples (Wood et al., 2009) and the reliability of the TAS-20 subscales in the ABI population has been questioned by some including Henry et al., (2006); and McDonald et al. (2011). Poor verbal skills, and memory problems have been found to contribute to being assessed as having alexithymia as measured by the TAS-20 (Wood & Williams, 2007). Further, the TAS-20 is a self-report measure and is therefore vulnerable to the influence of other variables such as subjective ratings of emotional experience, self-perception, affective disorders and lack of self-awareness (Testa et al., 2006; Wood et al., 2009) which are known to be present after ABI (Croker & McDonald, 2005; Hornak et al., 1996).

Alexithymia and its possible role in emotion recognition problems is mentioned in this chapter for completeness. Alexithymia was not measured in the current study for a number of reasons. Firstly, there are questions about the use of the TAS-20 in ABI samples (Henry et al., 2006; McDonald et al., 2011. Wood et al., 2009). Further investigations are needed to ascertain its appropriateness in measuring alexithymia in ABI population. Further, the main aims of the current study were to develop a screening test of emotion recognition, generate normative data from an age stratified sample and compare the performance of neurologically healthy participants with a sample of individuals with ABI. It is acknowledged that in any research project there are limitations on what can be investigated and the author recognises that further research investigating the role of alexithymia (and other factors such as executive function and affect) in emotion recognition would be beneficial. This is discussed in more detail in the discussion chapter of this thesis.

1.3 Theory of emotion recognition

Research has therefore established that emotion recognition difficulties after ABI often exist and negative emotions like fear, anger, disgust and sadness are more difficult to recognise than positive emotions such as happiness. Moreover, research findings report that emotion recognition is variable according to the location of the ABI (Calder et al., 1996; Hornak et al., 2003; Wang et al., 2002) and the media being used (Knox & Douglas, 2009; McDonald & Saunders, 2005; Wood & Williams, 2010a).

How do we recognise emotions? One theory is that we use mirror neurons. A mirror neuron is a neuron that fires both when an animal acts and when the animal observes the same action performed by another (Rizzolatti & Craighero, 2004). Brain imaging research has demonstrated that neurons show activity during the execution and also the observation of an action (Rizzolatti, Fogassi & Gallesse, 2001). In humans, brain activity consistent with that of mirror neurons has been found in the premotor cortex, the supplementary motor area, the primary somatosensory cortex and the inferior parietal cortex (Molenberghs, Cunnington & Mattingley, 2009). Levenson and Ruef (1992), have called this "shared physiology". Psychologists sometimes refer to this as "emotional contagion" (Hatfield, Cacioppo & Rapson, 1994), "affective empathy" (Zahn-Waxler, Robinson & Emde, 1992) and "automatic emotional empathy" (Hodges & Wegner, 1997).

Gallesse (2001) in his "shared manifold" hypothesis of emotion recognition suggests that recognising emotions is not exclusively dependent upon visual abilities or the capacity to represent the mental states of self and others which is often referred to as the ability to mentalize (Frith & Frith, 2003) or "theory of mind" (Baron-Cohen, 1995). According to this theory the same neural structures that are involved in processing and controlling actions, felt sensations and emotions are also active when the actions, sensations and emotions are detected in others (Gallesse, 2003). Thus, when we observe a particular emotional expression our motor system becomes active and "resonates" with that emotion as if we were feeling the same emotion. Gallesse (2003) suggests that it is through this "shared manifold" that intersubjective communication and ability to understand others is possible. According to Gallesse (2001), action observation implies action stimulation. He points to the everyday occurrences of observing others yawning or laughing which result in us performing the same action as evidence of this.

According to Gallesse (2001), our felt capacity to have relationships with others and how we "mirror" ourselves in the behaviour of others and recognise them as similar to us are rooted in empathy and it is empathy that enables us to generate a link between ourselves and others and have meaningful relationships. According to this theory emotions experienced by others become meaningful to us because we can share them with them. We understand the emotions of others through a mirror matching mechanism.

Radice-Neumann at al. (2007) rely on similar presumptions in their two stage theory of facial emotion recognition. They suggest that the first stage involves an individual correctly recognising the relevant facial features that depict the emotion (Tarr & Gauthier, 2000; Haxby, Hoffman & Gobbini, 2000). The second stage requires the individual to correctly interpret his or her own emotional state (Adolphs, Damasio, Tranel, Cooper & Damasio, 2000; Hornak et al., 2003). Thus, the second part of facial emotion recognition is self-emotion processing which involves the interpretation of one's own emotional state to facilitate the identification of the feelings of others (Adolphs, 2002; Adolphs Damasio, Tranel, Cooper & Damasio, 2000). Damasio (1999) suggests that one of the mechanisms which enables us to feel emotion is the activation of neural "as if body loops".

The idea that the perception of someone's emotional state activates the observer's corresponding representations which in turn activate somatic and autonomic responses (Blair, 2005) has some evidence to support it. It has been reported that when someone is impaired recognising a particular emotion they are also impaired in subjectively experiencing that emotion (Calder et al., 1996). Further, there are studies that have reported evidence supporting "mirroring" of facial emotions and how this ability is sometimes not seen in those with ABI (Knox and Douglas, 2009; McDonald et al., 2011).

However, some neuroscientists, for example Hickok (2008) argue that whilst mirror neuron theories are interesting and on the face of it are a reasonable idea, there is a lack of empirical evidence to support them. Hickok (2008) points out that the studies by Rizzolati et al. (2001; 2004) were based on motor responses in monkeys and that to extend this work to emotions in humans is overgeneralising. What is clear is that more research is needed to better understand mirror neurons and the role they play in humans and emotion recognition.

The new screening measure of emotion recognition deficits developed in the current study will add to the debate about how we recognise emotions. It could be used to screen for emotion recognition problems whilst investigating through measurement of physiological responding and neuroimaging (for example using Magnetic Resonance Imaging (MRI) and functional Magnetic Resonance Imaging (fMRI)), whether the same neural structures that are involved in controlling actions, sensations and emotions are also active when the actions sensations and emotions are detected in others as suggested by Gallesse (2003). In other words, the new screening measure could be useful in investigating evidence of associations between emotional recognition problems neural structures involved in emotion recognition and motor or physiological responding to emotional stimuli. The current research findings on physiological responding to emotional stimuli is now discussed.

Physiological responses to emotional stimuli

Physiological emotional under-arousal has been reported in individuals with mild head injury (Baker & Good, 2014). Hopkins, Dywan and Segalowitz (2002) measured the electro dermal activity (EDA) of a group of participants with ABI and matched controls when presented with faces that varied in emotional expression found that the ABI group failed to increase EDA in response to negative facial expressions and had a reduced ability to identify negative emotions particularly fear compared to the matched controls. De Sousa et al. (2011) measured physiological responding using facial electromyography (EMG) and skin conductance using finger electrodes. They reported that there was reduced physiological responses to the emotional expression of anger in their ABI injury group compared to the control group.

In a study investigating startle response, Williams and Wood (2012) measured EMG activity and the eye blink component of startle reflex recorded electromyographically from the orbicularis oculi muscle beneath the left eye. Eye blink amplitude and latency were computer scored using a commercial startle system (SR-HLAB San Diego Instruments, CA). The performance of individuals with ABI and matched controls, was compared. It was found that the ABI group produced the usual attenuation responses of startle response to pleasant pictures but a significantly lower startle response to unpleasant pictures and also rated the unpleasant pictures as less arousing that the control group. Measures of attention and information processing speed were also taken, though some of this data was incomplete. The authors concluded that unpleasant stimuli failed to arouse an aversive emotional reaction in individuals with

ABI and suggest that ABI may disrupt the neural pathways and structures which are involved in the aversive-defensive motivational system. They also argue that their findings support the conclusion offered by Saunders, McDonald and Richardson (2006) that there is a reduction in emotional responsiveness following ABI and not attention or information processing.

Together, the research on physiological responding provides evidence that physiological responding to emotional stimuli is affected by ABI and negative emotions seem to be particularly affected. The evidence suggests that some people with ABI may process negative emotions differently to people who do not have an ABI. The current study will contribute to the literature in this area by providing a quick and easy to administer stimuli that will enable deficits in emotion recognition whilst simultaneously measuring physiological responses.

1.4 Empathy and emotion recognition

According to Grattan and Eslinger (1989) empathy “refers to the capacity to apprehend another person’s situation or state of mind in such a way that there is a potential for sharing and increased understanding through an interpersonal relationship” (p.176). The ability to recognise and understand emotions is part of empathy, and difficulties recognising emotions are likely to interfere with a person’s ability to interpret how others are feeling, in other words their ability to empathise (Grattan & Eslinger, 1989).

Empathy is commonly understood to have two components (Baron-Cohen, 1995; Davis, 1980). One of the components is understanding the feelings of others. This is commonly known as cognitive empathy and is understood to denote the ability to recognise the mental state of another person and the ability to take the mental perspective of another person, allowing one to make inferences about their mental or emotional states i.e. understand other people. Cognitive empathy is thought to involve perspective taking and theory of mind (Eslinger, 1998).

The second component of empathy is sharing the feelings of others which is commonly known as affective or emotional empathy (Baron-Cohen, 1995). Emotional empathy is the capacity to experience affective reactions to the observed experiences of others, it is our emotional reactions to people (Baron-Cohen, 1995, Davis, 1980, Shamay-Tsoory, 2011). It is the ability to emotionally resonate with others' feelings while understanding that they are distinct from one's own (Baron-Cohen & Wheelwright, 2004). Emotional empathy is generally thought to be an unconscious process involving the sharing of emotions, affective responsiveness and emotional contagion.

The key difference between cognitive and emotional empathy is that the former involves understanding the other person's point of view, whereas emotional empathy includes sharing or experiencing the other person's feelings (Mehrabian & Epstein, 1972). The ability to recognise emotions is often seen as a precursor for empathy (Shamay-Tsoory, Tomer, Berger & Aharon-Peretz, 2003). Evidence of a relationship between emotion recognition and empathy in neurologically healthy individuals exists (Lawrence et al., 2006).

Theories of empathy have many similarities to the theories of emotion recognition mentioned above. Preston and de Waal's (2002) theory of empathy is based on a perception-action model. According to this model, perceiving another in a given situation automatically results in matching the other's neural state because perception and action rely on the same neural circuits. The perception of an object's state activates the subject's corresponding representations which in turn activate somatic and autonomic responses which results in the person feeling something like what the other person feels and enables the person to understand the other person's internal state (Preston & de Waal, 2002).

Feshbach (1987) suggests that empathy involves 3 processes. The first process is cognitive and is the ability to recognise the emotions in others; the second process is also a cognitive one and involves the person assuming the perspective and role of another person. The third process involves emotional responsiveness. Feshbach (1987) argues that "empathy is conceived to be the outcome of cognitive and affective processes that operate conjointly" (p.273).

It has been suggested that as well as being a form of empathy in its own right, the ability to recognise the mental state of another is necessary for empathy to occur (Batson, Fultz & Schoenrade 1987). The basis of this is that perceiving the internal mental state of another is presumed to act as a stimulus to activate an empathic response (Batson et al., 1987); to be empathic requires being able to recognise the emotions of others and respond appropriately. Milders et al. (2003) suggest that if the neurological structures associated with emotion recognition are impaired by ABI, it is likely that these individuals will have difficulty showing empathy and may not respond empathically to the emotional needs of others. They suggest that individuals who have impaired emotion recognition are likely to be unable to show empathy and may be seen as indifferent to the emotional needs of others.

The research literature on empathy impairments after ABI is fairly limited. However, those that do exist suggest that such impairments are not uncommon. Indeed research suggests that up to 60-70% of adults with ABI self-report little to no emotional empathy compared to 30% of matched controls, (de Sousa, McDonald & Rushby, 2012; de Sousa et al., 2010, 2011, Wood & Williams, 2008; Williams & Wood 2010a).

Poor empathic skills have been found to be widespread in individuals with ABI, and lack of empathy on the part of the individual with ABI to express their appreciation of the caregiver's stress has been related to a reduction in life satisfaction in caregivers (Wells, Dywan & Dumas, 2005). Moreover, individuals with ABI who have behavioural changes have been found to have lower empathy as measured by the Empathy Measure (Hogan, 1969) than neurologically healthy controls (Grattan & Eslinger, 1989).

Interestingly, Wood and Williams (2008) found there was no association between severity of ABI and emotional empathy which suggests that emotional empathy may be processed in a way that is relatively independent of cognitive deficits.

The link between emotion recognition and empathy in the ABI population is further established by MRI and fMRI studies which suggest that the processes involved in empathy are mediated by structures that have been shown to be involved in emotion recognition, namely those located in the dorsolateral prefrontal lobe, orbitofrontal cortex, amygdala and periamygdala structures and anterior temporal lobe structures (Rankin, Kramer & Millar, 2005).

Several studies by de Sousa (2010; 2011 and 2012) have investigated the relationship between self-reported emotional empathy, cognitive empathy and physiological responding. This research has provided further support that individuals with ABI have lower empathy as measured by the Balanced Emotional Empathy Scale (BEES; Mehrabian, 2000) and Inter Reactivity Index (IRI; Davis, 1980) than matched controls and also have less emotional reactivity (as measured by facial EMG activity according to the guidelines of Fridland & Cacioppo, 1986) to facial expressions than matched controls (de Sousa et al., 2010).

To summarise, there is a link between emotion recognition and empathy. Research has found that deficits in empathic functioning are a frequent legacy of ABI (Wood & Williams, 2008; Williams & Wood, 2010a) and there is evidence that deficits in empathy are associated with behavioural changes (Grattan & Eslinger, 1989). It has been suggested that empathy deficits may underpin some of the neuro-behavioural disorders associated with brain injury (Wood & Williams, 2008) and affect the ability of people who have an ABI to understand others and maintain satisfying social relationships.

1.5 Existing emotion recognition tests

Until recently studies investigating emotion recognition impairments after ABI used static photographs of actors portraying the six standard emotions of happy, sad, fear, disgust, anger and surprise (Ekman & Friesen, 1976). The EET (McDonald et al., 2003) was one of the first developed measures to use dynamic audio visual stimuli. It has the advantage of using stimuli which are more ecological, include spontaneous expressions as stimuli and combine visual and auditory social cues (McDonald et al., 2003). However, the EET is only one part of the TASIT. The TASIT was designed primarily to be a test of social inference not emotion recognition. Whilst the EET, with its dynamic displays of emotion was a step forward in measuring emotion recognition difficulties, it has some practical limitations. It is now visually outdated and is time consuming to complete making it impractical for many clinicians and individuals with ABI to use especially those individuals in the early stages after ABI who often have limited attention and concentration (Cattran, Oddy, da Silva Ramos, Goodson & Wood, 2018). Performance on the EET is likely to be affected by problems with information processing and working memory (Cattran et al., 2018) which limits its usefulness with individuals who have significant deficits in these domains. Another limitation is how the EET is administered. After each video clips is viewed, the viewer or someone on behalf of the viewer is required to enter the viewer's response on a paper record and calculate correct number of responses at the end of the test. An online test would be far easier to administer and results would be available automatically and not need to be manually calculated.

A more recently developed test is the Emotion Recognition Task (ERT) developed by Kessels et al. (2014). This involves the viewer watching morphed faces of facial features of individuals portraying one of the six standard emotions. The test is particularly interested in levels of emotional intensity, hence the use of morphing images and the images are displayed for a short period of time. This test is therefore different to real life dynamic images.

Another emotion recognition test using dynamic stimuli is the Geneva Emotion Recognition Test (GERT; Schlegel, Grandjean & Scherer, 2014). In this test 14 emotions (anger, pride, joy, amusement, pleasure, relief, interest, surprise, anxiety, fear, despair, sadness, disgust, irritation) are portrayed dynamically by 10 actors in 83 short video clips with audio. Whilst the dynamic audio-visual displays are more ecological, the use of so many emotions makes identifying the emotions difficult and the 14 emotions are not recognised in other research and are not widely agreed to be universal across cultures, unlike the 6 emotions identified by Ekman and Friesen (1971).

The most recently developed measure of emotion recognition is the Complex Audio-Visual Emotion Assessment Task (CAVEAT; Rosenberg et al., 2016). In this recent study 32 ABI participants and 32 matched controls were shown 38 video clips of actors portraying 22 emotions (11 positive and 11 negative and asked to choose the emotion the actor was feeling from a list. Construct validity was assessed by administering the task alongside other measures of social cognition including the EET (TASIT: McDonald et al,. 2003); Reading the Mind in the Eyes Test (RMET; Baron-Cohen, Wheelwright, Hill, Raste & Plumb, 2001); a measure of emotional empathy, the Balanced Emotional Empathy Scale (BEES; Mehrabian, 2000); and a self-report questionnaire assessing Alexithymia (the difficulty of identifying and describing feelings) called the Toronto Alexithymia Scale (TAS-20; Bagby, Parker & Taylor, 1994). They also used a number of neuropsychological measures including the Depression Anxiety and Stress Scale (DASS-21; Lovibond & Lovibond, 1995) which is a measure of emotional functioning with established psychometric qualities (Brown, Chorpita, Korotitsch & Barlow, 1997; Henry & Crawford, 2005). It was found that the CAVEAT was associated with all of these measures. However, a major shortcoming of this study is that it did not use the six standard emotions commonly used in other emotion recognition research. This means it is difficult to compare it to other emotion recognition research. To perhaps rectify this, the authors (Rosenberg et al., 2016) carried out a second study. In study two, a subset of video clips from the CAVEAT which was limited to the six standard emotions (happy, sad, angry, fear, surprise and disgust) were shown to 16 participants with ABI and 12 neurologically healthy participants. In study two the findings indicated that the ABI group performed worse than the control group in recognising the six emotions. However, these differences were reported as "trends" rather than statistically significant differences.

The full CAVEAT is very time consuming to complete. Further, asking viewers to identify an emotion from a list of 22 emotions makes it complex and confusing. Even the shortened version of the CAVEAT takes 20 minutes to complete and whilst there were trends in the ABI sample performing worse than the control group some of the emotions had quite similar percentages e.g. surprise and happy in both groups. Perhaps the two main limitations of the study as acknowledged by Rosenberg et al. (2016) themselves is that more research is needed to obtain normative data and test retest data needs to be obtained.

Measures of empathy

It is worth mentioning at this stage that the current measures of empathy are self-report measures. Whilst on the face of it simple to use, they have limitations including the ability of some of those with ABI to properly understand and complete them. Also, the usefulness of using self-reports of individuals with ABI may be compromised due to deficits with awareness (Douglas, O'Flaherty, & Snow, 2000). Further, these measures of empathy are measures of day to day empathy. Empathy is likely to play a role in emotion recognition and therefore it is important to investigate how the two things are related.

1.6 Rationale and aims of research

1.6.1 Relevance to counselling psychology

Counselling psychology considers how people relate with one another, how they think, feel and behave. It is interested in peoples' relationships and how individuals function in their everyday lives. A key aim of counselling psychology is to reduce psychological distress and promote the well-being of individuals, groups and families.

A significant number of individuals who have an ABI suffer with anxiety and depression and there is evidence that the percentage of people suffering may be as high as 50% (Ponsford, Olver, Ponsford and Nelms, 2002). Further, it has been reported that 25-

30% of relatives also have anxiety and depression with 60-80% reporting some emotional distress (Kreutzer et al., 1994; Livingston et al., 1985). In view of the significant number of people who have ABI (NICE 2014; Clinical Guidance 176), and the high rates of affective disorder and psychological distress in this population group it is likely that counselling psychologists will come in to contact and work with individuals with ABI and their families.

Being able to identify when people have problems in emotion recognition is important because difficulties interpreting how others are feeling is likely to be related to the communication problems and social difficulties that they are experiencing (Radice-Neumann et al., 2007). Emotion recognition problems affect the stability of relationships and are known to be related to social behaviour particularly the ability to communicate with others (Watts & Douglas, 2006); participate in social activities (Knox & Douglas, 2009) and social inclusion (May et al., 2017). We know that changes in social behaviour after ABI such as lack of concern for others, self-centredness, irritability (Williams & Wood, 2010; Wood & Yurdakul, 1997) are often more difficult for families to deal with than physical or cognitive changes (Brooks et al.,1986; Katsifaraki & Wood, 2014).

It is important to identify emotion recognition impairments because these problems can threaten the stability of relationships (Watts & Douglas, 2006). Often the patient's family is the main emotional and social support available and maintaining this support enables many patients with ABI to function (Wood et al., 2005). When close relationships break down, often the injured person struggles to function and can end up in residential care (Wood at al., 2005). The ability of family members to adjust after ABI depends to a large extent on how predictable the behaviour of the ABI person will be in different situations (Wood et al., 2005). Accordingly, the better we are at identifying and understanding emotion recognition impairments (and other neuro-behavioural characteristics) the better we will become at helping individuals and their families.

1.6.2 Reasons why a new screening measure of emotion recognition is needed

Currently, there are few assessment tools that directly assess neuropsychological disorders in the social and interpersonal sphere of ABI (McDonald et al., 2004) even though changes in social relationships are common (Ponsford et al., 1995) and one of the most distressing and disabling aspects of ABI (Brooks et al., 1986). Non-cognitive neuro-behavioural (NCNB) changes include increased impulsive and disinhibited behaviour along with lowered motivation and impaired emotional regulation and social perceptual abilities including emotion recognition problems (Cattran, Oddy, Wood & Moir, 2011). The term 'personality change' is commonly used to describe such changes, as family members in particular often perceive them as giving rise to a change in the person. There is a lack of literature looking at NCNB sequelae after ABI (Cattran et. al., 2011). Cattran et al. (2011) and Silver et al. (2011) report that efforts to objectively quantify NCNB changes which include facial emotion recognition problems in individuals following brain injury have been hampered by a lack of short, valid and reliable measures that have been designed for use with this population. As the prevalence of emotion recognition impairments after ABI is estimated to be between 13-39% it should be screened for (Babbage et al., 2011).

We know that problems with emotion recognition and expression can have an adverse impact on inter-personal relationships and affect outcome (Wood & Williams, 2008). However, despite the evidence that it adversely affects social functioning (Knox & Douglas, 2009; McDonald & Flanagan, 2004; McDonald & Saunders, 2005; Radice-

Neumann et al., 2007; Rosenberg, et al., 2016) and affect post-injury behaviour (May et al., 2017), currently emotion recognition is not the focus of most neuropsychological examinations. An exception is Cambridge Cognition (CANTAB) who now include in their cognitive test the ERT (Kessels et al., 2014) which is a morphing images emotion recognition task focusing on emotional intensity (discussed above).

The extent of emotion recognition problems is variable (Bornhofen & McDonald, 2008). It can be found in mild and moderate brain injuries, in other words, it is not limited to severe brain injuries (Kubu, 1999). Also, the actual emotion perception deficits also vary (McDonald & Saunders, 2005). This may be due to the different pathology of brain injury as well as the impact of other cognitive deficits that are present **(**Allerdings & Alfano, 2006**).** To be able to determine the impact of a particular psycho-social problem like emotion recognition impairment a screening test to measure the impairment is needed (Wood & Williams, 2008). The current study is important because it will enable emotion recognition problems to be screened for.

The new screening measure developed in the current research is important and will add benefit by enabling emotion recognition problems to be screened for more easily. Having such a screening measure available will be beneficial in the assessment and treatment of emotion recognition problems. Identification of emotion recognition problems will benefit individuals with ABI and their families because it will mean that problems can be identified and consequently, better understood and managed. Better informed rehabilitation has the potential of improving relationships and decreasing the problems of loneliness and sense of isolation that often exist after ABI. Moreover, improved understanding and support is likely to reduce the likelihood of the development of affective disorders in those with ABI and their families and improve outcomes (Wood et al., 2005). Improved psychosocial support is likely to be very cost effective both in financial and personal terms (Humphreys, Wood, Phillips & Macy, 2013).

The new screening measure will have significant implications for treatment planning. Rehabilitation therapists can develop treatment interventions to help families and others working with individuals with ABI to learn appropriate ways of coping with these problems (Wood et al., 2005). This may include helping family members to make clear statements and their emotional meaning as clear as possible (Marquardt et al., 2001).

To summarise, the development of a quick and easy to administer online screening measure of emotion recognition problems in individuals with ABI has been identified. A more clinically useful measure than those that currently exist is needed. It will be of benefit to counselling psychologists and others working with individuals with ABI and their families. It will be of benefit in screening for problems during assessment and could be used in rehabilitation and as an outcome measure.

The aims of this pilot study were:

1. To develop a short simple valid and reliable screening instrument to use in clinical, research and rehabilitation contexts for detection of emotion recognition problems using contemporary stimulus items.
2. The new screening test would consist of short video clips of actors portraying the six standard emotions and neutral. There would be two parts to the test. One part would screen for deficits recognising facial expressions (no vocal cues) and the second part would screen for deficits recognising emotions expressed facially with vocal cues.

3. To generate normative data from an age stratified sample of neurologically healthy participants and compare the performance of the neurologically healthy participants with a sample of participants with ABI.
4. To explore whether performance on the new test instrument had any association with general intelligence, gender, education or age. It would have been interesting to investigate other factors that may influence emotion recognition such as depression, anxiety, alexithymia and cognitive function. However, it was not practicable to investigate all of these factors in the current study because of time and resource constraints. Moreover, the author did not want to put excessive demands on the participants taking part in the study. The aim of this study was to develop a new screening measure of emotion recognition problems and it was anticipated that its findings would identify areas where further future investigations would be useful.

It was hypothesised that:

1. There would be test retest reliability. There would be a significant correlation between scores on first and second administration.
2. Performance on the new test would be correlated with performance recognising emotions measured by an existing emotion recognition scale (EET) which will confirm criterion validity.

3. Performance on the BERT would be significantly positively correlated with the ability to empathise measured by scores on two existing empathy rating scales (BEES and IRI).

4. Performance of the ABI participants on the BERT and EET would be worse than the performance of the neurologically healthy participants.
5. Performance would be improved in both groups in the second part of the new test ("with phrase" BERT), which provides more cues (facial expression and vocal cues), and there would be smaller group differences for the "with phrase" BERT than the "no phrase" BERT.

6. It would be possible to calculate clinical cut off scores from this study. Published tests such as the Test of Everyday Attention (TEA: Robertson, Ward, Ridgeway & Nimmo-Smith, 1996) have calculated cut off scores from one study.

Chapter 2: Methodology

2.1 Introduction

The rationale, aims and hypotheses central to the study are set out in the previous chapter at section 1.6. This chapter sets out how the aims were achieved.

2.2 Methodology

A key aim of the study was to develop a new screening instrument that would be quick and simple to administer. To achieve this it was decided that the BERT would be an online test. It was decided that all of the tests and measures used in the study would be administered online. This enabled participants to complete the tests involved in the study at a place and time that was most convenient to them and allow for recruitment of participants who were geographically dispersed. Online administration also enabled the data in the study to be collected easily and in a structured way which made analysis more straight forward.

2.3 Recruitment

Neurologically healthy adults – normative sample/control group

A key component of the study was to recruit neurologically healthy adult participants – the normative sample/control group.

This group was made up of community volunteers and staff working at the University of the West of England (UWE). An advert (see copy in Appendix 1) was placed in UWE's online staff magazine and adverts were placed on the social media Facebook and in community group settings (see copy in Appendix 2). To ensure there was an age stratified sample, participants were recruited in the following age bands; 18-34yrs; 35-49 yrs.; 50-64yrs and 65-80yrs.

Participants who were interested in taking part contacted the researcher by email. The participant was sent a copy of Participant Information Sheet A (Appendix 3) by email and asked to read this carefully. The participant contacted the researcher if he or she wanted to take part. On receiving this confirmation the researcher sent the participant an email with a PDF attachment (Appendix 4) which contained instructions about the test. The participant completed the test online using the information contained in the instructions. In order to obtain test retest data the participants completed the BERT (but not the other measures) again at least one week later. An email was sent to the participants reminding them to complete the BERT again one week after the first administration (Appendix 5). After completing the BERT for a second time an automatically generated email was sent to the participant providing them with details of a £10 voucher code to thank them for taking part in the study.

Inclusion criteria: Participants had to self-report that they were English speaking (in order that they could understand tasks and instructions which were written in English). They also had to self-report that they were over 18 years of age, had no history of psychiatric or developmental disorder or problems with their sight or hearing which would make it difficult to complete tasks on a computer.

Details of neurologically healthy controls recruited

Demographic details of the neurologically healthy participants are contained in table 3 (page 73). Ninety-two neurologically healthy participants (42 males and 50 females) were recruited. This sample size was sufficient because it provided sufficient power to show medium effect sizes in the planned analyses and enabled enough participants in each of the four age bands. The power calculation was done retrospectively by a colleague with statistical expertise. Please see email from statistician Paul White in Appendix 6. He ran a simulation model (Chow, Shao & Wang, 2003) and used this with the achieved sample sizes and observed p values. After adjusting to estimate the lower bound of power, the estimated power was calculated to be 85%.

The age range for participants was 20 to 80 years old, with a mean average age of 47.4 years (*SD* 15.4). Most (96.7%) had some educational qualifications with nearly three quarters (73.9%) having a degree or postgraduate qualifications. Three participants had no formal qualifications. Number of years of education for the control participants was on average 15.58 years (*SD* 2.34) as detailed in table 3 (page 73).

At the time of study, 87% of control participants were in employment and 13% were retired. The control participants were employed in occupations ranging from senior managerial/professional (n=12); intermediate managerial/administrative/ professional (n=36); junior managerial/administrative/professional (n=28); semi-skilled manual (n=4); and retired (n= 12).

Estimates of intellectual ability were determined by control participants completing the Spot the Word, second edition (STW2; Baddeley & Crawford, 2012). The STW2 scores (mean = 93.97; *SD* = 4.80) equate to a mean estimated IQ for the control group of 118. An IQ score of between 85 and 115 is generally considered to be average (this assumes a standard deviation of 15). Most people have an IQ of score of between 95 and 105. Thus the estimated IQ score of 118 for the control group suggests that the intellectual ability of this group is above average.

ABI sample

The ABI adult participants were recruited through three Headway centres in the southwest of England. Headway is the UK-wide registered charity that works to improve life after brain injury. It has a network of more than 125 groups and branches across the UK and provides support, services and information to people who have had a brain injury, their families and carers, as well as to professionals in the health and legal fields. Three Headway centres were approached by the researcher. These were: Headway Bedford; Headway Somerset; and Headway Swindon.

After ethical approval had been granted (see ethics section below) the researcher visited the Headway centres to talk to prospective participants and Headway staff about the study. Each Headway centre identified a member of staff who would liaise with the researcher and support the study. This person was responsible for identifying ABI participants who satisfied the inclusion criteria, and deal with administrative matters such as giving out participant information sheets.

Inclusion criteria**:** The inclusion criteria for the ABI participants was the same as for the neurologically healthy control group. In addition they had to have an ABI and be able to give informed consent to take part in the study (see section on Ethics below for details).

A Participant Information Sheet B (see Appendix 7) was given to prospective participants by the Headway centres. Prospective participants informed their Headway centre if they were interested in taking part in the study. They were given a consent form (see Appendix 8) to read. Once a participant had confirmed their wish to take part in the study, a mutually convenient time was arranged for the researcher to visit the participant at their Headway centre. The researcher was available whilst the ABI participants completed the tests that made up the study. The ABI participants could also complete the test at home or at a different place and time if they preferred.

One week after the first administration of the test the ABI participants were asked to complete the BERT again. The researcher was available whilst the participants completed the BERT for a second time. After completing the BERT twice the ABI participants were provided with a £10 voucher to thank them for taking part.

Details of ABI sample recruited

Twenty participants (10 males and 10 females) who had sustained moderate to severe ABI were recruited. Five were recruited from Headway Somerset; seven from Headway Swindon and eight from Headway Bedford. ABI participants were aged between 25 to 80 years (mean age 50.7 years; *SD* 13.3). 14 participants (70%) had post trauma amnesia (PTA) or loss of consciousness (LOC) of more than 24 hours indicating ‘severe’ brain injury and five participants (25%) had PTA or LOC between 1-24 hours indicating ‘moderate’ brain injury. Information on PTA and LOC for one participant was not available.

The majority of ABI participants (60%) had had a stroke or brain haemorrhage, 25% had sustained traumatic brain injury as a result of road traffic accidents or physical assault, and 10% had had aneurysms and one person a brain tumour.

Participants sustained ABI an average of 14.1 years previously (*SD* = 14.5 years, range 11 months – 48 years).

Thirty percent of ABI participants had no educational qualifications; the remainder had secondary school or vocational qualifications. One participant had a university degree.

Seventy five percent of ABI participants had been in employment at the time of ABI in a range of skilled, semi-skilled and management roles. One was in full time education and two were retired. It was not possible to determine occupational status of two participants.

The number of years of education for the ABI participants was on average 11.55 years (*SD* 2.04) and is presented in table 3 (page 73).

STW2 was completed by 75% of ABI participants, resulting in a mean estimate of premorbid intellectual ability of 107 for the group as a whole. This estimate suggests that the premorbid intellectual ability of the ABI group was average as it falls within the range of 85-115 which is generally accepted to be average. However, it is lower than the estimated IQ of the control group which was 118 which is above average.

All participants were informed of the study procedures and gave consent to take part in the study.

Summary of the groups' characteristics

The groups were matched on age and gender. They differed on IQ, number of years of education and occupational background. The control group was higher than the ABI group in these categories. Details of the groups' characteristics are presented in table 3 of the Results chapter (page 73) and demographic details are contained in Appendices 12 and 13.

2.4 Ethical Practice

ABI participants – obtaining informed consent

Before any of the ABI participants could take part in the study, steps were taken to ensure that the participant could give informed consent. The staff working at the Headway centres were asked to make sure that information about the study was only given to participants who could give informed consent. Each centre was instructed by the researcher that in cases where there was any doubt or uncertainty that a person was able to give informed consent then that person should be excluded from the study. The researcher was fortunate to have the guidance and support of her supervisor, Professor Nick Alderman and her Director of Studies, Dr Tony Ward to advise on the issue of informed consent. The researcher expected all ABI participants to be able to understand the purpose, the procedures, the potential risks and benefits of taking part and that they understood that participation was voluntary. The researcher expected participants to talk lucidly about the study, ask questions and confirm they were happy to take part.

Ethical approval

The study and its procedures were approved by the National Health Service National Research Ethics Service (NRES) Committee South West - Frenchay Research Ethics Committee (reference 15/SW/0229) and UWE Research Ethics Committee (reference HAS/14/03/64). The study was carried out in accordance with the British Psychological Society's (BPS's) Codes of Ethics (2009); the BPS's Ethical Guidelines (2014); and BPS's Code of Human Research (2010).

All participants were informed of the study procedures, what their participation in the study would entail and gave consent to take part in the study. The study involved vulnerable participants and accordingly specific measures were taken as outlined below:

- Prospective participants were informed that taking part in the study was voluntary.
- Participants were informed they could withdraw from the study without giving a reason at any time until the research report of the study had been submitted for assessment or publication by contacting the researcher.
- Prospective participants were given a detailed participant information sheet which gave information about the study; what would be involved if they decided to take part; researcher and supervisor contact details; and advised that information provided would be kept confidentially.
- As discussed above, fully informed consent was sought from all the ABI participants. The Headway centres were specifically asked to ensure that any prospective participants they identified were able to give informed consent.
- It was made clear to the participants that the tasks they would complete were for a research study and their personal performance on the tasks would not be disclosed to them.

All data collected has been kept confidentially with only the researcher, her director of studies and supervisor having access to the raw data which has been stored securely in password protected files in accordance with the Data Protection Act (1998).

Whilst it was not anticipated that there would be any particular risks to participants in taking part in the study, it was acknowledged that there is always the possibility for research participation to raise uncomfortable and distressing issues. Accordingly, participants were given the contact details of the researcher and her director of studies. No participants sought further information or advice from the research team.

They were offered the opportunity to ask questions and discuss the study before, during and after taking part. In addition, for the ABI participants a procedure was in place so that participants could be referred to relevant support services at their Headway centre if needed.

2.5 Procedures

2.5.1 Development of the Brief Emotion Recognition Test "BERT"

Prospective items for inclusion in the new test instrument comprised video clips of actors portraying seven responses. The responses were the six standard emotions (happy, sad, fear, disgust, anger and surprise) which are widely accepted to be universal across cultures (Ekman & Friesen, 1971) and neutral (no emotion). The video clips of the actors were both with and without verbal cues.

Equipment used

A Sony HVRZ7 camera with a resolution of HDV 1080p was used to video the actors. The footage was shot against a green screen and background was keyed out. The green background was replaced with a neutral grey graphic. When recording the camera was approximately three meters from the actors. The head and shoulders of the actors was in the screen shots.

Editing software was Premier Pro 2015 for the general editing, Adobe after Effects 2015 for the Chroma key work and Adobe Media Encoder 2015 for the final conversion to MPEG 4 format.

Item selection took place over three stages.

Stage 1: Generation of preliminary pool of video clips

Firstly, drama students (five male and five female) were recruited from the drama department of UWE. They were video recorded portraying the six standard emotions and a neutral response in which no emotion was present. They were asked to feel the emotion they were portraying whilst they were video recorded. Actors were recorded portraying each of the different emotions without any verbal content. Our rationale for this was that participants would have to identify the emotion being portrayed by facial expressions and upper body language alone. The actors we also recorded portraying each of the different emotions whilst saying one of the following neutral carrier phrases

- "What did you do that for?"
- "I'm going out now"
- "How did you do that?"

The prosody was congruent with the facial expression. The rationale for using neutral carrier phrases was that participants would be using facial expressions and prosody to identify the emotions being portrayed and that the semantic content of the phrase being spoken would not provide any additional cues i.e. the "with phrase" video clips would not be a straight forward semantic task. The order of the neutral carrier phrases was varied for each of the actors. A large initial pool of 140 video clips was created.

Stage 2*: Selection of a smaller pool of video clips*

In the second stage, this initial pool of video clips was reduced. The pool of clips was viewed and rated independently by the researcher and another researcher with experience in this area. Ratings were then compared to see which ones had been rated highly by both the researchers. The best two examples of each of the six standard emotions and neutral (no emotion) with verbal content (14 clips) and no verbal content (a further 14 clips) together with two video clips with verbal content and two without verbal content that could be used as practice items (four additional clips), were selected to use in the candidate pool. These 32 video clips were judged by the researcher and her director of studies to clearly and unambiguously represent the emotions.

Stage 3: Generation of the final pool of video clips

The reduced pool of 32 video clips were independently viewed by an opportunity sample of the researcher's colleagues consisting of 10 neurologically healthy volunteers (five males and five females). These volunteers self-reported that they had no history of ABI, psychiatric or developmental disorder or problems with sight or hearing which would make it difficult to complete tasks on a computer. The volunteers were asked to choose from a list of the six standard emotions and neutral which emotion was being portrayed in each video clip.

The recognition rates of the 10 individuals who viewed the 16 "no phrase" and 16 "with phrase" clips (total 32 clips) is presented in Appendix 9. Recognition rates of the control group on the "no phrase" and "with phrase" BERT are also presented in Appendix 9.

Performance of males and females

The overall performance of males and females was the same on the "no phrase" video clips (mean 14.2; *SD* 1.10). The average performance of males and females was the same (mean 14.2) on the "with phrase" video clips though the standard deviation for the males was slightly higher (*SD* 1.10 compared to *SD* 0.84 for the females) demonstrating that there was more variation in the males' scores.

Percentage recognition rates of the selected clips

The percentage recognition rates of the selected nine clips (two practice items, six clips of the six basic emotions and neutral) were 97.14% for the “no phrase” clips and 91.45% for the “with phrase” clips. In other words, the recognition rates were lower for the “with phrase” clips than the “no phrase” clips.

In the “no phrase” clips the average recognition rates were 97.5% for negative emotions and 95% for positive emotions. In the “with phrase” clips the average recognition rates were 87.5% for negative emotions and 90% for the positive emotions. These figures compare favourably to the recognition rates found in the control group who took part in the study. The control groups’ recognition rate was 98.75% for negative emotions and 100% for positive emotions in the “no phrase” BERT and 90.25% for negative emotions and 93% for positive emotions in the “with phrase” BERT (see table 2).

Table 2 Average recognition rates of the 10 individuals on the video clips that were selected for the BERT and recognition rates of the control group.

Emotion	“no phrase” recognition rate %		“with phrase” recognition rate %	
	10 individuals	Control group	10 individuals	Control group
Angry	100	95	90	98
Surprise	100	100	90	86
Neutral	100	100	90	86
Fear	90	100	90	96
Disgust	100	100	80	80
Happy	90	100	90	100
Sad	100	100	90	87
Positive emotions (happy and surprise)	95	100	90	93
Negative emotions (angry, fear, disgust and sad)	97.5	98.75	87.5	90.25
Overall average	97.14	99.29	88.75	91.63

A video clip for each of the six standard emotions and neutral plus two additional clips that would be used as practice items (P1 and P2) were selected. In other words nine clips were selected for the “no phrase” BERT and nine clips were selected for the “with phrase” BERT. Selection of clips for the BERT was based on the items having a minimum recognition rate of 80% suggesting interrater reliability. A final pool of 18 video clips was created. Fifty percent of the final video clip recordings were male and fifty percent were female.

Generation of the online test

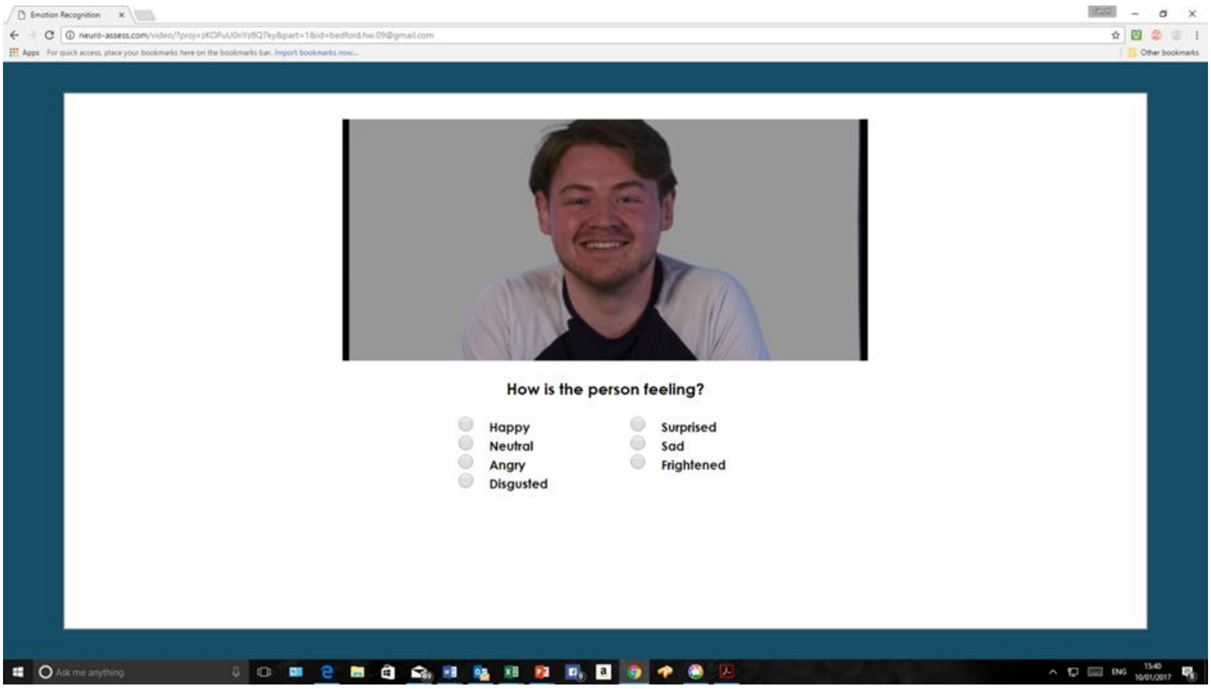
The final pool of video clips were put online. The order of the clips in the BERT was determined randomly and presented to each participant in the same fixed order. The order of the clips was not varied/counterbalanced. This was because the aim of the research was to develop a standardised test. This requires that the test is the same each time the test is administered. Limitations of not counterbalancing and using a fixed order are discussed in the Discussion chapter of this thesis.

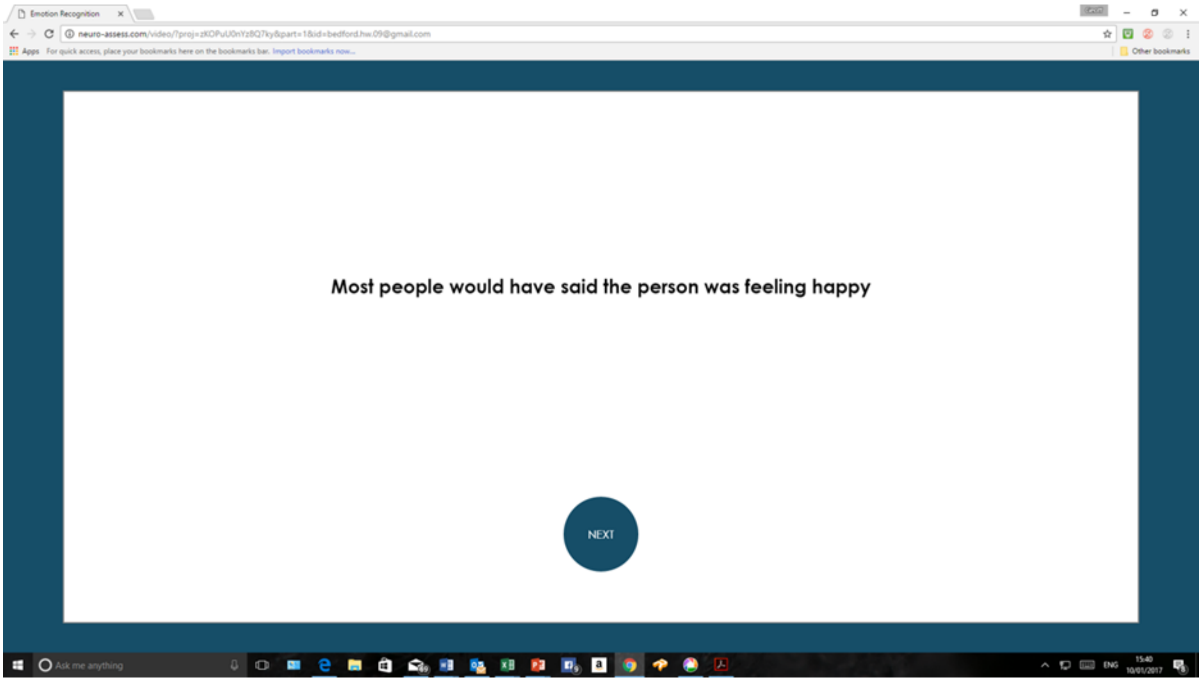
The two parts to the BERT are:

- “no phrase” BERT – a series of short (nine to seventeen seconds) video clips of actors portraying the six standard emotions and neutral using facial expressions only (no sound);
- “with phrase” BERT - a series of short (seven to nine seconds) video clips of actors portraying the six standard emotions and neutral using facial expressions and prosody which was congruent with the facial expression.

An example of the stimuli is presented in figure 1 below. The example is a screen shot of practice item 1 of the "no phrase" BERT. Other examples of the stimuli are contained in Appendix 10.

Figure 1. Screen shot of practice item 1 of "no phrase" BERT





2.5.2 Other materials

Various psychometric properties of the BERT were determined by comparing responses of the neurologically healthy control group and ABI group with a number of additional measures. The other measures were:

Existing emotion recognition measure: The Awareness of Social Inference Test (TASIT): Part 1 – Emotion Evaluation Test (EET; McDonald et al., 2003).

The EET consists of 28 video vignettes of professional actors portraying one of the six standard emotions and neutral (no emotion). All the scripts are ambiguous monologues or dialogues devoid of specific emotional content. The video vignettes are used to emulate real emotional expressions and viewers have to identify the emotion the target actor is feeling by choosing an emotion from a list of the six standard emotions and neutral. This test assesses the ability to interpret emotional expressions and paralinguistic cues in order to make judgments about speakers' mental states

(McDonald, 2011) and has been reported to have good psychometric properties with test retest reliability having a reported range of 0.74 to 0.88 (McDonald et al., 2006).

Emotional Empathy test: The Balanced Emotional Empathy Scale (BEES; Mehrabian, 1997).

The BEES is a measure of emotional empathy (Mehrabian, 1997). It is a 30 item self-report questionnaire that is able to distinguish between people who are more responsive to another's emotional experience from people who are less responsive (Mehrabian, 1997). Responses are rated using a 9-point Likert scale ranging from very strong agreement to very strong disagreement. The author has reported a mean normative scale of 45 (*SD* = 24) with high score equating to higher emotional empathy (Mehrabian, 2000). The BEES has good internal consistency and test retest reliability (alpha=0.87, r=0.77, Chauhan et al., 2008; Mehrabian, 2000). It has been used in the general population, and in ABI populations to measure emotional empathy (for example: Wood & Williams, 2008; Williams & Wood, 2010a; de Sousa et al., 2010; de Sousa et al., 2011).

Multifaceted empathy test – Interpersonal Reactivity Index (IRI;* Davis, 1980*)

The IRI is a 28 item self-report questionnaire that is measured on a five-point Likert scale ranging from zero (does not describe me well) to four (describes me very well). It consists of four, seven item subscales each intended to measure some aspect of empathy: Perspective Taking (the ability to shift to another's emotional perspective); Empathic Concern (feeling warmth and compassion for others); Fantasy (the ability to put oneself in a fictional situation); and Personal Distress (feeling fear or anxiety in response to seeing others in distress). Scores are calculated for each of the subscales.

Davis saw empathy as a multidimensional phenomenon of distinct but related constructs that involve reactivity to others. The IRI has been found to be positively correlated with the Hogan Empathy Scale (Hogan, 1969; Davis, 1980) which measures cognitive empathy and provides evidence that the IRI measures cognitive empathy (Shamay-Tsoory, Tomer, Goldsher, Berger & Aharon-Peretz, 2004). High scores equate to higher cognitive empathy. Further validation of the IRI has come from Bernstein and Davis (1982) who found a correlation between the perspective taking scale and accuracy in person perception. The four subscales that comprise the IRI have been reported by Davis (1983) to have satisfactory internal reliabilities (alpha ranges 0.71 to 0.77) and satisfactory test retest reliabilities (alpha ranges 0.62-0.80). Further, the IRI has been reported to be reliable in ABI (Shamay-Tsoory et. al., 2004).

Verbal intelligence measure – Spot the Word, Second Edition (STW2; Baddeley & Crawford, 2012)

STW2 is a measure which can be used as an estimate of pre-morbid intelligence. Performance on STW2 is reported to be highly correlated with verbal intelligence (Mill, Hill Vocabulary Score; Raven, 1958) and performance on the NART (Nelson, 1982). It involves presenting participants with one hundred pairs of items comprising one real word and one nonsense word invented to look like a word but having no meaning. Participants are required to identify the real word in each pair of items. This is a test of understanding written vocabulary and correlates highly with other well-known tests of written vocabulary such as the National Adult Reading Test (NART) (r=0.87) (Nelson, 1982; Baddeley, Emslie & Nimmo-Smith, 1993). STW2 was used rather than the NART because it has been shown to be relatively stable following neurological impairment and is a good estimator of premorbid abilities as it shows good discriminant validity (Yuspeh & Vanderploeg, 2000). Also, no verbal response is needed, thus it avoids the potentially discouraging effects of repeated failure of word pronunciation that is associated with the NART (Baddeley et al., 1993).

2.5.3. Administration of the new test and other measures to the control group

The BERT, EET and other measures (BEES, IRI and STW2) were administered online in the same order to the participants in the control group. The order of the video clips in the BERT and EET and the questions of the other measures (BEES, IRI and STW2) were presented in the same order to every participant. This was because the aim of the research was to develop a standardised test. As mentioned above, this requires that each time the test is administered it is in the same order so it is the same test for everyone who completes it.

Participants accessed the tests that made up the study "the tests" by following the instructions that had been sent to them. All participants were required to confirm their consent by checking a response box on the online consent form before completing any of the tests. Participants were asked demographic questions about their gender, age, occupation and level of education. Participants were shown the "no phrase" BERT, followed by the "with phrase" BERT, then the EET, BEES, IRI and finally STW2. An instruction slide preceded each of the tests. In the BERT and the EET participants are shown video clips of actors portraying emotions. After viewing each video clip the participant is instructed to choose the emotion they think the actor is portraying. They are provided with a list of the emotional categories (six standard emotions and neutral) and have to select one of the emotions (forced choice paradigm). Before completing the BERT and EET participants had the opportunity to complete two practice items and receive feedback on whether or not they had selected the correct response.

All online measures were administered in a single session. Time taken to complete the measures was about 45 minutes.

As mentioned above, the new test instrument ("no phrase" BERT and "with phrase" BERT) was re-administered one week after it was first administered to assess test retest reliability. The other measures were not re-administered, as these measures already have established test retest data. Participants were sent an email reminding them to complete the new test instrument again. In the second administration the format and content of the test instrument was exactly the same as the first administration. The second administration took approximately 5-10 minutes to complete.

2.5.4 Collection of validity data from the ABI group

In order to provide some preliminary findings of the construct validity of the new test instrument we wanted to compare the performance of a sample of ABI individuals with the performance of the neurologically healthy controls. To do this the new test instrument (BERT) and the other measures (EET, BEES, IRI and STW2) were administered to a small group of participants who had suffered ABI. These participants were recruited from three Headway centres (see above).

The tests were administered to the participants from Headway Bedford and Headway Swindon online. These ABI participants followed the same procedure as the neurologically healthy controls. They were required to confirm their consent by checking a response box on the online consent form before completing any of the tests and were asked demographic questions about their gender, age, occupation and level of education (see screen shots in Appendix 10). The tests administered were exactly the same (content and order) as those administered to the neurologically healthy controls. In other words, they were shown the “no phrase” BERT, followed by the “with phrase” BERT (see screen shots in Appendix 10), then the EET, BEES, IRI and finally STW2. As with the neurologically healthy controls, an instruction slide preceded each of the tests. Before completing the BERT and EET the ABI participants had the opportunity to complete two practice items and receive feedback on whether or not they had selected the correct response. All online measures were administered in a single session. Time taken to complete the measures was about 45 - 60 minutes.

Lack of sufficient internet access at Headway Somerset meant that the new test and other measures could not be administered online to the five Headway Somerset ABI participants. The researcher showed each of these participants the video clips that made up the “no phrase” BERT, “with phrase” BERT and the EET on a laptop screen. The size and format of the video clips on the screen was the same as the video clips in the online presentation. The order that the video clips were shown in was exactly the same as in the online version. The participants had a written list of the six standard emotions and neutral and were asked to point to or read from the list which emotion was being portrayed in each of the video clips. The five participants from Headway Somerset completed paper version of the BEES, IRI and STW2. The order of the questions was the same as in the online version. Time restrictions at Headway Somerset meant that participants from this centre completed the tests in a number of sessions.

All 20 participants in the ABI group completed the BERT (“no phrase” and “with phrase”) and EET. Whilst the majority (12) of the ABI participants completed all of the measures, time and other restrictions resulted in 8 of the ABI participants not completing all of the measures.

The researcher attended the various Headway centres one week after the first administration to help ensure the second administration of the BERT took place. In the second administration the format and content of the test instrument was exactly the same as in the first administration. The second administration took approximately 5-10 minutes to complete.

2.6 Data analysis

Data from the online tests was collected in Excel spreadsheets (Microsoft Excel, 2016). Data collected manually from the Somerset Headway participants was recorded in Excel spreadsheets in the same format as the online test result data.

Normality Analysis

Preliminary analysis of responses to the BERT using the Kolmogorov-Smirov Lilliefors significance correction test of normality showed most of the variables were not normally distributed. The analysis indicated that there was skewness in the data. The only variable that was normally distributed was the “with phrase” BERT variable. Results of Kolmogorov-Smirov Lilliefors analysis are contained in Appendix 11.

Summary of Normality analysis

The majority of the BERT data was found not to be normally distributed. In view of this non-parametric methods were used to analyse the BERT data. Non- parametric tests make no assumptions about parameters of the population distribution. This compares to parametric tests that do make assumptions about the population distributions.

Statistical analysis was undertaken using SPSS v22 (IBM Corp., 2013). The statistical methods used to analyse the data were:

- Spearman's Rho to investigate correlations between the correct scores for each part of the BERT ("no phrase", "with phrase", and total correct score) and the EET (an existing measure of emotion recognition deficits); the BEES and the IRI (measures of empathy). Spearman's Rho was used because it is a non-parametric test that can be used to measure the strength of association between two variables. Pearson's test was not chosen because it is used when the data is normally distributed.
- Spearman's Rho to investigate whether age, education or intelligence influence performance on the new test. It was not appropriate for Pearson's test to be used as this relies on data being normally distributed and the data in this study was not normally distributed. Spearman's Rho is a non-parametric test able to measure the strength of association between two variables.
- Spearman's Rho correlation was used to check out test retest reliability. The data was not normally distributed so a non-parametric test was needed.
- Mann Whitney U test was used to analyse gender and other differences between the two groups (discriminant validity). This test was chosen because it is a non-parametric test that can be used to compare ordinal data. It was not appropriate to use Chi square analysis to analyse gender and other differences between the groups because some of the cells in the analysis had values of less than five (Bewick, Cheek & Ball, 2004).
- Fisher's exact test was used to compare the number of individuals in each group getting the items in the BERT ("no phrase", "with phrase" and total) correct or incorrect. It was not appropriate to use Chi square because some of the cells had values of less than five (Bewick, Cheek & Ball, 2004).

- Cut off scores were calculated to enable the test to be used in a clinical and research settings. The calculation method used to calculate clinical cut off scores was *SD* x 1.65 (the multiplier used for normal distribution to cut off the top and bottom 5%) subtracted from the mean scores (Singh, 2006). The sensitivity (the ability of the test to correctly identify those people who had emotion recognition problems) and specificity (the ability of the test to correctly identify those people who did not have problems with emotion recognition) of the BERT was investigated using the cut off scores (Rumsey, 2003).
- Hierarchical regression analysis was conducted to explore whether the variables group, STW2 and years education explained or contributed to observed difference in performance on the BERT and explore the contribution of these variables to performance on the BERT.
- Mann Whitney U test was used to analyse if participants who scored below the cut off score on the BERT differed on the other measures (EET, BEES, IRI and STW2). This test was chosen because it is a non-parametric test that can be used to compare ordinal data.

2.7 Summary of methodology

A quantitative approach was used. A new test instrument (BERT) was created consisting of video clips of actors portraying the six standard emotions and neutral (no emotion) using facial expressions only ("no phrase" BERT) and using facial expressions and vocal prosody ("with phrase" BERT). Normative data from an age stratified sample of 92 neurologically healthy adults was obtained. Statistical analysis was used to determine validity, reliability and cut off scores for the BERT. Statistical analysis of the influence of age, gender, education or intelligence on performance on the BERT was carried out.

Data from a small sample of ABI adult participants was examined and compared with data from the neurologically healthy control group to provide some preliminary findings on whether the ABI group's performance was poorer than the control group and whether performance was influenced by the stimuli used – facial expressions only and facial expressions and vocal prosody.

Chapter 3: Results and Analysis of Results

3.1 Introduction

The results from this study will be presented in several sections. Firstly, group characteristics will be outlined highlighting where the groups were well matched and different. Findings relating to test retest reliability will then be outlined followed by the findings of associations of the BERT with the other measures used in the study, particularly the key other measure of emotion recognition, the EET. Results of the analysis comparing the control and ABI groups' performance on the BERT and the other measures is then reported. Finally, there is an explanation of the clinical cut off scores, their specificity and sensitivity.

3.2 Group characteristics

Analysis of the participants' characteristics (presented in table 3, page 73) revealed that the groups did not differ significantly in terms of their age (control group M=47.37, *SD*=15.43; ABI group M= 50.70, *SD*=13.27; U (N1= 92, N2= 20) = 798.00, p>.05). However, the control group had a significantly higher IQ (M=93.97, *SD*= 4.80) than the ABI group (M=76, *SD*=15.62); U (N1=92, N2=15) =139.00, p<.05 and the control groups' years education (M=15.58, *SD*=2.34) was higher than the ABI groups' (M=11.55; 2.04); U=139.00, p<.05. The groups also differed in occupational background. Fifty four percent of the control group identified as being senior or intermediate professional compared to only 15% in the ABI group. Further 45% of the ABI group identified as casual/lowest grade/ worker or unemployed compared to only 5% of the control group. There were no significant sex differences on the BERT, all tests p>.05.

Table 3: Summary of the groups' characteristics

	Control group			ABI group			Mann Whitney U (p value)
	n	mean	*SD*	n	mean	*SD*	
Age (years)	92	47.37	15.43	20	50.70	13.27	798.00 (p>.05)
STW2	92	93.97	4.80	15	76.00	15.62	139.00 (p<.05)
Years education	92	15.58	2.34	20	11.55	2.04	(p<.05)
Time since ABI (years)	N/A	N/A	N/A	20	14.1	14.5	_
Occupational background							
• Senior professional	12 (13%)	–	–	0 (0%)	–	–	_

• Intermediate professional	38 (41%)	–	–	3 (15%)	–	–	–
• Junior professional	37 (40%)	–	–	8 (40%)	–	–	–
• Skilled manual worker	5 (5%)	–	–	2 (10%)	–	–	–
• Semi-skilled manual worker	0 (0%)	–	–	2 (10%)	–	–	–
• Casual/lowest grade worker/ unemployed	0 (0%)	–	–	5 (25%)	–	–	–

3.3 Reliability – test retest

Analysis of the participants' performance on first administration (T1) and second administration (T2) of the BERT is presented in table 4.

Table 4: Spearman's Rho correlations for the control and ABI groups' performance on first and second administrations of the BERT

	Control group		ABI group	
"no phrase" 1st and 2nd administration	n=79	Spearman = - 0.022	n=15	Spearman = 0.651*
		p value = 0.845		**p value = 0.009**
"with phrase" 1st and 2nd administration	n=79	Spearman = 0.360*	n=15	Spearman = 0.571*
		p value =0.001		**p value = 0.026**
Total correct score 1st and 2nd administration	n=79	Spearman = 0.349*	n=15	Spearman = 0.781*
		p value =0.002		**p value =0.001**

*Significant at the p<0.05 level of significance

3.3.1 Test retest reliability - control group

Seventy-nine participants in the control group repeated the "no phrase" and "with phrase" parts of the BERT. The time between administrations was at least seven days (M= 14 days; *SD*= 8.30).

Spearman's Rho correlation

Analysis revealed a positive correlation between T1 and T2 of the total correct BERT score (r_s (79) = .35, p< .01) and "with phrase" BERT score (r_s(79) =.36; p<.01) in the control group. However, the correlation values were lower than expected and suggest the correlations are moderate. No statistically significant correlation was found between T1 and T2 of the “no phrase” part of the BERT ($r_s(79) = -.0.02; >.05$).

Percentage agreement across two administrations

The percentage agreement scores (i.e. the number of participants who got the same score on the BERT at T1 and T2) for the control and ABI groups are presented in table 5.

Table 5: Percentage agreement across two administrations of the BERT for the control and ABI groups

Part of BERT completed	Control group (n=79) Percentage agreement	ABI group (n=15) Percentage agreement
“no phrase”	95%	53%
“with phrase”	65%	33%
Total (“no phrase” and “with phrase” items)	61%	40%

“no phrase” BERT

Seventy five of the 79 participants in the control group achieved the same score on both administrations. This equates to a percentage agreement score of 95%.

“with phrase” BERT

Of the 79 participants in the control group who repeated the “with phrase” part of the BERT, 51 achieved exactly the same score on both administrations. This equates to a percentage agreement score of 65%.

Analysis of the control group’s performance on the “with phrase” BERT revealed that 72% of the participants correctly identify all of the items. However, there is a little variation in the data on the 2nd administration.

“total correct score” on the BERT

Forty nine of the 79 participants who repeated the BERT achieved the same score on both administrations. This equates to a percentage agreement score of 61%.

3.3.2 Test retest reliability - ABI group

Fifteen participants in the ABI group repeated the "no phrase" and "with phrase" parts of the BERT. The time between administrations was at least 7 days (M=10.01, *SD*=5.75).

Analysis of the ABI group's performance at T1 and T2 (presented in table 4) revealed that there was a statistically significant correlation on all parts of the BERT ("no phrase", "with phrase" and total correct score). The Spearman's Rho correlation coefficient values for the "no phrase" BERT was 0.65; for the "with phrase" BERT was 0.57 and for the total correct BERT was 0.78 suggesting strong positive correlations between the scores at T1 and T2 and some evidence of test retest reliability.

Percentage agreement across two administrations

Percentage agreement figures for the ABI group on the BERT are presented in table 5.

Analysis of the ABI group's performance on the "no phrase" BERT revealed eight of the 15 ABI participants who repeated the test got the same score on both administrations. This equates to a percentage agreement score of 53%. For the "with phrase" BERT only five participants who completed the "with phrase" BERT twice achieved the same score on both administrations (33%). In terms of the total correct BERT score ("no phrase" and "with phrase" correct scores), six ABI participants got the same total score at T1 and T2 equating to a percentage agreement score of 40%.

3.3.3 Summary of reliability

There were significant positive correlations for all parts of the BERT in the ABI group on T1 and T2. The strongest correlation found was for the total correct BERT. There was a correlation for the control group's performance on T1 and T2 of the "with phrase" and total correct BERT. No correlation was found for the control group's performance on the "no phrase" BERT, however the percentage agreement score was very high. There was a high ceiling effect.

3.4 Concurrent Validity

Concurrent validity of the BERT was determined via correlation coefficients with existing measures of emotion recognition and empathy deficits that were administered in the study. These were the EET, BEES and IRI. In addition, analysis was carried out to investigate the relationship between the BERT, age and STW2.

3.4.1 Concurrent Validity - control group

A series of Spearman's Rho tests were carried out to analyse the control group's performance on the BERT and the other measures (EET, BEES and IRI). The analysis is presented in table 6.

Analysis revealed that the control group's performance on all parts of the BERT ("no phrase", "with phrase" and total correct score) was correlated with the EET an established measure of deficits in emotion recognition. This finding suggests that the BERT may measure what the EET measures namely deficits in emotion recognition.

Table 6: Spearman's Rho correlation figures and $p<0.05$ significance values for the control group on the BERT and other measures

		BERT "no phrase"	BERT "with phrase"	BERT Total correct
Age		**-0.249***	0.014	-0.049
EET		**0.274***	**0.313***	**0.364***

BEES		0.037	**0.315***	**0.316***
STW2		0.054	0.174	0.199
IRI	Fantasy scale	0.050	**0.237***	**0.258***
	Empathic concern	0.140	0.113	0.132
	Perspective taking	-0.79	0.063	0.042
	Personal distress	0.131	0.043	0.069

n= 92 for all cells except for EET correlation where n= 91 and Spot the word where n= 89

*Correlation significant at the $p<0.05$ level of significance

Analysis revealed that the control group's performance on the "with phrase" BERT and the total correct BERT score was correlated with performance on the BEES, a self-report measure of the ability to experience the affective reactions to the emotional displays of others (emotional empathy). However, no correlation was found between performance on the BEES and the "no phrase" part of the BERT. The finding of no correlation is not surprising given the fact that nearly every participant in the control group got all of the "no phrase" items correct. In other words there is a high ceiling effect.

A correlation was found between the fantasy subscale of the IRI and the "with phrase" BERT and total correct BERT score. However, correlations were not found with the other subscales of the IRI. The IRI fantasy subscale measures the ability to put oneself in a fictional situation e.g to identify with fictitious characters in books or films. The questions in the IRI that are used to measure the fantasy subscale are: I daydream and fantasise, with some regularity, about the things that might happen to me; I really get involved with the feelings of the characters in a novel; Becoming extremely involved in a good book or movie is somewhat rare for me; After seeing a play or movie, I have felt as though I were one of the characters; When I am reading an interesting story or novel, I imagine how I would feel if the events in the story were happening to me.

Associations between the BERT and the empathy measures (IRI and BEES) were hypothesised. Accordingly, the finding of a correlation in the control group between the BERT and the IRI fantasy scale was hypothesised and suggests that the BERT detects some of the characteristic that these tests measure – the ability to empathise.

Analysis revealed no correlations between the STW2 test and the control group's performance on any parts of the BERT ("no phrase"," with phrase" or total correct score) and no correlations between age and the "with phrase" BERT or total correct score. However, analysis revealed a significant correlation between age and the "no phrase" BERT.

3.4.2 Concurrent validity - ABI group

Spearman's Rho tests were run to determine the relationship between the ABI group's performance on the BERT and the other measures. The analysis is presented table 7. Analysis revealed that the ABI group's performance on all parts of the BERT ("no phrase", "with phrase" and total correct score) were correlated with the EET. This result was hypothesised and suggests that the BERT may measure the same concept as the EET, namely deficits in emotion recognition.

Analysis revealed no correlation between the BEES and the BERT in the ABI group. This was not expected. Possible explanations for this finding are contained in the discussion chapter.

No significant correlations were found between STW2 and the ABI group's performance on the "no phrase" BERT or the total correct BERT score. A significant correlation was found between the STW2 and the "with phrase" BERT.

Table 7: Spearman's Rho correlation figures and p<0.05 significance values for the ABI group on the BERT and other measures

		BERT "no phrase"	BERT "with phrase"	BERT Total correct
Age		-0.134	-0.098	-0.140
EET		**0.757***	**0.780***	**0.878***
BEES		-0.211	0.005	-0.095
STW2		0.266	**0.584***	0.454
IRI	Fantasy scale	**0.808***	0.444	**0.724***
IRI	Empathic concern	-0.303	-0.189	-0.270
IRI	Perspective taking	0.670	0.121	0.144
IRI	Personal distress	0.473	-0.399	-0.040

n= 20 for all cells except for BEES correlation where n=16, IRI where n=12 and STW2 where n= 15
*Correlation significant at the p<0.05 level of significance

No significant correlations were found between age and ABI performance on any part of the BERT ("no phrase", "with phrase" or total score).

The analysis revealed a significant correlation between the fantasy subscale of the IRI and the ABI group's performance on the "no phrase" and total score of the BERT (presented in table 7). However, no significant correlations were found with the other subscales of the IRI - empathic concern; perspective taking and personal distress.

3.4.3 Summary of concurrent validity analysis

The performance of both groups on all parts of the BERT was correlated with the EET. This was as hypothesised.

In the control group no correlation was found between STW2 and the BERT suggesting performance on the BERT is not affected by general intelligence in this group. No associations were found between age and the control group's performance on the “with phrase” and total correct BERT, though a significant association was found between age and the “no phrase” BERT.

A correlation was found between the control group’s performance on the “with phrase” and total correct BERT score and the BEES and IRI fantasy subscale. No correlation was found between the “no phrase” BERT and the BEES or IRI fantasy subscale.

In the ABI group analysis revealed no association between performance on the BERT and BEES nor was any association found between age and performance on any part of the BERT. No correlation was found between the “no phrase” BERT or the total correct BERT score and STW2, though an association was found between the “with phrase” BERT and STW2. A significant correlation was found between the “no phrase” and total correct BERT score with one of the subscales of the IRI - fantasy subscale.

3.5 Discriminant Validity

3.5.1 Between group differences on the BERT

As hypothesised, analysis revealed that the ABI group’s performance on the BERT was poorer than the control group’s performance on the BERT. Analysis is presented in table 8 and figure 2).

The performance of the ABI group on the “no phrase” items of BERT was poorer (M=5.60, *SD*=1.5) than the control group’s (M= 6.95, *SD*=0.23); U (N1=20, N2=92) =395.5, $p < 0.05$). Individuals in the ABI group also correctly identified fewer expressions of the “with phrase” items of BERT (M=4.65, *SD*=1.60) than the controls (M=6.30, *SD*=0.91); U (N1=20, N2=92) = 364.5, $p<0.05$. The total BERT performance of the ABI group was poorer (M=10.25, *SD*=2.79) than that of the control group (M=13.25, *SD*=0.94); U (N1=20, N2=92) =270.0, $p<0.05$.

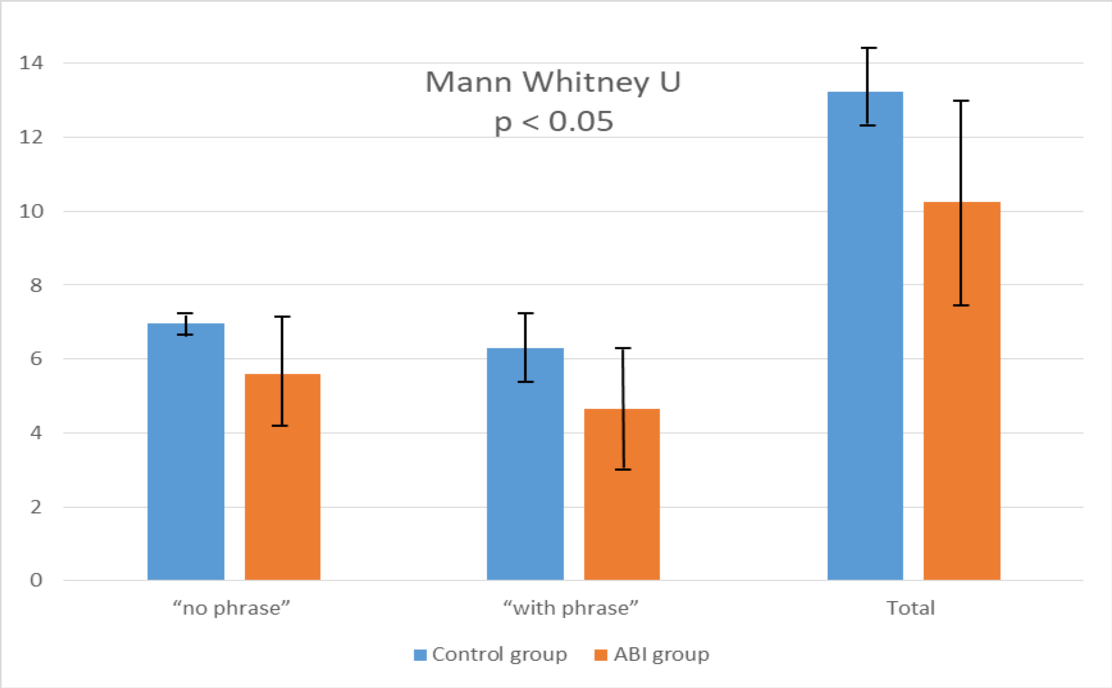
Table 8 Performance of the groups on the BERT

	Control group			ABI group			Mann Whitney U (p value)
	n	mean	*SD*	n	mean	*SD*	
"no phrase" 1st	92	6.95	0.23	20	5.60	1.50	395.50 (p<.05)
"no phrase" 2nd	80	6.99	0.12	15	6.07	1.22	286.00 (p<.05)
"with phrase" 1st	92	6.30	0.91	20	4.65	1.60	364.50 (p<.05)
"with phrase" 2nd	79	6.61	0.74	15	4.73	1.62	220.00 (p<.05)
Total BERT 1st	92	13.25	0.94	20	10.25	2.79	270.00 (p<.05)
Total BERT 2nd	79	13.60	0.74	15	10.80	2.60	191.50 (p<.05)

3.5.2 Comparison of performance on the "no phrase" and "with phrase" **BERT**

Wilcoxon signed ranks test analysis revealed that the performance of the control group on the "with phrase" BERT was significantly lower than the control group's performance on the "no phrase" BERT (z=-5.483, p<.05). Similarly, analysis revealed that the performance of the ABI group was also a significantly lower on the "with phrase" BERT than the "no phrase" BERT (z=-2.647, p<.05).

Figure 2: Means and *SD*s of the control and ABI groups' scores on the BERT



3.5.3 Multiple regression analysis on years education and STW2

In view of the finding that the groups differed on STW2 (a measure of pre-morbid intelligence) and year's education (see section 3.2 above), Stepwise multiple regression analysis was conducted to explore whether the variables group, STW2 and years education were significant predictors of performance on the "no phrase", "with phrase" and total BERT. Within the analyses, years education was not found to be a significant predictor of performance in relation to performance on any part of the BERT.

In the "no phrase" BERT analyses, Stepwise analysis included the variables group and STW2. A significant association was found (adjusted R^2= .39), F (2,101) =34.40, p<.05.

In order to explore the contribution of group and STW2 to performance on the "no phrase" BERT, multiple regression analyses were conducted. The first model, with group entered at the first step, the model explained 35% of the variance (adjusted R^2=.35, *SE* = .48; *F* (1, 102) =56.52; p < .01). The second model, which included both variables, explained 40.5% of the variance, *F* (2, 101) = 34.43, p < .01). Adding the STW2 measure explained an additional variance in performance (R squared change = .05, *F* change (2, 101) =8.29, p < .01). Group had a higher beta value (beta = -.40, p < .01) than the intelligence measure (beta = -.29, p < .05).

In the “with phrase” BERT analyses, Stepwise analysis included the variable STW2. A significant association was found (adjusted R^2= .27), F (1, 102) =39.38, p<.05.

In order to explore the contribution of group and STW2 to performance on the “with phrase” BERT, multiple regression analysis was conducted. The first model, with group entered at the first step, the model explained 21% of the variance (adjusted R^2=.20, *SE* = 1.02: F (1; 102) = 26.99; p < .01). The second model, which included both variables, explained 30% of the variance, *F* (2, 101) = 21.65, p < .01). Adding the STW2 measure explained an additional variance in performance (R squared change = .09, *F* change (2, 101) =13.10, p < .01). STW2 had a higher beta value (beta = .40, p < .01) than group (beta = -.20, p >.05).

In the total BERT analyses, Stepwise analysis included the variables STW2 and group. A significant association was found (adjusted R^2= .43), F (2,101) = 40.30, p<.05.

In order to explore the contribution of STW2 and group to performance on the total BERT, multiple regression analysis was conducted. The first model, with STW2 entered at the first step, the model explained 39% of the variance (adjusted R^2=.38, *SE* = 1.18; *F* (1, 102) =65.14; p < .01). The second model, which included both variables, explained 44% of the variance, *F* (2, 101) = 40.32, p < .01). Adding the group explained an additional variance in performance (R squared change = .05, *F* change (2, 101) = 9.85, p < .01). Intelligence (STW2) had a higher beta value (beta = .42, p < .01) than group (beta = -.31, p < .01).

Summary statistics, beta values and t values for these analyses of the different independent variables are presented in table 9.

Table 9. Results of multiple regression analysis for prediction of performance on the BERT

	Variable	Beta	t	Significance of t
"no phrase" BERT	Group	-.04	-3.97	<.05
	STW2	.29	2.88	<.05
"with phrase" BERT	STW2	.53	6.28	<.05
Total BERT	STW2	.42	4.28	<.05
	Group	-.31	-3.14	<.05

Note: Beta values are the standardised regression coefficients.

3.5.4 Between group differences on the other measures

Table 10. Groups' performance on the EET, BEES and IRI

	Control group			ABI group			Mann Whitney U	p value
	n	mean	*SD*	n	mean	*SD*		
EET	91	24.71	2.40	20	17.55	5.79	200.50*	p<0.05
BEES	92	45.80	32.45	16	29.13	21.34	474.50*	p<0.05
IRI Fantasy	92	15.89	4.52	12	15.5	4.91	520.00	p>0.05
IRI Empathic concern	92	16.38	4.48	12	17.25	6.05	490.50	p>0.05
IRI Perspective taking	92	13.35	3.74	12	18.00	4.51	241.00*	p<0.05
IRI Personal distress	92	16.83	3.95	12	14.92	3.20	389.50	p>0.05

*Correlation significant at the p<0.05 level of significance

Analysis of the performance of the groups on the other measures (EET, BEES and IRI) is presented in table 10. It revealed that the control group scored higher on the EET (M=24.71, *SD*=2.4) than the ABI group (M=17.55, *SD*=5.79); U (N1=91, N2=20) = 200.5, p<.05. It also showed that the control group scored higher on the BEES

(M=45.8, *SD*=32.45) than the ABI group (M= 29.13, *SD*=21.34); U (N1=92, N2=16) = 474.5, $p<.05$. The individuals with ABI scored higher on the IRI perspective taking subscale (M=18.0, *SD*=4.51) than individuals in the control group (M=13.35, *SD*=3.74); U (N1=92, N2=12) = 241, $p<.05$). No significant difference was found in the performance of the groups in the IRI other subscales (fantasy, empathic concern or personal distress).

Comparing the performance of the groups on the BERT

3.5.5 The performance of the control and ABI participants on each item in the BERT

Fisher's exact test and percentage of participants who got the items in the BERT correct were calculated for each of the items to investigate differences in performance of the control and ABI group. Alpha was adjusted to control for Type 1 errors. The results of Fisher exact test are shown in table 11.

A statistically significant difference in performance $p<0.05$ and $p< 0.007$ (controlling for Type 1 errors) was found between the control and ABI group in five out of seven "no phrase" items (all the different emotion clips except angry and sad). A statistically significant difference in performance $p<0.05$ was found between the control and ABI groups in five out of seven of the "with phrase" items (all the different emotion clips except sad and surprise) and two out of the seven "with phrase" items (angry and frightened) at $p <0.007$ (controlling for Type 1 errors).

Table 11. The number of participants in the control and ABI groups who got each item of the BERT correct with the Fishers exact test result (significant at p<0.05 and p<0.007)

"no phrase"		Item 1 Angry	Item 2 Surprise	Item 3 Neutral	Item 4 Frightened	Item 5 Disgusted	Item 6 Happy	Item 7 Sad
Controls	correct	87	92	92	92	92	92	92
	incorrect	5	0	0	0	0	0	0
ABI	correct	17	17	16	13	14	16	19
	incorrect	3	3	4	7	6	4	1
Fishers exact test value		0.15	0.005	0.0008	2E-06	1.6E-05	0.0008	0.179
significant p< 0.05		X	Yes	Yes	Yes	Yes	Yes	X
significant p< 0.007		X	Yes	Yes	Yes	Yes	Yes	X

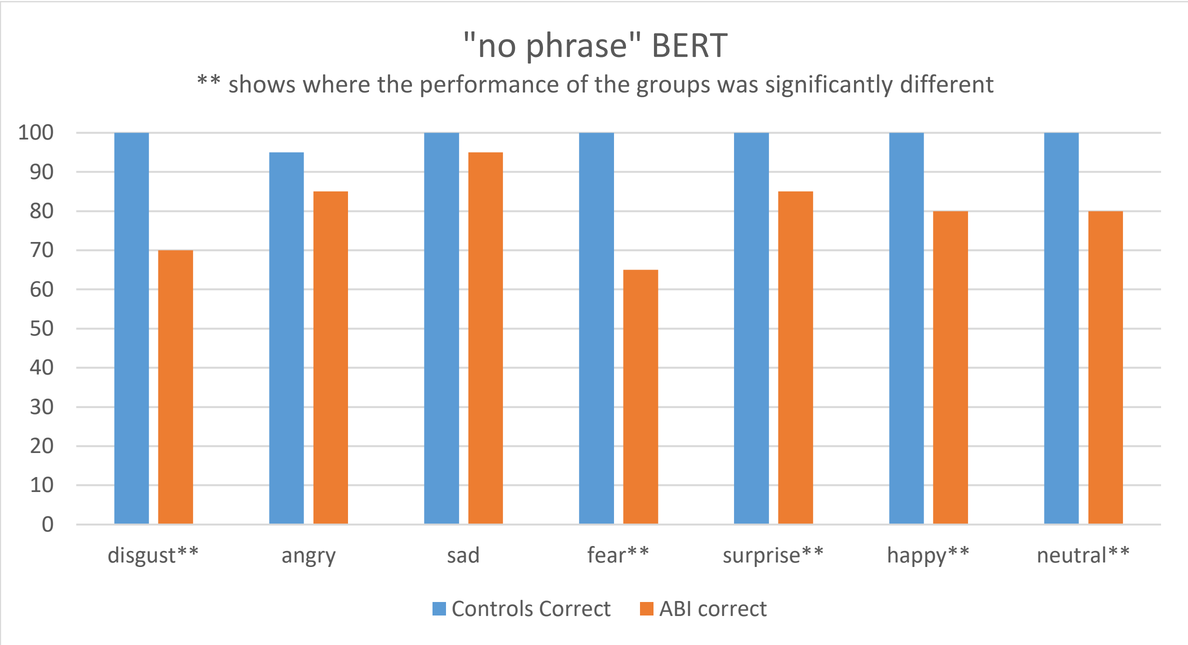
"with phrase"		Item 1 Angry	Item 2 Sad	Item 3 Happy	Item 4 Surprise	Item 5 frightened	Item 6 Disgust	Item 7 Neutral
Controls	correct	90	80	92	79	88	73	79
	incorrect	2	12	0	13	4	19	13
ABI	correct	13	14	18	14	14	10	10
	incorrect	7	6	2	6	6	10	10
Fishers exact test value		6.1E-0.5	0.0889	0.0306	0.1038	0.0021	0.0108	0.001
significant p< 0.05		Yes	X	Yes	X	Yes	Yes	Yes
significant p< 0.007		Yes	X	X	X	Yes	X	X

3.5.6 The groups' performance on the "no phrase" BERT

The control groups' performance was higher than the ABI groups' performance on every item of the "no phrase" BERT. Figure 3 shows the percentage of participants in the control and ABI groups who got each item of the "no phrase" BERT correct. All of the 92 control participants got six of the seven items correct. These were happy, disgusted, sad, surprise, neutral, frightened. There was only one emotion, angry, that the control group had any difficulty with. Five (5%) of the control group participants got this item incorrect.

Fisher's exact test revealed that the performance of the groups on the "no phrase" angry item was not statistically significant. Interestingly, the angry item was not the item that caused most difficulty for the participants in the ABI group. They struggled most with the emotion items fear and disgust. In other words the two items that had most errors in the ABI group both had negative valence. The second emotion item in the “no phrase” test that was found not to be statistically different was the sad emotion item. However, only one ABI participant got this item incorrect and none of the control group got it incorrect.

Figure 3: Percentage of control and ABI participants who got each item of the “no phrase” BERT correct



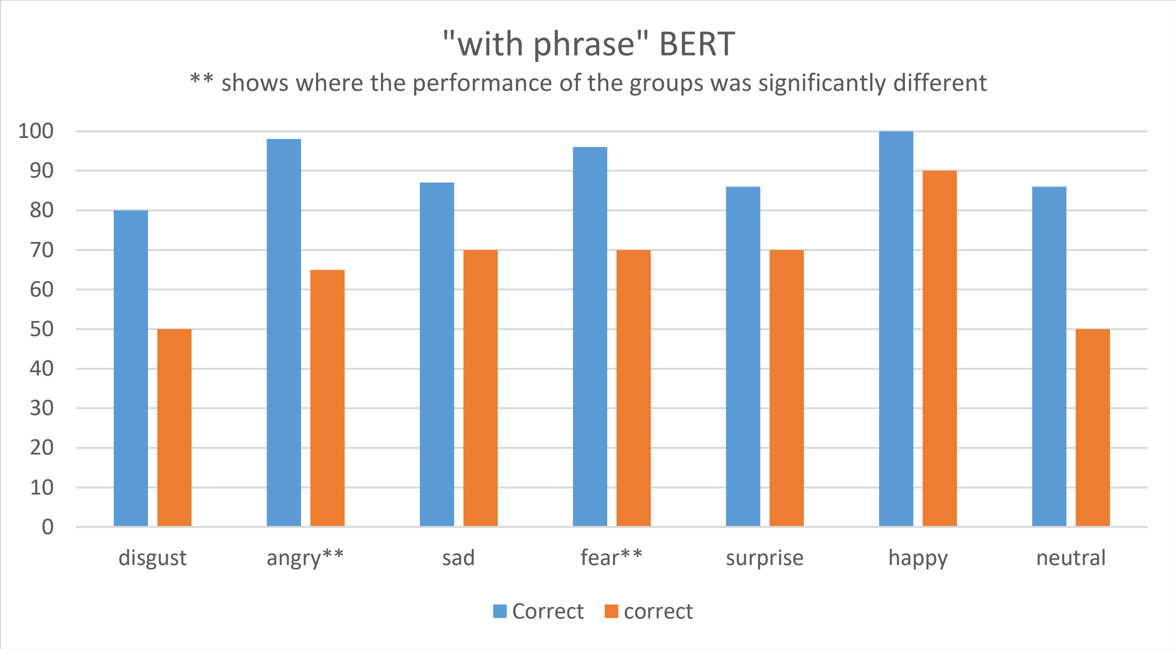
3.5.7 The groups’ performance on the “with phrase” BERT

The percentage of participants in the control and ABI groups who got each item of the “with phrase” BERT correct is presented in Figure 4.

In the control group, the emotion that had least errors was happy. All of the participants in the control group got this item correct. Most errors in the control group were made identifying the emotions surprise, sad and neutral. Fisher’s exact test (table 11) revealed there was not a statistically significant difference between the groups performance on the “with phrase” sad, surprise, disgust, happy and neutral items. Analysis revealed that 87% of control participants and 70% of ABI participants correctly identified the sad item. A similar finding was found for the surprise item where

86% of control participants and 70% of ABI participants identified this emotion correctly.

Figure 4: Percentage of control and ABI participants who got each item of the “with phrase” BERT correct



In the ABI group, most errors were made recognising the emotions angry (35%; seven participants incorrect), disgust (50%; 10 participants incorrect) and neutral (50%; 10 participants incorrect). The ABI group made more errors identifying emotions with negative valence than positive valence.

3.5.8 Between group differences on the other measures

The control group's performance on the EET was significantly better (M= 24.71, *SD* = 2.4) than the ABI group's (M= 17.55, *SD*= 5.79), U (91, 20) = 200.50, p<.05).

The control group's performance on the BEES was also significantly higher (M= 45.80, *SD* = 32.45) than the ABI group (M= 29.13, *SD*= 21.34), U (92,160) = 474.50, p<.05.

A statistically significant difference between the two groups was found on the perspective taking subscale of the IRI. The ABI group scored higher (M=18.00, *SD*=

4.51) than the control group (M= 13.35, *SD*=3.74), U (92, 12) = 241, p<.05. However, no significant differences between the groups were found in the other subscales of the IRI (fantasy; empathic concern and personal distress). Possible explanations for these findings are outlined in the discussion chapter.

3.5.9 Summary of discriminant validity

The control group performed statistically significantly better (p<0.05) on five of the seven video clips "no phrase" (all of the items except angry and sad). The ABI group had most difficulty correctly identifying the emotions fear and disgust in the "no phrase" BERT.

Analysis revealed that the control group performed significantly better in two of the seven "with phrase" items (angry and frightened).

There was a statistically significant difference between the control group and the ABI group on all parts of the BERT ("no phrase", "with phrase" and total score); the EET, BEES, IRI perspective taking scale and STW2. The control group's scores were significantly higher than the ABI group's scores on all of these measures. However, there was no statistically significant difference between the groups with regard to age or the other subscales of the IRI (fantasy; empathic concern and personal distress).

3.6 Clinical cut off scores

Analysis revealed that T1 and T2 scores for the control group did not differ significantly (presented in table 8 above). In view of this finding T1 scores for the control group were used to generate the cut off scores.

Clinical cut off scores were determined to examine whether the number of correctly identified items on the “no phrase”, “with phrase” and the total correct BERT score could discriminate between the control and ABI groups.

Clinical cut off scores are presented in table 12 together with the control group’s mean and *SD* performance, scores on the BERT and the percentage and number of participants in the control and ABI groups whose performance was below the clinical cut off scores.

Table 12: Clinical cut off scores for the “no phrase”, “with phrase” and total correct score on the BERT and the percentage of participants below the cut off scores

	Mean	*SD*	Cut off score (2dp)	Cut off score (0dp)	Controls below cut off score	ABI below cut off score
“no phrase”	6.95	0.23	6.57	6	5% (5/92)	60% (12/20)
“with phrase”	6.30	0.91	4.80	4	4% (4/92)	50% (10/20)
Total correct	13.25	0.94	11.70	11	5% (5/92)	65% (13/20)

Mann Whitney U analysis showed that there were significant correlations between the ABI participants who scored below the cut off score on the total BERT and their performance on the EET and IRI Fantasy subscale but there were no correlations with performance on the BEES or the other subscales of the IRI or on STW2 performance. The analysis is presented in table 13.

Table 13. Means, *SD*s and p values for ABI participants who performed above and below the cut off score of the BERT and their performance on the EET, BEES, IRI and STW2

	Above cut off			Below cut off			Mann Whitney U (p value)
	n	mean	*SD*	n	mean	*SD*	
EET	7	23.29	1.70	13	14.46	4.70	<.05
BEES	6	25.67	24.06	10	31.20	20.62	>.05
IRI Fantasy	6	19.00	2.97	6	12.00	3.85	<.05
IRI Empathic concern	6	16.83	6.11	6	17.67	6.53	>.05
IRI Perspective taking	6	19.50	5.17	6	16.50	3.56	>.05
IRI Personal distress	6	15.33	3.88	6	14.50	2.66	>.05
STW2	6	83.67	6.12	9	70.89	18.13	>.05

3.6.1 Summary of clinical cut off scores

The clinical cut off scores for the BERT are:

BERT “no phrase” – 6

BERT “with phrase” – 4

Total correct BERT - 11.

Chapter 4: Discussion of the findings

4.1 Introduction

This chapter discusses whether the research aims were achieved and the extent to which the findings support the research hypotheses. The study's findings on valence and other issues relevant to the existing body of emotion recognition research are also discussed, together with the implications of the findings for counselling psychology, the limitations of the study and future research potential.

The forthcoming discussion will contribute to the body of knowledge available on emotion recognition in ABI.

4.2 Were the aims of the study achieved?

4.2.1 Aim 1 *- To develop a short simple valid and reliable screening instrument to use in clinical, research and rehabilitation contexts for detection of emotion recognition problems using contemporary stimulus items.*

A short simple to administer screening instrument of emotion recognition problems called the BERT was developed. It consists of contemporary stimulus items. The validity and reliability of the instrument is discussed in sections 4.3.1 and 4.3.2 below. The potential use of the screening measure in clinical, research and rehabilitation contexts is discussed in sections 4.6, 4.8 and 4.9 below.

4.2.2 Aim 2 *- The new screening measure would consist of short video clips of actors portraying the six basic emotions and neutral. There would be two parts to the test. One part would screen for deficits recognising facial expressions (no vocal cues), and the second part would screen for deficits recognising emotions expressed facially with prosody congruent to the facial expression.*

This aim was achieved. The BERT has two parts. The first uses facial expressions only ("no phrase" BERT) and the second uses facial expressions, neutral sentences and vocal prosody which is congruent with the facial expression ("with phrase" BERT).

4.2.3 Aim 3 - To generate normative data from an age stratified sample of neurologically healthy participants and compare the performance of the neurologically healthy participants with a sample of participants with ABI.

This aim was achieved. Data from an age stratified sample of 92 neurologically healthy participants was obtained on performance on the BERT and other measures. This data was compared with data obtained from a sample of 20 participants with moderate to severe ABI.

4.2.4 Aim 4 - To explore whether performance on the BERT had any association with general intelligence, gender, education or age.

This aim was achieved.

Pre-morbid intelligence (STW2)

No significant correlations were found in the control group between performance on the BERT and the measure of pre-morbid general intelligence used in this study (STW2). This finding suggests that in neurologically healthy individuals performance on the BERT is not affected by general intelligence as measured by STW2.

In the ABI group no association was found between performance on the "no phrase" BERT and STW2 score. However, a significant relationship was found between STW2 score and performance on the "with phrase" BERT and a trend of a relationship was found between STW2 and total BERT score. Intelligence differences have been found to have some influence on performance on the EET (McDonald et al., 2003). Accordingly, the finding in the current study is consistent with that finding.

Cognitive reserve theories (Satz, 1993; Stern, 2002) suggest that pre-injury intellectual functioning can affect outcome after ABI, and individuals with higher intellectual function before their ABI tend to have better outcomes because of their higher intelligence. Cognitive reserve theory has some evidence to support it in other clinical populations. For example, in Alzheimer's disease higher premorbid intelligence has been found to be associated with later disease onset (Bigeo et al., 2002; Stern, Alexander, Prohovnik & Mayeux, 1992) and in HIV individuals with lower IQ have been found to have greater cognitive dysfunction than those with high IQ regardless of clinical severity (Basso & Bornstein, 2000, Stern, Silva, Chaisson & Evans, 1996).

Therefore, a possible explanation for the finding in the current study that ABI participants with lower STW2 scores performed worse on the "with phrase" BERT and the finding of a trend of poorer performance on the total BERT score is that individuals with lower STW2 scores have less cognitive reserve than individuals with higher STW2 scores, and this makes them more at risk of emotion recognition problems (Satz, 1993; Stern, 2002). More research is needed to explore the relevance of cognitive reserve theory in ABI (Kesler, Adams, Blasey & Bigler, 2003) and whether pre-morbid intelligence is a relevant factor when considering emotion recognition problems after ABI. A positive finding would have important implications for clinical practice as it could suggest that pre-morbid intelligence is a predictor of emotion recognition problems and consideration should be given to routinely screening for low pre-morbid intelligence.

The findings in the current study suggest that STW2 scores differentiate between the control and ABI groups' performance on the total BERT. The author and her supervisory team have discussed this and suggest that the reason STW2 can predict differences between the groups on performance on the BERT, is probably because the variables group and STW2 are confounded, thus making it difficult to say what the actual contribution of STW2 is. In other words, whilst STW2 seems to explain a significant amount of performance, the author and her supervisory team consider that it is possible that the BERT is picking up something other than pre-morbid intelligence. We know that many individuals with ABI have cognitive impairments (Bornhofen & McDonald, 2008a) and it is possible that the BERT may be picking up wider dysfunction such as executive functioning impairments. Executive function impairments were not measured in the current study. Please see section 4.8.5 below for a discussion of this limitation.

The size of the ABI sample in the current study was small and whilst both groups performed worse on the "with phrase" BERT, the ABI group found it particularly difficult. Also, a significant difference was found between the STW2 scores of the ABI and healthy control groups, with the ABI group mean score being much lower and the standard deviation of the ABI group's scores being much higher. Therefore caution is needed when drawing inferences from the findings in the current study. Further research using larger samples of ABI participants is needed to explore the impact of STW2 score on performance on the BERT.

Gender

Some research has found females are better at emotion recognition than males (for example, Rigon, Turkstra, Matlu & Duff, 2016). However, in the current study no significant gender differences were found in the control or ABI groups. The findings in the current study on gender suggest that the same clinical cut off scores can be used when the BERT is administered to men or women.

Education

A significant difference in years education was found between the healthy control and ABI groups. However, analysis showed that education was not a significant predictor of performance on the BERT.

Age

No significant correlations between age and the "with phrase" or total correct BERT were found in the control group. However, there was a significant correlation between age and the "no phrase" BERT. As mentioned previously, the vast majority of the control group participants got all of the items correct in this part of the test. Analysis of the data shows that of the five people who made an error on this item, four of them were in the older age group (65 to 80 years). All of these participants incorrectly identified the emotion of angry. There is some evidence that older age produces a reduction in the recognition of anger (Calder, et al., 2003). There is some evidence that older adults are less able to identify facial expressions than are young adults (for a meta-analysis, see Ruffman, Henry, Livingstone & Phillips, 2008), that they have better memory for positive than for negative faces (Mather & Carstensen, 2003), and that they attend less to negative than to neutral faces (Isaacowitz et al., 2006).

There is some evidence for an own-age bias in face recognition and person identification. Research suggests that adults of different ages are more likely to recognise faces of their own age group than faces and persons of other ages (Anastasi & Rhodes, 2006; Bäckman, 1991; Bartlett & Fulton, 1991; Lamont, Stewart-Williams & Podd, 2005; Wright & Stroud, 2002). Own-age bias is generally thought to be due to the amount of exposure an individual has to certain classes of faces. People typically see faces similar to their own more frequently and might, therefore, be more familiar with them (Bartlett & Fulton, 1991). The actors used in the current study are young adults (aged less than 30), therefore own age bias may explain why it was some of the older adults in the control group who made most errors. The older adults in this study may have been disadvantaged relative to the younger participants because of the age of the actors in the clips used. Further research using actors of different ages when comparing an age stratified sample is needed to investigate this further.

4.3 The main findings and whether these support the hypotheses

4.3.1 Hypothesis 1 – The new test would be reliable. There would be test retest reliability.

Reliability of the BERT – control group

The test retest data of the 79 neurologically healthy controls on the combined BERT total correct score ("no phrase" BERT and "with phrase" BERT) was statistically significant and suggests the BERT has some evidence of reliability. Correlation was also found on the "with phrase" BERT. Whilst the correlation values are significant, ideally we would have liked them to be higher (around 0.7) as this would have indicated a very strong correlation.

The finding of no significant correlation for the "no phrase" BERT on first and second administration may be explained by the high ceiling effect in the "no phrase" BERT. Nearly all the participants in the control group got all of the "no phrase" BERT items correct (maximum score). The finding of no correlation may therefore be due to the lack of gradient in the data and support the strength of the psychometrics of the measure. Indeed, the percentage agreement score across two administrations of the "no phrase" BERT was 95% suggesting that the "no phrase" BERT does in fact have evidence of test retest reliability in terms of achieving the same score twice. The finding suggests that test retest in neurologically healthy individuals may not be needed. Indeed there are existing screening measures with high ceiling effects in the normal data that are used and found to be clinically useful, for example the "lift counting task" in the Test of Everyday Attention (TEA: Robertson, Ward, Ridgeway & Nimmo-Smith, 1996).

The percentage agreement scores for the "with phrase" and total correct combined BERT scores were slightly lower (65% and 61% respectively) than the percentage agreement score for the "no phrase" BERT. These percentage agreement scores are lower than the usual criterion accepted for reliability which is 70%. A possible explanation for the lower percentage agreement scores is the slight variation in the items incorrectly identified on the second administration. The performance of the participants in the control group was slightly improved on the second administration. The mean total correct combined BERT score on first administration was 13.25 and was 13.60 on the second administration (see table 8). As a result of the fact that the number of test items incorrectly identified by the control group was very small any variation in the data had an effect on the percentage agreement score.

Reliability of the BERT – ABI group

The percentage agreement figures are lower than we would have hoped especially given the strong Spearman Rho's correlation values. A possible explanation for the low percentage agreement scores is the variability in the data. The ABI participants' performance was slightly better in the second administration (see mean scores in table 8).

The test retest reliability correlations for the ABI group were higher than those of the control group with the “no phrase”, “with phrase” and combined BERT total correct score having statistically significant correlation values. These findings suggest there is good test retest reliability on both parts of the BERT and the total correct BERT and suggests that administering the BERT on two occasions one week apart to someone who has an ABI may provide a good indication of whether the person has emotion recognition deficits.

4.3.2 Hypothesis 2 – The new test would have evidence of validity. Performance on the BERT would be correlated with performance on the EET, an existing emotion recognition scale which will confirm criterion validity.

The finding that the BERT was correlated with the EET an existing measure of emotion recognition deficits suggests that the BERT measures what it sets out to measure – emotion recognition deficits. However, whilst the correlation was reasonable for the ABI group it was lower than we would have liked for the control group. The finding of correlations does however give some support to the study’s hypothesis that the BERT would have validity.

4.3.3 Hypothesis 3 – Performance on the BERT would be correlated with the ability to empathise as measured by scores on two existing empathy rating scales (BEES and IRI)

The BEES was designed to assess emotional empathy “a vicarious emotional response to the perceived emotional experiences of others”, in other words measure the ability to feel what other people are feeling (Mehrabian & Epson, 1972). It was found that the BEES was correlated with the control group’s performance on the “with phrase” BERT and the total combined correct score of the BERT. This was as hypothesised. The finding suggests that the BERT may detect some aspects of emotional empathy. The finding of no correlation in the control group's performance on the "no phrase" BERT and BEES may be explained by the high ceiling effect in the data. As mentioned earlier, nearly every participant in the control group got all of the "no phrase" items correct.

No correlations were found between the ABI group's performance on the BERT and the BEES. Further, those ABI participants who scored below the cut off on BERT were not found to have lower BEES scores than those who scored above the cut off. The reason for this is not clear. The BEES was used in the current study because it has a good reliability coefficient and has been used in previous research investigating empathy deficits after ABI (for example; de Sousa et al., 2012; de Sousa et al., 2011; de Sousa et al., 2010; Rushby et al., 2013; Wood & Williams, 2008). A possible explanation for the lack of association in the current study is the small sample size. There were only 20 participants in the ABI group, and of these only 16 completed the BEES. This could have prevented the detection of a significant relationship between the two measures. Other possible explanations include the participants in the ABI group having difficulty completing the self-report measure. Completing it demands cognitive processing including concentration and working memory which are known to often be affected after ABI.

The finding of a significant difference between the control group and ABI group's performance on the BEES supports previous research which has found emotional empathy is often reduced after ABI (for example; Rushby et al., 2013; de Sousa et al., 2012; de Sousa et al., 2011; de Sousa et al., 2012; Wood & Williams, 2008).

The other measure of emotional functioning used in the current study was the IRI, an existing multi-dimensional measure of cognitive empathy. It was hypothesised that a correlation would be found between this measure and the BERT. A significant correlation was found between the control group's performance on the "with phrase" BERT and total combined BERT score and one of the subscales of the IRI, the fantasy subscale. A significant correlation was also found in the ABI group's performance on the "no phrase" BERT and total combined BERT score and the fantasy subscale of the IRI and it was found that ABI participants who scored below the cut off on BERT had lower IRI fantasy scores.

The fantasy subscale of the IRI purportedly measures the ability to put oneself in a fictional situation. For example to identify with fictitious characters in books or films. The finding in the current study may therefore mean that those people who are able to imagine themselves in fictional situations may be good at emotion recognition. However, there is some dispute about what the fantasy subscale actually measures. It has been suggested that it measures processes broader than empathy such as imagination which may be correlated with empathy but may not be empathy itself (Baron-Cohen & Wheelwright, 2004). Thus, the finding of an association between performance on the BERT and this subscale is interesting, but further investigation and understanding of this subscale is needed to be certain about what such an association actually means.

No associations were found between the control group's or ABI group's performance on the BERT and the other three subscales of the IRI which are: empathic concern (feeling warmth or compassion for others); perspective taking (the ability to shift to another's emotional perspective i.e. ability to adopt the point of view of another person); and personal distress (fear or anxiety in response to seeing others in distress). ABI participants who scored below the cut off on BERT did not differ on these IRI subscales to those who scored above the cut off. The finding of no associations between performance on the BERT and the three subscales of the IRI was not expected. The reason for the lack of association in the current study is not clear, but suggests that the BERT does not detect the facets of cognitive empathy (or other deficits) that these subscales of the IRI measure.

As with the fantasy subscale of the IRI there is some disagreement about what the other subscales of the IRI measure. For example, it has been suggested that the personal distress scale may in part assess anxiety and the inability to monitor and inhibit emotional reactions (Baron-Cohen & Wheelwright, 2004). It seems that more investigations on the IRI would help give greater certainty and clarity as to what the various subscales measure so that a clearer picture of what correlations with the subscales may mean.

The finding of no significant difference between the two groups' performance on three of the four subscales of the IRI (fantasy; empathic concern; and personal distress) is interesting. The finding compares to existing research which has found that individuals with ABI self-report lower cognitive empathy than do matched controls (de Sousa et al., 2010; Grattan & Eslinger, 1989; Wells et al., 2005). Only performance on the IRI perspective taking scale was found to be significantly different between the two groups which suggests that the ABI group was less able to shift to another's emotional perspective i.e. had reduced ability to adopt the point of view of another person. One issue that was apparent during the current study was that the IRI is quite a difficult self-report questionnaire to complete. It uses a nine point Likert scale and a number of the questions are "reversed". Completion of the IRI was done online by all of the control group participants and the majority of the ABI participants. Whilst this measure has been used in other ABI research it appears that the IRI has been completed manually before. The fact that it was completed online may have affected how participants answered the questions. For example it may be that in the previous studies where the measure has been completed manually the questions have been read out to the participants and may have been explained or clarified whereas the online version requires the participants to read, understand and respond to the questions. In the current study the participants with ABI all completed the tasks on a desk top computer with a reasonably sized screen. It is possible that factors such as clarity and size of the images on the screen could have affected performance as could completing the measures online. Further research exploring these factors is needed.

In summary the findings suggest that the BERT may pick up on some aspects of empathy. This finding is not surprising as theories of empathy acknowledge that recognising emotions is a fundamental process involved in empathy (Feshbach, 1987; Preston & de Waal, 2002). Those that have attempted to identify the components of empathy such as Rankin et al. (2005), have identified that empathy has different cognitive components (including working memory; perspective taking; abstract reasoning; cognitive flexibility and reactive cognitive flexibility) as well as emotional components (which include recognising other's emotions, emotional responsiveness, identifying one's own emotional state and expressing one's emotional state). However, empathy as a construct does not have a universally agreed definition and this has implications for understanding its role in emotion recognition and social cognition generally. Ideally, it would be good if a clear definition of empathy and its components could be agreed and used in future research.

***4.3.4 – Hypothesis 4 – Performance of the ABI group would be worse than the neurologically healthy group on the BERT* and EET**

As hypothesised the performance of participants in the ABI group was found to be statistically worse than that of the control group on the all parts of the BERT ("no phrase" and "with phrase" and the total score. The difference between the groups was statistically significant. Whilst the sample size of the ABI group was small (20 adults) the finding provides some evidence of the construct validity of the BERT.

Further the performance of the participants in the ABI group on the EET was significantly worse than the neurologically healthy controls. This finding supports the general finding in the literature that after brain injury recognising emotions is often impaired (for example the studies of Knox & Douglas, 2009; McDonald et al., 2003; Williams and Wood, 2010b).

4.3.5 Hypothesis 5 - Performance would be improved in both groups in the second part of the new test ("with phrase" BERT) which provides more cues (facial expression and vocal cues) and there would be smaller group differences for the "with phrase" BERT than the "no phrase" BERT

It was hypothesised that performance on the "with phrase" BERT would be better than the "no phrase" BERT. This hypothesis was based on the "with phrase" BERT having multimodal stimuli (neutral sentences and vocal prosody congruent with facial expressions) and evidence from previous research involving multi-modal stimuli which suggests the presence of more cues can help in the recognition of emotions. For example, the presence of more cues being present in dynamic displays of emotion than static displays and this aiding emotion recognition has been proposed as a possible explanation in two studies for the finding that participants were better at recognising emotions in dynamic displays than static displays (McDonald & Saunders, 2005; Williams & Wood, 2010a).

Contrary to the hypothesis both the control and ABI groups' performed worse on the "with phrase" BERT than the "no phrase" BERT. The ABI group performed significantly worse than the control group. We know that individuals with ABI have difficulty recognising emotion in speech and facial expressions (McDonald et al., 2004) and face and voice discrimination have different cognitive demands (Dimoska et al., 2010). Emotions in voice are conveyed by two sources: speech content and prosody, making dual processing and working memory demands (Dimoska et al., 2010). Thus, impaired recognition of vocal cues may reflect a loss of efficiency, such as cognitive impairment that is not specific to vocal emotion. In the current study no general cognitive measures were taken. This is a limitation of the study and is discussed in more detail in section 4.8.5 below. It would be useful if in future research using the BERT, cognitive measures are taken to explore what impact if any, these have on performance on the BERT. However, existing research suggests that general cognitive impairment cannot fully account for deficits in prosodic perception, for example, it does not explain differential impairment identifying different emotions (Dimoska et al., 2010; Spell & Frank, 2000).

A possible explanation for the finding in the current study is that different types of stimulus (visual and vocal) require different neural structures to be used **(**Adolphs et al., 2002; Adolphs et al., 2003; Brück, Kreifelts & Wildgrubber, 2011). Whether stimuli are presented in one modality or multi modally is thought to involve different parts of the brain (Brück et al., 2011). Most agree that emotional prosody engages brain systems (especially right hemisphere) which overlap with those used in facial expression recognition (Zupan et al., 2009). However, there is evidence that they do not entirely coincide (Adolphs et al., 2002). Another possible explanation is that the prosody used in the video clips was less well presented in some clips than others and this could have distracted participants from recognising the facial expression. Further work exploring this would be helpful as would investigations into the impact of possible order effect.

The accurate interpretation of vocal cues of emotion is very important but not well researched (Zupan et al., 2009) despite the fact that successful social communication relies on understanding and being able to respond to multiple sources of information. Wildgruber et al., 2007 have put forward a "cerebral network model" to explain how multiple sources of information are processed. This model advocates that there are 3 stages. In the first stage the brain has to extract the relevant visual and vocal signals that are being presented. In the second stage the brain processes integrate the visual and vocal signals and in the third stage cognitive evaluation of the information takes place. Thus, applying this model to the current study someone who performs poorly on the "with phrase" BERT may have a problem at any or all of these stages. Further research, exploring where and at what stage the deficit is, for example using neural imaging (MRI or fMRI) whilst the BERT is completed, is needed.

Evidence suggests that individuals with ABI have greater impairment for vocal emotion recognition than facial recognition (McDonald & Saunders, 2005; Spell & Frank, 2000). Research investigating different modes of stimuli have shown that the performance of ABI individuals is worse when stimuli are presented auditorily only i.e. without visual cues (Marquardt at al., 2001). Further, there is evidence that ABI individuals perform better on moving facial displays than audio visual display, audio only displays and static photos (McDonald & Saunders, 2005). Thus, the finding in the current study that the ABI group was impaired on both the "no phrase" BERT and "with phrase" BERT and that both groups performed better on the "no phrase" BERT than the "with phrase" BERT fits with the findings of McDonald and Saunders in their 2005 study.

Another possible explanation for poorer performance on the “with phrase” BERT may be attributable to having used neutral phrases. There is evidence that emotional facial expressions are more easily classified when accompanied by congruent emotional prosody (De Gelder & Vroomen, 2000). In the current study the prosody was consistent with the facial expression being portrayed, however, the verbal content of was neutral which meant there was no supportive verbal content to help identify the emotion. The poorer performance of both groups on this part of the BERT may be explained by the neutral content of the verbal expression causing confusion and making the target emotion more difficult to identify.

The performance of the ABI group was much lower than the control group’s on the “with phrase” BERT. It may be that the individuals with ABI who performed poorly on the “with phrase” BERT relied on the verbal content at the expense of the facial expressions, prosody and non-verbal cues. This explanation fits with existing research findings that individuals with ABI are more likely to give precedence to verbal content whilst people without ABI are more likely to attend to affective prosody when information is not congruent (Marquardt et al., 2001; McDonald & Saunders, 2005). Over reliance on vocal content could disadvantage the understanding of emotion as evidence suggests that 55 percent of the emotional meaning of a message is expressed through facial, postural, and gestural means, and 38 percent of the emotional meaning is transmitted through the tone of voice. Only seven percent of the emotional meaning is actually expressed with words (Mehrabian, 1997).

Evidence suggests congruous and incongruous vocal content and prosody are encoded and processed by different parts of the brain and that when verbal content (congruent or incongruent) is present it requires engagement of additional cerebral resources (Brück, Kreifelts & Wildgrubber, 2011). There is some evidence that when verbal content is incongruous it is more difficult to decode the actual target emotion than when the verbal content is congruent (Zupan et al., 2009).

In the current study the emotional prosody was congruent with the facial expression, but the verbal content was neutral. Only a small number of studies have investigated the ability of individuals with ABI and neurologically healthy people to identify emotion portrayed in neutral affective sentences. Marquardt at al., 2001 is one of the few studies that have. As well as looking at congruous and incongruous sentences and finding (as in the current study) that the participants with ABI showed significantly reduced capacity to identify emotion irrespective of mode presented (whether the information was presented with facial expressions coded in the same way as the prosody or whether the congruous and ambiguous sentences were presented without visual clues, in other words by audio only) the study compared emotion recognition of congruous and neutral items. It found that nearly all of the control group (99%) were able to correctly identify both types of items. In comparison the study found that the majority (97%) of the ABI participants were able to correctly identify the congruous items, but only 86% were able to identify the neutral sentences. In the Marquardt et al. (2001) study, the percentage of the ABI group that were able to correctly recognise emotions when neutral sentences were used was higher than those found in the current study. This may be explained by the fact that in the Marquardt et al. (2001) study, the participants had to pass a preliminary screening test to see if they were able to recognise emotions depicted in pictograms. In other words, the participants had to be pretty good at recognising emotions to take part. Also, the study was very small involving just seven ABI participants and seven matched controls. The Marquardt et al. (2001) study's findings on neutral sentences were similar to those in the current study, however the number of participants used in the study was very small and the study involved selection criteria. More research, using larger sample sizes is needed to investigate emotion recognition from neutral sentences.

Finally, another possible reason for the better performance on the “no phrase” BERT is that the length of the video clips was slightly longer in the “no phrase” BERT than the “with phrase” BERT. Accordingly, the better performance may be explained by the participants having more time to view the “no phrase” clips and therefore more time to decide which emotion was being portrayed. A future study using the same length “no phrase” and “with phrase” video clips is needed to investigate whether length of clip can explain the difference in performance.

4.3.6 Hypothesis 6 - It would be possible to calculate clinical cut off scores

The data obtained from the neurologically healthy controls enabled clinical cut off scores for the “no phrase” BERT, “with phrase” BERT and total correct combined score on the BERT to be calculated. In this group there was no evidence of a correlation between the STW2 scores and performance on the BERT. Further, no significant difference in performance on the total BERT was found between ABI participants who scored below the BERT cut off and those who scored above in terms of total STW2 score suggesting that one set of clinical cut off scores can be used. However, performance on the BERT was found to be associated with STW2 score (see section 4.2.4 above for discussion on this).

BERT “no phrase” - clinical cut off score is 6

The finding in this study was that the majority of the control group found the “no phrase” BERT very straightforward. Using the clinical cut off score of 6 that has been calculated, 95% of the control group were above this score on first administration and 99% on second administration. In comparison more than half of the ABI participants scored below the cut off score on first administration (60%) and second administration (53%). The findings suggest that if someone gets even one item incorrect they may have problems with facial emotion recognition and warrant further investigations.

BERT "with phrase" - clinical cut off score is 4

The ABI group's performance was much lower than the control group's. Applying the calculated cut off score of 4 for first administration, 96% of the control group scored above this score whereas only 50% of the ABI participants managed to do this. The findings suggest that performance below the cut off score of 4 may be an indication that there are difficulties recognising emotions from facial expressions with congruent prosody and neutral verbal content and further investigations are warranted.

Total combined correct BERT score - clinical cut off score is 11

When the correct scores of the "no phrase" BERT and "with phrase" BERT are combined the cut off score is 11. Applying this cut off score it was found that only just over a third of the ABI group (35%) performed above this compared to 95% of the control group. The difference between the groups is marked. The finding suggest that administering both parts of the test may be a helpful way of screening for emotion recognitions problems. However, given the small sample size used further research is needed to confirm the cut off scores.

4.4 How to use the BERT - What are the different parts of the BERT screening for?

Administering both parts of the BERT ("no phrase" and "with phrase") is efficient and cost effective. Most people are able to complete it in about 5-10 minutes. The current study is a new study, and accordingly, further research is needed to investigate its validity. However, on the findings we have, it is possible to put forward suggestions about what the two parts of the BERT are measuring and how they may be used in practice. There appears to be no reason why the two parts of the BERT could not be administered separately or together.

4.4.1 The "no phrase" BERT

The "no phrase" BERT detects problems recognising moving (dynamic) facial expressions and non-verbal cues. It contains no vocal cues (prosody or content). A growing body of evidence shows that many adults are impaired in their ability to recognise facial emotions after ABI (see for example; McDonald, 2005; Babbage et al, 2011). The results of this current study indicate that getting even one item in this part of the test incorrect is unusual in neurologically healthy controls. This means the "no phrase" BERT could be a very useful screening tool of emotion recognition problems. It is quick and easy to administer and the results would give an indication of whether the person may have emotion recognition problems which warrant further investigations.

4.4.2 The "with phrase" BERT

The "with phrase" BERT detects problems recognising moving (dynamic) facial expressions and congruent prosody with neutral verbal content (the phrases are not consistent or inconsistent with the emotion being expressed). Like the "no phrase" BERT it is a useful screening tool for emotion recognition problems. It may detect problems processing multi-modal stimuli as well as being a useful screening tool to help identify those people who rely too much on verbal content with the consequence that they miss or are unable to identify the actual emotion someone is feeling. The findings suggest that individuals, both neurologically healthy controls and individuals with ABI find this part of the BERT more difficult than the “no phrase” BERT with individuals with ABI finding it particularly more difficult.

4.4.3 Administering both the “no phrase” and “with phrase” BERT

Successful social communication relies on understanding multiple sources of information (Bornhofen & McDonald, 2008a). Administering both the “no phrase” and “with phrase” BERT would provide more information about emotion recognition problems than administering just one of them. The complete BERT may be a useful screening tool to identify if there are problems with facial emotion recognition when the stimuli is simple (dynamic visual facial expressions) and/or there are problems recognising emotions when the stimuli are dynamic facial expressions and vocal cues. Based on the findings in the current study it would be expected that individuals with ABI would struggle more on the “with phrase” BERT. Thus, someone who scores above the cut off score on the “no phrase” BERT but below the cut off score on the “with phrase” BERT may be able to recognise emotions which are expressed without verbal content but struggle when there are multiple sources of information to process especially where some of the information (verbal content) is inconsistent with the other cues available. This information may be helpful when assessing emotion recognition problems and planning rehabilitation. Further, it would be expected that individuals with ABI would struggle more when face and voice are incongruent (Zupan et al., 2009) so future work extending the current BERT to include congruent and incongruent vocal content would be useful.

4.5 Findings on valence

The participants found some emotions easier to identify than others. This supports existing research which has found the nature of emotion recognition difficulties varies depending on the emotional valence of the stimuli. As previously found, (for example by Calvo & Lundqvist, 2008; and Spell & Frank, 2000), happy was the easiest emotion to recognise for both the ABI and control group. One explanation for happy being easier to recognise than negative emotions such as fear is that happy can be recognised by a single feature; a smile, whereas other emotions require attention to multiple aspects (Adolphs, 2002).

Whilst surprise is recognised to be one of the standard emotions it does not have clear valence (Kreibig, 2010). In the current study it was found that when the actors were asked to portray the emotion surprise, the majority expressed it in a positive way – a "happy" surprise. Accordingly, in the current study surprise has been categorised as a positive emotion. The ABI participants in current study found the positive emotions (happy and surprise) easier to identify than the negative ones (fear, anger, disgust). This finding is consistent with earlier research (including: Adolphs et al., 1999; Croker & McDonald 2005; McDonald et al., 2003).

Inconsistent with existing research findings, the negative emotion sad was not found to be particularly difficult to identify by participants in the control or ABI group in the present study. Only one person in the ABI group got this wrong on the "no phrase" BERT and no-one in the control group got it incorrect. In the "with phrase" BERT more of the ABI participants got the sad item incorrect (30%) and found it as difficult as frightened and surprise to recognise, though they found the other negative emotions (disgust and angry) and also the neutral item more difficult to recognise.

The reason why sad was not found to be as difficult to recognise as the other negative emotions of disgust and fear is not clear. It may be that the negative emotions of disgust and fear have a very clear basic evolutionary survival purpose and so are easier to recognise. Processing of these emotions has been associated with the "older" brain structures of the brain like the amygdala (Adolphs et al., 2002; Adolphs et al., 1994, 1995; Calder et al., 1996). However, the amygdala has also been associated with recognising sad expressions (Adolphs & Tranel, 2004) so one may expect that someone who has difficulty recognising fear will also have difficulty recognising sad expressions, but in the current study this was not always the case.

One of the most difficult emotions for the ABI group to identify was disgust. Poor performance compared to the control group was very noticeable in the "no phrase" BERT where 30% incorrectly identified this emotion compared to none of the control group. However, performance was even poorer in the "with phrase" BERT where only 50% correctly identified disgust compared to 86% of the control group. This finding supports previous research which has found problems recognising disgust after ABI (Hornak et al., 1996; Jackson & Moffat, 1987; and McDonald et al., 2003).

As mentioned above significant differences were found between the performance of the neurologically healthy control group and ABI group on both the "no phrase" and "with phrase" BERT. Analysis of the individual items, controlling for multiple comparisons (Type 1 error) found clear group differences in recognising happy, surprise, fear, disgust and neutral but not angry or sad in the "no phrase" BERT. In the "with phrase" BERT, the percentage of participants who correctly identified each of the emotions in the "with phrase" BERT was higher for the neurologically healthy control group than the ABI group. However, analysis controlling for multiple comparisons (Type 1 error) only found clear group differences in recognising angry and fear but not sad, disgust, happy surprise or neutral. Further investigations, using a larger and matched ABI group to explore this further would be useful.

The current study supports existing research (for example that of Calvo & Lundqvist, 2008; Croker & McDonald, 2005; McDonald et al., 2003; Spell & Frank, 2000) that some emotions are easier to recognise than others after ABI. It has been suggested that different neurological pathways may be involved in processing different emotions (Adolphs et al., 1999; Kessels et al., 2014; Wood & Williams, 2010). There is some evidence to support this. For example, there is evidence that the ventral striatum is involved in recognising anger (Calder, Keane, Lawrence & Manes, 2004) and neuroimaging studies investigating disgust (including those of Calder, Keane, Manes, Antoun & Young, 2000 and Sprengelmeyer et al.,1996), provide evidence that the facial expressions associated with disgust engage different regions of the brain (insula and putamen) than other facial expressions.

It is possible that the reason why some participants had more difficulty recognising certain emotions than others is because of their particular type of ABI. In other words because they have damage to particular regions or neurological networks and this damage affected their ability to recognise some emotions. The evidence suggests that whilst identifying different emotions may use some of the same neurological pathways they may also involve different ones. For example, it has been estimated that approximately 50% of patients with amygdala damage have impaired ability to recognise sad facial expressions (Fine & Blair, 2000). If exactly the same processes were involved then one would expect this figure to be nearer 100%. Therefore, whilst existing studies provide us with some evidence of the neurological processes involved in emotion recognition, further research is needed to give us an even better understanding. The BERT could be used in further investigations into whether different neurological pathways are involved in recognising different emotions and also in studies exploring the effects of particular types of brain injury on emotion recognition. Neuroimaging (for example MRI and fMRI scans) could take place whilst individuals with ABI complete the BERT to explore neurological differences whilst different emotions are being observed.

The BERT could also be used to explore the theory that the reason for the current findings on valence is that impaired emotion recognition is associated with impairment of the ability to physiologically respond to emotionally charged stimuli (Rapcsak et al., 2000). It is proposed that fear is the most emotionally charged emotion so the lack of physiological response to fear is most noticeable (Hopkins, Dywan and Segalowitz, 2002). Further research involving participants completing the BERT whilst their physiological responding is measured (for example using facial EMG; skin conductance, heart rate, eye tracking or EEG) would add to this area of knowledge.

4.6 Contributions made by the current study

The current study makes a number of contributions. These will now be discussed.

4.6.1 Development of a screening tool that can rapidly detect emotion recognition difficulties after ABI

The current study has developed a new quick and easy to administer computerised screening tool that can be used to screen for emotion recognition problems in people who have ABI. The BERT has a number of advantages over existing measures such as the EET. These include it being an online measure; quicker and easier to administer; not visually outdated; and its results are available instantly on line. These make it a useful clinical tool. The BERT can be used to screen for emotion recognition problems and help identify if further evaluation of emotion recognition problems or preliminary interventions are needed. It can be used in rehabilitation as a baseline measure to determine change; and being easy to administer means it can be performed by support staff who have had training as well as clinicians (Roebuck-Spencer et al., 2017). Its implications for clinical practice and rehabilitation are discussed in more detail below.

4.6.2 Screen for emotion recognition problems shortly after ABI

The ease of administration of the BERT means it can be used to screen for emotion recognition impairments in the early stages after ABI. This has important implications for clinical practice because we know that emotion recognition problems are present straight after injury (Borgaro et al., 2004; Green et al., 2004) and the importance and usefulness of having a test that can assess possible problems in emotion recognition during early recovery has been highlighted (Borgaro et al., 2004). The BERT is a brief screening measure that can be used in an acute setting where the patient's ability to endure extensive assessment may be limited (Borgaro et al., 2004). Further, there is evidence that deficits in emotion recognition can be a marker for behavioural problems and lack of insight in ABI patients (Spikman, et al., 2013), thus the BERT has clinical implications in being able to be a marker for these deficits and enable further investigations to be identified and rehabilitation interventions to be made.

4.6.3 Informing rehabilitation

To date there has been a lot of focus on cognitive function including memory, attention and processing speed as predictors of outcome (May et al., 2017). Cognitive deficits do affect individuals with ABI and there is evidence that measures of cognitive function such as working memory can predict psychosocial outcome following ABI (Wood & Rutterford, 2006). However, having an acceptable level of cognitive function does not always predict ability to return to social functioning (Wood, 2001). We now know that the ability to recognise and respond to social information (social cognition) is just if not more important as other cognitive functions (May et al., 2017) and one may underlie the other.

Currently, problems recognising emotions after ABI often go undetected even though these problems cause difficulties in interpreting situations and may result in inappropriate interactions and reduced communication. Emotion recognition deficits have been associated with poor social outcome and community integration difficulties and have been highlighted as an area to target in rehabilitation (May et al., 2017).

Identifying problems with emotion recognition has clinical implications for treatment planning. Patients and families can be better informed about the difficulty the ABI person may be having in understanding emotions (and also possibly expressing emotions). Understanding a problem helps people to deal with it (Tam, McKay, Sloan & Ponsford, 2015; Wood et al., 2005). Interventions such as teaching strategies to try to minimise these problems are beneficial (Marquardt et al., 2001). For example training family members to use statements that are congruent in affect, make the emotional meaning of their sentences as clear and unambiguous as possible and training them to use verbal qualifiers such as “Of course I was only joking when I said that” may be helpful (Marquardt et al., 2001). For individuals with ABI with emotion recognition problems, helpful interventions include emotion identification training and helping them to identify statements that seem confusing and seek feedback to clarify meaning (Marquardt et al., 2001).

Longitudinal research including that of Milders et al. (2003) and Ietswaart et al. (2008) suggests that impairments in emotion recognition are long lasting and do not change over time. However, there is growing evidence that emotion identification training can result in significant improvements in facial emotion recognition (Bornhofen &

McDonald, 2007; Guercio, Podolska-Schroeder & Rehfeldt, 2004; Radice-Neumann, Zupan, Tomita, & Willer, 2009). In other words that improvement is possible. This is not surprising as there is evidence that emotion recognition training is helpful in other clinical populations including autism (Bolte et al., 2002; 2006) and schizophrenia (Wolwer, Frommann, Halfmann, Piaszek, Streit & Gaebel, 2005). Whilst it's important to remember that the ABI population differs to these other populations the strategies used may be applicable and useful to the ABI population. The BERT could be a useful tool in facial recognition training and as a baseline measure of emotion recognition deficits. The findings show that the "no phrase" BERT is easier than the "with phrase" BERT, so different parts of the BERT could be used according to the severity of emotion recognition problems. In other words, the "no phrase" BERT could be used in emotion recognition training with individuals who need basic emotion recognition training and the "with phrase" BERT could be used with individuals who would benefit from complex emotion recognition training.

4.6.4 Support for previous research findings

The findings in the current study support previous research on problems with facial and vocal emotion recognition after ABI and previous findings on valence (outlined above).

4.6.5 The finding that neutral verbal content appears to make emotion recognition more difficult

The inclusion of neutral sentences in the "with phrase" BERT makes the current study unusual because there are few previous studies that have used neutral sentences. The findings in the current study suggest that neutral vocal content makes emotion recognition more difficult and may provide a useful marker of emotion recognition problems.

Zupan et al. (2009) suggests that the neural substrates of facial and vocal emotion recognition are shared, and the bimodal processing of facial and vocal information acts as an emotional or affective prime to trigger the stored emotional knowledge within emotion in the voice and face. According to Zupan et al. (2009), when information from facial and vocal stimuli is not congruent (as is the case with neutral sentences) it can result in confusion (Zupan et al., 2009).

Some of the problems individuals with ABI have with emotion recognition may stem from an impairment managing the dual processing demands of understanding the speech prosody (the *how)* and the content of the spoken speech (the *what*) (Dimoska et al., 2010). We know that individuals with ABI find it more difficult to recognise emotion when the vocal content is incongruous (Marquardt et al., 2001; Zupan et al., 2009) and rely more on verbal content than paralinguistic cues than matched controls (McDonald & Flanagan, 2004). Dimoska et al. (2010) suggest that it is an impairment in processing of emotional prosody itself rather than semantic processing demands which leads to an over-reliance on the "what" rather than the "how" in conversational remarks. Thus, the use of neutral sentences in the current study may have confused the individuals with ABI. Another explanation is that cognitive deficits such as poor working memory, information processing speed and reasoning resulted in an over reliance on semantic information at the expense of other cues such as prosody (McDonald, Bornhofen, Shum, Long, Saunders & Neulinger, 2006).

The study's findings highlight that the use of neutral sentences in emotion recognition tasks is an area that requires further investigation.

4.6.6 The BERT could add to the debate on theories of emotion recognition

The BERT could be used to add to the debate on theories of emotion recognition. Neuroimaging using MRI and fMRI could be done whilst individuals complete the BERT to explore whether Gallesse's "shared manifold" hypothesis of emotion recognition, namely that when we observe emotions in others our motor system becomes active and resonates with that emotion as if we were feeling the same emotion (Gallesse, 2003). The BERT could be used to add to the debate on the theory that emotion recognition involves the interpretation of our own emotional state to identify emotions in others (Adolphs, 2002; Adolphs et al., 2000). Whilst observing the different items in the BERT participants could be asked how they are feeling to explore this theory.

The BERT could also be used to explore theories that physiological responding to emotion stimuli is affected after ABI (for example the research of Baker &Good, 2004; Hopkins et al., 2002, De Sousa et al., 2011; Wood & Williams, 2012). Measures of physiological responding (using for example electro dermal activity (EDA), facial EMG, skin conductance using finger electrodes, eye blink component of startle reflex and heart rate) could be taken whilst the BERT is administered. The effect of valence could also be explored using the BERT.

4.7 Relevance of current study to Counselling Psychology

People with ABI and their families may need professional assistance to maintain a reasonable quality of life even more than a decade post-injury (Hoofian et al., 2001). Anxiety and depression have been found to be evident in a significant proportion (approximately half) of people who have had ABI (Ponsford, Olver, Ponsford & Nelms, 2002) and is evident in 25-30% of relatives with 60-80% reporting some emotional distress (Kreutzer et al., 1994; Livingston et al., 1985). An individual with ABI or family member may be referred to a Counselling Psychologist or other psychological therapist because of anxiety, depression or other psychological distress. It is therefore important that Counselling Psychologists and others working with people affected by ABI understand as much as possible about the effects of ABI.

As well as providing a screening measure of emotion recognition problems which may be helpful for counselling psychologists, the current study adds to the existing literature on emotion recognition impairments after ABI. It highlights the difficulties some individuals with ABI have with emotion recognition. Hopefully this will help to enable their voice to be heard and influence the ways in which therapy is organised and developed (McLeod, 2009). For example, in a therapeutic capacity, if someone having therapy has difficulty recognising emotions then it is helpful for the therapist to be aware of this. Having a good understanding of the person's problems helps therapists retain an empathic position (Clarkson, 2003). It may also help inform work done in therapy. For example, it may be helpful to train someone who struggles with recognising emotions on how to ask for clarification when sentences seem confusing or surprising or help family members make their emotional meaning as clear as possible using verbal qualifiers such as "I was only joking when I said …" (Marquardt et al., 2001).

An important factor in post-injury recovery is social behaviour (Struchen, Pappadis, Sander, Burrows & Myszka, 2011). Changes in social behaviour including lack of concern for others, anger and irritability, self-centredness and inflexibility are known to be common and debilitating consequences of ABI (Williams & Wood, 2010a; Wood & Yurdakul, 1997). These changes are often a greater burden for patients and families than physical or cognitive deficits (Brooks et al., 1986; Katsifaraki & Wood, 2014). Up until recently little has been understood about the neuropsychological deficits that may underpin changes in social behaviour (Cattran et al., 2011). What is acknowledged is that understanding these deficits could potentially have important implications for the assessment, rehabilitation and prognosis of behavioural changes after ABI (May et al., 2017).

Emotion recognition is known to be related to social behaviour, particularly communication competence (Watts & Douglas, 2006) and social participation (Knox & Douglas, 2009). Both these skills are important for successful relationships. Maintaining close relationships has been shown to be important in maintaining well-being and a positive sense of self after ABI (Douglas & Spellacy, 2000). Emotion recognition has been identified as one of the pre-requisites for adequate social functioning (May et al., 2017). The BERT will make an important contribution in helping improve social functioning because it is a usable tool that can screen for emotion recognition problems. Being able to identify and measure emotion recognition problems is important especially as it is not always associated with severity of ABI or time since injury (May et al., 2017*).* Research suggests there is a link between poor emotion recognition skills and inappropriate behaviour and poorer social communication skills post injury (Milders et al., 2008; Spikman et al., 2013) and social integration (Knox & Douglas, 2009; May et al., 2017; Struchan et al., 2008). The BERT will make an important contribution as it will enable emotion recognition problems to be screened for.

Partners and family members are often the main social and emotional support available to individuals who have ABI (Wood et al., 2005). They frequently have a huge burden upon them and have to deal with cognitive, behavioural and neuro-physical changes, and suffer, often silently (Wood et al., 2005). We know that family members' capacity to make adjustments after ABI largely depends on how predictable the ABI person's behaviour will be in various situations (Wood et al., 2005). Currently, relatives are unprepared for the neuro-behavioural changes that occur as a result of ABI and consequently are unprepared for the demands that occur in their role as care taker (Man, 2002).

The BERT has important implications for individuals with ABI and their families as it provides a means of screening for emotion recognition problems. Being able to identify these problems and explain them to the individual with ABI and their family, will help them understand the problem, inform treatment planning, and enable family members to predict and understand behaviour better which will result in them being prepared for the difficulties caused by poor emotion recognition (Marquardt et al., 2001).

In summary, the BERT is important for counselling psychology because emotion recognition deficits have been shown to effect behaviour and the stability of relationships. The BERT enables deficits in emotion recognition to be screened for. This will help identify when an individual has emotion recognition impairments. The BERT is important in the assessment, rehabilitation and support of individuals with ABI and their families. The more that can be done to support caregivers and individuals with ABI the better the outcomes will be (Marquardt et al., 2001; Wood et al., 2005).

4.8 Limitations of the current study

Like any research study, despite the significance of the findings and the contribution to the existing body of knowledge, this research study has some limitations and areas that require further investigations. It is important to recognise that these limitations could have influenced some of the findings and may have resulted in some misleading conclusions.

4.8.1 Floor or ceiling effects

The emotions in the “no phrase” BERT were very easy for nearly all the participants in the control group to identify. Whilst there is the argument that this introduces “problems with differential task difficulty and floor effects” (Calvo & Lundqvist, 2008; Rapcsak et al., 2000; Biel et al., 1997; Russell, 1994), it seems that this is not actually a problem for the BERT as the finding suggests that neurologically healthy people are able to correctly identify the emotions in the BERT and any error may indicate that the person has problems with emotion recognition.

4.8.2 Is the BERT ecological?

The six standard emotions and neutral were used in this study. These were four negative emotions (fear, anger, disgust and sad), two positive emotions were used (happy and surprise) and neutral. Arguably using these means that it reduces the ecological validity because all the emotions that exist in real life are not displayed (Rosenberg et al., 2016) or available to choose from.

Arguably the BERT is more ecological and real life than many previous tests as it consists of moving (dynamic) displays of emotion and multimodal stimuli whereas most previous studies have used static displays (photos) or unimodal stimuli. However, the BERT uses clips of actors portraying emotions and therefore the emotions displayed are different to those displayed in real life which are more spontaneous and changeable. Accordingly the ecological validity of the BERT (the ability to predict real-life functioning) can be questioned. Notwithstanding this, the BERT may still be a very valuable screening tool for deficits in emotion recognition and further research in emotion recognition.

4.8.3 Participant sample

The control group included a lot of UWE staff, hence there is a question of how representative of the general population the sample is. This group had a significantly higher IQ (as measured by STW2) and education, than the ABI group. The possibility that the control group's better performance on the BERT may be due to the group's higher IQ or years education was analysed. Education was not found to explain performance, however, STW2 appears to explain a significant amount of performance. Possible explanations for this are discussed earlier in this chapter in section 4.2.4.

Another limitation is that the minimum age for participants in the study was 18 years old. There is some evidence that participants under the age of 22 may be socially immature with regard to the social maturation of the frontal lobes and this could influence how they respond to the BEES (Wood & Williams, 2008) and possibly the other measures.

The sample size of the ABI group was small (20 participants) so the findings may be influenced by low power. Future studies using a larger sample size is needed. Also, all the participants in the ABI group were recruited from Headway centres, had moderate to severe ABI and had to satisfy inclusion criteria. It is possible that the participants who made up the ABI group may have included a disproportionate number of people who were not working (people who work may be less likely to attend Headway centres during the day) perhaps because of poor social behaviour or other difficulties, and may have had greater emotion recognition difficulties than if a different group of ABI participants were selected.

4.8.4 Ethnicity and age of the actors used in the video clips

The actors used in the video clips for the new test were all of the same ethnicity (white British) and were all young adults. As mentioned above, there is some evidence that own age bias exists in emotion recognition (Ruffman et al., 2008). Therefore the use of young adult actors may have favoured the young adult participants. The lack of ethnic diversity in the actors used may also have influenced the results. Further research using actors of different ages and different ethnic backgrounds is needed to investigate this further.

4.8.5 Are other executive function deficits involved?

The consequences of ABI are multifactorial and can include executive and attentional dysfunction (Williams & Wood, 2010b). Thus, whilst the findings suggest that the BERT has some evidence of validity as it correlates with the EET, an existing measure of emotion recognition, and is correlated with some measures of empathy (the BEES and fantasy sub-scale of the IRI) it is possible that the ABI group's poor performance on the BERT was due or contributed to by other impairments. Emotion recognition problems may reflect a more general deficit in the capacity for emotional information processing (Lane, Sechrest, Riedel, Shapiro & Kaszniak, 2000).

In the current study executive function was not measured. This is a limitation of the study. There is evidence that additional skills including working memory, reasoning and new learning contribute to dynamic emotion recognition (McDonald et al., 2006). A range of executive processes are needed to perform the BERT. The person needs to be able to see and hear the stimuli on the computer screen. Thus, poor performance may be due to visual or auditory impairments. Whilst the qualifying criteria to take part in the study included no visual or auditory impairments, this was self-reported and not measured. Accordingly, it is not certain that the participants had no visual or auditory impairments. Attentional control and working memory are important for emotional processing (Ridout et al., 2007) and poor performance on the BERT may have been due to executive processes which are commonly impaired after ABI, such as attention, processing speed, working memory, word retrieval or cognitive flexibility (Douglas, 2004).

In other words, it is plausible that the BERT may detect emotion recognition problems, or emotion recognition and other impairments, or impairments other than emotion recognition. Further research is needed to investigate the sensitivity of the BERT to detect emotion recognition problems and understand which other areas of cognitive functioning need to be measured to ensure the BERT accurately measures emotion recognition problems rather than other impairments. Moreover, as impairments after ABI are often multifactorial (Brooks et al., 1986), measuring these other factors could also help highlight targets for interventions.

4.8.6 Forced rather than open response

The study used forced choice recognition rather than open-response. The participants had to choose the emotion being portrayed from a choice of six alternatives and neutral. One could argue that forced choice design does not represent an ecologically valid measure because having to put a label on an expressed emotion does not happen in social interactions and in real life emotions are often expressed quickly or in combination with others (Osbourne-Crawley & McDonald, 2016). Future research using an open response design may provide a more in depth understanding of emotion recognition problems.

4.8.7 Self-report questionnaires

A number of self-report questionnaires were used in the current study. Self-reports raise questions about the validity of the participants' responses as they may be influenced by factors such as how the person would like to be seen or how they think about themselves and this may be different to how the person actually is. Independent clinician ratings may be more accurate than self-ratings (Norris & Tate, 2000).

We know that individuals with brain injury are sometimes unaware of their deficits (Spikman & Naalt, 2010) and self-report questionnaires only measure the person's beliefs about their own abilities. This factor may provide a possible explanation for the poor correlations between the self-report questionnaires used (BEES and IRI) and performance on the BERT. In practice, it is helpful to ask relatives and carers for their views when building a picture of the ABI person's difficulties (Spikman & van der Naalt, 2010). In other words, it is useful to compare the ABI person's self-rated measures with their relative's rated versions. The accuracy of self-report is a very interesting issue in terms of over estimating (or under estimating) ability. An interesting future study involving the BERT would be to ask how well people think they identify emotions and compare this with their actual performance.

4.8.8 The use of STW2

In the current study, a significant difference was found between the groups' STW2 scores, and STW2 was found to be a significant predictor of performance on the BERT. The use of STW2 in the current study is a potential limitation. It was chosen because it is reported to be highly correlated with verbal intelligence (Raven, Raven & Court, 2000), and correlates highly with other well-known tests of written vocabulary such as the National Adult Reading Test (NART) (r=0.87) (Nelson, 1982; Baddeley, Emslie &

Nimmo-Smith, 1993). It has been shown to be relatively stable following neurological impairment, and there is evidence it is a good estimator of premorbid abilities as it shows good discriminant validity (Yuspeh & Vanderploeg, 2000). Another reason why STW2 was chosen was because no verbal response was needed, thus it avoided the potentially discouraging effects of repeated failure of word pronunciation that is associated with the NART (Baddeley et al., 1993).

However, in the current study the groups differed on the number of years of education individuals had received. Performance on STW2 has been found to be significantly influenced by education (Yuspeh & Vanderploeg, 2000) and so it is plausible that this affected the data. Further research investigating the influence of education on STW2 is needed to explore if some education adjustment is necessary when using the measure in clinical settings (Yuspeh & Vanderploeg, 2000). It would have been preferable to use the NART instead of STW2 as the NART appears to be largely resistant to neurological damage (Crawford, 1992; O'Carroll, 1995). Further research using the NART to measure intelligence is needed to explore the effect of intelligence on performance of the BERT.

4.8.9 Limitations of a computerised screening test

The limitations of computerised screening measures have been detailed by Bauer et al. (2012). They include the technical characteristics of using a computer based test. Technical issues can affect test administration and reliability. In the current study a number of technical issues arose. There were a number of challenges getting the BERT online as well as technical problems administering the test. Problems included the test not working reliably when Wi-Fi connection was poor and the test not working on particular web browsers or appliances. In future work using the BERT, it will be important to ensure that the test works smoothly and any ongoing technical issues are addressed. Other limitations of an online assessment are that performance may be affected by hearing, visual and cognitive deficits such as attentional focus and factors such as the size of screen and clarity of sound can impact on how easily stimuli are recognised.

As with all screening tests the BERT is not diagnostic. Screening tests like the BERT give an indication that there may be a problem rather than diagnosing a problem (Cullen, O'Neill, Evans, Coen, & Lawlor, 2007). They provide an indication that further investigations may be needed (Morley et al., 2015).

The BERT can be administered by people other than clinicians. Whilst this has advantages, it also has disadvantages. Important information may be overlooked such as premorbid abilities and behavioural or motivational issues that may affect test performance (Bauer et al., 2012). Also, the potential to cause distress by false-positive screening test results or over diagnosis has been highlighted (Bond, Garside, & Hyde, 2015; Krantz & Meyers, 2015), as have false-negatives or failure to detect impairments when present resulting in failure to treat appropriately.

4.8.10 Limitation of not varying order of clips or counter balancing

The aim of the study was to develop a standardised test of emotion recognition. For this reason the order of the video clips was the same for each participant. There was no counter balancing of faces or type of emotion nor were the facial expressions and vocal cues counterbalanced. It is possible that how the facial expressions and vocal cues were paired resulted in some pairings being clearer and therefore easier to identify than others. This is a limitation of the study. Presenting the clips in a different order and counterbalancing the clips may have produced different results. For a standardised test it is important that if there is a bias or impact arising from the order of the clips it will be the same for everyone. However, it would be interesting to see if administering the test with the clips in a different order has any effect on performance. Further research investigating if varying the order of the clips and counterbalancing the facial expressions and word pairings affects results is needed.

4.9 How work done in the current study could be developed

The current study was a preliminary study. It has fulfilled its aim of developing a new screening instrument of emotion recognition and has reported some interesting findings. There is potential to investigate some of the findings further.

4.9.1 Larger and different ABI samples

The current study compared the performance of a neurologically healthy sample with a small group of people with ABI. It would be informative to repeat the study using a larger sample of ABI participants. This would help improve the power of the study. Further, repeating the study using ABI participants recruited from different sources, with different types, severity and time since injury, would help to explore and develop understanding about how these factors affect emotion recognition ability. This has implications for being able to identify individuals who are more as risk of having emotion recognition problems.

4.9.2 Influence of age on emotion recognition

Further research is needed to investigate if age, particularly older age affects emotion recognition and performance on the BERT. In the current study a correlation was found between performance on the “no phrase” test and the older participants. Should further investigation support this finding then adjustments may need to be made to account for these differences, for example in how the clinical cut off scores are calculated for older people.

4.9.3 Influence of pre-morbid characteristics

Further research investigating how pre-morbid characteristics including education and intelligence affect performance on the BERT is needed. Further findings that emotion recognition performance is impacted by pre-morbid IQ would add support to theories of cognitive reserve (Salz, 1993; Stern, 2002). This would have important implications for clinical practice, as it would suggest that pre-morbid intelligence is a predisposing factor to emotion recognition problems and could result in the introduction of routinely measuring pre-morbid intelligence after ABI.

4.9.4 Influence of affective state: anxiety, depression

Another limitation is that measures of anxiety and depression were not taken in this study. Whilst research has established that emotion recognition problems are present shortly after injury and therefore caused by the injury itself rather than secondary factors such as anxiety and depression (Borgaro et al., 2004; Green et al., 2004), we know that after ABI it is common for individuals to develop anxiety and depression (Ponsford et al., 2002). Further, research suggests there is a mood congruent memory bias for the processing of emotional faces in some populations, for example, Ridout, Astell, Reid, Glen and O'Carroll (2003), found that individuals with dysphoria were impaired in recognising the emotions of sadness and neutral compared to individuals in a control group who did not have dysphoria. Including measures of anxiety and depression in the current study was beyond the scope and resources available. However, affective state is undoubtedly an important factor in emotion recognition and further research investigating the impact of affective state on emotion recognition in the ABI population is needed.

4.9.5 The role of alexithymia

Another possible limitation is that alexithymia was not measured in this study. As stated in the introduction chapter, the reasons for not measuring alexithymia included it being outside the scope and resources of the study; that currently, there are questions about the reliability of using the alexithymia measure (TAS-20) in ABI samples (Wood et al., 2009); and that current research findings on the association between alexithymia and emotion recognition in the ABI population are not clear.

However, the fact that alexithymia may result in individuals being unable to vicariously experience the emotions of others (Williams & Wood 2010b; Wood & Williams 2013) is important. Evidence suggests that the mechanism we use in our own subjective experiences of emotion are used when recognising the same emotions in others (Calder, Lawrence, & Young, 2001; Bastiaansen, Thioux, & Keysers, 2009). Existing theories of emotion recognition suggest that if you cannot identify or describe your own emotions (as is suggested by the current research on alexithymia) then your ability to recognize emotions in others may also be impaired. For example, Gallesse, (2001), in his “shared manifold” hypothesis suggests that when we observe someone expressing an emotion our motor system becomes active and “resonates” with that emotion as if we were feeling the same emotion. In basic terms we interpret others' emotions by processing our own.

The role of alexithymia in emotion recognition, emotional difficulties and social behaviour generally needs to be better understood. There is evidence that individuals with somatoform disorders and disordered eating have impaired emotion recognition and higher rates of alexithymia than healthy controls (Pedrosa-Gil et al., 2008; Ridout et al., 2010). Bird and Cook (2013) argue that emotional difficulties in autism are due to alexithymia. Their "alexithymia hypothesis", which they apply to autism may arguably equally apply to individuals with ABI. In other words that there are disproportionate levels of alexithymia in ABI rather than emotion recognition and empathy deficits being a characteristic of ABI. We know that emotion recognition problems and alexithymia are higher in the ABI population (Williams and Wood, 2010) and this leads one to question whether the BERT (and possibly the EET) measures alexithymia rather than emotion recognition problems.

However, the prevalence of alexithymia after ABI appears to be higher than the prevalence of emotion recognition problems (Babbage et al., 2011; Wood & Williams, 2010b). If Bird and Cook (2013) are correct and emotion recognition problems and empathy deficits are a consequence of co-occurring alexithymia rather than a primary feature of ABI then why aren't the levels the same? Also, alexithymia is not always as a result of ABI it occurs in 10-14.8% of the general population (Berthoz, Pouga & Wessa, 2010). Further research is needed to investigate the relationship between alexithymia and emotion recognition problems in individuals ABI.

4.9.6 Further investigations of the characteristics and impairments of individuals who score below the BERT cut off score

Research is needed to better understand the causes of emotion recognition difficulties after ABI. As mentioned in section 4.8.5 above, ABI often results in a number of impairments which include, cognitive, behavioural and emotional problems (Wood et al., 2005). Yim, Babbage, Zupan, Neumann and Willer (2013), suggest that impairment in several cognitive processes, in particular non-verbal memory, working memory and speed of processing, may contribute to emotion recognition deficits in individuals with ABI. Indeed, studies have found that emotion recognition is related to executive functions (Lee, Lee et al., 2009; Henry, Philips, Crawford, Theodore & Summers, 2006), speed of processing, attention and working memory (Henry et al., 2009; Mathersul et al., 2009; Philips et al., 2008) and language abilities (Barrett, Lindquist & Gendron, 2007). However, other studies have failed to find any associations between emotion recognition and particular cognitive functions (Pinkman, Penn, Perkins, & Lieberman, 2003; Shamay-Tsoory, Shur, Baracai-Goodman, Medlovich & Levkovitz, 2007).

Therefore, whilst we know that cognitive functioning and facial emotion recognition are impaired in a significant proportion of people with moderate-to-severe ABI (Yim et al., 2013), our understanding of the relationship of these two domains in the ABI population, as well as in other clinical and healthy populations, is limited and more research is needed to help us understand the links (Yim et al., 2013). The BERT could be used in further research to explore the links. It could help identify individuals with emotion recognition problems (those below the cut off score), and further investigations to explore whether these individuals have any cognitive functioning deficits, or any behavioural and social problems could take place. In other words, further testing of individuals who score below that BERT cut off score, could provide some very useful information about the impairments they have and the relationships between these impairments. It could also explore whether individuals below the cut off score are more likely to have other characteristics, for example, an affective disorders, lower intelligence, lower empathy, or alexithymia. This further research would help explore the inter-relationship of different impairments which could help target appropriate rehabilitation interventions.

4.9.7 Understanding the role of emotion recognition in social behaviour and social cognition

Emotion recognition problems are now understood to play a role in reduced and difficulties in interpersonal relationships (May et al., 2017). However, we know that other factors also influence interpersonal social skills and impede social relationships (Milders et al., 2003). Amongst these are impaired self-regulatory behaviour (Ganesalingam, Sanson, Anderson & Yeates, 2007); inappropriate behaviour and indifference (Groom, Shaw, O'Connor, Howard & Pickens, 1998); problems with word retrieval (Douglas 2004); cognitive flexibility (Prigatano, 1992); inaccurate self-appraisal (Kervick & Kaemingk, 2005) and impairments in disinhibition and inflexibility (McKinlay, Brooks, Bond, Martinage & Marshall, 1981; Tate & Broe, 1999). In addition, psychological reactive factors such as depression, anxiety and poor self-esteem may also impact on relationships and affect psychosocial outcome (McDonald, 2003).

Social cognition plays an important role in social behaviour (May et al., 2017), and we are learning more about the part played by emotion recognition/perception of social cues in this. Theories of social cognition have identified it as one of three main functions involved, the others being retrieval of social knowledge/understanding other people's intentions and selecting an appropriate response (Adolphs, 2009; Corrigan 1997; Ochsner 2008). In a recent study investigating the impact of the social cognition functions (May et al., 2017) emotion recognition was found to be the most strongly associated with post-injury behaviour and community integration. The study's finding provides further evidence that problems in emotion recognition have a big impact on people with ABI and their families and reinforces the importance of identifying emotion recognition problems after ABI.

In addition, the May et al. (2017), study supports earlier research (for example the studies of Knox & Douglas, 2009; Milders et al., 2008; Spikman et al., 2013; Struchan et al., 2008; Watts & Douglas, 2006) that the association between emotion recognition problems and post injury social functioning cannot be fully explained by the severity of the injury, time since injury or education. The fact that these earlier studies used different emotion recognition tasks suggests that the association is not dependant on the task used.

The relationship between emotion recognition problems, cognitive deficits (including intuition), social behaviour and social cognition is not clear. Whilst there is mounting evidence that emotion recognition problems are associated with post injury social functioning, some research has found that problems with social behaviour exist where patients do not have problems recognising facial expressions (Beer, Heerey, Keltner, Scabini & Knight, 2003). Also, there is evidence that facial emotion recognition can be impaired when there is no deficit in cognitive abilities (Yim et al., 2013) and a wide range of social cognition measures including emotion recognition have been found to be unrelated to particular general cognitive functions such as memory, attention, executive functioning (Spikman et al., 2012). More research is needed to understand the links and relationships between emotion recognition deficits and these other factors.

4.9.8 Rehabilitation training

As well as being a useful screening tool to help identify people with emotion recognition deficits, there is potential for the BERT to be used in rehabilitation to target particular emotion recognition deficits and as a baseline measure. There is already some evidence that emotion recognition training can improve facial emotion recognition and follow up at six months post training has demonstrated that these changes are maintained (Zupan, Neumann, Babbage & Willer, 2015). However, there is some research that suggests that identification training has not always been linked with improvements in social behaviour (McDonald, 2011). Improving outcome through appropriate rehabilitation is extremely important. The BERT could be used in further research investigating emotion recognition training, how long treatment gains remain, how/if they generalise to everyday life and whether emotion recognition training does positively impact outcome.

4.9.9 Other clinical populations with emotion recognition problems

Difficulty recognising facial expressions is known to be impaired in other conditions including autism (Bauminger, 2002; Boraston, Blakemore, Chilvers & Skuse, 2007; Ozonoff, Pennington & Rogers,1990); schizophrenia (Edwards, Jackson & Pattison 2002; Gessler, Cutting, Frith & Weinman, 1989; Hooker & Park, 2002; Mandal, Pandey & Prasad, 1998; Sergi, Rassovsky, Nuechterlein & Green, 2006); learning disabilities (McKenzie, Matheson, McKaskie, Hamilton & Murray, 2000); frontotemporal dementia (Keane, Calder, Hodges & Young, 2002; Lavenu, Pasquier, Lebert, Petit & Van der Linden, 1999); multiple sclerosis (Beatty, Orbelo, Sorocco, & Ross, 2003: Weinstein, Patterson & Rao,1996); Parkinson’s disease (Dujardin et al., 2004; Kan, Kawamura, Hasegawa, Mochizuki & Nakamura, 2002). The BERT may be useful in screening tool for emotion recognition impairments in other clinical groups. Further research is needed to investigate this.

Once emotion recognition problems have been identified it is possible that theories of emotion recognition and strategies used in other clinical populations with emotion recognition problems, for example autism (Baron-Cohen, 1995) and eating disorders may be helpful (Radice-Neumann et al., 2007).

4.10 Conclusion

The principal goal of this study was to create a valid, reliable method of rapidly screening for emotion recognition difficulties in people with ABI. The new test, BERT, addresses the need to have an online screening measure of emotion recognition difficulties that is efficient, easy to use and is quicker to administer than existing measures.

In summary, the BERT has two parts. The “no phrase” BERT consists of moving facial expressions and non-verbal cues (no verbal content). The “with phrase” BERT contains moving facial expressions with neutral carrier phrases (prosody congruent with facial expression). Administration of both parts is quick – it only takes around five to ten minutes, though there is potential for the two parts to be administered separately. An age stratified sample of 92 neurologically healthy adults with a variety of occupations and different educational backgrounds performed at a high level on the BERT. Performance was found not to be affected by gender in either the control or ABI group suggesting the same cut off scores can be used when administering the test to males or females. Intelligence (as measured by STW2) was not found to affect performance on any part of the BERT in healthy controls or on the “no phrase the “no phrase” BERT in the ABI group. However, it was found to be associated with performance on the “with phrase” BERT in the ABI group. Possible explanations for this finding are discussed in this chapter including cognitive reserve theory (Salz, 1993; Stern, 2002), and that the BERT may be picking up other impairments, such as executive dysfunction. The further work needed to explore these explanations is outlined.

No association was found with age and performance on the “with phrase” BERT, but a correlation was found between the “no phrase” BERT and age. Further research on the effect of age, particularly older age on performance of the BERT is needed. The study found some evidence of validity in that performance on the BERT was found to be correlated with performance on an existing measure of emotion recognition (EET). The BERT was also found to be associated with some existing measures of empathy.

Comparison of the performance of the neurologically healthy controls with that of 20 adults who had sustained moderate-to-severe brain injury, found that the participants with ABI performed significantly worse on both parts of the BERT. This finding suggests the ABI group were significantly impaired in emotion recognition relative to the neurologically healthy controls which is consistent with existing research. The findings of the study suggest that identifying even one item incorrectly on the “no phrase” BERT may indicate deficits in recognising moving facial expressions with non-verbal cues, and a low score on the “with phrase” BERT may indicate impairments recognising moving facial expressions with verbal cues. The finding that both groups performed less well on the “with phrase” BERT was not expected. It had been anticipated that performance on the “with phrase” BERT would be better, due to there being vocal cues as well as visual cues. Possible explanations for this finding including how the use of neutral sentences may have made it difficult to process multiple sources of information (Wildgruber, et al., 2007), and areas for future research, are discussed in this chapter.

Further studies replicating the use of the BERT are needed to demonstrate its psychometric qualities and its performance in larger samples of ABI participants. However, the work done to date suggests the BERT will be a useful tool for clinicians and others working with individuals with ABI in assessment, treatment and research capacities. The development of BERT is important because having a measure that can efficiently and easily screen for emotion recognition impairments in the ABI population was needed. We know that emotion recognition problems occur after ABI and that these problems impact negatively on psychosocial functioning and effect relationships (Rosenberg et al., 2016). We also know that problems are not limited to severe ABI (Kubu, 1999) and the extent of deficits varies (McDonald & Saunders, 2005) probably due to the different pathology of brain injury as well as the impact of other factors including cognitive deficits **(**Allerdings & Alfano, 2006).

This study makes an important contribution to counselling psychologists and others working with individuals with ABI and their families. It helps highlight the need to understand how emotion recognition problems affect psychosocial functioning. The better we are at identifying and understanding emotion recognition problems, the better we will become at predicting and working with problematic behaviour (Wood et al., 2005). This will improve rehabilitation and psychosocial interventions which will help to decrease problems of loneliness, sense of isolation and relationship problems that often exist after ABI. Moreover, improved support will help to reduce the likelihood of the development of affective disorders in those with ABI and their families and improve outcomes. Improvement in psychosocial functioning is very cost effective both in financial and personal terms.

In terms of its use, the BERT could be a useful tool in future research investigating emotion recognition problems. As well as being a useful screening measure in the ABI population, it could potentially play a useful role in other populations where problems recognising emotions have been identified, such as schizophrenia (Edwards et al., 2002), disordered eating (Ridout et al., 2010), and autism (Baron-Cohen 1995).

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List of Appendices

APPENDIX 1

Volunteers required for research into emotion recognition
by Tony Ward, Health and Applied Science

UWE Bristol postgraduate, Jo Howe, is researching emotion recognition with the aim of identifying where people have problems recognising emotion (for example, after a stroke or head injury) and develop ways in which to support them.

To support her research Jo requires volunteers to take part in a short online trial to gauge how difficult it is to recognise different emotions.

The trial will take no longer than 15 minutes and can be accessed from any computer with an internet connection. A five minute follow up would also be required one week later.

Anyone who completes the trial will be given a £10 Amazon voucher.

For more information and to participate, please email Jo Howe.

Thanks,

APPENDIX 2

Volunteers required for research into emotion recognition

I'm a postgraduate at the University of the West of England, Bristol and am researching emotion recognition with the aim of identifying where people have problems recognising emotion (for example, after a stroke or head injury) and develop ways in which to support them.

To support my research I need volunteers to take part in a short online trial to gauge how difficult it is to recognise different emotions.

The trial will take approximately 45 minutes and can be accessed from any computer with an internet connection. A five minute follow up would also be required one week later.

Anyone who completes the trial will be given a £10 Amazon voucher.

For more information and to participate, please email me at Joanne2.Howe4@live.uwe.ac.uk

Thank you.

Jo Howe

APPENDIX 3

Participant Information Sheet - A

Study: Emotion Recognition and Empathic Functioning after Brain Injury: Development of a new test

Why have I been given this form?
This information sheet is to give you information about what will be involved if you decide to take part in the study in order to help you decide whether or not you would like to take part. Please read it carefully.

Who is the researcher and what is the research about?
The researcher is Jo Howe, a Counselling Psychologist in Training studying at UWE. This study is about developing a new test to measure emotion recognition and empathy. Empathy is the ability to understand and share the feelings of others. People with poor empathic skills often encounter difficulties in their daily lives, particularly with relationships. It has been known for some time that people who have had a head injury often have reduced emotion recognition and empathic skills. This study aims to understand more about this and develop a test that can identify if someone has reduced emotion recognition or empathic skills so that they can receive appropriate help, support and treatment.

Why have I been approached?
Because you are someone who may be interested in taking part in this study.

Do I have to take part?
No. Participation in this study is voluntary.

Can anyone take part?
Yes, provided you are over 18, have not had a head injury and do not have problems with your sight or hearing that would make it difficult to complete tasks on a computer.

Can I withdraw from the study?
Yes. You are free to withdraw from the study without giving a reason at any time until the research report has been submitted for assessment or publication, by contacting the researcher, Jo Howe.

What does participation involve?
You will be asked to complete a number of tasks on a computer. Before completing the tasks you will be asked to confirm that have read this participant information sheet.

The researcher will send you information explaining how you access the tasks on your computer. The new test will include watching short video clips of actors portraying various emotions and then answering some questions. Full explanations about the items in the test will be given and you will be able to practice each item.

You will also be asked to answer some basic demographic questions, such as whether you are male or female and your age and complete a few other tests that measure empathy and a short cognitive function test.

In order to see if the test is reliable you will be asked to complete some of the tasks in the test twice, approximately one week apart.

Completing the tests and other information will take approximately 40 minutes.

What are the possible benefits of taking part?
You will get the opportunity to participate in a research project and experience the research process in general. Also, after completing the test twice you will receive a £10 voucher as a thank you.

Hopefully this study will provide useful information about emotion recognition and empathy after brain injury.

Are there any risks in taking part?
It is not anticipated that there will be any risks in taking part in this research. However, there is always the possibility for research participation to raise uncomfortable or distressing issues. Should this happen then you can contact the researcher, her Director of Studies or NHS Direct.

Anonymity and confidentiality
Any information that could identify you will be removed. The data will be anonymized. All information which is collected during the course of the study will be kept strictly confidential and will be locked in a secure place.

What will happen to the results of the research?
The research findings will be put in a report and used by the researcher as part of her studies. It may also be sent to an academic journal for publication or used in presentations. Your identity will not be revealed in any report, publication or presentation.

What do I do now?
If you want to take part in this research please contact the researcher, Jo Howe by e-mailing her at joanne.howe4@btinternet.com

What if I have questions about the research?
Should you have any questions about the research before, during or after it, then please contact the researcher Jo Howe, by e-mailing her at joanne.howe4@btinternet.com or the researcher's Director of Studies, Dr. Tony Ward, Associate Professor of Health and Counselling, Faculty of Life and Health Sciences, Frenchay Campus, Coldharbour Lane, Bristol BS16 1QY, Tel: 0117 328 3109; E-mail: Tony.Ward@uwe.ac.uk.

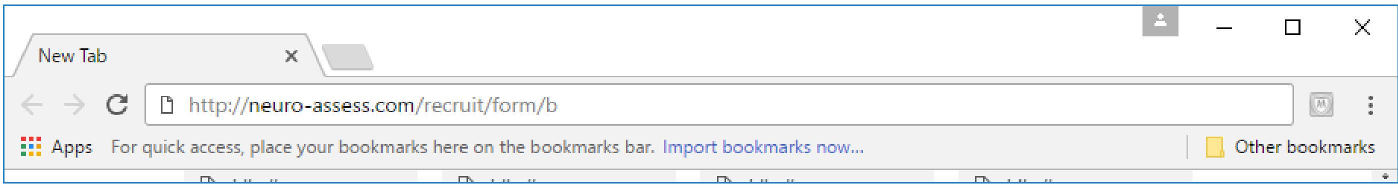
APPENDIX 4

Thank you for your interest in taking part in my study.

To do the test you will need the following:

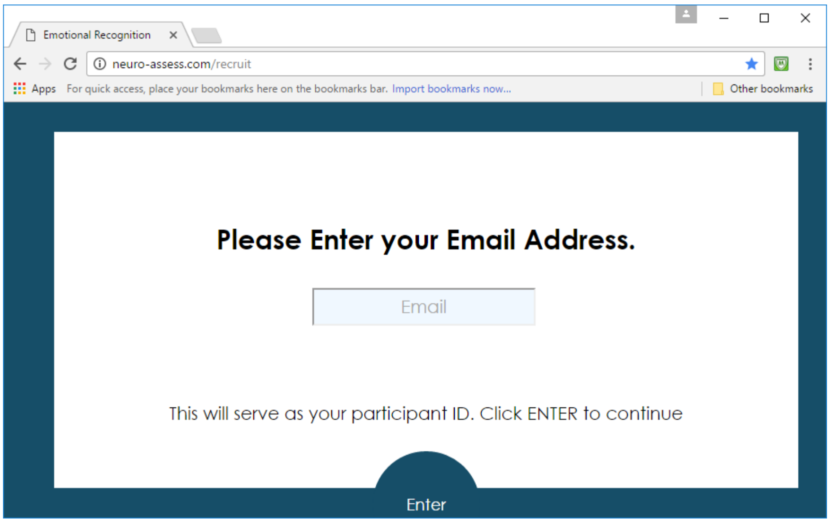
- A computer or lap-top running MS-Windows - the test will not work on tablets, smart-phones etc.
- The internet browser Google Chrome.
- If you have not go this browser then please let me know.
  The test will not work on other internet browsers – such as Explorer, Edge, Mozilla etc.
- A decent internet connection because the test includes video clips.
  A wired connection is preferable to a Wi-Fi connection
- The sound must be on – some of the video clips have sound
- Enough time to complete all the tasks that make up the test in one sitting.
  This should take approximately 40 to 60 minutes
  Here is the link to the test
  http://neuro-assess.com/recruit/form/b

The easiest way to access the test is to copy the link and to paste it in to your Google chrome address box



The password in **test**

Once you have accessed the test website, you will need to insert your email address in the big box in the middle of the screen.



You will need to repeat a couple of the tasks again after a week which will take about 5 – 10 minutes.

You will receive an email reminder about this. After completing the test twice you will be sent a code to redeem a £10 Amazon voucher.

Should you experience any problems or have decided you do not want to take part, the please let me know.

Thank you for taking part. I hope you enjoy the test

Best wishes, Jo Howe

APPENDIX 5

Dear

Thank you for taking part in this study which is designed to find out some information about how people recognise other people's emotions.

A week or so ago you completed a number of tasks and now is the time to complete part of the test again. It should take about 10 minutes to complete the task today.

Click the link to continue http://neuro-assess.com/recruit/form/a

APPENDIX 6

Email from Paul White, Statistician about the power calculation

From: Paul White
Sent: 15 March 2018 16:20
To: Tony Ward; Joanne Howe (Student - SOLS)
Subject: RE: Please can you help me calculate the power of my test?

Hi Both

Power is a pre-data collection concept. If you get a significant result and then use the sample means and standard deviations from the data to then power you would get sample sizes which are probably smaller than you had; conversely if you did not get a significant effect, and used the sample means and standard deviations to estimate the sample size then the sample size estimates would be larger than you had. It is for this reason that SPSS and similar do not (as part of their output) then go on and give power/sample sizes to achieve power as it would simply recast the data you have.

If BERT is useful at discriminating between ABI and Control then to have clinical utility then it should show good sensitivity and good specificity (i.e. to be able to discriminate between the two groups without incurring too many false positives and false negatives).

In general, effect size, using Cohen's d has broad interpretations of

$d = 0$	indicates the absence of an effect

For statistically significant effects,

$0 < d < 0.1$	indicates a trivial effect,
$0.1 < d < 0.2$	indicates a small effect,
$0.2 < d < 0.5$	indicates a moderate effect,
$0.5 < d < 0.8$	indicates a medium size effect,
$0.8 < d < 1.3$	indicates a large effect,
$1.3 < d < 2.0$	indicates a very large effect
$d > 2.0$	huge!!

In these sense d is the number of standard deviations which separate the two groups. With a head injury groups you might expect differences to be anywhere between d = 0.5 to d = 1.0. d = 0.5 would probably indicate "yes there is a difference" but the scale would not have good utility. d = 0.8 … is probably getting to the level where you might say "this scale is showing levels of sensitivity and specificity which could make a difference in practice". Of course a d > 0.8 would be even better … but that might be very much wishful thinking at the outset. So … let's suppose we stick with d = 0.5 to 0.8.

At the outset you would not know how many participants you would get. Agreed it is easier to get more controls than case. So let's suppose we aim for N = 100, thinking an 80:20 split would be okay. Suppose you are going to use the Mann Whitney (Mann Whitney Wilcoxon test). Below is the output from each of 10,000 simulations for d = 0.5, 0.6, 0.7, 0.8 with an 80:20 split.

Mann-Whitney-Wilcoxon Tests (Simulation)

Numeric Results for Testing Mean Difference = Diff0.   Hypotheses: H0: Diff1 = Diff0; H1: Diff1 ≠ Diff0
H0 Dist's: Normal (M0 S) & Normal (M0 S)
H1 Dist's: Normal (M0 S) & Normal (M1 S)
Test Statistic: Mann-Whitney-Wilcoxon Test

Power	N1/N2	H0 Diff0	H1 Diff1	Target Alpha	Actual Alpha	Beta	M0	M1	S
0.482	20/80	0.0	-0.5	0.050	0.047	0.518	0.0	0.5	1.0
(0.010)	[0.473	0.492]			(0.004)	[0.043	0.051]		
0.643	20/80	0.0	-0.6	0.050	0.053	0.357	0.0	0.6	1.0
(0.009)	[0.633	0.652]			(0.004)	[0.049	0.057]		
0.764	20/80	0.0	-0.7	0.050	0.046	0.236	0.0	0.7	1.0
(0.008)	[0.756	0.773]			(0.004)	[0.042	0.051]		
0.869	20/80	0.0	-0.8	0.050	0.051	0.131	0.0	0.8	1.0
(0.007)	[0.862	0.876]			(0.004)	[0.047	0.055]		

Notes
Pool Size: 20000. Simulations: 10000. Run Time: 12.52 seconds.

References

Chow, S.C.; Shao, J.; Wang, H. 2003. Sample Size Calculations in Clinical Research. Marcel Dekker. New York.
Devroye, Luc. 1986. Non-Uniform Random Variate Generation. Springer-Verlag. New York.
Matsumoto, M. and Nishimura, T. 1998. 'Mersenne twister: A 623-dimensionally equidistributed uniform pseudorandom number generator.' ACM Trans. On Modeling and Computer Simulations.
Zar, Jerrold H. 1984. Biostatistical Analysis (Second Edition). Prentice-Hall. Englewood Cliffs, New Jersey.

Report Definitions
Power is the probability of rejecting a false null hypothesis.
N1 is the size of the sample drawn from population 1.
N2 is the size of the sample drawn from population 2.
Diff0 is the mean difference between (Grp1 - Grp2) assuming the null hypothesis, H0.
Diff1 is the mean difference between (Grp1 - Grp2) assuming the alternative hypothesis, H1.
Target Alpha is the probability of rejecting a true null hypothesis. It is set by the user.
Actual Alpha is the alpha level that was actually achieved by the experiment.
Beta is the probability of accepting a false null hypothesis.
Second Row: (Power Prec.) [95% LCL and UCL Power] (Alpha Prec.) [95% LCL and UCL Alpha]

Summary Statements
Group sample sizes of 20 and 80 achieve 48% power to show a difference in means when there is a difference of 0.5 between the null hypothesis mean difference of 0.0 and the actual mean difference of -0.5 at the 0.050 significance level (alpha) using a two-sided Mann-Whitney-Wilcoxon Test. These results are based on 10000 Monte Carlo samples from the null distributions: Normal (M0 S) and Normal (M0 S), and the alternative distributions: Normal (M0 S) and Normal (M1 S).

You will see in the above that an 80:20 split will give 87% power for d = 0.8.

If I tweak the parameters e.g. a sample size of N = 110 keeping approximately the ratio you did get … then …

Mann-Whitney-Wilcoxon Tests (Simulation)

Numeric Results for Testing Mean Difference = Diff0. Hypotheses: H0: Diff1 = Diff0; H1: Diff1 ≠ Diff0
H0 Dist's: Normal (M0 S) & Normal (M0 S)
H1 Dist's: Normal (M0 S) & Normal (M1 S)
Test Statistic: Mann-Whitney-Wilcoxon Test

Power	N1/N2	H0 Diff0	H1 Diff1	Target Alpha	Actual Alpha	Beta	M0	M1	S
0.513	21/89	0.0	-0.5	0.050	0.050	0.488	0.0	0.5	1.0
(0.010)	[0.503	0.522]			(0.004)	[0.046	0.054]		
0.663	21/89	0.0	-0.6	0.050	0.048	0.337	0.0	0.6	1.0
(0.009)	[0.653	0.672]			(0.004)	[0.044	0.052]		
0.796	21/89	0.0	-0.7	0.050	0.048	0.204	0.0	0.7	1.0
(0.008)	[0.788	0.804]			(0.004)	[0.044	0.052]		
0.889	21/89	0.0	-0.8	0.050	0.050	0.111	0.0	0.8	1.0
(0.006)	[0.883	0.895]			(0.004)	[0.045	0.054]		

Notes
Pool Size: 20000. Simulations: 10000. Run Time: 13.46 seconds.

References

Chow, S.C.; Shao, J.; Wang, H. 2003. Sample Size Calculations in Clinical Research. Marcel Dekker. New York.
Devroye, Luc. 1986. Non-Uniform Random Variate Generation. Springer-Verlag. New York.
Matsumoto, M. and Nishimura, T. 1998. 'Mersenne twister: A 623-dimensionally equidistributed uniform pseudorandom number generator.' ACM Trans. On Modeling and Computer Simulations.
Zar, Jerrold H. 1984. Biostatistical Analysis (Second Edition). Prentice-Hall. Englewood Cliffs, New Jersey.

Report Definitions
Power is the probability of rejecting a false null hypothesis.
N1 is the size of the sample drawn from population 1.
N2 is the size of the sample drawn from population 2.
Diff0 is the mean difference between (Grp1 - Grp2) assuming the null hypothesis, H0.
Diff1 is the mean difference between (Grp1 - Grp2) assuming the alternative hypothesis, H1.
Target Alpha is the probability of rejecting a true null hypothesis. It is set by the user.
Actual Alpha is the alpha level that was actually achieved by the experiment.
Beta is the probability of accepting a false null hypothesis.
Second Row: (Power Prec.) [95% LCL and UCL Power] (Alpha Prec.) [95% LCL and UCL Alpha]

Summary Statements
Group sample sizes of 21 and 89 achieve 51% power to show a difference in means when there is a difference of 0.5 between the null hypothesis mean difference of 0.0 and the actual mean difference of -0.5 at the 0.050 significance level (alpha) using a two-sided

Mann-Whitney-Wilcoxon Test. These results are based on 10000 Monte Carlo samples from the null distributions: Normal (M0 S) and Normal (M0 S), and the alternative distributions: Normal (M0 S) and Normal (M1 S).

i.e. 89% power.

In the above simulations, I simulated from a normal distribution. I could use other distributions. Some distributions would give an increase in power (relative to the normal) and others a decrease in power (relative to the normal). A good rule of thumb is to reduce overall sample size by pi/3 (pi being the number 3.14159 ….) to get a lower bound on power. If I do this (I won't give all of the output) … power comes in at 85%.

So … if we were starting right at the beginning and were blind to data … but had a gut feeling that BERT would show some good discriminatory powers … and you felt n = 110 was viable with a 90:20 split … then we would have guestimated a power of about 85%.

I can see you have Total Bert 2 … I am not sure how those data were obtained (e.g. same participants) … but that data looks good too.

I am not sure if this helps?

P.

APPENDIX 7

Participant Information Sheet - B

Study: Emotion Recognition and Empathic Functioning after Brain Injury: Development of a new test

Why have I been given this form?
This information sheet is to give you information about what will be involved if you decide to take part in the study in order to help you decide whether or not you would like to take part. Please read it carefully.

Who is the researcher and what is the research about?
The researcher is Jo Howe, a Counselling Psychologist in Training studying at UWE. This study is about developing a new test to measure emotion recognition and empathy. Empathy is the ability to understand and share the feelings of others. People with poor empathic skills often encounter difficulties in their daily lives, particularly with relationships. It has been known for some time that people who have had a head injury sometimes have reduced emotion recognition and empathic skills. This study aims to understand more about this and develop a test that can identify if someone has reduced emotion recognition or empathic skills so that they can receive appropriate help, support and treatment.

Why have I been approached?
Because you are someone who may be interested in taking part in this study.

Do I have to take part?
No. Participation in this study is voluntary.

Can anyone take part?
Yes, provided you are over 18, and have had a head injury which resulted in you losing consciousness and/or having post traumatic amnesia. Also, to be able to take part you will not have a psychiatric or developmental disorder or have problems with your sight or hearing that would make it difficult to complete tasks on a computer.

Can I withdraw from the study?
Yes. You are free to withdraw from the study without giving a reason at any time until the research report has been submitted for assessment or publication, by contacting the researcher, Jo Howe.

What does participation involve?
You will be asked to complete a number of tasks on a computer. Before completing the tasks you will be asked to confirm that have read this participant information sheet.

The researcher, Jo Howe will be with you when you complete the tasks or will send you information explaining how to access the tasks on your computer. The tasks will include watching short video clips of actors portraying various emotions and then answering some questions. Full explanations about the tasks will be given and you will be able to practice each item.

You will also be asked to answer some basic demographic questions, such as whether you are male or female and your age and complete a few other tests that measure empathy and a short cognitive function test.

In order to see if the test is reliable you will be asked to complete some of the tasks in the test twice, approximately one week apart.

Completing the tests and other information will take approximately 40 minutes.

What are the possible benefits of taking part?
You will get the opportunity to participate in a research project and experience the research process in general. Also, after completing the test twice you will receive a £10 voucher as a thank you.

Hopefully this study will provide useful information about emotion recognition and empathy after brain injury.

Are there any risks in taking part?
It is not anticipated that there will be any risks in taking part in this research. However, there is always the possibility for research participation to raise uncomfortable or distressing issues. Should this happen then you can contact the researcher, her Director of Studies or NHS Direct.

Anonymity and confidentiality
Any information that could identify you will be removed. The data will be anonymized. All information which is collected during the course of the study will be kept strictly confidential and will be locked in a secure place.

Relatives' questionnaire
Part of the study involves asking relatives and carers of people who have had a head injury to complete a short questionnaire about their experiences of living with or caring for someone with a head injury. You will be asked on the consent form if you are happy for your relative/carer to complete a questionnaire about their view of your ability to recognize emotions and be empathic.

What will happen to the results of the research?
The research findings will be put in a report and used by the researcher as part of her studies. It may also be sent to an academic journal for publication or used in presentations. Your identity will not be revealed in any report, publication or presentation.

What do I do now?
If you want to take part in this research please contact the researcher, Jo Howe by e-mailing her at joanne.howe4@btinternet.com

What if I have questions about the research?
Should you have any questions about the research before, during or after it, then please contact the researcher Jo Howe, by e-mailing her at joanne.howe4@btinternet.com or the researcher's Director of Studies, Dr Tony Ward, Associate Professor of Health and Counselling, Faculty of Life and Health Sciences, Frenchay Campus, Coldharbour Lane, Bristol BS16 1QY, Tel: 0117 328 3109; E-mail: Tony.Ward@uwe.ac.uk.

APPENDIX 8

Centre Number:

Participant Identification Number for this trial:

CONSENT FORM C (ABI PARTICIPANT)

Title of Project: Emotion Recognition and Empathic Functioning in Brain Injury: Development of a new test

Name of Researcher: Jo Howe

Please tick box

1. I confirm that I have read the participant information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected. ☐
3. I understand that data collected during the study, may be looked at by regulatory authorities. I give permission for these individuals to have access to my records. ☐
4. I understand that the information collected about me may be used to support other research in the future, and may be shared anonymously with other researchers. ☐
5. I understand that all information provided will be anonymised and kept confidentially. ☐
6. I understand that after the research has been completed it may be published in a journal, report or presented to other students of professionals. I understand that my identity will not be revealed in any report, publication or presentation. ☐
7. I agree to take part in the above study. ☐
8. I confirm I am happy for my relative/carer to complete a questionnaire about their views of my ability to recognise emotions and be empathic. ☐

____________________	____________________	____________________
Name of participant	Date	Signature
____________________	____________________	____________________
Name of person taking consent	Date	Signature

APPENDIX 9

Recognition rates of the 10 individuals who rated the 16 “no phrase” clips, the clips that were selected for the “no phrase” BERT, and the recognition rates of the control group on the “no phrase” BERT items

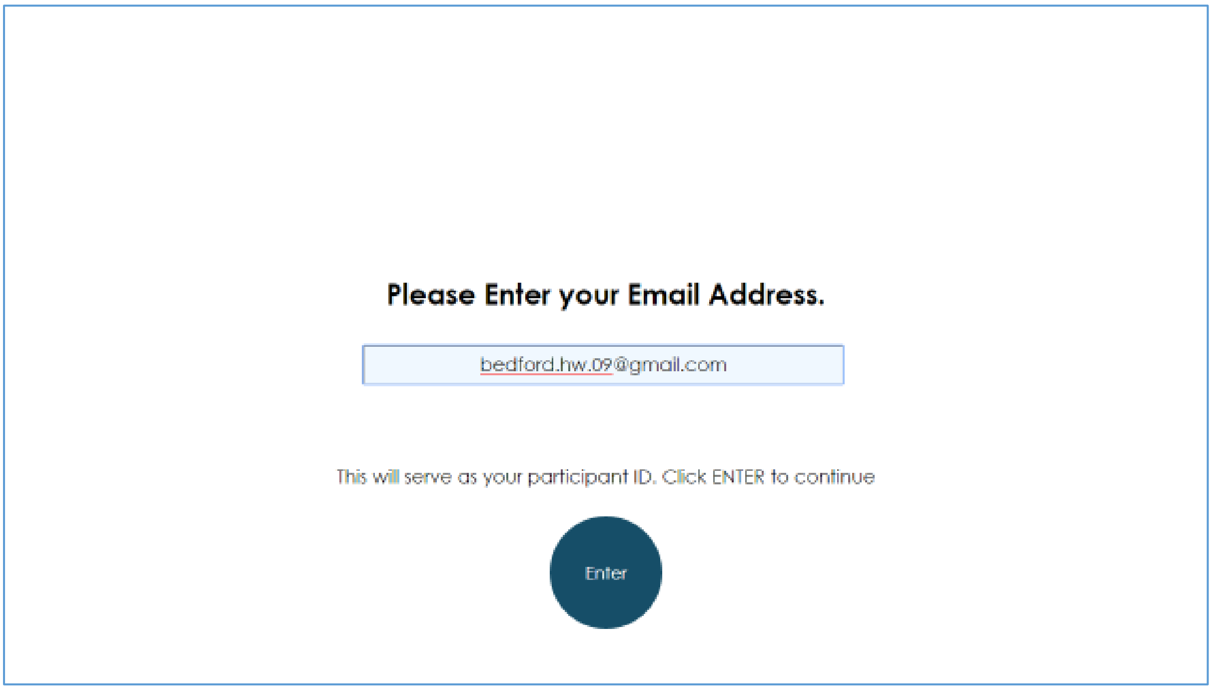
	“no phrase” item and whether selected for BERT (X – not selected for “no phrase” BERT)	Recognition rates of the 10 individuals presented with 32 clips (%)	Recognition rates of control group (%)
Happy	Practice 1	100	N/A
Sad	Practice 2	100	N/A
Angry	1	100	95
Surprise	2	100	100
Neutral	3	100	100
Fear	4	90	100
Disgust	5	100	100
Happy	6	90	100
Sad	7	100	100
Anger	X	60	N/A
Disgust	X	70	N/A
Fear	X	70	N/A
Surprise	X	90	N/A
Neutral	X	70	N/A
Fear	X	80	N/A
Angry	X	70	N/A

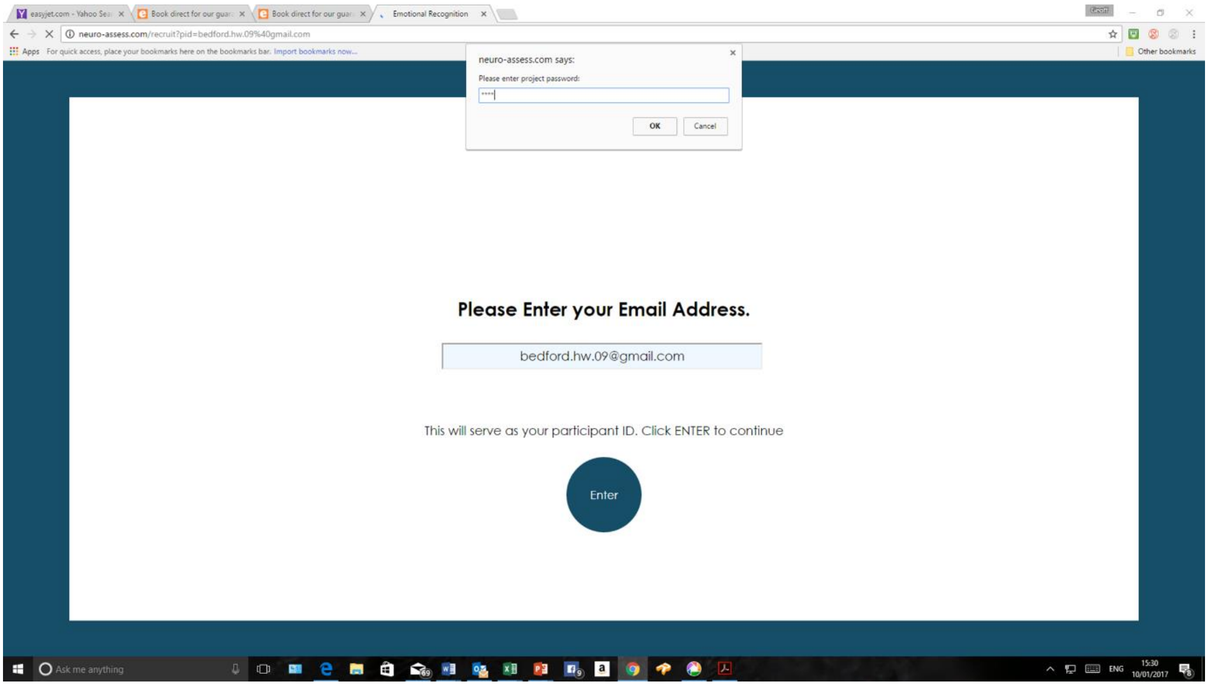
Recognition rates of the 10 individuals who rated the 16 "with phrase" clips, the clips that were selected for the "with phrase" BERT, and the recognition rates of the control group on the "with phrase" BERT items

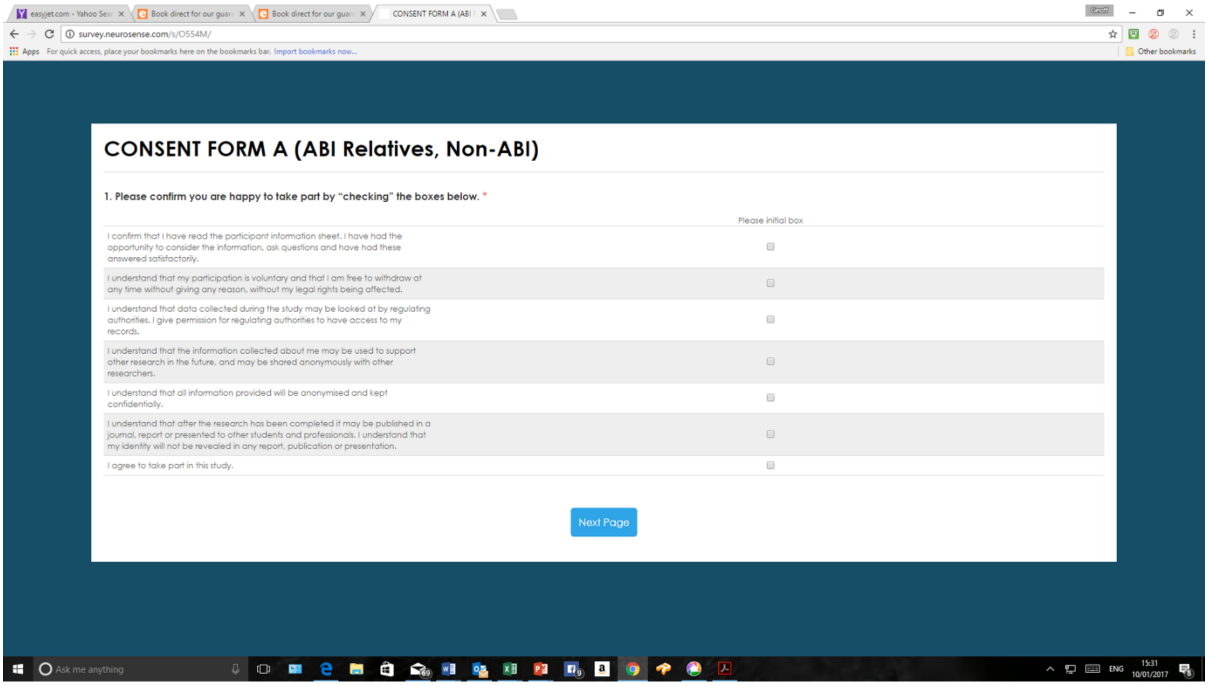
	"with phrase" item and whether selected for BERT (X – not selected for "with phrase" BERT)	Recognition rates of the 10 individuals presented with 32 clips (%)	Recognition rates of control group (%)
Disgust	P1	100	N/A
Happy	P2	100	N/A
Angry	1	90	98
Sad	2	90	87
Happy	3	90	100
Surprise	4	90	86
Fear	5	90	96
Disgust	6	80	80
Neutral	7	90	86
Angry	X	100	N/A
Surprise	X	70	N/A
Fear	X	90	N/A
Neutral	X	70	N/A
Angry	X	60	N/A
Surprise	X	70	N/A
Sad	X	60	N/A

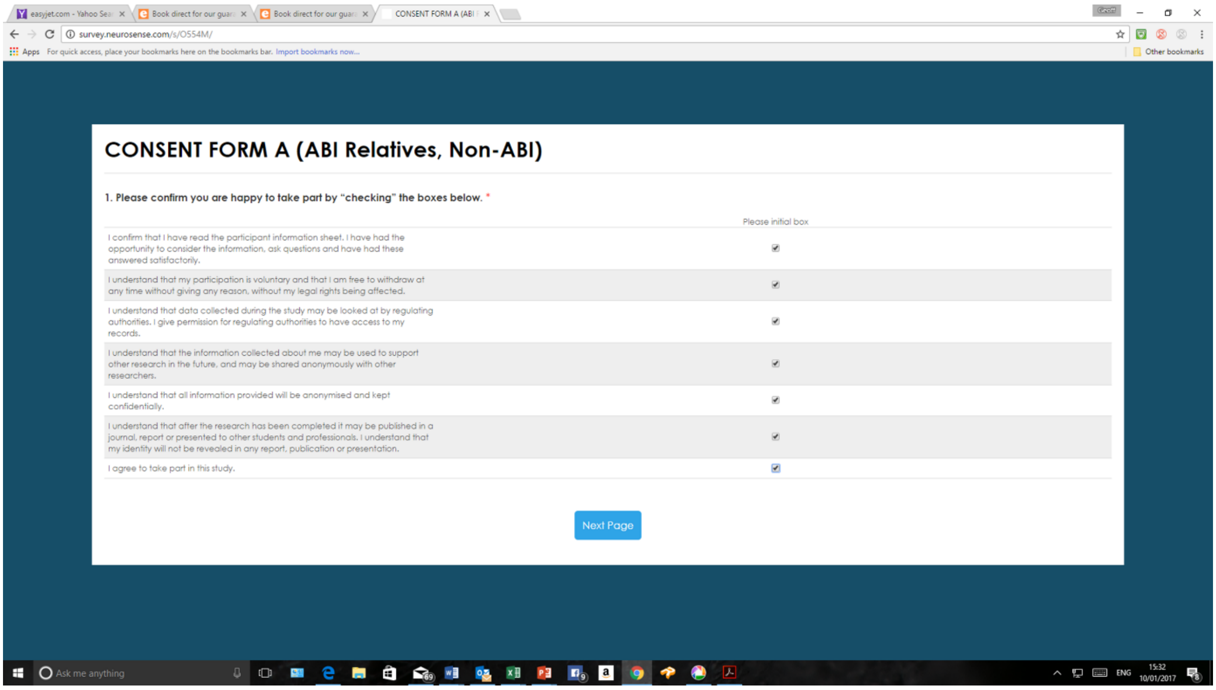
APPENDIX 10

Screen shots of the BERT




neuro-assess.com says:
Please enter project password:
OK
Cancel
Please Enter your Email Address.
bedford.hw.09@gmail.com
This will serve as your participant ID. Click ENTER to continue
Enter


survey.neurosense.com/s/O554M/
CONSENT FORM A (ABI Relatives, Non-ABI)
1. Please confirm you are happy to take part by "checking" the boxes below. *
Please initial box
I confirm that I have read the participant information sheet. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my legal rights being affected.
I understand that data collected during the study may be looked at by regulating authorities. I give permission for regulating authorities to have access to my records.
I understand that the information collected about me may be used to support other research in the future, and may be shared anonymously with other researchers.
I understand that all information provided will be anonymised and kept confidentially.
I understand that after the research has been completed it may be published in a journal, report or presented to other students and professionals. I understand that my identity will not be revealed in any report, publication or presentation.
I agree to take part in this study.
Next Page


survey.neurosense.com/s/O554M/
CONSENT FORM A (ABI Relatives, Non-ABI)
1. Please confirm you are happy to take part by "checking" the boxes below. *
Please initial box
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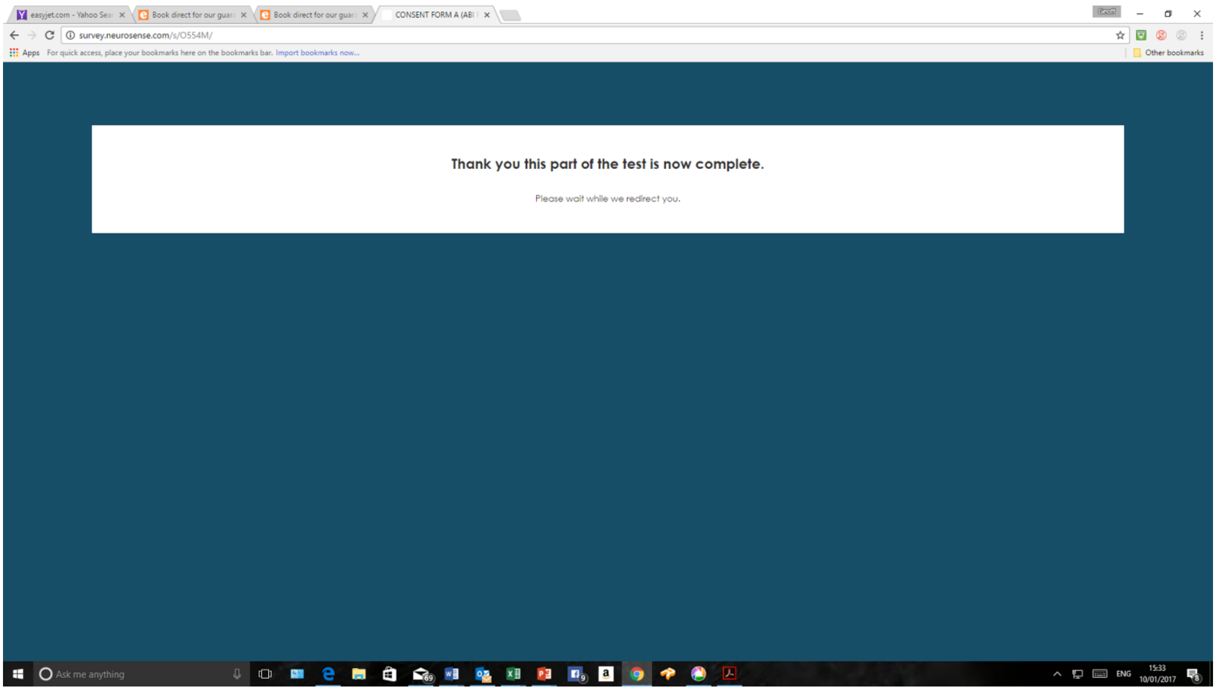
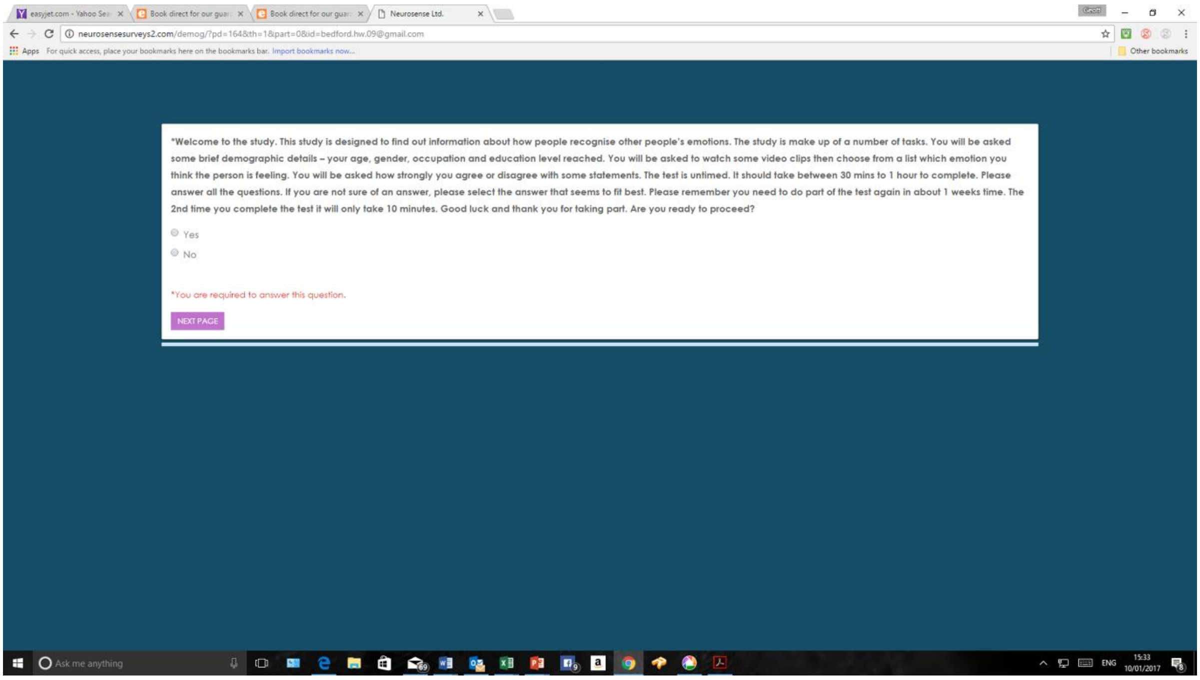
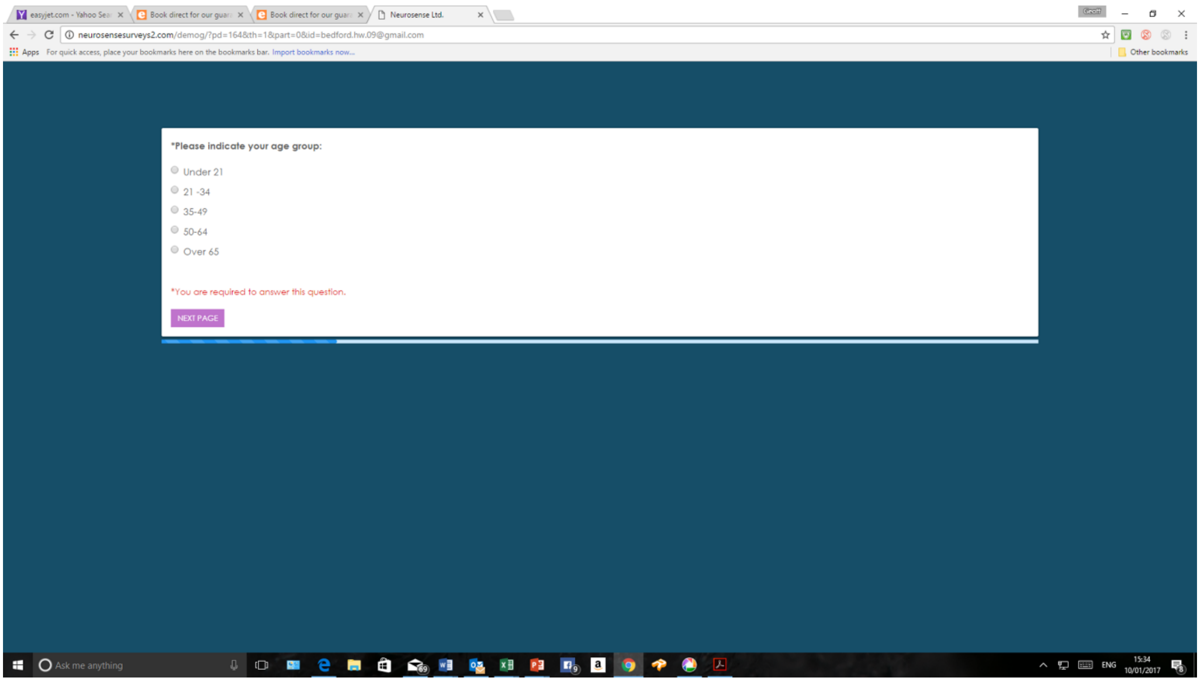
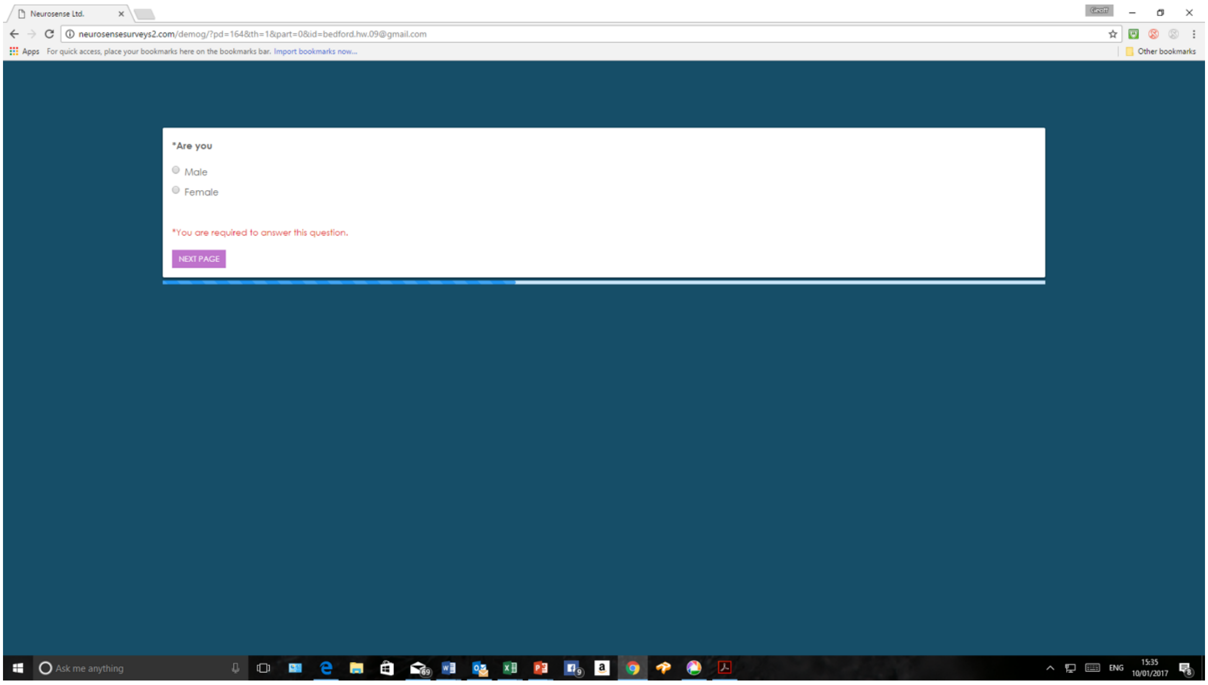
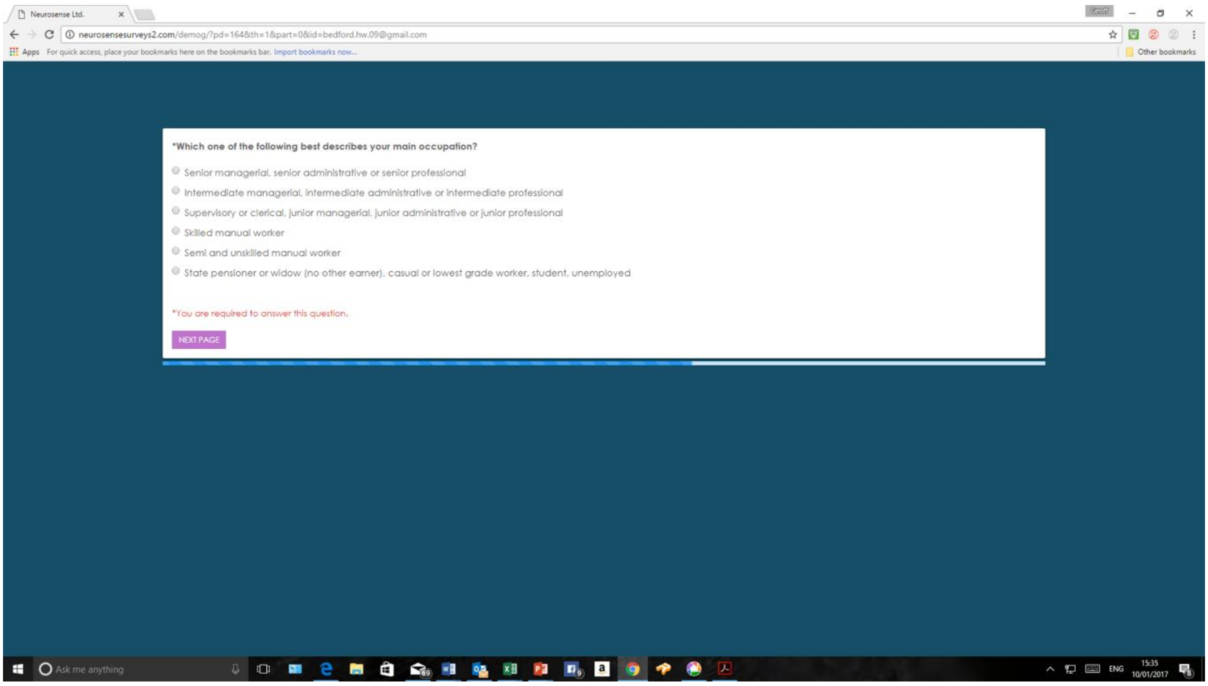
I understand that data collected during the study may be looked at by regulating authorities. I give permission for regulating authorities to have access to my records.
I understand that the information collected about me may be used to support other research in the future, and may be shared anonymously with other researchers.
I understand that all information provided will be anonymised and kept confidentially.
I understand that after the research has been completed it may be published in a journal, report or presented to other students and professionals. I understand that my identity will not be revealed in any report, publication or presentation.
I agree to take part in this study.
Next Page

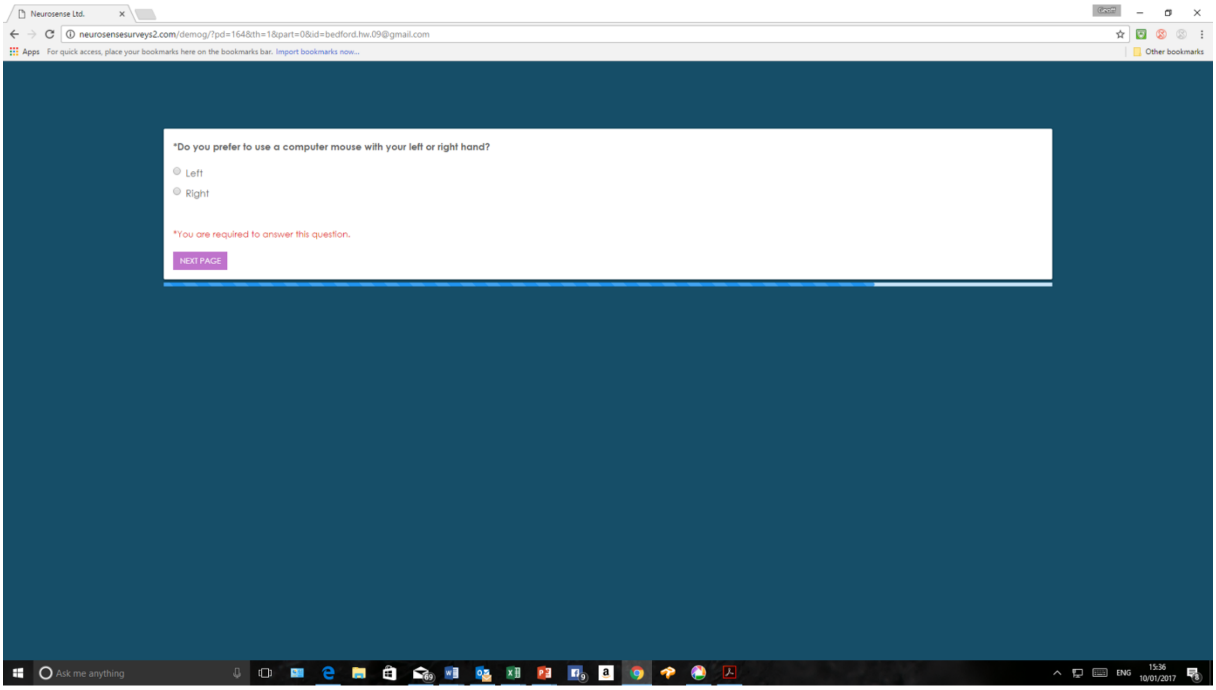

survey.neurosense.com/s/O554M/
Thank you this part of the test is now complete.
Please wait while we redirect you.

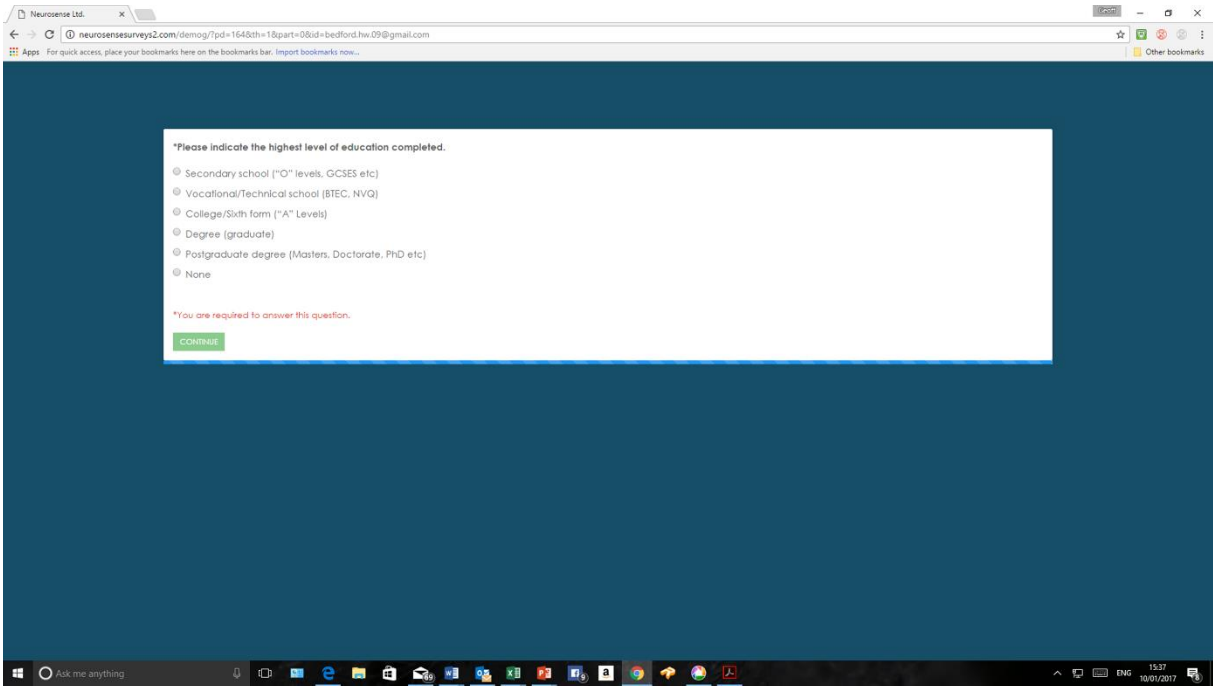

*Welcome to the study. This study is designed to find out information about how people recognise other people's emotions. The study is make up of a number of tasks. You will be asked some brief demographic details – your age, gender, occupation and education level reached. You will be asked to watch some video clips then choose from a list which emotion you think the person is feeling. You will be asked how strongly you agree or disagree with some statements. The test is untimed. It should take between 30 mins to 1 hour to complete. Please answer all the questions. If you are not sure of an answer, please select the answer that seems to fit best. Please remember you need to do part of the test again in about 1 weeks time. The 2nd time you complete the test it will only take 10 minutes. Good luck and thank you for taking part. Are you ready to proceed?
Yes
No
*You are required to answer this question.
NEXT PAGE

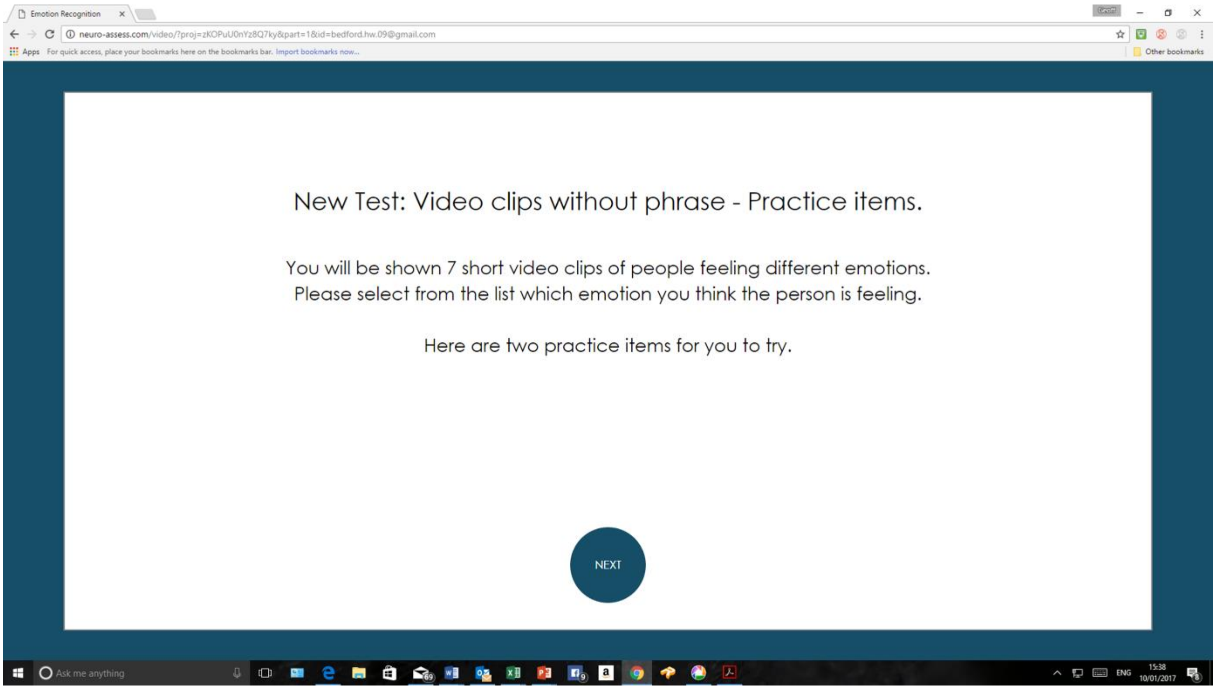

*Please indicate your age group:
Under 21
21 -34
35-49
50-64
Over 65
*You are required to answer this question.
NEXT PAGE

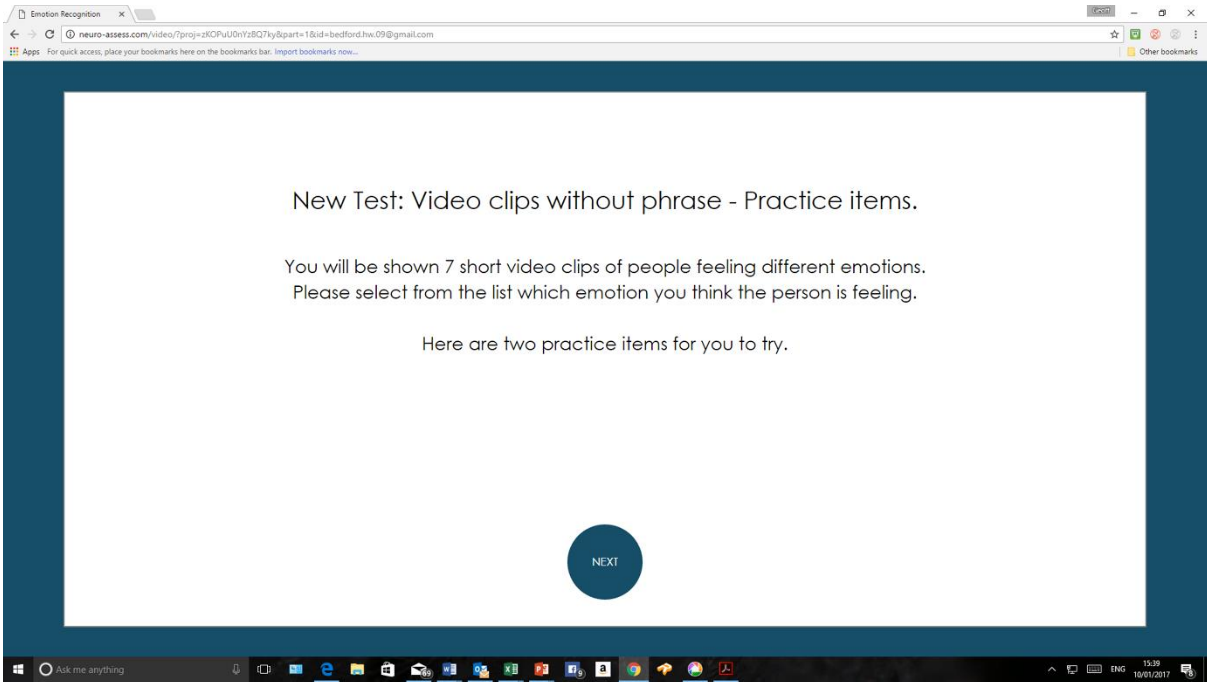

Neurosense Ltd.
neurosensesurveys2.com/demog/?pd=164&th=1&part=0&id=bedford.hw.09@gmail.com
Apps For quick access, place your bookmarks here on the bookmarks bar. Import bookmarks now...
Other bookmarks
*Are you
Male
Female
*You are required to answer this question.
NEXT PAGE
Ask me anything
ENG
15:35
10/01/2017

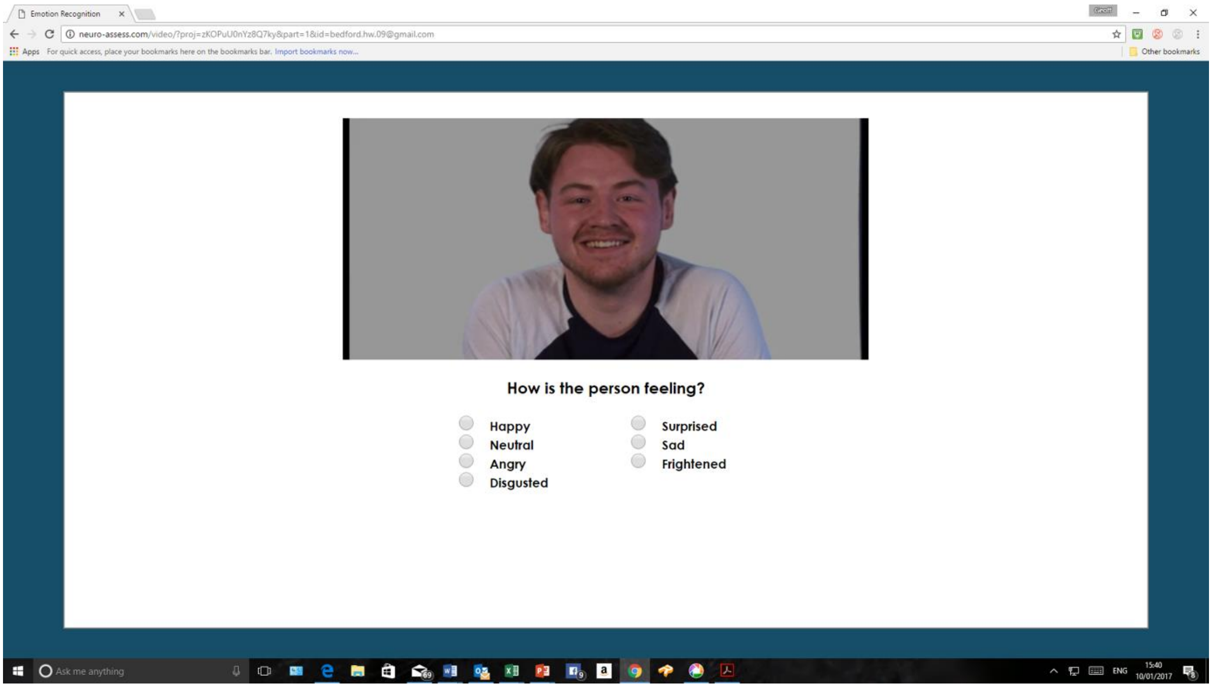

Neurosense Ltd.
neurosensesurveys2.com/demog/?pd=164&th=1&part=0&id=bedford.hw.09@gmail.com
Apps For quick access, place your bookmarks here on the bookmarks bar. Import bookmarks now...
Other bookmarks
*Which one of the following best describes your main occupation?
Senior managerial, senior administrative or senior professional
Intermediate managerial, intermediate administrative or intermediate professional
Supervisory or clerical, junior managerial, junior administrative or junior professional
Skilled manual worker
Semi and unskilled manual worker
State pensioner or widow (no other earner), casual or lowest grade worker, student, unemployed
*You are required to answer this question.
NEXT PAGE
Ask me anything
ENG
15:35
10/01/2017

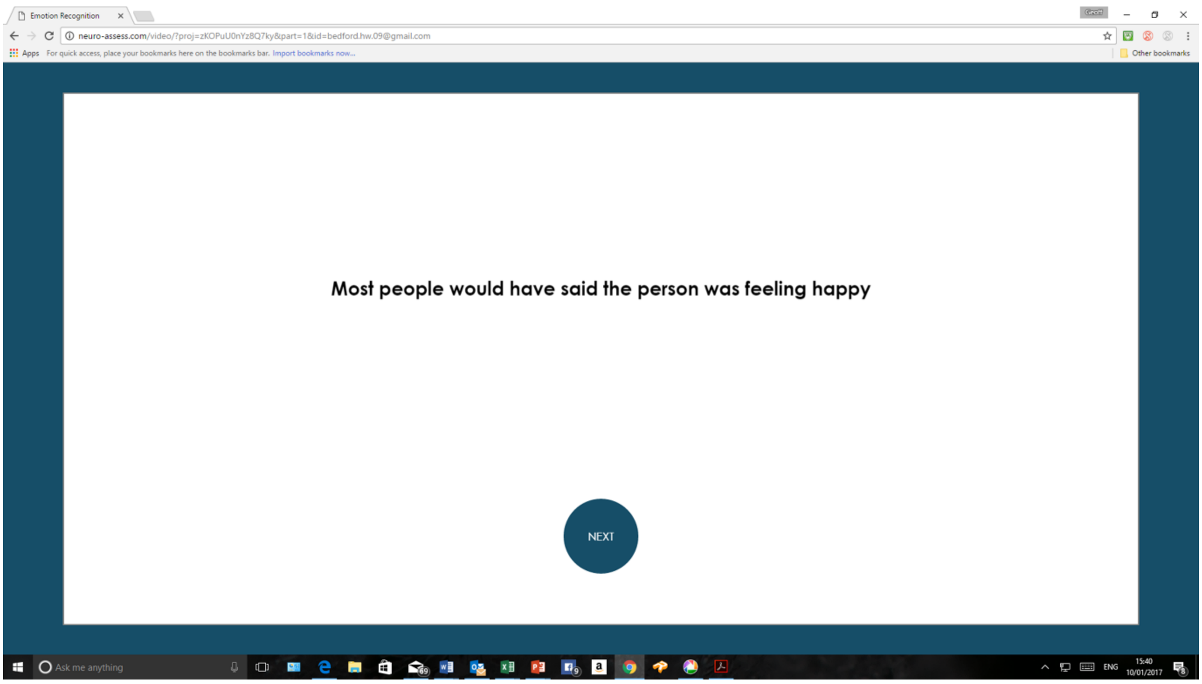

Neurosense Ltd.
neurosensesurveys2.com/demog/?pd=164&th=1&part=0&id=bedford.hw.09@gmail.com
*Do you prefer to use a computer mouse with your left or right hand?
Left
Right
*You are required to answer this question.
NEXT PAGE
Ask me anything

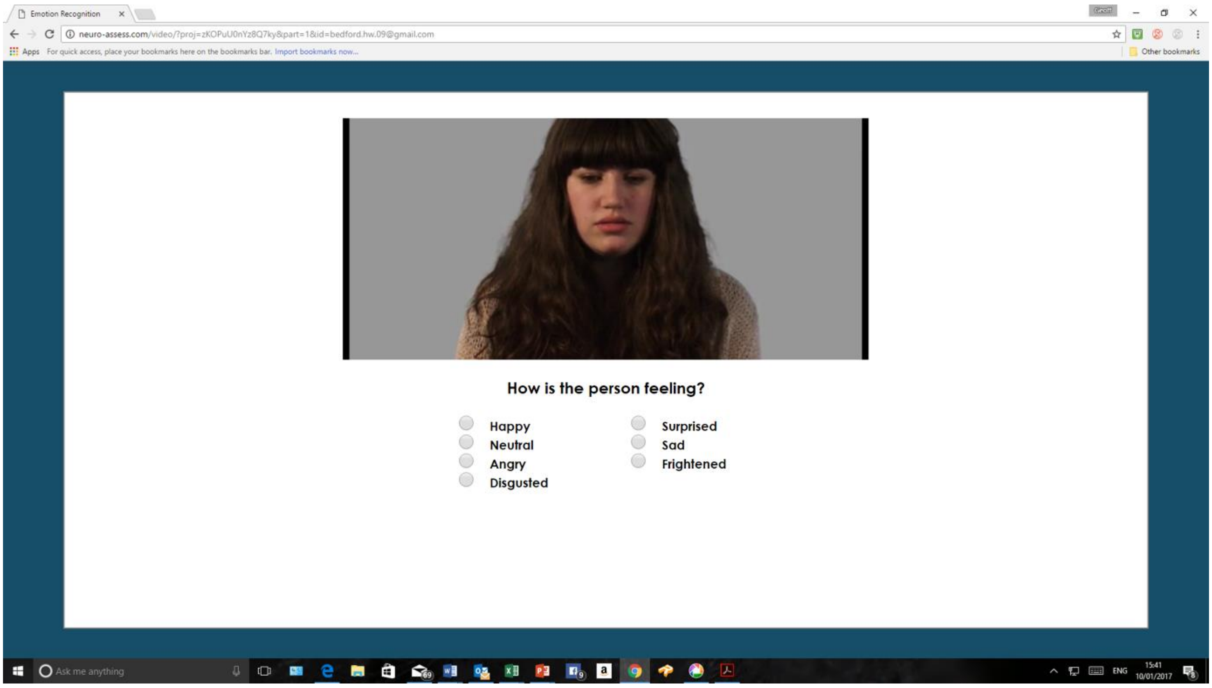

Neurosense Ltd.
neurosensesurveys2.com/demog/?pd=164&th=1&part=0&id=bedford.hw.09@gmail.com
*Please indicate the highest level of education completed.
Secondary school ("O" levels, GCSES etc)
Vocational/Technical school (BTEC, NVQ)
College/Sixth form ("A" Levels)
Degree (graduate)
Postgraduate degree (Masters, Doctorate, PhD etc)
None
*You are required to answer this question.
CONTINUE
Ask me anything

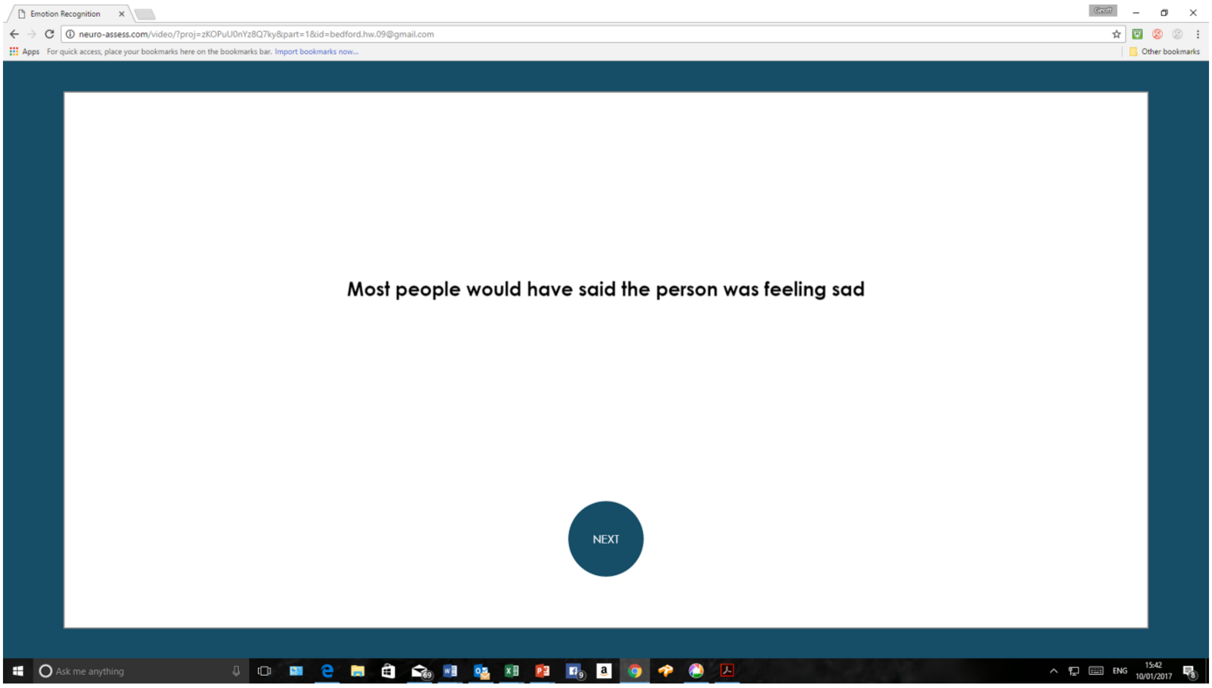

Emotion Recognition
New Test: Video clips without phrase - Practice items.
You will be shown 7 short video clips of people feeling different emotions.
Please select from the list which emotion you think the person is feeling.
Here are two practice items for you to try.
NEXT

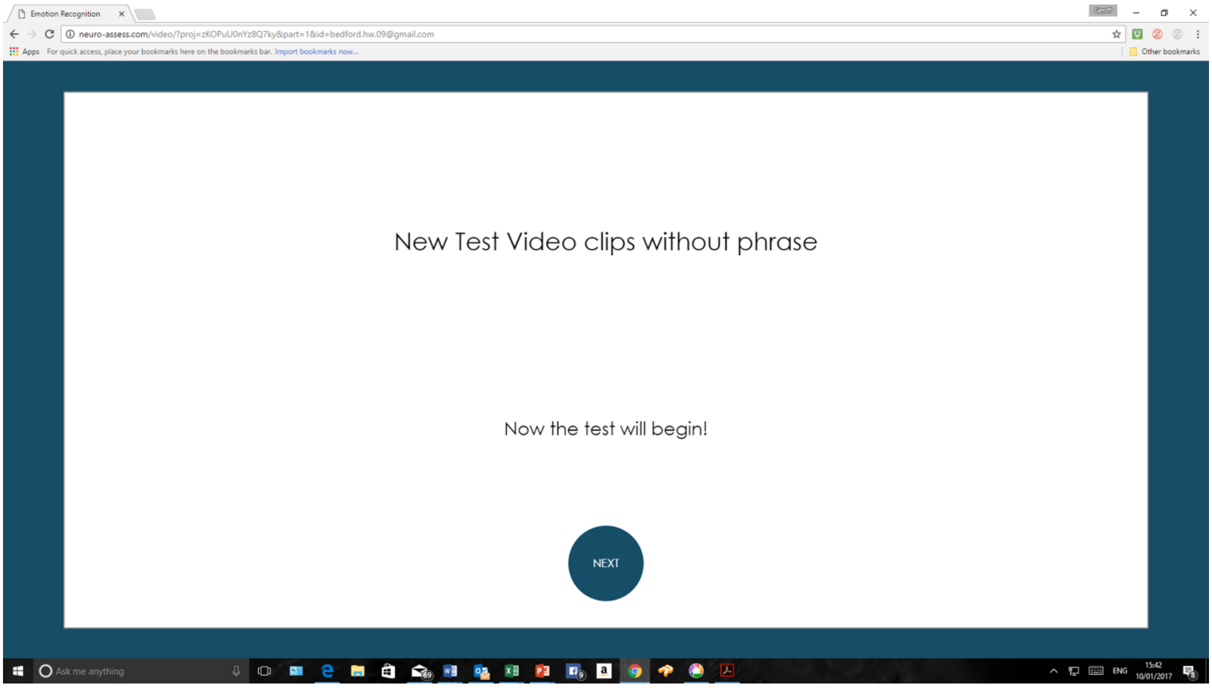

Emotion Recognition
New Test: Video clips without phrase - Practice items.
You will be shown 7 short video clips of people feeling different emotions.
Please select from the list which emotion you think the person is feeling.
Here are two practice items for you to try.
NEXT

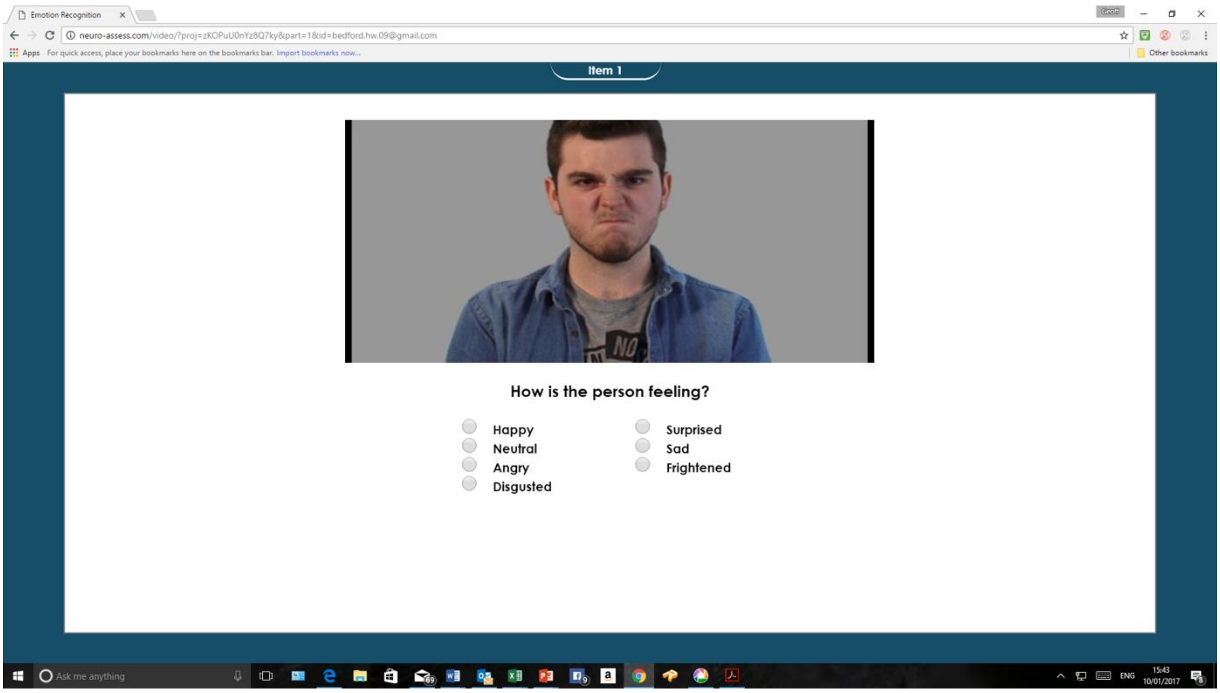

Emotion Recognition
neuro-assess.com/video/?proj=zKOPuU0nYz8Q7ky&part=1&id=bedford.hw.09@gmail.com
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened

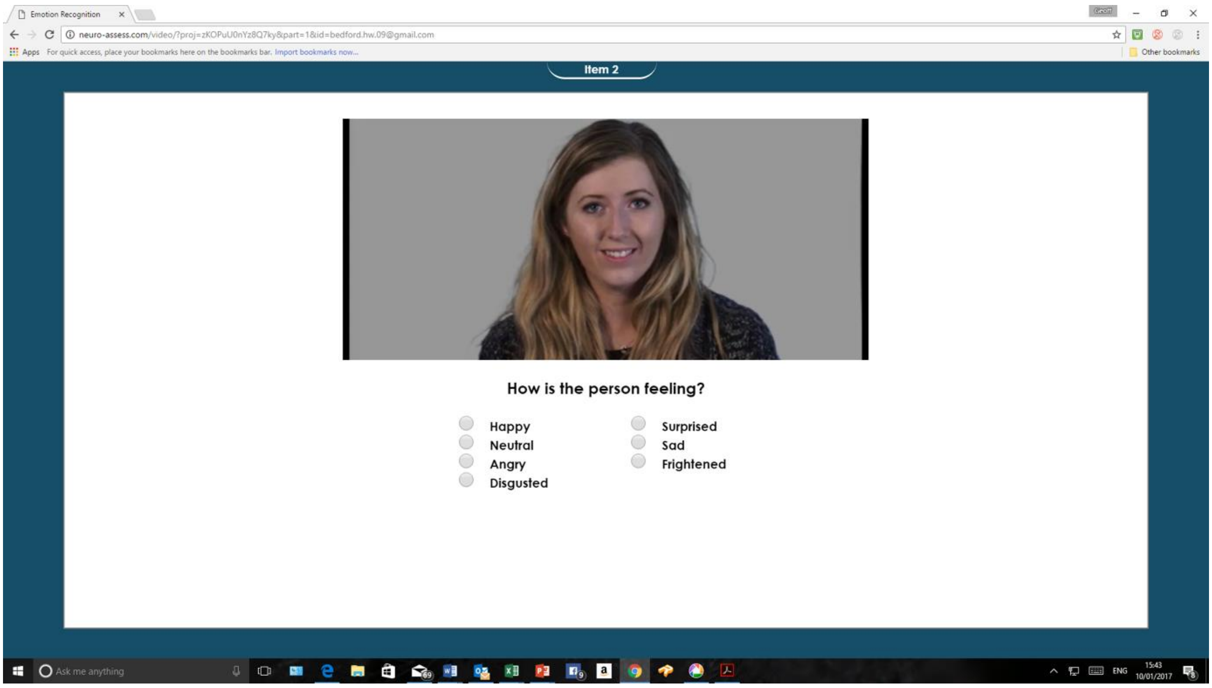

Emotion Recognition
neuro-assess.com/video/?proj=zKOPuU0nYz8Q7ky&part=1&id=bedford.hw.09@gmail.com
Most people would have said the person was feeling happy
NEXT

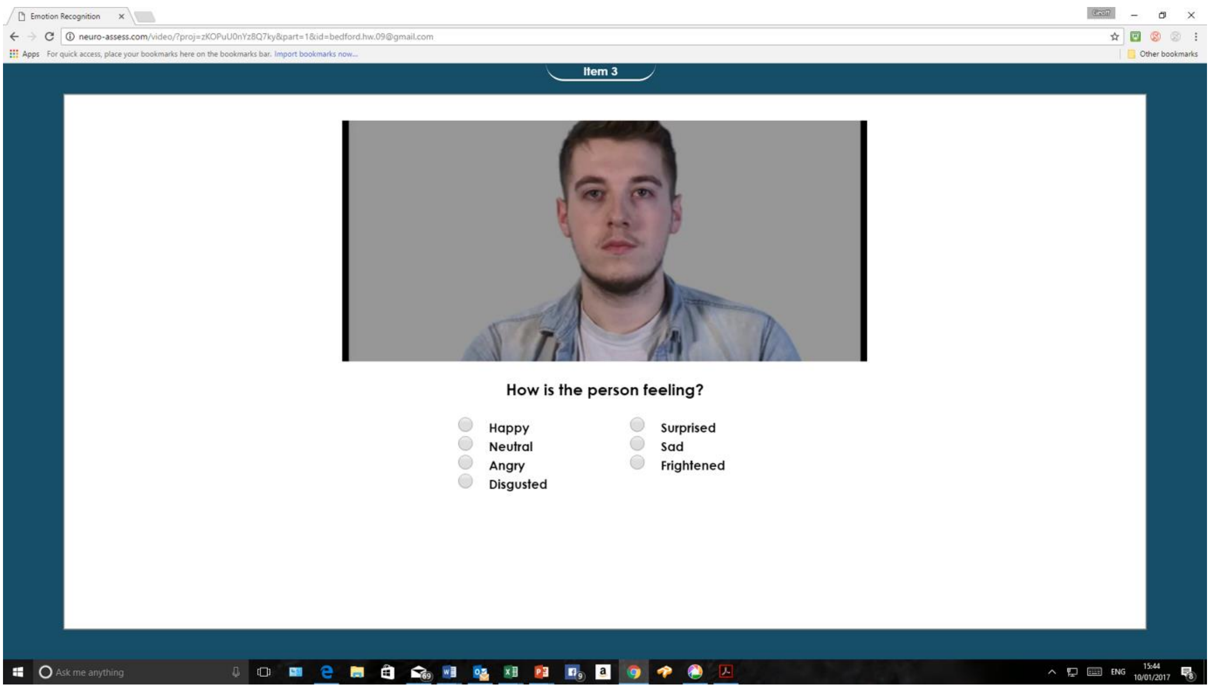

Emotion Recognition
neuro-assess.com/video/?proj=zKOPuU0nYz8Q7ky&part=1&id=bedford.hw.09@gmail.com
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened

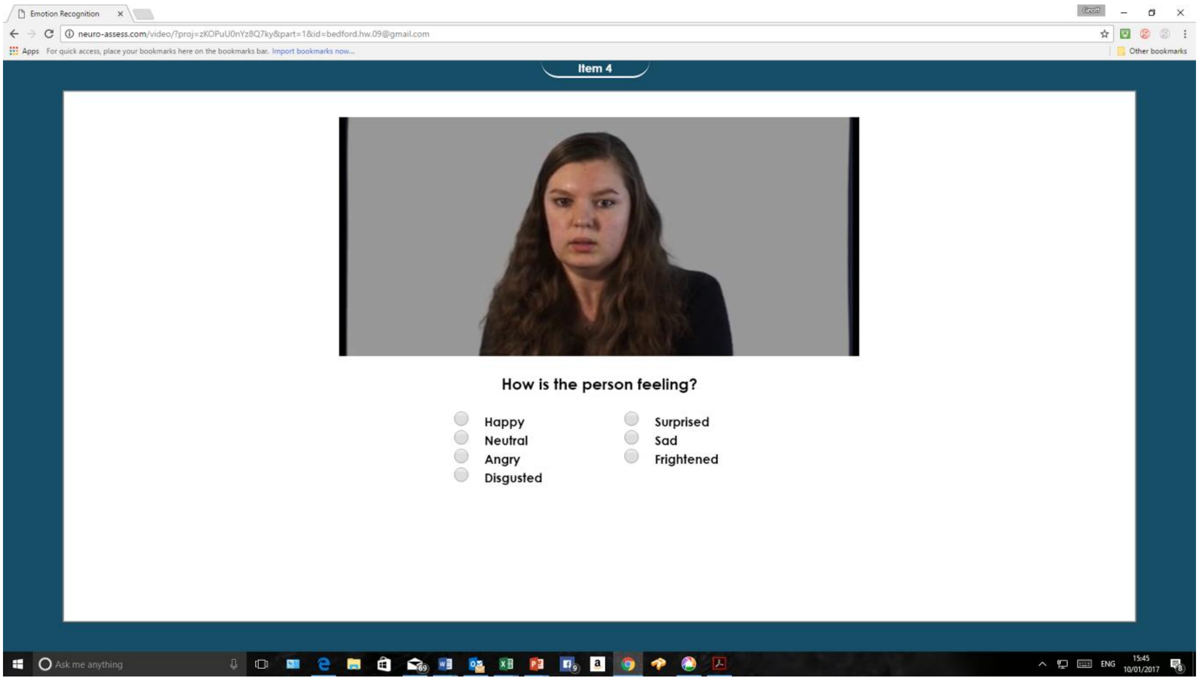

Emotion Recognition
neuro-assess.com/video/?proj=zKOPuU0nYz8Q7ky&part=1&id=bedford.hw.09@gmail.com
Most people would have said the person was feeling sad
NEXT

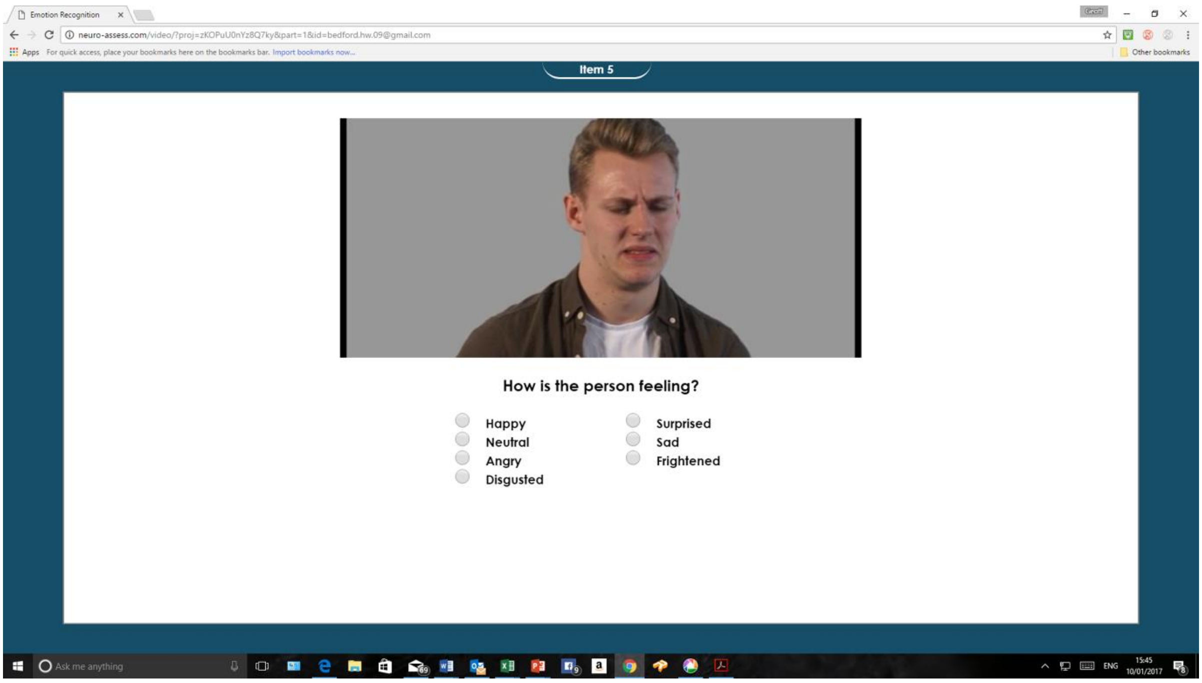

Emotion Recognition
neuro-assess.com/video/?proj=zKOPuU0nYz8Q7ky&part=1&id=bedford.hw.09@gmail.com
New Test Video clips without phrase
Now the test will begin!
NEXT
Ask me anything

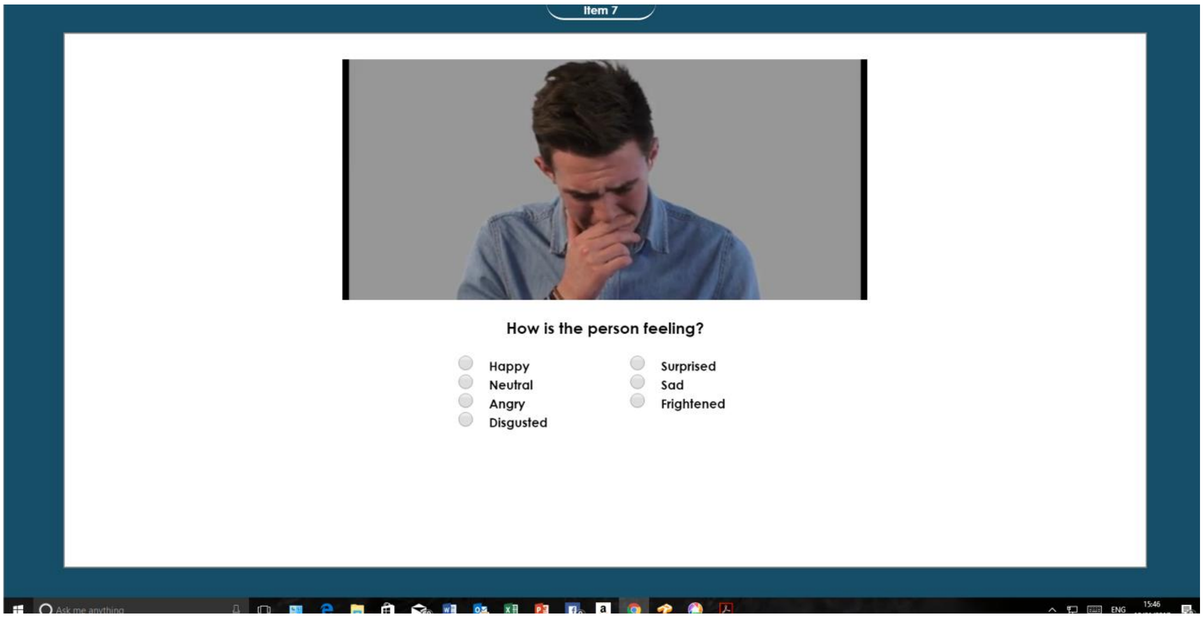

Emotion Recognition
neuro-assess.com/video/?proj=zKOPuU0nYz8Q7ky&part=1&id=bedford.hw.09@gmail.com
Item 1
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened
Ask me anything

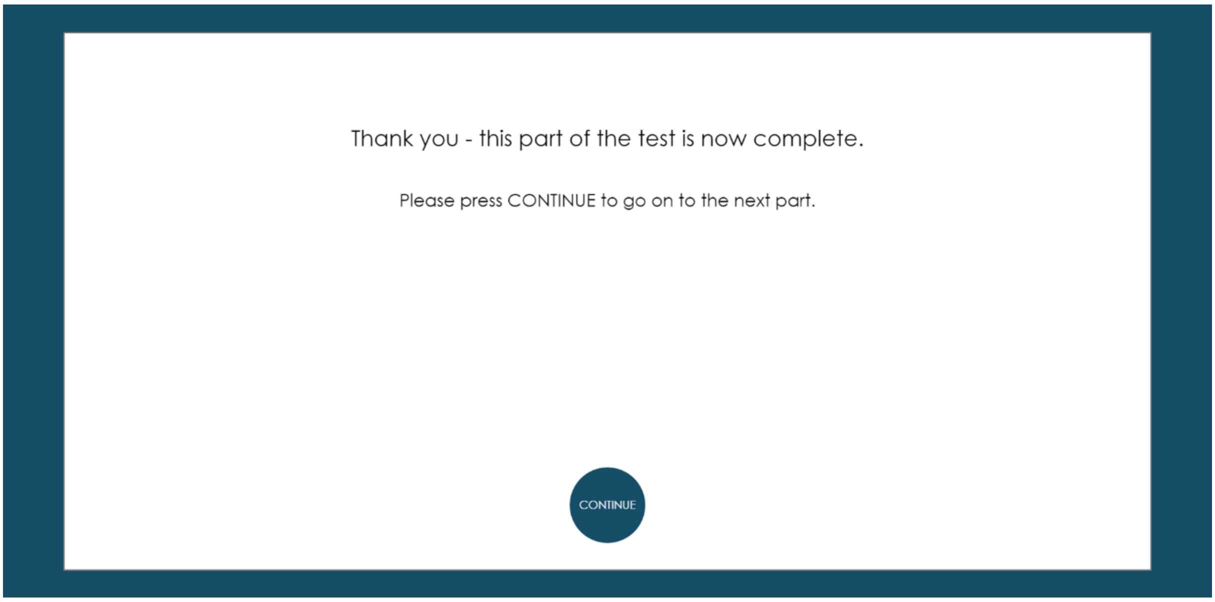

Emotion Recognition
Item 2
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened
Ask me anything

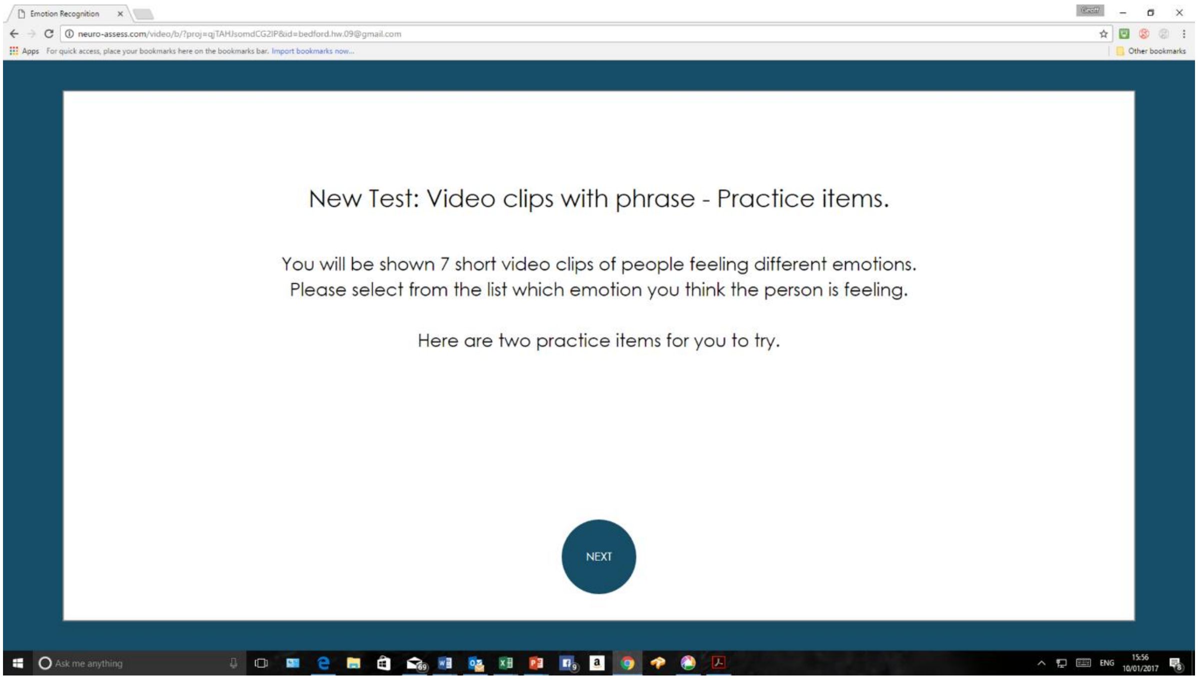

Emotion Recognition
Item 3
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened
Ask me anything

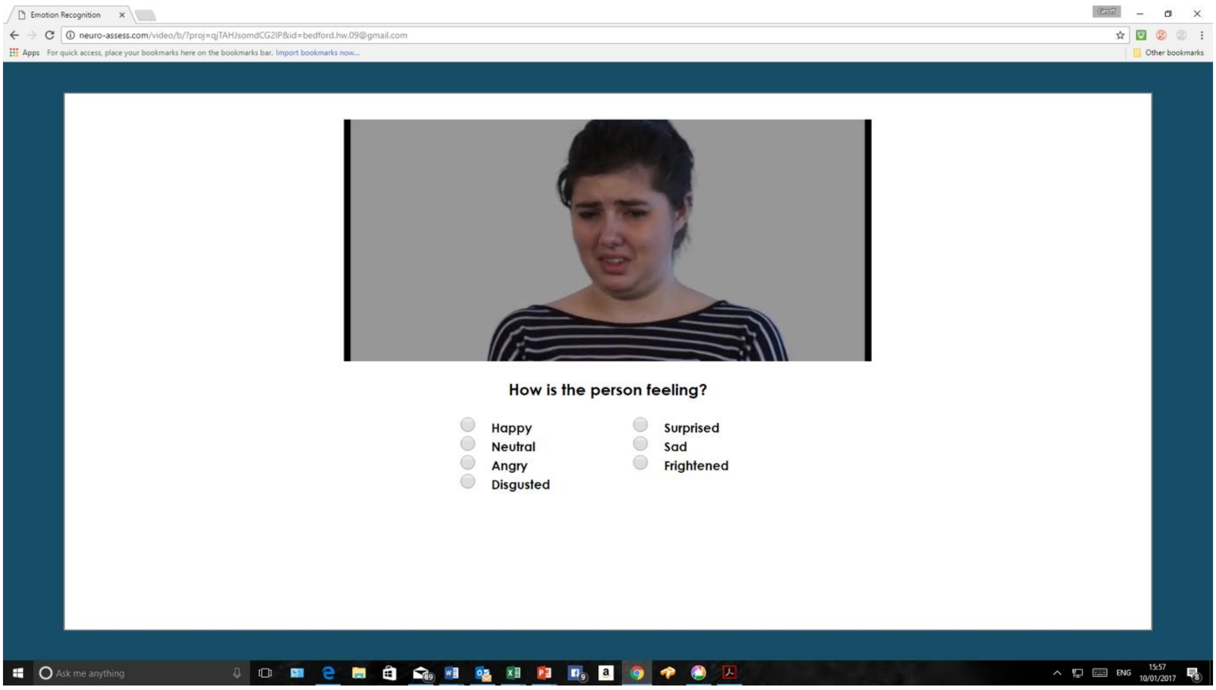

Emotion Recognition
neuro-assess.com/video/?proj=zKOPuU0nYz8Q7ky&part=1&id=bedford.hw.09@gmail.com
Apps For quick access, place your bookmarks here on the bookmarks bar. Import bookmarks now...
Other bookmarks
Item 4
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened
Ask me anything
ENG
15:45
10/01/2017

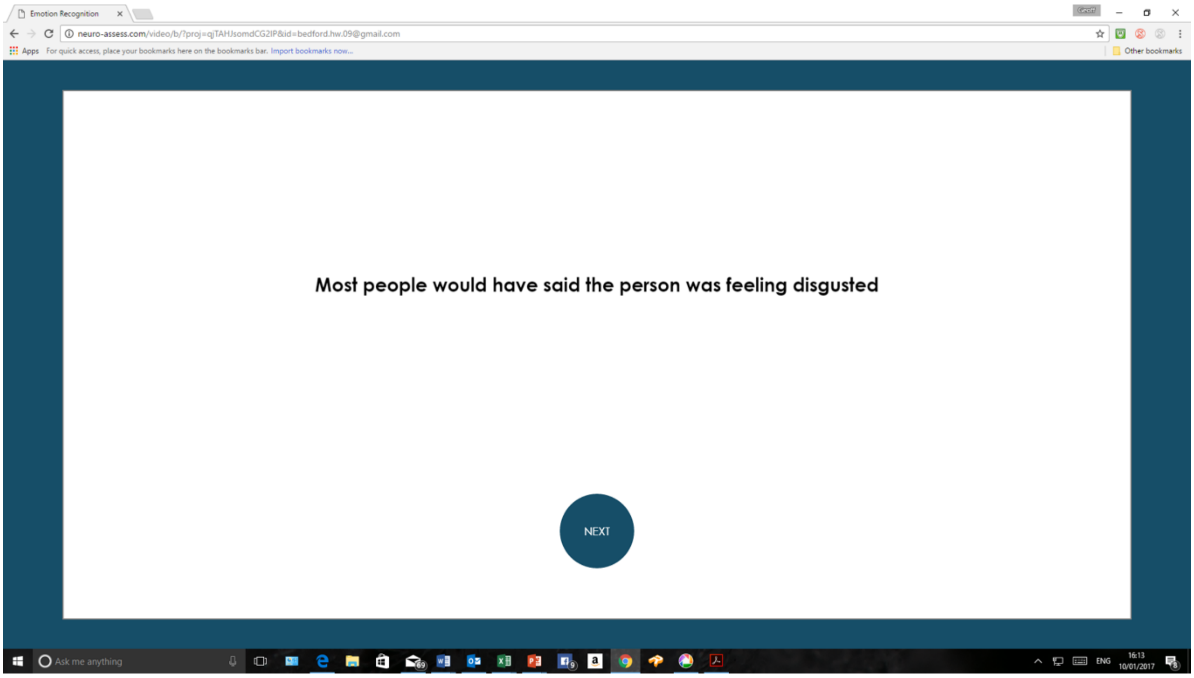

Emotion Recognition
neuro-assess.com/video/?proj=zKOPuU0nYz8Q7ky&part=1&id=bedford.hw.09@gmail.com
Apps For quick access, place your bookmarks here on the bookmarks bar. Import bookmarks now...
Other bookmarks
Item 5
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened
Ask me anything
ENG
15:45
10/01/2017

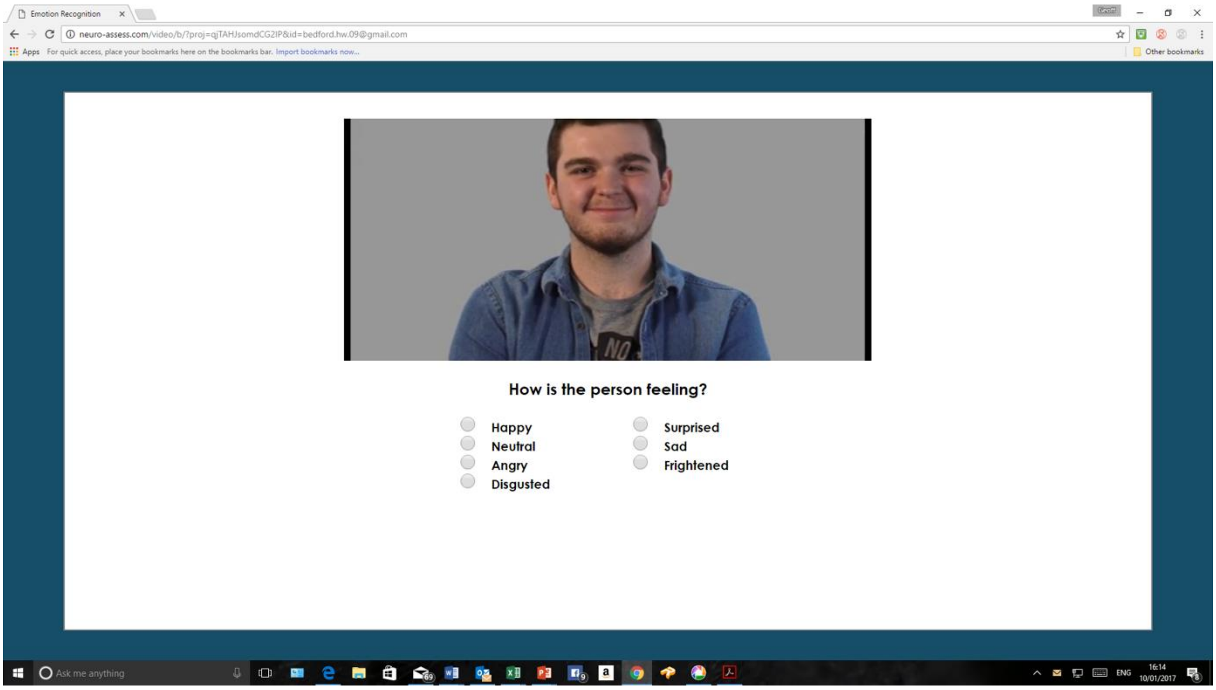

Item 7
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened

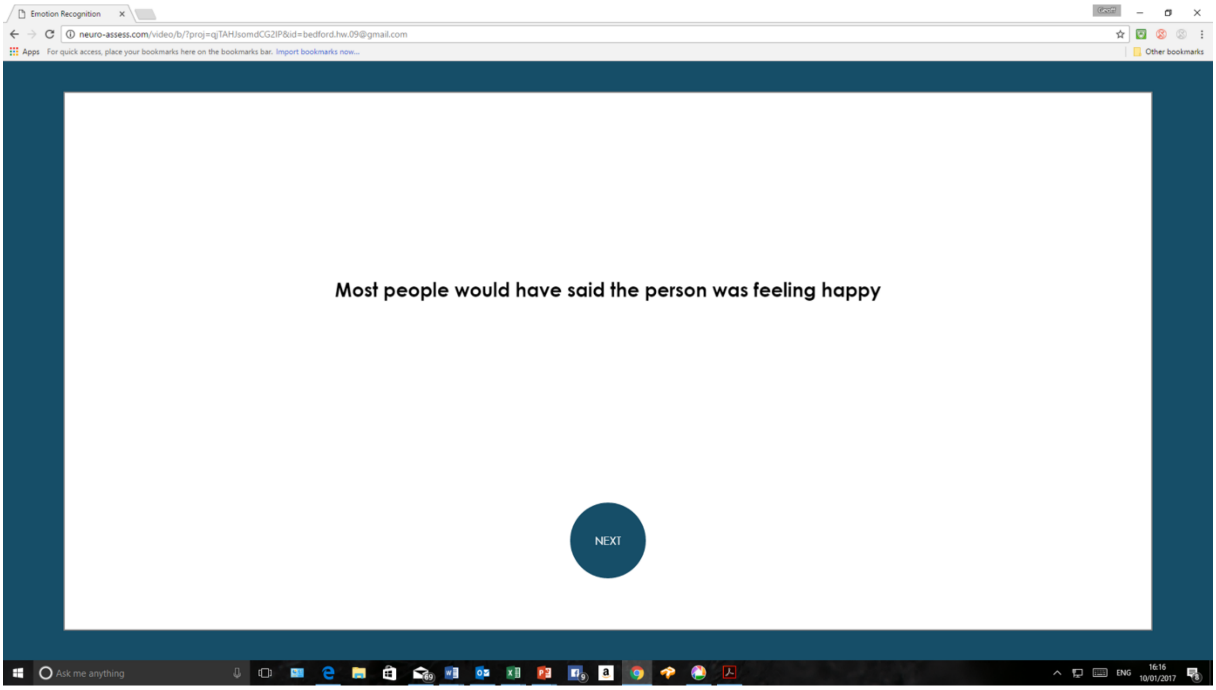

Thank you - this part of the test is now complete.
Please press CONTINUE to go on to the next part.
CONTINUE

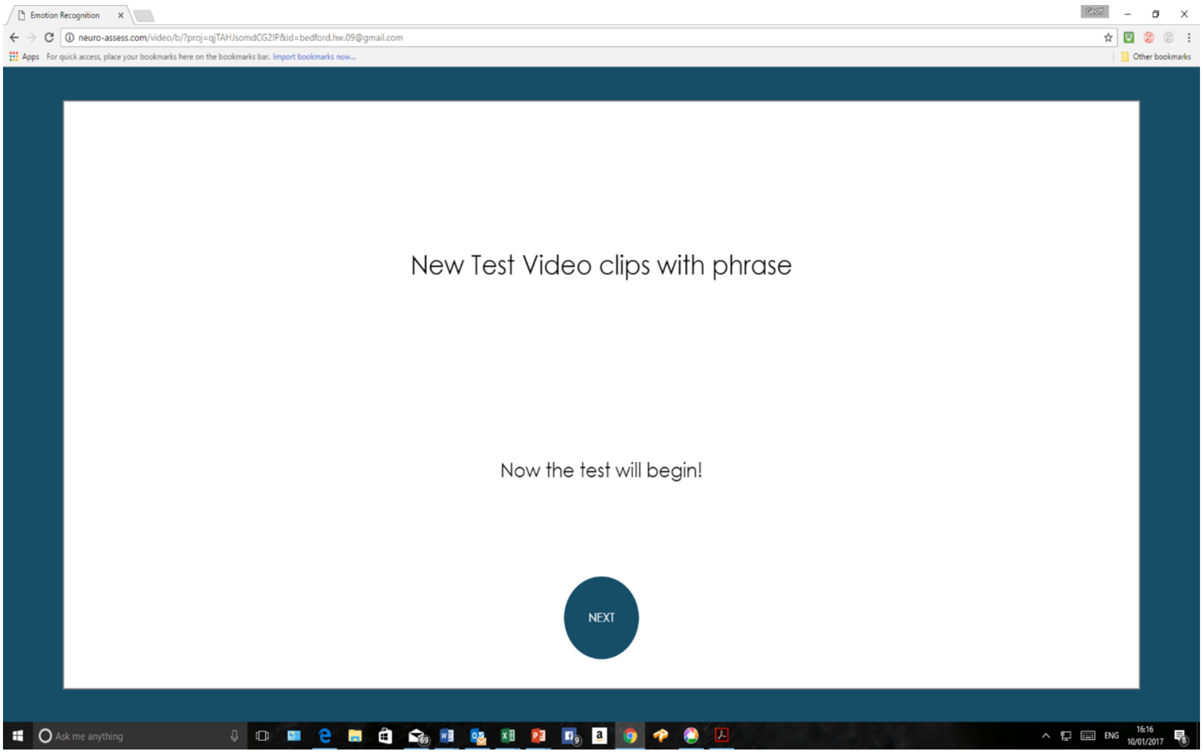

Emotion Recognition
New Test: Video clips with phrase - Practice items.
You will be shown 7 short video clips of people feeling different emotions.
Please select from the list which emotion you think the person is feeling.
Here are two practice items for you to try.
NEXT

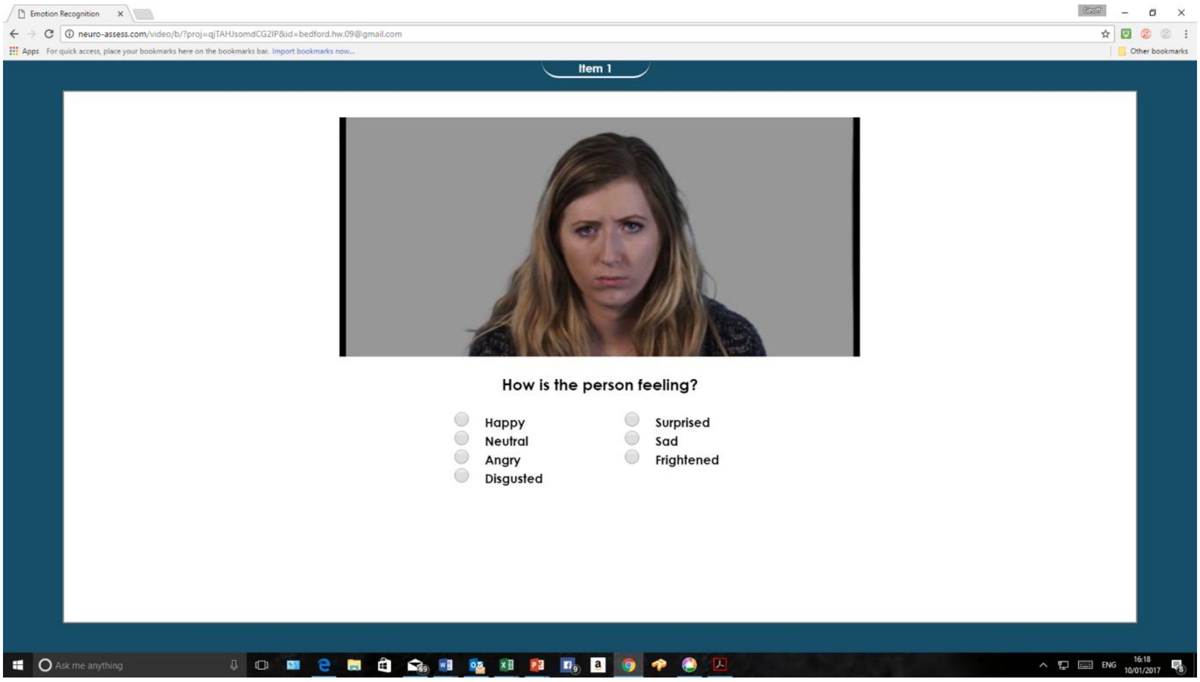

Emotion Recognition
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened

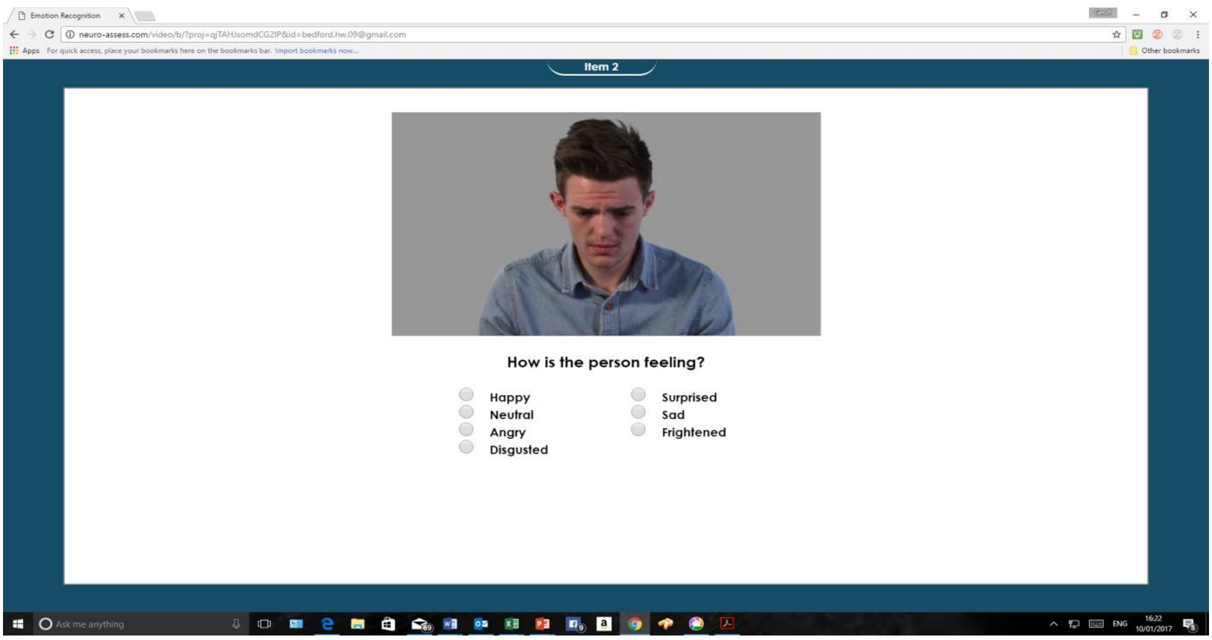

Emotion Recognition
neuro-assess.com/video/b/?proj=qjTAHJsomdCG2IP&id=bedford.hw.09@gmail.com
Most people would have said the person was feeling disgusted
NEXT

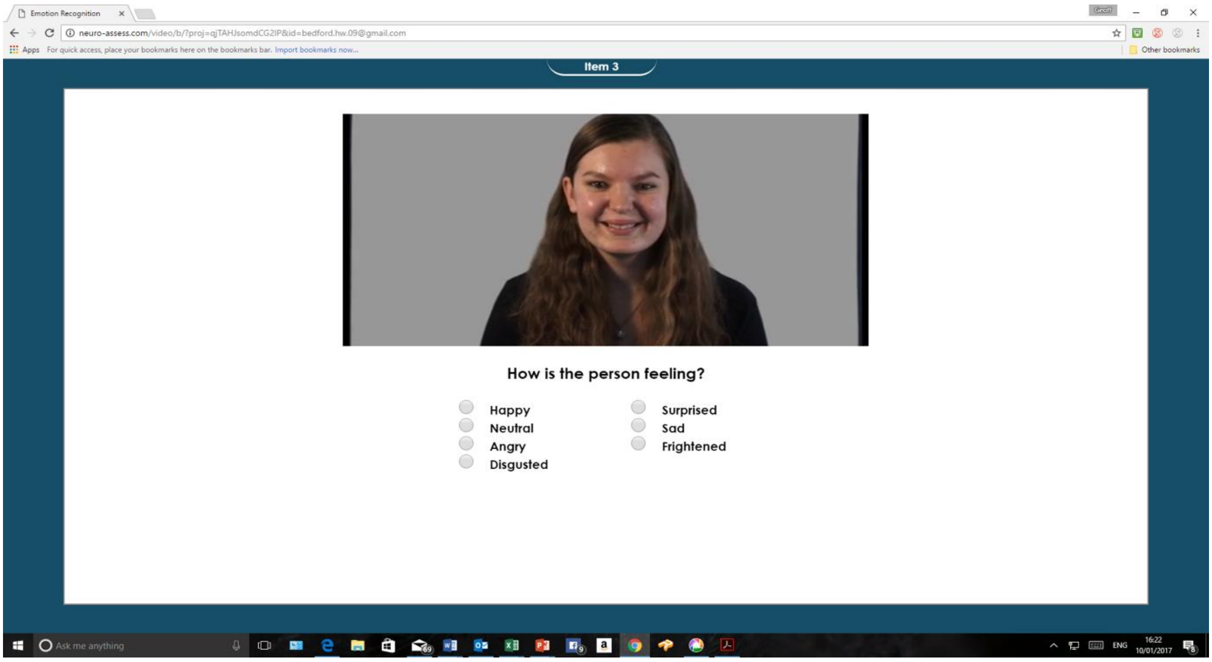

Emotion Recognition
neuro-assess.com/video/b/?proj=qjTAHJsomdCG2IP&id=bedford.hw.09@gmail.com
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened

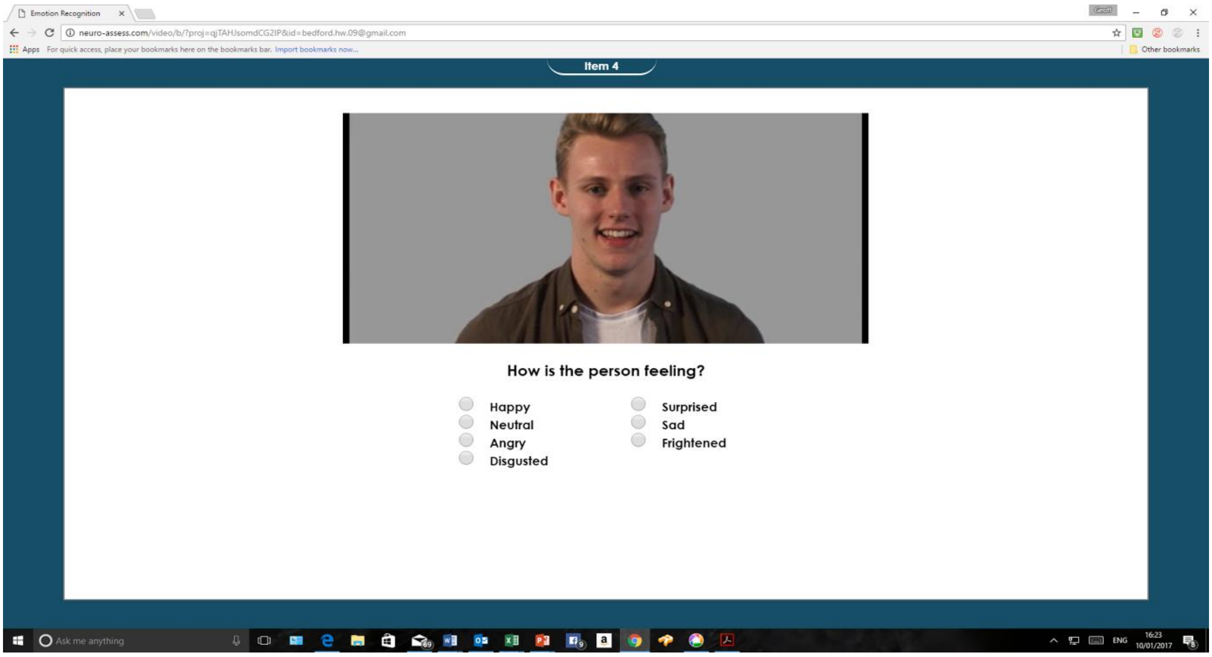

Emotion Recognition
Most people would have said the person was feeling happy
NEXT
Ask me anything

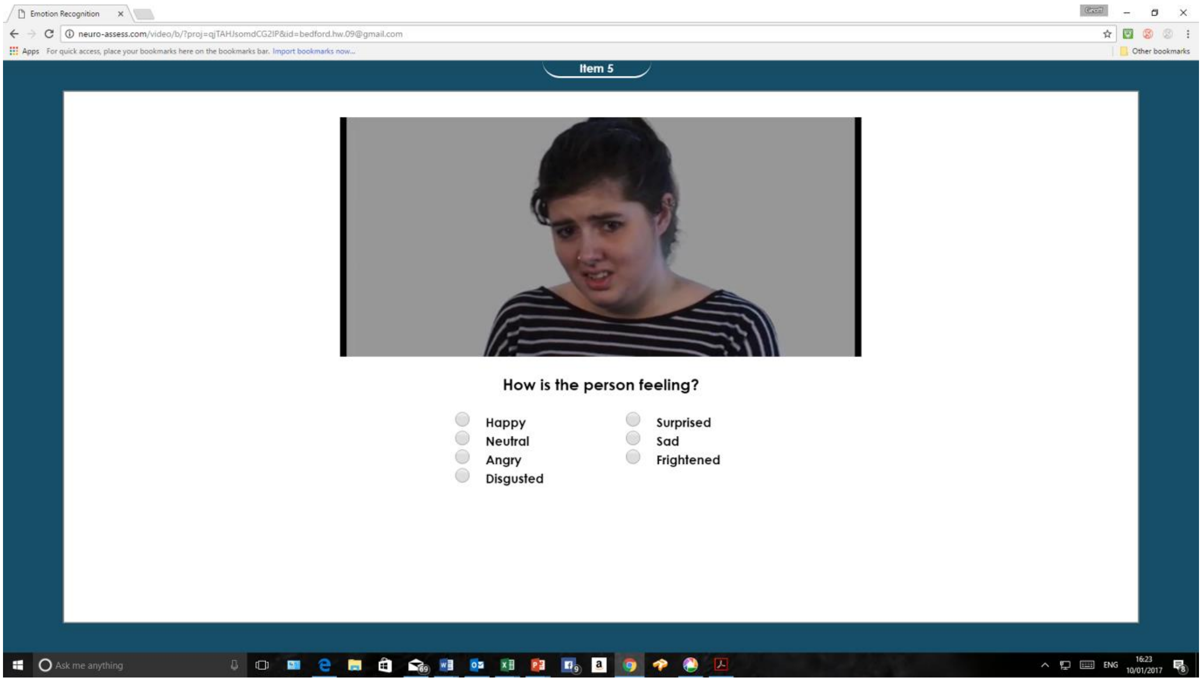

Emotion Recognition
New Test Video clips with phrase
Now the test will begin!
NEXT
Ask me anything

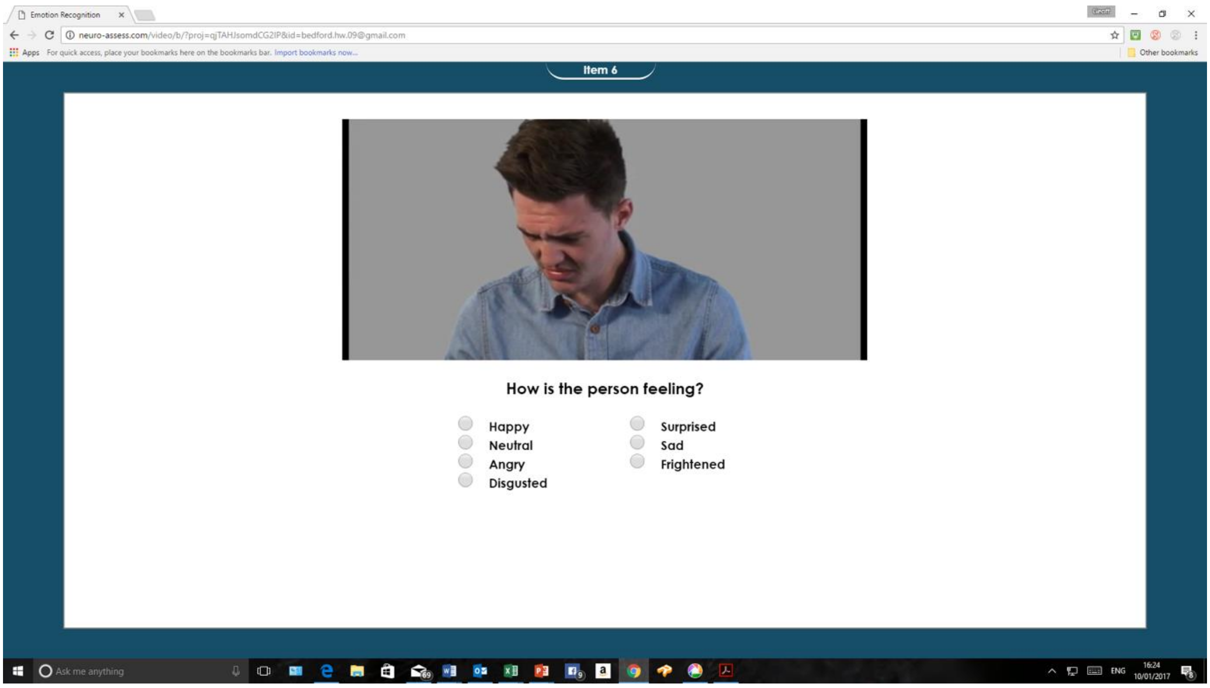

Emotion Recognition
Item 1
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened

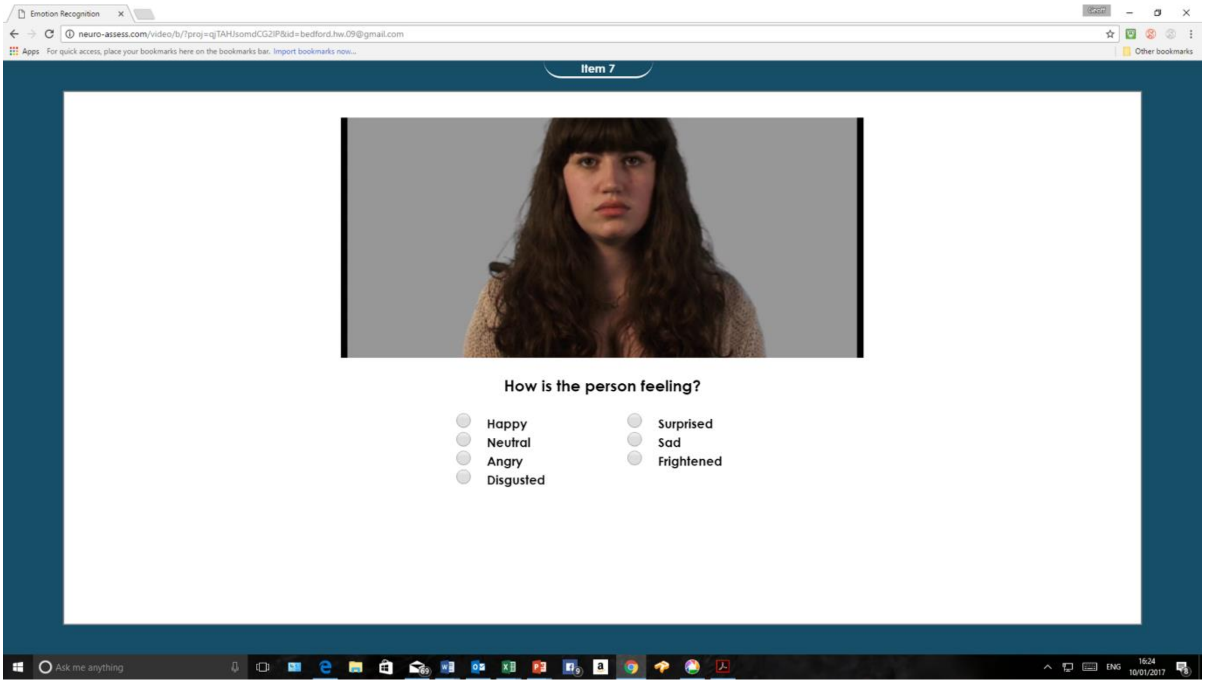

Emotion Recognition
Item 2
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened

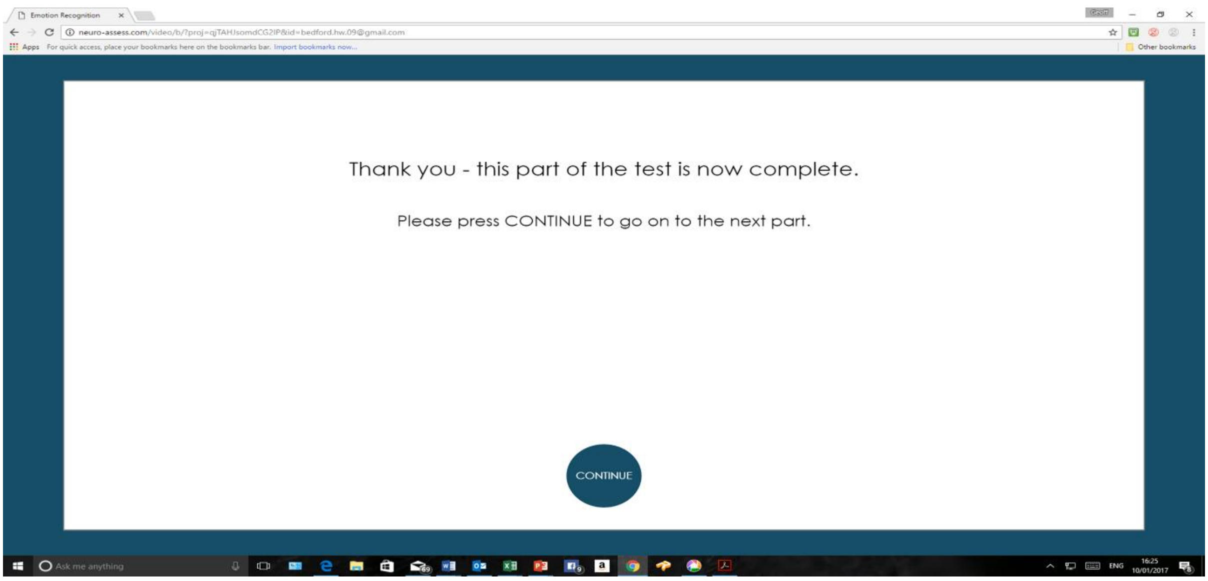

Emotion Recognition
neuro-assess.com/video/b/?proj=qjTAHJsomdCG2IP&id=bedford.hw.09@gmail.com
Item 3
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened

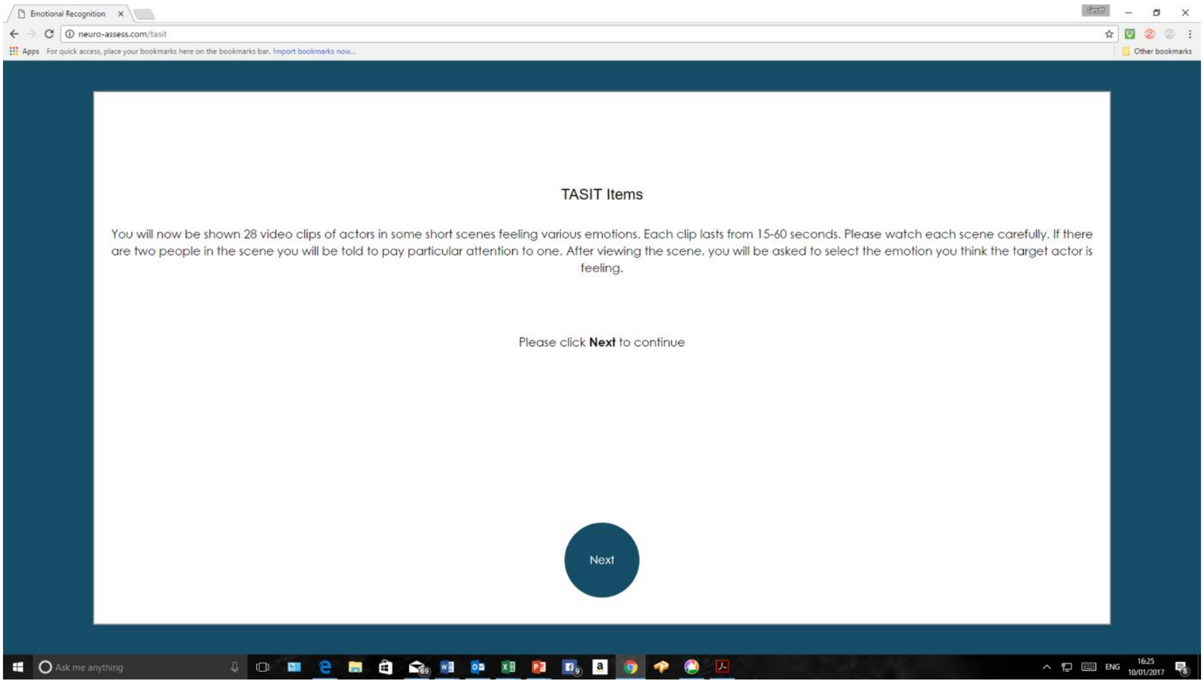

Emotion Recognition
neuro-assess.com/video/b/?proj=qjTAHJsomdCG2IP&id=bedford.hw.09@gmail.com
Item 4
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened


Emotion Recognition
neuro-assess.com/video/b/?proj=qjTAHJsomdCG2IP&id=bedford.hw.09@gmail.com
Item 5
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened
Ask me anything


Emotion Recognition
neuro-assess.com/video/b/?proj=qjTAHJsomdCG2IP&id=bedford.hw.09@gmail.com
Item 6
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened
Ask me anything


Emotion Recognition
neuro-assess.com/video/b/?proj=qjTAHJsomdCG2IP&id=bedford.hw.09@gmail.com
Item 7
How is the person feeling?
Happy
Neutral
Angry
Disgusted
Surprised
Sad
Frightened


Emotion Recognition
Thank you - this part of the test is now complete.
Please press CONTINUE to go on to the next part.
CONTINUE


Emotional Recognition
neuro-assess.com/tasit
TASIT Items
You will now be shown 28 video clips of actors in some short scenes feeling various emotions. Each clip lasts from 15-60 seconds. Please watch each scene carefully. If there are two people in the scene you will be told to pay particular attention to one. After viewing the scene, you will be asked to select the emotion you think the target actor is feeling.
Please click Next to continue
Next
Ask me anything

APPENDIX 11

The p values of Kolmogorov-Smirov test of Normality for the BERT

	Application	Control group 1st application n=92 2nd application n=79	ABI group 1st application n=20 2nd application n=15
"no phrase"	1st	0.54*	0.30*
	2nd	0.53*	0.28*
"with phrase"	1st	0.32*	0.15
	2nd	0.42*	0.21
Total correct	1st	0.31*	0.23*
	2nd	0.42*	0.20*

*Significant at the p<0.05 level of significance indicating the variable is not normally distributed.

APPENDIX 12

Demographic details of neurologically healthy participants

Participant	Age	M/F	Occupation (see key below)	Years Education (see note below)
1	46	F	2	18
2	53	M	1	16
3	46	F	1	13
4	43	M	1	16
5	40	M	3	13
6	22	M	3	16
7	52	M	1	18
8	30	M	3	18
9	27	M	2	16
10	55	F	2	16
11	55	F	2	13
12	56	F	1	18
13	39	F	2	16
14	28	F	2	18
15	28	F	2	16
16	61	F	3	18
17	35	F	2	18
18	30	F	3	18
19	59	F	2	16
20	51	F	2	18
21	62	F	1	18
22	49	F	3	16
23	58	M	4	18
24	48	F	1	13
25	34	M	3	16
26	70	M	3	9
27	47	F	2	16
28	64	F	3	16
29	31	F	2	18
30	54	M	3	13
31	29	M	3	16
32	25	F	3	13
33	75	F	3	9
34	36	F	3	18
35	37	M	2	16
36	46	F	2	16

37	34	M	2	16
38	45	F	3	13
39	35	M	2	18
40	37	F	2	11
41	33	F	2	16
42	49	F	3	18
43	23	F	3	16
44	75	M	3	11
45	59	F	2	16
46	31	F	2	18
47	58	M	2	16
48	49	M	2	16
49	70	M	3	11
50	29	F	3	16
51	29	F	2	18
52	31	F	3	16
53	48	M	2	18
54	31	F	3	18
55	72	F	3	11
56	60	F	3	13
57	69	F	3	16
58	74	M	1	9
59	56	F	2	16
60	43	F	2	16
61	51	M	4	11
62	46	F	1	11
63	64	M	3	13
64	50	M	2	16
65	55	M	2	16
66	64	M	2	13
67	75	F	3	13
68	58	F	1	16
69	37	F	2	16
70	31	M	2	16
71	55	M	2	13
72	50	F	2	16
73	55	F	1	16
74	26	M	3	18
75	32	F	4	18
76	55	F	3	16
77	68	M	2	13
78	57	F	3	13

79	80	F	2	16
80	37	M	3	18
81	70	F	3	16
82	70	M	4	13
83	27	M	3	16
84	46	M	1	18
85	29	M	3	16
86	80	M	4	16
87	54	M	2	16
88	44	M	2	16
89	31	M	3	16
90	25	M	3	16
91	50	M	2	16
92	25	M	3	16

Key explaining occupations

Number	Occupation type
1	Senior managerial/professional
2	Intermediate managerial/administrative/professional
3	Junior managerial/administrative/professional
4	Skilled manual worker
5	Semi-skilled manual worker;
6	Retired, casual or lowest grade worker, student, unemployed

Years education

The mean years education for the neurologically healthy participant group is 15.58 years (*SD* 2.34)

The table below shows how years education has been calculated.

Participants were asked to say the highest level of education they completed

Highest level of education completed	No. of years education assumed
No formal education	9
Secondary school	11
BTEC/A levels	13
Degree	16
Post grad degree	18

APPENDIX 13

Demographic details of ABI participants

Participant	Age	M/F	Occupation (see key below)	Years Education (see note below)	Type of ABI
ABI 1	46	F	5	11	Stroke
ABI 2	56	M	3	13	RTA
ABI 3	52	M	3	13	RTA
ABI 4	58	M	6	13	RTA
ABI 5	54	M	5	9	Stroke
ABI 6	40	F	3	11	Aneurysm
ABI 7	49	F	2	13	Stroke
ABI 8	67	F	3	9	Stroke
ABI 9	52	M	6	9	Aneurysm
ABI 10	37	F	2	16	Stroke
ABI 11	52	F	3	11	Stroke
ABI 12	32	F	3	13	Brain Haemorrhage
ABI 13	50	M	2	13	brain tumour
ABI 14	63	M	4	13	Stroke
ABI 15	25	M	4	11	Brain Haemorrhage
ABI 16	80	F	6	9	RTA
ABI 17	36	M	6	9	Brain Haemorrhage
ABI 18	44	F	3	13	Stroke
ABI 19	70	F	6	9	Brain Haemorrhage
ABI 20	51	M	3	13	RTA

Key explaining occupations

Number	Occupation type
1	Senior managerial/administrative/professional
2	Intermediate managerial/administrative/professional
3	Supervisory or clerical, junior managerial/administrative/professional
4	Skilled manual worker
5	Semi and unskilled manual worker
6	Pensioner, casual or lowest grade worker, student, unemployed

Years education
The mean years education for the ABI participant group is 11.55 years (*SD* 2.04)
The table below shows how years education has been calculated.
Participants were asked to say the highest level of education they completed.

Highest level of education completed	No. of years education
No formal education	9
Secondary school	11
BTEC/A levels	13
Degree	16
Post grad degree	18

Participant	LOC (Loss of consciousness) 0 =No LOC; 1=<30 mins; 2= 1-24 hrs; 3=>24hrs;? = no information	PTA (Post trauma amnesia) 0 = No PTA; 1= <1hr PTA; 2= 30 min-24hrs PTA; 3= > 1 day;? = no information	Time since injury (years)
ABI 1	?	?	22
ABI 2	3	2	32
ABI 3	3	3	25
ABI 4	3	3	35
ABI 5	3	3	5
ABI 6	2	2	20
ABI 7	2	?	5
ABI 8	2	?	4
ABI 9	2	?	48
ABI 10	3	?	7
ABI 11	3	?	5
ABI 12	3	3	10
ABI 13	2	?	40
ABI 14	3	3	3
ABI 15	3	?	1
ABI 16	3	3	2
ABI 17	3	3	19
ABI 18	3	0	2
ABI 19	3	?	3
ABI 20	3	3	3

APPENDIX 14

Development of a new screening test to identify emotion recognition problems after brain injury

Authors: Jo Howe and Tony Ward, Department of Psychology, University of the West of England, Bristol, UK.
Nick Alderman, Brain Injury Services, Partnerships in Care, Grafton Manor, Grafton Regis, UK and University of the West of England, Bristol, UK.

Introduction

Brain injury affects 10 million people every year (Langois, Rutland-Brown and Wald, 2006) and according to the World Health Organisation will be one of the major causes of death and disability by the year 2020 (Hyder et al., 2007). A substantial number of people have difficulty recognising emotions after an acquired brain injury (ABI) and this difficulty has a major impact on psychosocial outcome. The need to have an easily administered test which enables clinicians to quickly assess this has been identified. The aim of this study was to develop a new easily administered, reliable and valid test which enables clinicians to quickly assess people with brain injury.

Method

The test consisted of 14 short video clips of actors portraying different emotions. Half the clips included neutral carrier phrases (for example, "What did you do that for?") and half had no phrases. Participants were asked to identify the emotion the actor was feeling.

Performance of 92 neurologically healthy adults aged between 18 to 80 years (control group) was compared with that of 20 adults who had sustained moderate-to-severe brain injury (ABI group). Several other established measures were administered to establish the validity of the new test.

Results

Among the control group there was no difference in the scores of the new test between men and women, nor were there correlations with age, occupation or the verbal intelligence. Both groups found it more difficult to identify emotions in the clips with phrase, though the performance of the ABI group was significantly poorer.

The new test has good psychometric qualities regarding validity and reliability

Discriminant validity

Chi square analysis demonstrated a statistically significant difference in performance ($p< .05$) between the groups in six of the seven clips without phrase and 5 of the 7 clips with phrase. An increase in errors was significantly associated with brain injury with the ABI group having a significantly lower global score. The mean total scores of the two groups was significantly different (Figure 1).

A clinical cut off score of 11/14 suggests that around 30% of people who've had a moderate-to-severe brain injury could have difficulty recognising emotions.

Concurrent validity

Concurrent validity was comprehensively demonstrated for the new test through its association with an existing measure of emotion recognition namely, TASIT (McDonald et al., 2003), Part 1 – Emotion Evaluation Test (EET). The associations clearly supports that the new test measures what it purports to measure namely deficits in emotion recognition.

In the control group there was correlation with the with phrase and total part of the test and an existing measure of emotional empathy, the Balanced Emotional Empathy Scale (BEES) (Mehrabian, 2000) but no correlation with the no phrase part of the test (Figure 2).

Reliability

Spearman's rho correlation indicates that test-re-test reliability is good for both the ABI and control groups ($p<.05$)

Figure 1. Graph showing mean total scores for the ABI and control groups

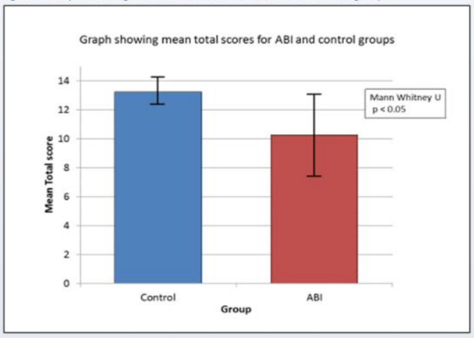


Figure 2. Table of correlations (Spearman's Rho) between new test, EET and BEES

		Control group			ABI group		
		No phrase	With phrase	Total	No phrase	With phrase	Total
TASIT (EET)	Correlation coefficient	0.274**	0.313**	0.364**	0.58**	0.78**	0.88**
BEES	Correlation coefficient	0.04	0.32**	0.364**	-0.21	0.01	-0.10

** Spearman's rho correlation is significant at $p <.05$

Conclusions

Results suggest the new test which takes only about 5 minutes to complete may provide a valid, reliable method of rapidly detecting emotion recognition difficulties after brain injury. This could be a useful test for clinicians to use in diagnosing emotion recognition deficits. Further investigation is needed to establish how these difficulties relate to psychosocial functioning problems and improve outcome by informing rehabilitation support to brain injured individuals and their families.

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Acknowlegments

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