Test-retest Reliability of The Brain Injury Screening Tool (BIST)

A dissertation submitted to Auckland University of Technology in partial fulfilment of the degree of Bachelor of Health Science Honours.

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Abstract

The Brain Injury Screening Tool was developed to provide clinicians with a brief tool to assess mild traumatic brain injuries and guide clinical care pathway decisions in both primary and secondary care. However, there is a need to ensure that the BIST is stable, and that any changes in responses over time are due to recovery, and not due to changes in *how* people respond to questions in the BIST (test-retest reliability). The aim of this study was to test the responses of a sample of healthy people on two separate occasions to determine the stability of responses, whilst controlling for the potential influence of mood.

A sample of sixty-eight (68) adults aged between 18 and 58 years completed the 15-item BIST symptom scale on two different occasions (baseline and two weeks later) in addition to the Depression, Anxiety and Stress Scale (DASS-21). At the initial assessment, data was also collected regarding the participants' age, gender, income, ethnicity, and health comorbidities in order to assess whether such sociodemographic factors influence symptom reporting or not. The results of the study indicated that both the BIST symptom score and the BIST subscale scores exhibited moderate to good test re-test reliability with Intraclass Correlation Coefficients (ICC) ranging between 0.51 and 0.83. Wilcoxon Signed Ranks Tests found no significant differences in symptom reporting on the BIST total scale or the BIST subscales between the two time points at the $p<0.05$ level.

The evidence of moderate to good test-retest reliability in a healthy sample demonstrated here increases confidence that any changes in symptom reporting in mild traumatic brain injury patients using the BIST tool are more likely to reflect real symptom change, rather than measurement error. This study supports the use of the BIST as a symptom scale to monitor recovery in patients in both primary and secondary care, however, further research needs to be conducted to explore symptom reporting and reliability of the BIST in those under the age of 16 years.

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Signed:

Date: 28/01/2022

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Ethics Approval

Ethical approval for this study was obtained through The Auckland University of Technology Ethics Committee (AUTEC #21/99) and all participants provided informed consent before taking part in the study.

Introduction and Literature Review

Traumatic brain injury (TBI) is defined as an alteration in brain function or brain pathology as a result of an external force (Menon et al., 2010). TBI's can be penetrating injuries where there is a breach of the skull and dura layer leading to direct damage to the brain, or they can be closed-head injuries where there is no penetration of the skull but the brain is damaged via movement within the skull (Blennow et al., 2016). The damage to the brain from a TBI can be caused by either rotational or linear acceleration forces or blunt force trauma to the head with impact deceleration (Blennow et al., 2016). Intracranial pressure gradients are generated by these forces and these pressure gradients then stretch and damage axons (Blennow et al., 2016).

TBIs can be sustained in numerous ways including playing sports, during recreational activities, vehicle accidents, interpersonal assaults, or everyday trips and falls (Feigin et al., 2013). There are four primary mechanisms of TBIs: direct impact, sudden or rapid acceleration and/or deceleration, penetrating injury, or blast injury (Menon et al., 2010). Direct impact refers to the head hitting an object, or the head being struck by an object, such as hitting the ground during a fall or a windshield during a car accident, or the head being struck by a bat or a ball during sporting activity. Sudden or rapid acceleration and deceleration occurs when there is no direct contact with the head but the brain inside the skull still experiences violent motion causing whiplash injury. Penetrating injuries occur when high-speed projectiles such as bullets or shrapnel drive into the brain. These injuries can also occur with low-velocity objects such as knives or bones from fractures of the skull driven into the brain. Finally, blast injury refers to injury caused by impact from a pressure wave usually generated by explosions (Blennow et al., 2016).

The types of damage that can result from these external forces include focal contusions, diffuse axonal injury or bleeding/haematomas in or around the brain (Drew & Drew, 2004). Focal contusions are bruises or swelling in a specific area of the brain. These are also commonly referred to as coup injuries, particularly when the bruising occurs directly under the site of impact, or countrecoup injuries when the bruising occurs on the opposite side of direct impact (Vagnozzi et al., 2010). Coup-countrecoup injuries can also occur, where there is bruising on both sides of the brain, usually a result of the violent motion or back and forth movement of the brain inside the skull (Vagnozzi et al., 2010). Diffuse axonal injury refers to the widespread damage of the brains white matter or bundles of axons. This damage is often a result of the stretching, twisting, or tearing of the axons by shearing forces (Drew & Drew, 2004). Finally, haematomas refer to either bleeding into the brain itself (Intracerebral haematoma) or bleeding into the area between the skull and the dura mater which is the tough outer protective layer of the brain (Epidural haematoma) (Drew & Drew, 2004). Any bleeding around the brain or within the brain is a serious medical concern requiring surgery, particularly if decompression of the brain is required to release pooled blood and relieve pressure.

TBI's are clinically classified by severity as mild, moderate or severe (Blennow et al., 2016) using the Glasgow Coma Scale (GCS) that determines the level of consciousness of the patient by a point system based on motor responsiveness, verbal performance and eye opening to appropriate stimuli (Teasdale & Jennett, 1974). There is considerable variation in how a TBI may impact an individual and their level of functioning but people typically experience a variety of impairments at the cognitive, somatic and emotional levels (Theadom et al., 2018). These impairments can include difficulty concentrating, headaches,

fatigue, taking longer to think, dizziness, nausea and vomiting, and feelings of frustration, irritability, or restlessness (Forrest et al., 2018; Theadom et al., 2018).

TBI's are referred to as the 'silent epidemic', contributing to deaths and disabilities globally (Dewan et al., 2018). It is estimated that the global incidence of all-cause and all-severity TBI's is approximately 69 million people (95% CI 67-74 million) each year (Dewan et al., 2018). TBIs affect an estimated 36,000 people in New Zealand every year (Feigin et al., 2013). The majority of traumatic brain injuries (95%) are classified as being mild in severity. Most people recover well in the weeks to months following their TBI, however, research suggests that up to 40% of people affected by a mild TBI can experience chronic symptoms for many years after their injury that significantly impact their day-to-day lives (Theadom et al., 2018). Such poor recovery may be a result of several risk factors that include, but are not limited to, a pre-existing health condition, older age, a history of previous TBI's, maladaptive coping and a lack of, or delayed medical attention (Forrest et al., 2018).

There are some groups that are at a higher risk of not only sustaining a TBI but experiencing significant long-term problems as a result of their injury. These groups can be defined by factors such as race, age, ethnicity, education, sex, income, disability, socio-economic status or geographical location. Research has shown that younger individuals are the most common subjects of TBI and face long term disabilities (Biswas et al., 2017). Epidemiological studies of gender differences in TBI outcomes show that mortality rates were 1.28 times higher in females than males, and females were 1.57 times more likely to experience poor outcomes or severe disability as a result of a TBI, than males (Kraus et al., 2000). Other groups at a higher risk are ethnic minorities, military service members or

veterans, people in correctional facilities, those that experience homelessness, and survivors of partner violence (Gao et al., 2018). These groups are not only at a greater risk of sustaining a TBI, but their poor or limited access to appropriate healthcare delays treatment. Research has shown that ethnic and racial minorities are less likely to receive follow-up or rehabilitative care following a TBI, and more likely to have poor functional, psychosocial and employment outcomes than non-minority groups (Arango-Lasprilla et al., 2009). Research has also shown that veterans who obtained TBIs whilst deployed report on-going symptoms post-treatment, difficulty accessing healthcare and co-occurring health conditions such as depression or post-traumatic stress disorder more so than veterans that had not obtained a TBI during their service (Mac Donald et al., 2017).

U.S statistics show that approximately 46% of those in correctional facilities have a history of TBI (Durand et al., 2017). Not only are people in this group at a higher risk of sustaining a TBI in inmate-related altercations, but they are also less likely to be screened for a TBI and face challenges with receiving TBI-related care whilst in, and long after their time in prison (Durand et al., 2017). Finally, people who experience homelessness are 2-4 times more likely to sustain a TBI of any type or severity and up to 10 times more likely to have a history of moderate to severe TBI (Stubbs et al., 2020).

Research has proven that early detection and early intervention improves long-term recovery in TBI patients (Maas et al., 2017, Ponsford et al., 2002). It is therefore crucial to identify those who may be at risk of potentially experiencing on-going problems in order to prevent higher levels of individual and societal burden (Shaikh et al., 2021). Currently however, to get access to specialist services, patients are required to visit their general practitioner in order to be referred to such services. Furthermore, to support a patient's

recovery, general practitioners need to be aware of the services available to make referrals to, and this is one of the crucial barriers that can hinder recovery in mild TBI patients (McPherson et al., 2018). Additionally, patients can report difficulty in understanding and navigating the healthcare system in general which further delays access to necessary treatment (McPherson et al., 2018; Theadom et al., 2021). General medicine clinicians need to have confidence in identifying and effectively managing mild TBI symptoms and clinical indicators that may be present, in order to determine who may require more intensive rehabilitation and may require a less intensive intervention such as education and follow up with primary care (Theadom et al., 2021). Indicators of risk of poor recovery and potential need for early intensive rehabilitation include severe headaches, repeated vomiting, worsening symptoms, prior brain injuries, mental health history, more than a brief loss of consciousness and aged over 65 years (Ontario Neurotrauma Foundation, 2018).

Research shows that in comparison to moderate to severe brain injuries, mild TBIs are often more difficult to diagnose (Ruff et al., 2009). This is often due to the relatively rapid resolution of acute symptoms (such as brief loss of consciousness and disorientation) and the fact that it is typically difficult to find any objective evidence of an injury in neuroimaging when the TBI is mild (Ruff et al., 2009). General practitioners and primary care providers are often the first clinicians that TBI patients see and are also the only ones that can refer them to intensive rehab (ACC Concussion Service) or specialist services. Consequently, ensuring there are guidelines to follow for appropriate diagnosing and management of TBIs is critical. Research shows that delays in referral to specialists or concussion services are often due to the mild TBI not being diagnosed or recognised at the time of injury; general practitioners not knowing about available services or choosing to manage the patient themselves until they have exhausted their own resources and

knowledge; or patients not seeking assistance until the symptoms prevent further appropriate functioning at home or at work (Forrest et al., 2018).

There have been a number of tools that have been developed to assess acute symptoms of TBI's and to monitor recovery. Two of the most commonly utilised symptom assessment tools are the Rivermead Post Concussion Questionnaire (RPQ) and the Sports Concussion Assessment Tool (5th edition) (SCAT5). The RPQ was designed to measure the severity of post-concussion symptoms in a self-report questionnaire given to patients, where they rate the degree to which they suffer from the 16 listed post-concussion symptoms relative to the symptoms they experienced at the onset of the TBI (Eyres et al., 2005). Patients rate their symptoms on a scale of 0 (no change in symptoms) to 4 (severe symptoms) including symptoms such as headaches, forgetfulness or poor memory, irritability and taking longer to think. When assessing post-concussion symptom severity, the RPQ has shown to do this with reasonable reliability in terms of test re-test and inter-rater reliability for total and individual symptom scores (Eyres et al., 2005). However, despite its common utility, the RPQ fails to meet other modern psychometric standards such as external construct validity, and it has demonstrated poor overall fit to the Rasch model indicating a lack of uni-dimensionality of the scale (Eyres et al., 2005). The underlying factor structure of the RPQ has also been found to vary considerably questioning utility of the total scores when predicting outcomes (Theadom et al., 2021).

The SCAT5 was designed as a standardised test assessing acute concussion obtained in sporting activities (Hänninen et al., 2021). It consists of a physical assessment, a series of questions assessing memory and a 22-item symptom scale that asks patients to rate their symptoms on a scale from 0 (none) to 6 (severe) (Echemendia et al., 2017; Hänninen et al.,

2021). Although the SCAT5 has demonstrated good test re-test reliability (Hänninen et al., 2021) and acceptable internal consistency (Sikkema, 2018), other psychometric properties of the SCAT5 are reported as poor, and its application is reported as time consuming making it difficult to implement in a busy clinical context such as a GP practice (Echemendia et al., 2017). Due to the design of the scale catering to TBI's obtained in sporting contexts only, the utility of the tool in tracking recovery and decision making for injuries sustained outside of sporting context is unclear (Echemendia et al., 2017).

The poor applicability of the SCAT5 to non-sport related mild TBIs means it cannot be utilised efficiently in cases of vehicle accidents, falls, trips and assaults, which all make up to 80% of mild TBI injuries (Shaikh et al., 2021). The use of the SCAT5 is also reported to be restricted to those who have been specifically trained in the use of this tool (Echemendia et al., 2017; Sikkema, 2018) which could affect wider implementation across the health care sector. The limitations of these tools and a lack of a standardised assessment tool which can also guide health care pathway decision making has led to patients receiving inconsistent care and advice across the country.

To address the need for a tool to assist assessment of mild TBI and to guide health care pathway decision making, a working group developed a new tool called the Brain Injury Screening Tool (BIST) (Theadom et al., 2021). The BIST was created in an attempt to provide clinicians of various backgrounds a quick and short tool to assess TBIs across a wide age range, obtained across various situational contexts (work, school, sports, violence), across a variety of healthcare settings and without the need for specialist training (Theadom et al., 2021) . A further aim of the BIST was to improve patient recovery by identifying the presence or absence of aforementioned clinical indicators that are linked to

an increased risk of poor recovery, providing up-to-date, evidence-based advice and providing early access to specialist or rehabilitation services should they be required (Theadom et al., 2021). Members of the working group included clinicians from primary care, hospital services, rehabilitation services, physiotherapists, psychologists and academics to ensure the tool could be as widely applicable to different health care contexts, whilst also improving consistent of health care across the country.

The BIST starts off by asking the patient about their injury and subsequent symptoms including whether they lost consciousness, if they had been sick (vomited), if they experienced any seizures, if they take any blood thinners or if they have had any issues with their mental health. This is followed by the 15-item symptom report scale that asks the patient to rate out of 10 (0 = not at all, 10 = severe) symptoms across physical, vestibular-ocular and cognitive levels (Theadom et al., 2021). Patient responses are scored, and if the score is < 66 (full version of the symptom scale conducted >24 hours after injury), the patient is considered at a low risk of poor recovery and the BIST recommends monitoring the patient and following up within 5-7 days. If the patient scores above 66, they are considered at a moderate risk and the BIST will recommend referring the patient to specialist concussion clinic. If there are clinical indicators that suggest the patient is at risk of a brain bleed, a recommendation to refer the patient to hospital is given. (Theadom et al., 2021).

In terms of the psychometric properties, the concurrent validity of the BIST is reported to be excellent, highly correlating with existing scales such as the SCAT5 (r = 0.90) and RPQ (r = 0.91). High internal consistency of the BIST (Cronbach's $\alpha = 0.94$) also compares favourably to previous scales (SCAT5: $\alpha = 0.94$, RPQ: $\alpha = 0.95$). High

readability of the symptom items in the BIST, as well as its short application (6 minutes) supports the use of this tool as an initial assessment tool across and in busy clinical environments and further adds to its clinical utility (Theadom et al., 2021). Past research on the BIST has also concluded that the 15-item symptom scale has demonstrated a good fit to the RASCH model (Shaikh et al., 2021) and research findings support the use of raw scores of the total and subscales of the BIST in clinical decision making.

However, the test retest of the BIST has not yet been explored. To address this gap in the current evidence base, this research aims to determine the test-retest reliability of the BIST. Having good test-retest reliability signifies the internal validity of a tool or test, ensuring that the measurements obtained in one sitting are representative and stable over time (Guttman, 1945). If a test or tool has poor reliability, it becomes difficult to prove that the data provided by said tool is an accurate measurement of participants' performance and not a result of environmental, psychological, or methodological factors in the testing session (Guttman, 1945). To determine test-retest reliability of the 15-item symptom scale needs to be demonstrated in a healthy population (which high levels of change should be unlikely) to increase confidence that any changes that may be observed in symptoms in a mild TBI patient are more likely reflecting changes in actual symptoms, rather than due to any measurement error due to variation in responding at different timepoints. As the symptoms in the 15-item symptom scale are non-TBI specific (e.g. headache, poor sleep, fatigue), this further supported use of the tool to explore symptom reporting in a non-injured sample (Petrie et al., 2014).

There are many complexities in people's reporting of symptoms in everyday life and some variability in symptom reporting in healthy populations has been observed. Past

research on symptom reporting has shown that one of the major influences on patient symptom reporting is mood and how they may be feeling at the time (Garden et al., 2010). It is well established that mood can fluctuate over the course of a day or over a number of days, however in some cases mood can fluctuate more drastically for many different reasons including major life events, illness, stress or fatigue, or hormonal imbalances. For this reason, and to ensure the BIST maintains ecological validity, this research will also explore whether the sample's responses are directly related to how they are feeling during the completion of the BIST, thus controlling for the potential influence of mood because mood fluctuations and mental health disorders (such as Depression and Anxiety) are common in the general population.

Methods

i) Participants and Recruitment

This study involved the recruitment of healthy individuals over the age of 16 years with no previous history of TBI in the past 5 years. Recruitment was conducted from the beginning of May to mid-August and participants were recruited via several social media platforms such as Facebook and Twitter. Adverts were also placed around the community in public libraries, sports and recreation centres, university campuses, cafes, and supermarkets, and via word of mouth. The eligibility criteria for participants were that they needed to be over the age of 16, able to provide informed consent, and have not suffered a TBI in the past 5 years. Those interested in participating were asked to contact the research team using the number and email provided in the advert. Upon initial contact, the research team had a discussion with each interested individual, explaining the study, what was required from the participants themselves and their eligibility was checked. Following this discussion, participants were able to ask any questions they had about the study and were sent information sheets and consent forms to read and sign if they wanted to take part.

ii) Study design

This was a community-based study with a test re-test design conducted over a two-week period. The timeframe was based on previous evidence that the optimal time interval between testing is two weeks (Streiner et al., 2015). A link to an online questionnaire was sent to each participant for the initial assessment via the REDcap online database upon receipt of the signed consent form. Following the completion of the first questionnaire, a link to the second assessment was sent out two weeks later. Automatic reminders were set up in REDcap to prompt participants to complete the questionnaires every three days if they had not already

done so. Upon completion of both assessments, baseline and two weeks later, participants were sent a $30 MTA voucher as a thank you for their time and contribution.

iii) Instruments

The initial assessment included questions regarding sociodemographic factors. The questions asked about the participants' age, gender, ethnicity, living situation, education level and any mental health or medical comorbidities they may have had at the time of the assessment. This data was collected to obtain an accurate description of the characteristics of the sample as well as to assess whether such sociodemographic factors influence symptom reporting or not.

The Brain Injury Screening Tool (BIST) consists of a 15-item self-report symptom scale and participants were asked to rate their experiences of each symptom on a scale of 0 (not at all) to 10 (severe). These questions were to be answered based on how they were feeling at the time of completing the questionnaire. Based on the responses of participants, a total symptom score and three subscale scores were calculated (Physical subscale, Cognitive subscale, and Vestibular subscale), where higher scores suggested higher severity of symptoms. The impact item was not used in this study as the wording specifically refers to the impact of an injury and was not deemed to be relevant for the population or purposes of the study.

The 21-item Depression, Anxiety and Stress Scale (DASS-21) was also used in both assessments to control for the potential influence of mood. The 21 items assess levels of Depression, Anxiety and Stress, and these 3 subscales consist of 7 items each. To identify any outliers or drastic changes in mood over the two timepoints, change scores were calculated on each of the three subscales. Past research has shown that the DASS-21 displays good to excellent psychometric properties (Antony et al., 1998). The DASS-21 displays high internal

consistency (α = 0.94 for Depression, 0.87 for Anxiety and 0.91 for Stress) and moderate to high concurrent validity with other measures of depression, anxiety and stress, therefore making it an excellent instrument for measuring such features (Antony et al., 1998).

iv) Ethical Consideration

The principles of the New Zealand Code of Ethics were upheld and respected in this study. Prior to participating in the study, all adults who expressed interest were sent Participant Information Sheets (Appendix A) to read. Participants were provided with sufficient information and assurances that their participation is to be voluntary, and they had a right to withdraw from the study at any time. The privacy and anonymity of all participants were retained, and each participant was given an ID number (i.e. P100, P101, P102 etc.) to remove any personal identifying information and to ensure confidentiality. They were provided with consent forms to sign and return once they understood the information provided in the Participant Information Sheet. Ethical approval for this study was obtained through The Auckland University of Technology Ethics Committee (AUTEC #21/99).

Any information that could potentially identify participants was kept separate from the questionnaire data. Any electronic identifying information was kept in a password protected file, and any hard copies were kept in a locked cabinet. Collecting contact details separately to the questionnaire responses prevented any connection to their individual questionnaire responses. There were no cultural, financial, or employment pressures involved that could trigger distress or discomfort to the participants. When high levels of mood were identified, the participants were given the opportunity to contact AUT Counselling Services should they have required professional assistance with this. The researcher also offered to make a referral to their GP if the participant wanted and gave permission for them to.

v) Statistical analysis

Data were extracted from REDcap and analyzed in SPSS. Normality of the data was checked prior to conducting analysis to ensure the correct statistical procedures were applied. The variables in the dataset were not normally distributed based on Skewness and Kurtosis. Skewness can be described as a measure of the asymmetry of the distribution, and Kurtosis refers to the "peakedness" of the distribution (Kim, 2013). Skewness and Kurtosis for each variable was checked and variables scoring >3 were considered to be non-normally distributed. Non-normally distributed data were presented using medians and interquartile range values and means and standard deviations used for normally distributed data. The participant characteristics were described in frequencies and percentages, and to determine the test re-test reliability of the BIST total and BIST subscale scores, Intraclass Correlation Coefficients were used with 95% confidence intervals (CI). Intraclass Correlation Coefficients were interpreted as either poor (<0.50), moderate (0.51-0.75), good (0.76-0.90) or excellent (>0.91) (Koo & Li, 2016). When determining whether there were any significant differences in measurement between baseline and Time 2, Wilcoxon signed ranks tests were conducted and a p-value of 0.05 was used to indicate statistical significance. To determine individual variation in symptom reporting, change scores for each item on the BIST were calculating by subtracting participant responses at Time 2 from participant responses at Baseline. Spearman's correlation coefficients were used to explore relationships between sociodemographic variables, BIST scores and the three subscales of the DASS-21 (depression, anxiety and stress).

Results

Of the 105 adults who expressed interest in the study, eighty-two (78.1%) participants returned their consent forms and consented to be a part of this study. Of the 82 interested adults, 78 (95.1%) completed both assessments at baseline (Time 1) and then two weeks later (Time 2). Upon observing the data, nine (11.5%) participants were excluded from the analysis as they were identified by Tukey's test as being an extreme outlier based on abnormally high variations (mood change scores) between the two timepoints (>3 above or below the interquartile range). These high levels of changes in mood were deemed to have high risk of influencing the reporting of symptoms. Whilst exploring the influence of mood variation on symptoms is important within a clinical context, for the purposes of looking at stability of symptom reporting measure they were excluded for this analysis. Whilst excluding participants with extreme changes in mood, the sample did still include people with consistently high levels of anxiety, stress and depression as would be expected in the general population. Following removal of these high mood change participants, to explore test re-test reliability of the BIST, data from 69 (84.1% of the consenting participants) were analysed. The sample of participants ranged in age from 18 years to 58 years, with a median age of 27 years (Interquartile range (15.00) as illustrated in Table 1.

The sample reported high variability in health ratings, ranging from 30 to 100 out of 100, with a median health rating of 78 out of 100. The majority of the sample (85.5%) indicated they were not currently experiencing any effects from a physical or mental health condition (comorbidities). Those that reported having comorbidities reported conditions including asthma, arthritis and Attention-Deficit Hyperactivity Disorder (ADHD). Participants reporting comorbidities were still included in the study as there is a high prevalence of comorbidities in the general population. Excluding these people from the study

would have reduced generalisability of the findings to the New Zealand general population context and were therefore retained in the analysis.

Table 1. The sociodemographic characteristics of N=69 non-injured general population participants.

	Frequency (N)	Percentage (%)
Sex		
Male	16	23.5
Female	52	76.5
Ethnicity		
European	25	36.8
Māori/Pasifika	8	11.8
Asian	12	17.6
Other	23	33.8
Employment		
Full/Part Time employed	39	57.3
Student	25	36.8
Homemaker	2	2.9
Other	2	2.9
Level of Education		
University	52	76.5
College/Professional Training	10	14.7
Secondary school	6	8.8
Living Situation		
Alone	9	13.2
With others	58	85.3
Other	1	1.5
Comorbidities		
Yes	9	13.2
No	59	86.8

As shown in Table 2. There was diversity in the levels of mood across participants (from normal to severe) despite exclusion of participants with extreme changes in mood levels between the two timepoints. Exclusion of participants with extreme changes in mood, have the desired effect of ensuring mood was relatively stable between the two timepoints to reduce effect of mood on symptom reporting.

Table 2. Mood Characteristics of the participant sample

	Median (IQR) Baseline	Median (IQR) Follow-up	Range	Mean change over time (SD)
Anxiety	2.00 (4.00)	2.00 (5.50)	0-21	-0.33 (4.72)
Stress	3.00 (7.00)	2.00 (5.00)	0-14	-0.49 (5.80)
Depression	6.00 (6.00)	5.00 (7.50)	0-19	-0.36 (5.07)

The median and interquartile range for baseline and follow-up on the BIST total and subscale scores are presented in Table 3. No significant difference was found between the scores at the two timepoints for the BIST total or the three subscales (physical, cognitive and vestibular). Intraclass correlation coefficients for the BIST total score and the three subscale scores ranged from 'moderate to good' (BIST total score = 0.79, BIST Physical = 0.83, BIST Cognitive = 0.72 and BIST Vestibular = 0.51).

Table 3. Test re-test reliability of the BIST and BIST Subscales for non-injured participant sample.

	Baseline Median (IQR)	Follow up Median (IQR)	Wilcoxon Signed Ranks Test	*p* Value (Sig.)	ICC	95% CI Lower	95% CI Upper
BIST Total	24.00 (36.00)	30.00 (35.5)	1168.5	0.98	0.79	0.66	0.87
BIST Physical	18.00 (25.25)	19.00 (23.50)	945.0	0.31	0.83	0.73	0.90
BIST Cognitive	4.00 (12.50)	6.00 (8.50)	1006.0	0.09	0.72	0.54	0.83
BIST Vestibular	1.00 (5.00)	3.00 (5.00)	618.5	0.56	0.51	0.21	0.70

Looking at the individual items within the BIST scale, the most frequently rated symptoms were 'I feel tired during the day', 'I get angry/irritated easily', 'I feel restless' and 'I need to sleep more' (88.2%, 79.4%, 76.5%, 76.5% respectively). The symptoms least frequently reported were 'I feel dizzy' and 'I feel like I'm at sea when I close my eyes' (36.7% and 26.5%). As shown in Table 4, there only small changes were observed on individual items between time 1 and time 2. Taking longer to think and feeling restless were the items revealing the most change over time, with the item on sleep showing little change over time. Whilst some symptoms including feeling tired during the day, needing to sleep

more and feeling angry were experienced by the majority of participants, few participants experienced the three items within the vestibular scale.

Table 4. Mean change scores between baseline and follow-up on the individual symptom items.

	Number of participants (%) reporting not experiencing symptom at all	Median Score Baseline (IQR)	Median Score Follow-Up (IQR)	Mean change	Standard. Deviation
Headache	28 (40.6)	1.00 (4.00)	1.00 (3.00)	-.41	2.97
My neck hurts	25 (36.2)	2.00 (4.00)	2.00 (4.00)	-.19	3.08
I don't like bright lights	26 (37.7)	1.00 (5.00)	1.00 (5.00)	-.04	2.66
I don't like loud noises	20 (29.0)	3.00 (5.00)	2.00 (4.00)	.12	3.04
I feel dizzy or like I could be sick	43 (62.3)	0.00 (1.00)	0.00 (2.00)	.03	1.97
If I close my eyes, I feel like I am at sea	50 (72.5)	0.00 (1.00)	0.00 (1.00)	-.06	1.20
I have trouble with my eyesight	38 (55.1)	0.00 (2.00)	1.00 (3.00)	.13	2.95
It takes me longer to think	33 (47.8)	1.00 (3.00)	1.00 (3.00)	.42	2.60
I forget things	20 (29.0)	2.00 (4.00)	2.00 (2.00)	.03	2.28
I get confused easily	40 (58.0)	0.00 (2.00)	1.00 (2.00)	.17	2.27
I have trouble concentrating	24 (34.8)	1.00 (5.00)	2.00 (3.00)	.25	2.39
I feel angry or irritated easily	15 (21.7)	2.00 (4.00)	2.00 (3.00)	-.14	2.08
I feel restless	16 (23.2)	2.00 (4.00)	1.00 (4.00)	-.33	2.22
I feel tired during the day	8 (11.6)	3.00 (4.00)	3.00 (5.00)	-.04	2.12
I need to sleep a lot more or find it hard to sleep at night	16 (23.2)	3.00 (6.00)	3.00 (5.00)	.00	2.97

Table 5 displays correlations between participant socio-demographic variables and the BIST total scores and the DASS-21 item scores (mood ratings) at baseline. The variables that were significantly correlated with the baseline BIST total score at the $p<0.01$ level included being female, of a young age, the overall health rating and mood ratings (DASS-21 items; Anxiety, Stress and Depression). The variables not significantly correlated were comorbidities, living situation, ethnicity, and education level, as illustrated by Table 5.

Table 5. Correlations between participant sociodemographic variables and BIST total scores at baseline.

	Age	Sex	Ethnicity	Overall Heath	Education	Living Situation	Comorbidities	Anxiety	Stress	Depression
Sex	0.37**									
Ethnicity	0.03	0.05								
Overall Health	0.45**	0.32**	0.08							
Education	0.21	0.16	0.29*	0.17						
Living Situation	-0.03	0.03	-0.15	-0.06	-0.05					
Comorbidities	-0.12	-0.22	-0.11	-0.42**	0.01	0.01				
Anxiety	-0.47**	-0.30*	-0.10	-0.54**	-0.23	0.05	0.31**			
Stress	-0.42**	-0.30*	-0.03	-0.47**	-0.24	-0.05	0.19	0.64**		
Depression	-0.30**	-0.34**	-0.11	-0.58**	-0.11	0.04	0.40**	0.73**	0.74**	
BIST Total Score	-0.43**	-0.32**	-0.16	-0.52**	-0.19	0.07	0.23	0.66**	0.67**	0.69**

**= $p<0.01$, *= $p<0.05$

Discussion

This study aimed to determine the test re-test reliability of the Brain Injury Screening Tool (BIST) in a non-injured adult sample over the course of two weeks. Intraclass correlation coefficients and tests of difference for symptom reporting demonstrated that the BIST exhibited moderate to good test re-test reliability for both the BIST overall score as well as for the symptom cluster subscales. There were several sociodemographic variables that significantly correlated with higher symptom scores in this sample including being of female gender, being of a younger age, lower overall health ratings and higher levels of stress, anxiety, and depression.

There were several participants in the sample that reported having medical comorbidities (attention-deficit hyperactivity disorder, asthma, and arthritis). These participants were retained in the analysis because comorbid conditions are common in the general population. Including adults with comorbidities in the study consequently increased the ecological validity of the BIST, make the sample more representative of the wider population and improve overall generalizability of the results. However, it is likely that including adults with comorbid conditions affected the stability of symptom reporting especially where some symptoms may relate to their comorbid conditions. For example, if they have a history of migraines this could affect reporting on the ‘headache’ item, or if they have a history of insomnia, then this may affect reporting on the ‘sleep’ item. However, it was important for a test-retest study to explore stability within this more variable context to ensure the tool still had ecological validity as TBIs often co-occur with other comorbidities (Xiong et al., 2019). This may mean that the test-retest reliability of the BIST was underestimated.

Many symptoms of mild TBI are non-specific to TBI (Petrie et al., 2014) and can be experienced by healthy non-TBI injured individuals. This was evident in the responses of several of the non-injured participants reporting experiences of some symptoms in the severe range. Symptoms such as fatigue and sleep are commonly experienced by people in the general population. For example, it has been found by previous research that 28.6% of the general population report having problems with their sleep and sleep patterns and 35% reporting fatigue (Petrie et al., 2014). However, of importance to this study, the severity of these symptoms generally remained fairly consistent between time 1 and time 2 suggesting that the test re-test reliability of the BIST remained adequate in the presence of these higher symptom cases.

The results of the study also indicated that depression, anxiety, and stress were all highly correlated with the total BIST symptom score. Past research has indicated that approximately 20% of the general population in New Zealand report symptoms of anxiety and depression (Petrie et al., 2014) and because of this, those that reported high levels of anxiety, stress or depression were included in this study. In order to minimize the potential influence of mood on symptom reporting, any outliers revealing atypically high variation in mood across the two timepoints (baseline and follow up) were excluded. This was because any high variation in mood would likely reflect external circumstances. High levels of depression, anxiety and stress were still significantly correlated with higher symptoms scores even after the exclusion of these outliers, suggesting that mood levels of participants need to be taken into account when investigating symptom reporting. In summary, the inclusion of participants with poor health ratings and high mood scores may have reduced the test re-test reliability of the BIST symptom scale, but significantly improved the overall ecological validity of the BIST and the generalization of these results across the general population.

In most cases, symptom reporting was relatively stable in this sample of non-TBI injured participants, however there were some cases where there was significant variation in symptom reporting between baseline and follow up. The reason behind this is unclear but it is suspected that this may be related to environmental, social, or biological influences participants may have been subject to between the two timepoints. At no point in either assessment were the participants asked if they had experienced any major life event, illness, or hormonal change during the two weeks which could have influenced their symptom responding. Further details of life demands and current health at each timepoint would have provided some further clarity regarding whether the symptoms they were experiencing were related to these life events or to their comorbidity(ies). For this reason, further understanding of people's experiences and the influence of those experiences on symptom reporting in the general population is required.

When looking at how the BIST compares to existing tools such as the SCAT-5 and the RPQ, research shows that all three tools demonstrate moderate to good test-retest reliability (BIST= 0.51-0.83, SCAT-5= 0.85 and RPQ= 0.72-0.89). Having good test-retest reliability signifies the internal validity of a tool or test, ensuring that the measurements obtained in one sitting are representative and stable over time (Guttman, 1945). The BIST appears to have lower test-retest reliability than the RPQ and SCAT-5 but this is likely to reflect the inclusion of people with high mood and comorbid conditions. The vestibular subscale of the BIST demonstrated the lowest test-retest reliability (0.51). The lower reliability of this subscale is likely to be attributed to the fact that the items on this subscale were those that were least experienced by the participants which is as expected in a healthy, non-injured population and more likely to be more TBI specific. When assessing post-concussion symptom severity, the RPQ has shown good test re-test and inter-rater reliability

for total and individual symptom scores (Eyres et al., 2005). However, despite its common utility, the RPQ fails to meet other modern psychometric standards such as external construct validity, and the RPQ and SCAT-5 have both demonstrated poor overall fit to the Rasch model indicating a lack of uni-dimensionality of the scale (Eyres et al., 2005) restricting use of a total symptom score. There are advantages and disadvantages of using total scores or subscale scores. Total scores are useful to give an indication of overall symptom burden, whereas subscale scores (or symptom clusters) enable exploration of particular types of symptoms. The ability to use either a total score or subscale scores increase the research and clinical utility of a symptom measures for mild TBI. The BIST however has demonstrated a good overall fit to the Rasch model (Shaikh et al., 2021). Rasch analysis of the full scale with three domains as subtests resulted in acceptable model fit ($\chi 2(6) = 3.8$, $p > 0.05$), with good reliability (Person Separation Index = 0.84), and uni-dimensionality (Shaikh et al., 2021). This study has added to the evidence base of the psychometric properties of the BIST.

Limitations:

This study had a number of limitations that need to be taken into account. Firstly, as with any openly advertised self-report measure, there was a risk of self-selection bias. For example, people experiencing symptoms or who know someone who has experienced a TBI may more likely be interested in the topic and willing to take part. Additionally, participants completed both assessments online. In clinical practice it is likely that the BIST symptom scale would be administered more flexibly depending on the clinical procedures of the practice e.g., conducted online in the waiting room via a tablet or in-person as part of the consultation by a GP or a nurse. The online administration of this study may reduce generalisability to how symptoms are reported in an in-person format, however, the degree to which the mode of administration has an impact on symptom reporting needs to be explored.

A large proportion of the sample were from higher level education backgrounds, and this may not be representative of the general population. There was also a higher proportion of females in this study. A study by Lippa and colleagues in 2018 explored gender differences in post-concussion symptom reporting and found that males and females differed in the reporting of somatosensory and vestibular post-concussion symptoms (Lippa et al., 2018). Females reported higher scores in both subscales (M = 8.1, SD = 5.5) than males (M = 4.9, SD = 3.8) (Lippa et al., 2018) therefore, it is probable that the gender of participants in this study may have had an impact on symptom reporting but further exploration of this is needed.

Participants were required to provide informed consent to take part in the online study, and because of this, those under the age of 16 were not included in the study. This is an important limitation, as the BIST is designed for people over the ages of eight years. Consequently, further research needs to be conducted to determine the test re-test reliability of the BIST in people between the ages of 8 and 16 years. Finally, it is also important to note that the BIST is currently only available in English, precluding use with people who speak other languages. TBIs and the impact of prolonged recovery from mild TBI is a global issue, therefore further work needs to be done in exploring the possibility of translating the BIST into other languages and the clinical utility of the BIST in other cultures and societies.

Implications and Recommendations:

An important contribution of this research is that it provides further evidence and support for the use of the BIST in clinical settings across the country to assess initial symptom burden and change over time. The findings of this research, in addition to previous evidence of good internal consistency, factor structure and strong association with other measures of symptom burden post mild TBI suggest that the BIST is a reliable tool to use in

the assessment and management of mild TBI. In addition to test-retest reliability, this research also controlled for the potential influence of mood on symptom reporting, and it was found that high levels of depression, anxiety and stress were significantly correlated with higher symptoms scores suggesting that mood levels of participants need to be taken into account when investigating symptom reporting. The BIST has an advantage over previous tools in that it was designed for use by any medical professional and is not limited to doctors or those who have received specific training. This may assist in implementation of a tool to enable assessment of symptoms following mild TBI within busy clinical contexts.

Conclusion:

The results of the study indicated that both the BIST symptom score and the BIST subscale scores exhibited moderate to good test re-test reliability with intraclass correlation coefficients (ICC) ranging between 0.51 and 0.83. These findings increase confidence that any changes in symptoms in mild TBI patients are more likely to be related to real symptom change (e.g., improvement, symptom plateau or decline) following mild TBI, rather than measurement error. High levels of depression, anxiety and stress were significantly correlated with higher symptoms scores even after the exclusion of these outliers, suggesting that mood levels of participants need to be taken into account when investigating symptom reporting. The findings of this study support the use of the BIST as a symptom scale to monitor recovery in patients in both primary and secondary care and to explore changes in symptoms over time. However, further research needs to be conducted to explore symptom reporting and reliability of the BIST in those under the age of 16 years and utility of different language translations.

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Appendices:

Appendix A**:** Participant Information Sheet

Participant Information Sheet

Date Information Sheet Produced:

19th March 2021

Project Title

Testing a Brain Injury Screening Tool

An Invitation

My name is Yelda Tokhi, and I am currently completing my Honours degree in Psychology at AUT. I am being supervised by Professor Alice Theadom and Dr Nusrat Shaikh. I would like to invite you to take part in my research.

It is your choice if you would like to take part in this study and you will not be advantaged or disadvantaged by your decision.

What is the purpose of this research?

The Brain Injury Screening Tool (BIST) was developed by a group of clinicians to identify and recommend care pathways for patients experiencing a mild brain injury (concussion). To ensure that tool is stable and that any changes in responses over time are due to recovery from brain injury and not due to changes in how people naturally respond to the questions, we need to test the questionnaire with healthy people to see if their answers are similar over time and how their answers relate to how they are feeling.

The findings of this research will be used for my thesis and a research publication.

How was I identified and why am I being invited to participate in this research?

We are looking for adults (over 16 years of age) who have not had a brain injury in the past 5 years.

We are not able to involve those who are currently experiencing symptoms from a serious unstable medical condition e.g., cancer, heart problems, respiratory conditions as this will affect the results.

How do I agree to participate in this research?

If you would like to take part in my research, please contact me either by phone, email, or text. You are welcome to contact me to ask any questions you may have about the research at any time. I will then send you a link to the first questionnaire. Before the questionnaire there will be a consent form which will give some statements about the research and ask if you agree to take part (consent). Taking part is voluntary (your choice) and you do not have to take part if you do not wish to do so.

You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice of having your data removed from the study or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

What will happen in this research?

The project will involve you completing two questionnaires on two occasions. The questionnaires together take about 10 minutes to complete. I will then contact you to ask you to complete the same questionnaires two weeks later. The questionnaires are completed online. If you agree to take part, I will send you a link to the questionnaire.

What are the discomforts and risks?

The questionnaires will ask you about symptoms that people commonly experience in everyday life and also ask you about your mood. You may find some of the questions upsetting.

How will these discomforts and risks be alleviated?

AUT Health Counselling and Wellbeing is able to offer three free sessions of confidential counselling support for adult participants in an AUT research project. These sessions are only available for issues that have arisen directly as a result of participation in the research and are not for other general counselling needs. To access these services, you will need to:

- drop into our centres at WB219 or AS104 or phone 921 9992 City Campus or 921 9998 North Shore campus to make an appointment. Appointments for South Campus can be made by calling 921 9992.
- let the receptionist know that you are a research participant and provide the title of my research and my name and contact details as given in this Information Sheet.

You can find out more information about AUT counsellors and counselling on http://www.aut.ac.nz/being-a-student/current-postgraduates/your-health-and-wellbeing/counselling.

What are the benefits?

I will use the findings of this study for my research project that will me achieve my Honours in Psychology degree.

The findings of this study will be used to develop a tool to help identify a mild brain injury and to see how people are recovering after injury. It is hoped that the tool will be used throughout NZ in primary and secondary care.

What compensation is available for injury or negligence?

In the unlikely event of a physical injury as a result of your participation in this study, rehabilitation and compensation for injury by accident may be available from the Accident Compensation Corporation, providing the incident details satisfy the requirements of the law and the Corporation's regulations.

How will my privacy be protected?

Your contact details and identifying information (e.g. name and address) will be stored separately to your questionnaire answers. You will be asked for your contact details at the end of the first questionnaire. This is a separate questionnaire and so your details will be stored separately from your questionnaire answers. You will not be personally identified in any report, thesis or article arising from this study. We will link your two questionnaire responses by using a unique study number.

What are the costs of participating in this research?

In total taking part in the study will take about 20 minutes of your time (2 x 10 minutes). You will receive a $30 as a thank you for your time and contribution on completing the second questionnaire.

What opportunity do I have to consider this invitation?

We will be recruiting people and collecting data between May and August 2021. You will be able to take part at any time during this period.

Will I receive feedback on the results of this research?

I will send you a copy of the results on completion of the study (by the end of 2021). The findings will also be available on the TBI Network website https://tbin.aut.ac.nz/.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, *Professor Alice Theadom, email: alice.theadom@aut.ac.nz phone: 021 2460728*

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, *ethics@aut.ac.nz* , (+649) 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Yelda Tokhi

Phone: 022 3774 795. Email: jfg5135@autuni.ac.nz

Project Supervisor Contact Details:

Alice Theadom, email alice.theadom@aut.ac.nz, phone; 021 02460728

Approved by the Auckland University of Technology Ethics Committee on *type the date final ethics approval was granted*, AUTEC Reference number *21/99*

Appendix B: Consent Form

AUT
TE WĀNANGA ARONUI O TĀMAKI MAKAU RAU

Consent Form

Project title: *Testing the validity of a Brain Injury Screening Tool*

Project Supervisors: *Professor Alice Theadom and Dr Nusrat Shaikh*

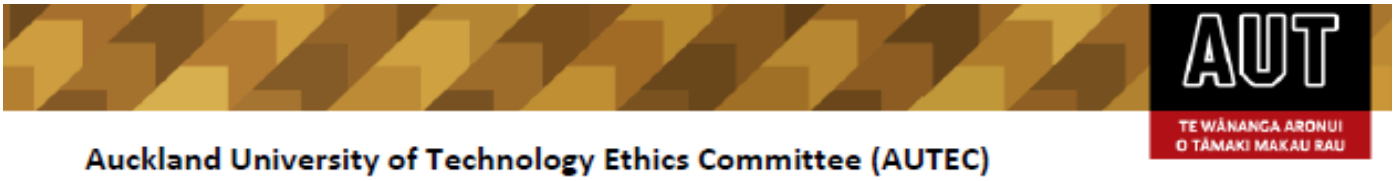
Researcher: *Yelda Tokhi*

- ○ I have read and understood the information provided about this research project in the Information Sheet dated 19th March 2021.
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- ○ I understand that if I withdraw from the study then I will be offered the choice between having my data removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- ○ I agree to take part in this research.
- ○ I wish to receive a summary of the research findings (please tick one): Yes○ No○

I agree to the above statements and provide my consent to take part in this research

Approved by the Auckland University of Technology Ethics Committee on 1st April 2021 AUTEC Reference number 21/99

Appendix C: Ethics Approval



Auckland University of Technology Ethics Committee (AUTEC)

Auckland University of Technology
D-88, Private Bag 92006, Auckland 1142, NZ
T: +64 9 921 9999 ext. 8316
E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

1 April 2021

Alice Theadom
Faculty of Health and Environmental Sciences

Dear Alice

Re Ethics Application: **21/99 Test-retest Validity of the Brain Injury Screening Tool (81ST)**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 1 April 2024.

Non-Standard Conditions of Approval

1. Include in the Consent Form a bullet point about what is required of the participant in this research, i.e. to complete 2 surveys 2 weeks apart.

Non-standard conditions must be completed before commencing your study. Non-standard conditions do not need to be submitted to or reviewed by AUTEC before commencing your study.

Standard Conditions of Approval

1. The research is to be undertaken in accordance with the Auckland University of Technology Code of Conduct for Research and as approved by AUTEC in this application.
2. A progress report is due annually on the anniversary of the approval date, using the EA2 form.
3. A final report is due at the expiration of the approval period, or, upon completion of project, using the EA3 form.
4. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form.
5. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
6. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.
7. It is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard and that all the dates on the documents are updated.

AUTEC grants ethical approval only. You are responsible for obtaining management approval for access for your research from any institution or organisation at which your research is being conducted and you need to meet all ethical, legal, public health, and locality obligations or requirements for the jurisdictions in which the research is being undertaken.

Please quote the application number and title on all future correspondence related to this project.

For any enquiries please contact ethics@aut.ac.nz. The forms mentioned above are available online through http://www.aut.ac.nz/research/researchethics

(This is a computer-generated letter for which no signature is required)

The AUTEC Secretariat
Auckland University of Technology Ethics Committee

Cc: Jfg5135@autuni.ac.nz; nshaikh@aut.ac.nz

Appendix D: Sociodemographic Questionnaire

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BIST Test Retest
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New Participant

Study ID	_____
Have you had a brain injury (or concussion) in the past 5 years?	◯ Yes ◯ No
What is your sex?	◯ Female ◯ Male
What is your date of birth?	_____
What ethnicity(ies) do you associate with?	☐ new zealand european ☐ maori ☐ samoan ☐ cook island maori ☐ tongan ☐ niuean ☐ chinese ☐ indian ☐ other
What is your highest level of education?	◯ primary school ◯ high school ◯ polytechnic/college/professional qualification ◯ university

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BIST Test Retest
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Sociodemographics

Study ID	_____
Who do you live with?	◯ Alone ◯ Living with family/partner ◯ Living with friends ◯ Other
If choose Other, please specify	_____
What is your main current employment status?	◯ Full time employment (>35 hours per week) ◯ Part time employment (< 35 hours per week) ◯ Student ◯ Homemaker ◯ Unemployed ◯ Retired ◯ Other
If choose Other, please specify	_____

Appendix E: BIST Symptom Scale and Health Questions

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BIST symptom scale

Study ID _____

Please rate how much you experience the following right now (at this point in time). 0 = Not at all, 10 = Severe (very bad)	
headache (my head hurts)	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10
my neck hurts	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10
I don't like bright lights	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10
I don't like loud noises	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10
I feel dizzy or like I could be sick	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10
If I close my eyes, I feel like I am at sea	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10
I have trouble with my eyesight (vision)	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10
I feel clumsy	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10
it takes me longer to think	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10
I forget things	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10

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Health

Study ID	_____
How would you rate your current health on a scale of 0-100?	Worst imaginable health state ---------- Best imaginable health state *(Place a mark on the scale above)*
Are you experiencing any effects from a physical or mental health condition?	◯ Yes ◯ No
If yes - what conditions have you been diagnosed with?	_____

Appendix F: DASS-21

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DASS-21

Study ID _____

Please read each statement and indicate how much the statement applied to you over the past week. There are no right or wrong answers.Do not spend too much time on any statement.
The rating scale is as follows:
0 =Did not apply to me at all - NEVER
1= Applied to me to some degree, or some of the time- SOMETIMES
2 = Applied to me to a considerable degree, or a good part of time- OFTEN
3 = Applied to me very much, or most of the time- ALMOST ALWAYS

1. I found it hard to wind down	◯ 0 ◯ 1 ◯ 2 ◯ 3
2. I was aware of dryness of my mouth	◯ 0 ◯ 1 ◯ 2 ◯ 3
3. I couldn't seem to experience any positive feeling at all	◯ 0 ◯ 1 ◯ 2 ◯ 3
4. I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	◯ 0 ◯ 1 ◯ 2 ◯ 3
5. I found it difficult to work up the initiative to do things	◯ 0 ◯ 1 ◯ 2 ◯ 3
6. I tended to over-react to situations	◯ 0 ◯ 1 ◯ 2 ◯ 3
7. I experienced trembling (eg, in the hands)	◯ 0 ◯ 1 ◯ 2 ◯ 3
8. I felt that I was using a lot of nervous energy	◯ 0 ◯ 1 ◯ 2 ◯ 3
9. I was worried about situations in which I might panic and make a fool of myself	◯ 0 ◯ 1 ◯ 2 ◯ 3
10. I felt that I had nothing to look forward to	◯ 0 ◯ 1 ◯ 2 ◯ 3
11. I found myself getting agitated	◯ 0 ◯ 1 ◯ 2 ◯ 3
12. I found it difficult to relax	◯ 0 ◯ 1 ◯ 2 ◯ 3
13. I felt down-hearted and blue	◯ 0 ◯ 1 ◯ 2 ◯ 3
14. I was intolerant of anything that kept me from getting on with what I was doing	◯ 0 ◯ 1 ◯ 2 ◯ 3

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15. I felt I was close to panic	◯ 0 ◯ 1 ◯ 2 ◯ 3
16. I was unable to become enthusiastic about anything	◯ 0 ◯ 1 ◯ 2 ◯ 3
17. I felt I wasn't worth much as a person	◯ 0 ◯ 1 ◯ 2 ◯ 3
18. I felt that I was rather touchy	◯ 0 ◯ 1 ◯ 2 ◯ 3
19. I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)	◯ 0 ◯ 1 ◯ 2 ◯ 3
20. I felt scared without any good reason	◯ 0 ◯ 1 ◯ 2 ◯ 3
21. I felt that life was meaningless	◯ 0 ◯ 1 ◯ 2 ◯ 3