

The effectiveness of cognitive behaviour therapy for reducing anxiety symptoms following traumatic brain injury: A meta-analysis and systematic review

Little, Alice; Byrne, Christopher; Coetzer, Rudi

NeuroRehabilitation

DOI:

<https://doi.org/10.3233/nre-201544>

Published: 22/01/2021

Peer reviewed version

[Cyswllt i'r cyhoeddiad / Link to publication](#)

Dyfyniad o'r fersiwn a gyhoeddwyd / Citation for published version (APA):

Little, A., Byrne, C., & Coetzer, R. (2021). The effectiveness of cognitive behaviour therapy for reducing anxiety symptoms following traumatic brain injury: A meta-analysis and systematic review. *NeuroRehabilitation*, 48(1), 67-82. <https://doi.org/10.3233/nre-201544>

Hawliau Cyffredinol / General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Review Article

The effectiveness of cognitive behaviour therapy for reducing anxiety symptoms following traumatic brain injury: A meta-analysis and systematic review

A. Little^a, Christopher Byrne^{b,c} and Rudi Coetzer^{b,c,*}

^a*North Wales Clinical Psychology Programme, School of Psychology, Bangor University, UK*

^b*North Wales Brain Injury Service, Betsi Cadwaladr University Health Board, NHS Wales, UK*

^c*School of Psychology, Bangor University, UK*

Received 17 August 2020

Accepted 10 November 2020

Abstract.

BACKGROUND: Anxiety is a common neuropsychological sequela following traumatic brain injury (TBI). Cognitive Behaviour Therapy (CBT) is a recommended, first-line intervention for anxiety disorders in the non-TBI clinical population, however its effectiveness after TBI remains unclear and findings are inconsistent.

OBJECTIVE: There are no current meta-analyses exploring the efficacy of CBT as an intervention for anxiety symptoms following TBI, using controlled trials. The aim of the current study, therefore, was to systematically review and synthesize the evidence from controlled trials for the effectiveness of CBT for anxiety, specifically within the TBI population.

METHOD: Three electronic databases (Web of Science, PubMed and PsycInfo) were searched and a systematic review of intervention studies utilising CBT and anxiety related outcome measures in a TBI population was performed through searching three electronic databases. Studies were further evaluated for quality of evidence based on Reichow's (2011) quality appraisal tool. Baseline and outcome data were extracted from the 10 controlled trials that met the inclusion criteria, and effect sizes were calculated.

RESULTS: A random effects meta-analysis identified a small overall effect size (Cohen's d) of $d = -0.26$ (95% CI -0.41 to -0.11) of CBT interventions reducing anxiety symptoms following TBI.

CONCLUSIONS: This meta-analysis tentatively supports the view that CBT interventions may be effective in reducing anxiety symptoms in some patients following TBI, however the effect sizes are smaller than those reported for non-TBI clinical populations. Clinical implications and limitations of the current meta-analysis are discussed.

Keywords: Traumatic brain injury, anxiety, cognitive behaviour therapy, meta-analysis

1. Introduction

Traumatic brain injury (TBI) is defined as an injury to the brain as a result of external force. There are

many possible causes of TBI, but they are most commonly caused by road traffic accidents, falls and assaults (Hyder, Wunderlich, Puvanachandra, Gururaj, & Kobusingye, 2007). In the UK, reports estimate that someone is admitted to hospital every three minutes following a TBI (Headway, 2015). TBI is a significant public health concern and a leading cause of disability in the developed world (Fleminger,

*Address for correspondence: Dr Rudi Coetzer, North Wales Brain Injury Service, Colwyn Bay Hospital, Hesketh Road, Colwyn Bay LL29 8AY, UK. Tel.: +44 030 008 555 06; E-mail: Rudi.Coetzer@wales.nhs.uk.

41 & Ponsford, 2005; McAllister, 2008; Roozenbeek,
42 Mass, & Menon, 2013; Stocchetti, 2014).

43 TBI is associated with long-term disability, which
44 can significantly impact daily functioning and quality
45 of life (Hyder et al., 2007). The sequelae following
46 TBI often includes physical and cognitive difficul-
47 ties (McAllister, 2008), and an increased incidence
48 of psychiatric illness (Deb, Lyons, Koutzoukis, Ali,
49 & McCarthy, 1999; Koponen et al., 2002), including
50 anxiety disorders.

51 1.1. Anxiety disorders and TBI

52 Anxiety is a commonly reported psychological
53 complaint following TBI (Coetzer, 2010) and is the
54 most prevalent psychiatric diagnosis within the first
55 12 months post-injury (Gould, Ponsford, Johnston, &
56 Schonberger, 2011). Neurobiological damage, phys-
57 ical and psychological adjustment, coping style,
58 feelings of grief, loss, and uncertainty regarding the
59 future are all considered to contribute to the aetiol-
60 ogy of anxiety following TBI (Williams, Evans, &
61 Fleminger, 2003). Post-injury biopsychosocial mod-
62 els of adjustment consider both direct and indirect
63 influences, in addition to a variety of mediating fac-
64 tors (Lishman 1973; Gainotti 1993; Kendall & Terry;
65 1996).

66 Previous research examining the relationship be-
67 tween neuroanatomical regions and specific anxiety
68 presentations have attempted to identify brain areas of
69 importance. Obsessive Compulsive Disorder (OCD)
70 is frequently associated with lesions to the frontal
71 and connected subcortical areas such as the orbito-
72 frontal cortex, anterior cingulate gyrus and caudate
73 nucleus (Rydon-Grange & Coetzer, 2015; Schwar-
74 zbold et al 2008). However, as highlighted by
75 Coetzer (2004), the difficulty of separating over-
76 lapping symptomology in this clinical population is
77 important to consider. For example, perseverative be-
78 haviour, which is also associated with frontal lesions,
79 can be mistaken for repetitive behaviour in OCD.
80 Therefore, it is important to consider cognitive fac-
81 tors as an alternative hypothesis for the development
82 of such symptoms, rather than anxiety *per se*.

83 The emergence of Post-traumatic Stress Disorder
84 (PTSD) following TBI has shown a relationship with
85 the degree of post-traumatic amnesia (PTA). A large
86 study ($n > 1100$) by Bryant et al (2009) demon-
87 strated that individuals with a mild TBI were more likely
88 to develop PTSD than those without a TBI. However,
89 those with longer periods of PTA were found to
90 have less severe intrusive thoughts, which highlighted

91 the potentially protective nature of PTA in evolution
92 of PTSD after TBI. Furthermore, another factor to
93 consider is that individuals with altered levels of con-
94 sciousness may have “islands of memory” whereby
95 memories may be processed directly through the
96 amygdala during the traumatic event. This may result
97 in an implicit memory processes that result in an
98 emotional or perceptual memory, without the explicit
99 autobiographical component.

100 Anxiety symptomology can manifest as apprehen-
101 sion, worry and fear, or as a diagnosable mental health
102 disorder (Soo & Tate, 2012). Post-TBI, individuals
103 are considered to be at increased risk of develop-
104 ing anxiety disorders (Hiott & Labbate, 2002), with
105 the prevalence estimated to range between 11% and
106 70% (Rao & Lykestos, 2000; Rao & Lykestos, 2002).
107 Furthermore, those with a pre-morbid psychiatric his-
108 tory are likely more vulnerable to post-TBI mood
109 disturbances, with prevalence rates of up to 75% in
110 this sub-group (Gould, Ponsford, Johnston, & Schon-
111 berger, 2011). This wide range in prevalence is likely
112 due to the heterogeneous nature of the population
113 and variability in outcome measurements used across
114 studies. In terms of specific anxiety disorders, PTSD
115 (19%), OCD (15%), panic disorder (14%), gener-
116 alised anxiety disorder (9%) and phobias (10%), are
117 most frequently diagnosed following TBI (Hibbard,
118 Uysal, Kepler, Bogdany, & Silber, 1998).

119 Post-TBI anxiety can hinder the recovery pro-
120 cess and result in up to four times poorer functional
121 outcomes and increased impairment (Bryant et al.,
122 2010). Patients who experience anxiety following
123 TBI report significantly increased disability and
124 reduced quality of life (Fann, Katon, Uomoto, &
125 Esselman, 1995; Whitnall, 2006). Anxiety has also
126 been associated with the subjective over-estimation
127 of the severity of physical and cognitive impair-
128 ments (Fann et al., 1995; Byrne, Coetzer, & Addy,
129 2017), potentially having a further adverse effect on
130 outcome. Effective treatment of anxiety in this popu-
131 lation may therefore help reduce subjective reporting
132 of physical and cognitive impairments, and as a result
133 improve outcome and quality of life.

134 1.2. Treatments for anxiety

135 In non-TBI clinical populations, additional to psy-
136 chological treatments, in some patients anxiety is
137 often managed effectively with pharmacotherapy
138 (Murrough, Yaqubi, Sayed, & Charney, 2015; Bande-
139 low et al., 2015). There is evidence however, that
140 pharmacological interventions may have limited

141 efficacy in the TBI population. Individuals with
 142 TBI may be increasingly vulnerable to negative side
 143 effects (Warden et al., 2006) and the exacerbation
 144 of cognitive difficulties (Perna, Bordini, & Newman,
 145 2001). The development of effective alternative, non-
 146 pharmacological treatments, including psychological
 147 interventions to augment existing approaches to reha-
 148 bilitation, are therefore important to consider.

149 1.2.1. Non pharmacological interventions

150 Despite the high prevalence of anxiety disorders
 151 following TBI and the negative impact they have on
 152 rehabilitation outcomes, in comparison to the gen-
 153 eral clinical population, there has been relatively
 154 little research into potential treatments. Within the
 155 TBI population, the evidence-base for psychological
 156 interventions for anxiety has been steadily expand-
 157 ing over the last 20 years. To date, the intervention
 158 that has had the most research within this population
 159 is Cognitive Behaviour Therapy (CBT). CBT is ulti-
 160 mately based on the premise that cognitions influence
 161 behaviour and emotions, and a change in one of these
 162 areas will bring about reciprocal change in the others.
 163 It is beyond the scope of this meta-analysis to provide
 164 a detailed description of CBT. Beck (1995; 1998) pro-
 165 vides a more detailed description of the development
 166 and application of CBT.

167 Over recent years there has been increased interest
 168 in developing and adapting alternative interventions
 169 for use within the TBI population. Such interventions
 170 that have been considered, include Acceptance and
 171 Commitment Therapy (ACT) and Mindfulness Based
 172 Cognitive Therapy (MBCT), which have shown
 173 promising results (Kangas & McDonald, 2011; Whit-
 174 ing, Deane, Simpson, & McLeod, 2017; Bedard et
 175 al., 2012). The role of exercise as an intervention
 176 to reduce anxiety symptoms has also been consid-
 177 ered, and results are promising (Gordon et al., 1998;
 178 Rzezak et al., 2015; Weinstein, et al., 2017).

179 1.2.2. CBT for anxiety in non-TBI Populations

180 In the general population CBT is a recommended
 181 intervention for the treatment of a range of anxi-
 182 ety disorders (National Institute for Health and Care
 183 Excellence [NICE], 2011) There is a wealth of
 184 empirical evidence supporting the efficacy of CBT
 185 for reducing anxiety symptoms, including several
 186 reviews of high-quality meta-analyses (Deacon &
 187 Abramowitz, 2004; Norton & Price, 2007). Hoffman,
 188 Asnaani, Vonk, Sawyer and Fang (2012) conducted
 189 a large-scale review to examine CBT as a treatment
 190 for a variety of disorders, including anxiety. Large

191 effect sizes for the treatment of OCD and medium
 192 effect sizes for social anxiety disorder, PTSD and
 193 panic disorder were reported consistently (Hoffman
 194 et al., 2012; Carpenter et al., 2018). In another meta-
 195 analysis of 108 clinical trials, Norton and Price (2007)
 196 considered the efficacy of CBT across a range of anx-
 197 iety disorders. CBT resulted in significantly larger
 198 effect sizes in comparison to no treatment or control
 199 conditions across all the anxiety disorders, particu-
 200 larly generalised anxiety disorder and PTSD.

201 1.2.3. CBT in TBI populations

202 Over recent years, CBT has been increasingly used
 203 as a treatment within TBI populations. It has been
 204 argued that its highly structured and goal-oriented
 205 approach, in addition to a focus on concrete thoughts
 206 and behaviours, means that it is an appropriate inter-
 207 vention for individuals with cognitive impairments
 208 (Hodgson, McDonald, Tate, & Gertler, 2005; Doer-
 209 ing & Exner, 2011). Additional adaptations may
 210 also be beneficial to ensure that CBT is accessible
 211 to the TBI population. A recent review by Gal-
 212 lagher, McLeod and McMillan (2016) reported that
 213 increased socialisation to the CBT model and util-
 214 ising external memory aids were the most common
 215 adaptations used.

216 In 2007, Soo and Tate conducted a systematic
 217 review of the available randomised control trials
 218 (RCTs) to investigate the efficacy of psychological
 219 treatment for anxiety following TBI. At the time,
 220 there were only three RCTs that met the inclusion
 221 criteria for their systematic review, examining the
 222 efficacy of CBT (Bryant, Moulds, Guthrie & Nixon,
 223 2005; Tiersky et al., 2005) and interpersonal process
 224 recall therapy (IPRT; Helffenstein & Wechsler, 1982).
 225 They found evidence in support of the effectiveness
 226 of CBT for the treatment of acute stress disorder
 227 post-TBI and for the combination of CBT and neuro-
 228 rehabilitation as an intervention for general anxiety
 229 symptoms following mild to moderate TBI. They
 230 reported limited evidence for the efficacy of IPRT
 231 and identified significant flaws in the methodology
 232 of this study. Soo and Tate (2007) highlighted the
 233 complexity of assessing anxiety within TBI popula-
 234 tions; specifically, due to difficulties with differential
 235 diagnoses and diagnostic overshadowing.

236 Much of the current evidence-base was derived
 237 from research with individuals who have experienced
 238 acquired brain injury (ABI), which includes TBI
 239 as well as cerebrovascular accidents (CVA). This is
 240 often due to difficulties with recruitment within rela-
 241 tively small local TBI populations approached during

clinical research projects. A meta-analysis using a mixed ABI population reported effect sizes ranging from 0 to 0.42 when investigating the efficacy of CBT on reducing anxiety symptoms (Waldron, Casserly & O’Sullivan., 2013). Although often resulting in similar neuropsychiatric sequelae, the aetiology and neuropathology of TBI and CVA are very different (Tateno, Murata, & Robinson, 2002; Werner & Engelhard, 2007), therefore, the nature and cause of anxiety, as well as response to treatment may differ between these populations. For this reason the present meta-analysis will focus specifically on TBI populations only.

The current evidence-base examining the efficacy of treatments for anxiety post-TBI is conflicted and equivocal, with studies utilising a variety of sample sizes, outcome measures, severity of TBI and focus of the intervention. As a result, it is difficult to make comparisons across studies and there is a need to synthesise current research. There have been no previous meta-analyses of controlled trials investigating specifically CBT as the primary psychological intervention to treat anxiety following TBI. The current meta-analysis therefore aims to answer the following question: *Is CBT an effective intervention to reduce anxiety symptoms following TBI?*

2. Method

2.1. Identification and selection of studies

Three electronic databases (Web of Science, Pub Med and PsycInfo) were searched for eligible studies up to May 2020, using the following search terms: (“Cognitive Behav* Therapy” OR “CBT”) AND (“anxiety” OR “stress”) AND (“traumatic brain injury” OR “TBI” OR “brain injury” OR “head trauma” OR “head injury” OR “brain damage”). The search was limited to English language articles, published since 1990. An ancestral search of the identified articles was also conducted. This search method, using three databases and an ancestral search, was considered a comprehensive approach to gaining access to relevant articles. Articles were screened initially via examination of title and abstract, after which full text articles were assessed according to the following eligibility criteria:

- I. Participants must be 18 years or over
- II. The sample must contain participants who have sustained a TBI of any severity (i.e. mild, moderate or severe)

III. Studies must be controlled trials (i.e. must contain both an intervention group and a control group)

IV. Interventions must specifically have used CBT as an intervention. For the purpose of this meta-analysis, studies were included if the intervention targeted both cognitive and behavioural processes or was stated to use an intervention that was underpinned by CBT principles.

V. Studies must include an anxiety related outcome measure.

VI. Study data must be quantitative.

In the case of unreported data, authors were contacted via email, three email reminders were sent to non-responders.

2.2. Assessment of study quality

The quality of each study was assessed using Reichow, Volkmar and Cicchetti’s (2008) criteria, a method with strong psychometric properties. Each individual study was initially appraised for quality using Reichow’s (2011) primary and secondary indicators (e.g. participant characteristics, statistical analysis, randomised assignment, social validity) and each indicator was assigned a quality rating of high, acceptable or unacceptable. An overall strength rating of strong, adequate or weak, was then determined for each study (Reichow et al., 2008). Quality ratings were independently checked by the second author (CB). Quality ratings are listed in Table 1.

2.3. Data extraction and analysis

The Metafor package for the statistical software environment, R (The R Foundation, 2018; Viechtbauer, 2010) was used to analyse all data in this meta-analysis. Data from anxiety related measures were extracted from each article by the first author. Email requests and reminders were sent for unreported data if necessary. Wherever possible, data from intention to treat (ITT) analyses were used as this is considered to provide a more pragmatic and unbiased comparison between conditions (Soares & Carneiro, 2002).

The mean change in anxiety score, from pre to immediately post-CBT intervention, divided by the baseline standard deviation, was used to calculate the effect sizes for each RCT. The difference between the effect sizes for the intervention and control group of

Table 1
Quality appraisal ratings using reichow's (2011) criteria

	Ashman et al. (2014)	Bell et al. (2016)	Bryant et al. (2003)	Cooper et al. (2017)	Hsieh et al. (2012)	Nguyen et al. (2017)	Ponsford et al. (2015)	Potter et al. (2016)	Silverberg et al. (2013)	Tiersky et al. (2005)
Primary Indicators										
Participant characteristics	High	High	High	High	High	High	High	High	High	High
Independent variable	High	High	High	High	High	High	High	High	High	High
Comparison condition	High	High	High	High	High	Adequate	High	High	High	High
Dependent variable	High	High	High	High	High	High	High	High	High	High
Link between research question and data analysis	High	High	High	High	High	High	High	High	High	High
Statistical analysis	Adequate	High	Adequate	High	Adequate	Adequate	High	High	High	Adequate
Secondary Indicators										
Random assignment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Interobserver agreement	No	No	No	No	No	No	No	No	No	No
Blind raters	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fidelity	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Attrition	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Generalisation/ maintenance	No	Yes	Yes	Yes	No	Yes	Yes	No	No	No
Effect size	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social validity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Overall quality rating	Adequate	Strong	Adequate	Strong	Adequate	Adequate	Strong	Strong	Strong	Adequate

each study were then analysed (Viechtbauer, 2010). For each outcome measure, correlation coefficients (test re-test reliability) were extracted from the current evidence-base.

Due to the potential heterogeneity of CBT interventions, and variability in methodological rigour within the identified studies, a random effects meta-analysis model was used. This model is based on the assumption that the true effect size varies between studies and therefore predicts the overall standardised mean change (SMC; Borenstein, Hedges, Higgins & Rothstein, 2010). Negative effect sizes would indicate an average reduction in anxiety scores from pre to post-intervention. Each study's effect size was then weighted by its sample size, and pooled to provide an overall effect size for the effectiveness of CBT interventions in reducing anxiety symptoms. Using Cohen's (1988) criteria, an effect size of 0.2 is considered to be a small effect, 0.5 a medium effect, and 0.8 a large effect.

3. Results

An initial screening process yielded 938 articles. Following title and abstract examination 871 were excluded as they were found not to be relevant to the research question. The remaining 67 full-text articles were assessed and 11 were found to satisfactorily meet the above inclusion criteria. Unfortunately, one author did not respond to requests for data, therefore 10 studies were included in the meta-analysis. The selection of studies followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (Moher, Liberatti, Tetzlaff & Altman, 2009). See Figure 1 for the PRISMA diagram demonstrating the search process. All 10 of the included studies were RCTs.

3.1. Study characteristics

3.1.1. Methodological quality

The quality of the included studies was considered to be 'Adequate' (Ashman, Cantor, Tsaousides, Spielman, & Gordon, 2014; Bryant, Moulds, Guthrie, & Nixon, 2003; Hsieh et al., 2012; Nguyen et al., 2017; Tiersky et al., 2005) or 'Strong' (Bell et al., 2016; Cooper et al., 2017; Ponsford et al., 2016; Potter, Brown, & Fleminger, 2016; Silverberg et al., 2013). Out of the 10 articles included, eight stated that they utilised ITT analysis. Tiersky et al. (2005) did not appear to use ITT and Potter et al. (2016) lost one

participant to follow up but did not attempt to impute missing data.

3.1.2. Participants

All participants included in the current meta-analysis were over the age of 18 and gave informed consent to participate in the individual studies. All participants were recruited from community samples, and had sustained TBIs of varying severity (i.e. mild, moderate or severe). The studies by Bell et al. (2016) and Cooper et al. (2017) used military samples, including only active service members.

Eight of the studies recruited from rehabilitation services, where TBI diagnoses and severity were confirmed by clinicians (Ashman et al., 2014; Bell et al., 2016; Bryant et al., 2003; Cooper et al., 2017; Hsieh et al., 2012; Ponsford et al., 2016; Potter et al., (2016); Silverberg et al., 2013). Nguyen et al. (2017) and Tiersky et al. (2005) relied on self-reported symptoms of loss of consciousness and PTA to confirm TBI.

All the included studies recruited participants that had experienced a TBI at least six months prior to participating in the study, with the exception of the studies by Silverberg et al. (2013) who recruited at six weeks and Bryant et al. (2003) who recruited at two weeks post-injury. In total, 359 participants were randomised to a CBT based intervention and 342 were randomised to a control condition. Several of the included studies required participants to have a diagnosed psychological disorder including anxiety (Hsieh et al., 2012; Ponsford et al., 2016), depression (Ashman et al., 2014; Ponsford et al., 2016), acute stress disorder (Bryant et al., 2003) or be at risk of developing postconcussion syndrome (PCS; Potter et al., 2016).

3.1.3. Trial design

All of the studies included in the current meta-analysis were RCTs, where participants were randomly allocated to either an intervention or control arm of the trial. Seven of the studies utilised a two-group parallel trial (Ashman et al., 2014; Bell et al., 2016; Bryant et al., 2003; Nguyen et al., 2017; Potter et al., 2016; Silverberg et al., 2013; Tiersky et al., 2005) where participants were randomised to a CBT condition or a control condition. Hsieh et al. (2012) and Ponsford et al. (2015) utilised a three-group parallel trial, adding motivational interviewing (MI) or non-directive counselling (NDC) prior to CBT, in comparison to a control condition. To capture the effect of the CBT, data was extracted from the NDC and CBT condition and the control condition, pre and

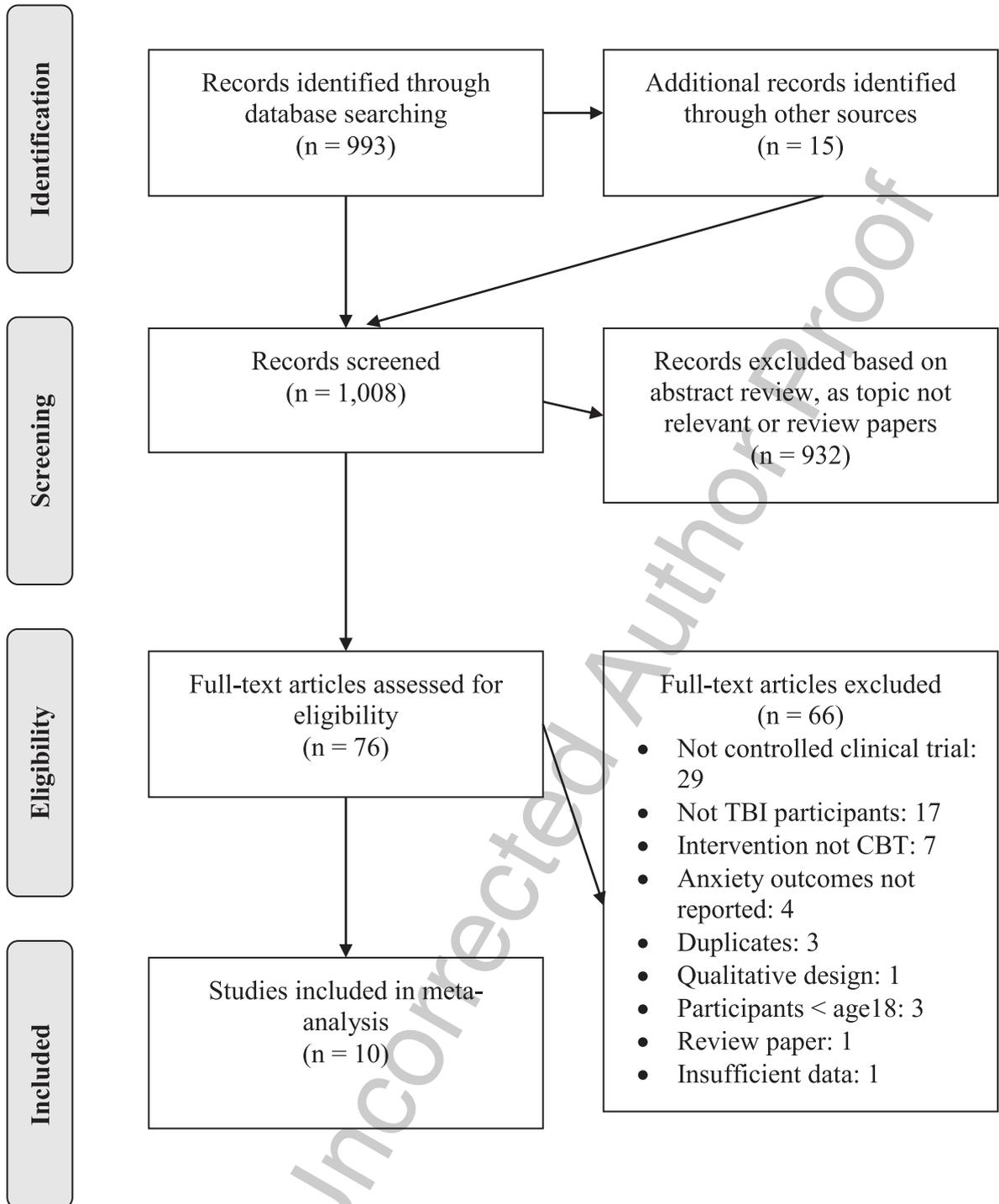


Fig. 1. PRISMA diagram (Moher et al., 2009).

433 post-CBT (in the study by Ponsford et al., (2016) data
 434 were extracted from week three and week 12). Cooper
 435 et al. (2017) utilised a four-group parallel trial, compar-
 436 ing psychoeducation, to computerised cognitive

rehabilitation, therapist implemented cognitive reha-
 bilitation and CBT. Pre and post-data were extracted
 from the psychoeducation and the CBT condition for
 this study.

437
 438
 439

3.1.4. Control conditions

Three of the studies utilised a wait list control (WLC; Potter et al., 2016; Ponsford et al., 2015; Tiersky et al., 2005), three utilised a treatment as usual (TAU) condition (Hsieh et al., 2012; Nguyen et al., 2017; Silverberg et al., 2013), two utilised a psychoeducation condition; face-to-face (Cooper et al., 2017) or via telephone (Bell et al., 2016), and three studies used various forms of face-to-face counselling or psychotherapy (Ashman et al., 2014; Bryant et al., 2003).

3.1.5. Intervention type

The studies all administered a CBT-based intervention, however, they varied in terms of session length, frequency and format of delivery. All the interventions were manualised, to ensure treatment fidelity. All interventions were conducted individually and face-to-face, except for the studies by Cooper et al. (2017) who used a combination of individual and group interventions, and Bell et al. (2016) who conducted their CBT informed intervention via telephone call. The length of the interventions varied between 5 and 33 sessions delivered over a period of between 5 weeks and 6 months.

The primary focus of the CBT interventions included depression (Ashman et al., 2014; Ponsford et al., 2015), anxiety (Hsieh et al., 2012; Ponsford et al., 2015), acute stress disorder (Bryant et al., 2003), cognitive functioning (Bell et al., 2016; Cooper et al., 2017); postconcussional complaints (Potter et al., 2016; Silverberg et al., 2013), sleep disturbance and fatigue (Nguyen et al., 2017) and psychological symptoms (Bell et al., 2016; Tiersky et al., 2005).

Despite the differing primary focus of interventions, all incorporated the basic underlying principles of CBT including; psychoeducation, cognitive restructuring, behavioural activation, problem solving and relapse prevention. All studies incorporated structure weekly homework activities, to support participants in the practice and generalisation of skills between sessions.

3.1.6. Adaptations

The studies by Ashman et al. (2014), Hsieh et al. (2012), Nguyen et al. (2017), Ponsford et al. (2016) and Potter et al. (2016) clarified the adaptations made to CBT interventions, to ensure accessibility for TBI populations. Adaptations included incorporating compensatory strategies such as written handouts, external memory aids, simplifying complex concepts, providing organisational support, implementing new

strategies *in vivo* where possible. With the exception of Bell et al. (2016) and Cooper et al. (2017), all of the studies stated that their CBT interventions were delivered by professionals who had experience in delivering CBT to TBI populations.

3.1.7. Follow up

Five of the included studies included a follow up to determine maintenance effects. Follow ups took place at two months (Nguyen et al., 2017), 12 and 18 weeks (Cooper et al., 2017) and six months (Bell et al., 2016; Bryant et al., 2003). At 21 weeks, Ponsford et al. (2016) provided a top up CBT session to participant and then re-administered outcome measures at 30 weeks.

3.1.8. Outcome measures

All the studies included in the current meta-analysis utilised anxiety related outcome measures. These included the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983), the State Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), the Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988), the Symptom Checklist-90-R, (SCL-90-R; Derogatis, 1994) and the PTSD checklist-military version (PCL-M; Weathers, Huska, & Keane, 1991). In the event that multiple anxiety measures were administered, measures were prioritised in the following order, according to frequency of use across the studies to maximise the consistency of extracted data and improve homogeneity; HADS, BAI, STAI, SCL-90; PCL-M. The main characteristics of the 10 articles included in this meta-analysis are summarised in Table 2 and Table 3.

3.2. Effect of CBT at reducing anxiety symptoms

A random-effects model allowed the meta-analysis to predict the overall SMC, based upon the distribution of true effect sizes (Viechtbauer, 2010). See Figure 2 for the forest plot illustrating the meta-analysis of the included 10 studies, for the anxiety outcome measure, following the completion of a CBT informed intervention. The pooled SMC was -0.26 (95% CI -0.41 to -0.11). This represents a small overall effect size of CBT in the reduction of anxiety symptoms following TBI.

The 95% confidence intervals of the overall effect size do not cross the zero threshold, which indicates that the results are statistically significant; however, it could be argued that the margin is close. A Cochrane's

Table 2
Main characteristics of studies included in the meta-analysis

Author (year)	Design	TBI severity	Anxiety measures	Other outcome measure(s)	CBT intervention (led by)	Focus of the CBT intervention	Setting (location)
Ashman et al. (2014)	RCT	Mild–Severe	STAI	BDI-II, Life-3, ISEL, LES	16 weekly sessions of manualised individual CBT based on CBT techniques for treating depression (postdoctoral fellows in clinical neuropsychology)	Depression	Community (USA)
Bell et al. (2016)	RCT	Mild	PCL-M	BSI-18, RPQ, EuroQol, PSQI, PHQ-9, CD-RISC, B-IFE, AUDIT, SDS, SF-12, CSC	12 bi-weekly telephone sessions of problem-solving therapy based upon CBT principles (Master’s level counsellors)	Psychological symptoms	Community, military sample (USA)
Bryant et al. (2003)	RCT	Mild	BAI	ASDI, IES, BDI, CAPS	5 weekly sessions of manualised individual CBT (clinical psychologists)	Acute stress disorder	Community (Australia)
Cooper et al. (2017)	RCT	Mild	SCL-90 PCL-M	PASAT, KBCI	10 weekly sessions of manualised individual and group integrated cognitive rehabilitation and CBT. Focus on cognitive restoration and anxiety/depression symptoms (doctoral level psychologists)	Cognitive difficulties.	Community, military sample (USA)
Hsieh et al. (2012)	RCT	Moderate–Severe	HADS-A DASS	CSA, SPRS-2, SADI,	12 weekly sessions of individual manualised CBT (clinical neuropsychologists)	Anxiety	Community (Australia)
Nguyen et al. (2017)	RCT	Mild–Severe	HADS-A	PSQI, ISI, BFI, FSS, ESS	8 weekly sessions of individual manualised CBT (clinical neuropsychologist)	Sleep Disturbance	Community (Australia)
Ponsford et al. (2015)	RCT	Mild–Severe	HADS-A DASS	SPRS-2	9 weekly sessions of manualised CBT (clinical psychologist or neuropsychologist)	Anxiety and depression	Community (Australia)
Potter et al. (2016)	RCT	Mild–Moderate	HADS-A STAI	RPQ, BICRO-39, QOLAS, IES-R, CIS20R, MPQ, STAXI-2, EuroQol	12 weekly sessions of individual manualised CBT (clinical neuropsychologist)	Post-concussion complaints	Community (UK)
Silverberg et al. (2013)	RCT	Mild	HADS-A	RPQ, M2PI, IPQ	6 weekly sessions of individual manualised CBT (doctoral level psychologists with neuropsychology experience)	Post-concussion complaints	Community (Canada)
Tiersky et al. (2005)	RCT	Mild – Moderate	SCL-90R Attention Questionnaire, CRI, SCL-90, CIQ	PASAT, RAVLT, ACFI,	Individual CBT and cognitive remediation three times a week for 11 weeks (33 sessions) (clinical psychologist with experience in brain injury).	Psychosocial symptoms	Community (USA)

ACFI–Aged Care Funding Instrument; ASDI–Acute Stress Disorder Interview; AUDIT–Alcohol Use Disorders Identification Test; BAI–Beck Anxiety Inventory; BDI–Beck Depression Inventory; BICRO-39–Brain Injury Community Rehabilitation Outcome Scale; BDI-II–Beck Depression Inventory-II; B-IFE–Brief inventory for Functioning Evaluation; BSI-18–Brief Symptom Inventory-18; CAPS–Clinician Administered PTSD Scale; CD-RISC–Connor-Davidson Resilience Scale-10; CIQ–Community Integration Questionnaire; CIS20R–Checklist of Individual Strength; CRI–Coping Response Inventory; CSA–Coping Scale for Adults; CSC–Client Satisfaction Scale; DASS–Depression Anxiety Stress Scales; ESS–Epworth Sleepiness Scale; EuroQol–European Quality of Life; GOSE–Glasgow Outcome Scale; HADS–Hospital Anxiety and Depression Scale; HISC–Head Injury Symptom Checklist; FSS–Fatigue Severity Scale; IES-R–Impact of Event Scale-Revised; ISEL–Interpersonal Support Evaluation List; IPQ-R–Illness Perception Questionnaire- Revised; ISI–Insomnia Severity Index; KBCI–Key Behaviour Change Inventory; LES–Life Experiences Survey; M2PI–Mayo-Portland Participation Index; MPQ–McGill Pain Questionnaire; PASAT–The Paced Auditory Serial Addition Task; PHQ-9–Patient Health Questionnaire-9; PSQI–Pittsburgh Sleep Quality Index; QOLAS–Quality of Life Assessment Schedule; RAVLT–Rey Auditory Verbal Learning Test; RCT–Randomised Controlled Trial; RPQ–Rivermead Postconcussion Symptoms Questionnaire; SADI–The Self-Awareness of Deficits Interview; SPRS-2–The Sydney Psychosocial Reintegration Scale; STAI–State-Trait Anxiety Inventory; STAXI-2–State-Trait Anger Expression Inventory-2 SCL-90-R–Symptom Checklist-90-R; SDS–Sheehan Disability Scale; SF-12–Short Form Health Survey; TBI–Traumatic brain injury; UCL–Utrechtse Coping List.

Table 3
Methodological characteristics and findings of articles included in the meta-analysis

Author (Year)	Intervention Group					Control Condition	Control Group					Findings
	N (pre)	N (post)	Age (M, SD)	Gender (% M)	Time Since Injury (M, SD)		N (pre)	N (post)	Age (M, SD)	Gender (% M)	Time Since Injury (M, SD)	
Ashman et al. (2014)	39	22	47.1 (10.6)	37.8%	13.3 (16.7) years	Supportive psychotherapy (SPT)	38	21	48.1 (10.2)	48.6%	11.8 (16.9) years	Significant time effects for the BDI, STAI and QOL outcome measures, but no group effect. No significant difference between CBT and SPT intervention groups post-intervention.
Bell et al. (2016)	178	132	29.25 (7.20)	93.26%	Not reported	Psycho-education	178	160	29.44 (7.27)	93.36 %	Not reported	Post-intervention the PST/CBT group demonstrated greater reductions in psychological distress, and PTSD symptoms; but effects not sustained at 12m follow up.
Bryant et al. (2003)	12	12	29.42 (13.93)	33.3%	<2 weeks	Supportive counselling (SC)	12	12	33.00 (14.37)	33.3%	<2 weeks	Significantly fewer participants in the CBT group met criteria for PTSD post-treatment than the SC group (8 % vs 58% respectively). Significant reduction on the BAI for the CBT group.
Cooper et al. (2017)	32	25	32.03 (8.98)	93.8%	306.63 (193.15) days	Psycho-education	32	25	30.09 (7.61)	91.2%	290.71 (161.08) days	Integrated CR and CBT reduced functional cognitive symptoms compared to education only.
Hsieh et al. (2012)	10	10	36.4 (14.1)	70%	50.4 (89.7) months	Treatment as usual (TAU)	8	8	35.6 (9.8)	87.5%	23.0 (18.5) months	No statistical analysis for anxiety measure. Significant reduction in HADS and DASS scores for the CBT groups compared to TAU.
Nguyen et al. (2017)	13	11	45.53 (13.87)	69.23%	795.15 (714.23) days	Treatment as usual (TAU)	11	10	41.90 (12.95)	63.64%	2093.36 (2192.62) days	Significant improvement in sleep quality and reduction in fatigue for CBT group compared to TAU. Secondary improvements were significant on the HADS.
Ponsford et al. (2015)	26	26	39.88 (14.24)	76.9%	3.58 (5.87) years	Waitlist control (WLC)	23	23	39.87 (12.88)	73.9%	2.61 (3.68) years	Significantly greater reduction in HADS scores for the CBT groups compared to WLC.
Potter et al. (2016)	26	25	40.1 (10.3)	58%	23% 6–12 m 23%12–24 m 54%>24 m	Waitlist control (WLC)	20	20	43.1 (13.1)	50% M	35% 6–12 m 15%12–24 m 50%>24 m	Significant increase in quality of life and reduction on anxiety for the CBT group compared to WLC.
Silverberg et al. (2013)	15	13	40.4 (13.5)	40%	23.13 (7.0) days	Treatment as usual (TAU)	13	11	37.5 (10.0)	38%	25.4 (9.1) days	Significantly fewer participants in the CBT group experienced PCS symptoms. Reduction anxiety scores on the HADS (no statistical analysis).
Tiersky et al. (2005)	14	11	47.55 (11.78)	54.5%	5.01 (5.46) years	Wait list control (WLC)	15	9	46.00 (9.35)	32.3%	22.2 (2) years	Significant reduction on the SCL 90-R anxiety subscale for the CBT group compared to WLC.

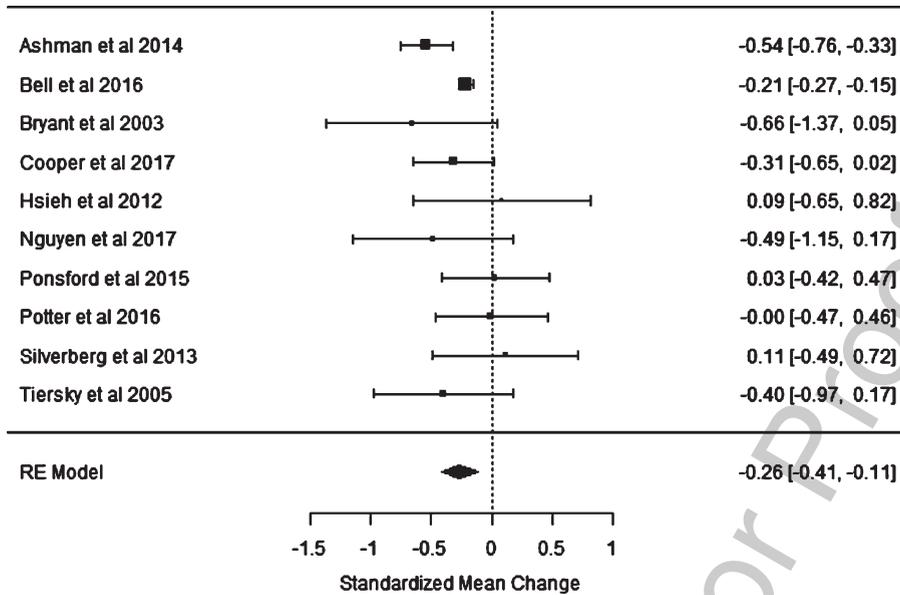


Fig. 2. Forest Plot of the Effect size (ES) and 95% Confidence Intervals (CIs) in the 10 Included Studies.

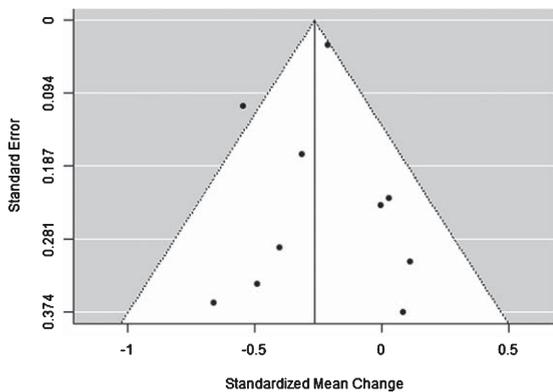


Fig.3. Funnel Plot to Assess for Publication Bias.

significant effect sizes; Ashman et al. (2014) and Bell et al. (2016). The CBT interventions utilised in these studies were delivered over the longest time periods (16 weeks and 24 weeks respectively). Bell et al. (2016) was the largest study in the meta-analysis which involved telephone interventions within a military sample. The 95% CIs of the remaining eight studies crossed the line of null effect, indicating that a null effect could have been a true effect. Many of the smaller studies had large CIs and were likely underpowered due to small samples.

3.3. Publication bias

To assess for publication bias, a funnel plot of the included studies was created (see Figure 3). An asymmetrical funnel plot would indicate the presence of publication bias. Visual inspection of the funnel plot revealed no obvious evidence of publication bias, given the relatively symmetrical pattern around the SMC. There was evidence of a wide distribution of effect sizes amongst the smaller studies, indicating that smaller studies with small or non-significant results have been published.

4. Discussion

The current meta-analysis synthesized the available controlled trials literature on the effectiveness

Q test of heterogeneity was completed and was found to be non-significant ($p = .09$), indicating that the combined estimate is a meaningful description of the included studies.

A further conservative analysis was conducted, excluding the studies which did not clearly identify using an ITT analysis (Potter et al., 2016; Tiersky et al., 2005). This resulted in a SMC of -0.27 (95% CI -0.45 to -0.10).

The forest plot demonstrated that the greatest effect size was found by Bryant et al. (2003), which compared CBT to supportive counselling. This study had a very small sample size and large CIs, which cross the line of null effect, therefore indicating a lack of precision and a non-statistically significant result. Two of the studies reported statistically

538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553

554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578

of CBT for reducing anxiety symptoms following TBI, and found a small, but significant effect size (SMC = -0.26). This finding suggests that following TBI, CBT interventions result in a small reduction in anxiety symptoms in comparison to control conditions, indicating that CBT is the mechanism for change, not just contact with clinicians. The overall effect size found in this meta-analysis falls within the confidence intervals of each included study. In addition, the confidence intervals of all studies overlap, indicating homogeneity and increased reliability of the finding.

The findings from the current meta-analysis are supported by Waldron, Casserly and O'Sullivan's (2013) meta-analysis, which was conducted within an ABI (not exclusively TBI) population. Waldron and colleagues reported effect sizes ranging from 0 to 0.42 when investigating the efficacy of CBT on reducing anxiety symptoms, with various focuses of the CBT intervention (e.g. social skills, coping, etc.). The average effect size was 0.17, which is similar to the small effect size reported in this meta-analysis. The overall effect size reported in this meta-analysis is smaller than the medium to large effect sizes that have been reported in non-TBI clinical populations. This could suggest that CBT is not as effective at reducing symptoms of anxiety within the TBI population; possibly due to the presence of cognitive impairment acting as a barrier to treatment effectiveness.

In comparison to pharmacological interventions, CBT has a negligible side effect profile (Schermuly-Haupt, Linden, & Rush, 2018), and was generally well tolerated across the studies, with 82% of participants who started CBT completing the intervention. The manualised nature of CBT meant that treatment fidelity was high, and it was feasible to administer widely across TBI populations. CBT is also considered to be a more cost-effective approach than pharmacological interventions alone, with costs of CBT offset by reduced access to healthcare (Myhr & Payne, 2006).

As with all meta-analyses, the overall effect size of the present meta-analysis appear to be driven by the larger studies. In this meta-analysis, studies by Ashman et al. (2014) and Bell et al. (2016) are the primary studies driving the effect size. Bell et al. (2016) was the largest study within this meta-analysis, with a sample of 356 military service personnel. Participants received 12 bi-weekly telephone calls, of either an education only intervention, or a CBT informed problem-solving therapy (PST). Post-treatment, the PST group significantly improved on the PCL-M

compared to the control group ($p = .04$, treatment difference 2.89). Results however were not maintained at a 6 month follow up. The authors consider whether these effects were specific to the PST intervention, or whether improved problem solving resulted in a generalised feeling of improved wellbeing. Additionally, potential qualitative differences within military samples, and compared to civilians, need to be taken into consideration.

Similarly, Bryant et al. (2003) found that receiving five sessions of CBT within two weeks of injury, resulted in significantly fewer instances of PTSD than supportive counselling (SC; 8% vs 58%). Although this finding could be explained by rapid early spontaneous recovery, which occurs shortly after TBI (Nudo, 2013). Additionally, in comparison to the SC group, the CBT group reported a significant reduction in anxiety ($p = .05$); however, these effects did not persist at the six-month follow up. It would be important for future research to include robust follow up periods to determine the maintenance effect of CBT interventions.

Ponsford et al. (2016) reported a significant improvement in anxiety in their study. The current meta-analysis did not identify a significant effect. It must be noted however that for this meta-analysis, to maximise consistency, data was extracted immediately pre and post-intervention (at 3 and 12 weeks). The positive effect size reported by Ponsford et al. (2016) was found at 21 weeks, following a booster session of CBT; the effect of which was not considered within this meta-analysis.

Within the study by Ashman and colleagues (2016) a third of participants met the diagnostic criteria for an anxiety disorder at baseline, which reduced to 20% post-intervention; this difference was not found to be statistically significant. This meta-analysis only used the trait scale of the STAI and found a statistically significant difference between the CBT and SPT groups. This suggests that there was significant reduction on the trait scale of the STAI, but this did not translate into a significant reduction in diagnosable anxiety disorders.

The distinction between a statistically significant effect size and a clinically significant reduction in anxiety symptoms needs to also be considered also. It is therefore important to question what an effect size of -0.26 would look like in terms of reduction of anxiety symptoms. Four out of the five studies that administered the HADS, did not report post-intervention scores that were below the clinical threshold (Hsieh et al., 2012; Ponsford et al., 2016;

Potter et al., 2016; Silverberg et al., 2013). The mean post-intervention score from Nguyen et al. (2017) was below the clinical threshold, however it was not above clinical threshold at pre intervention. This suggests that although reductions in HADS scores were identified, scores did not reduce to below clinical thresholds, and it is not known whether symptom reductions were clinically observable, or meaningful.

Whelan-Goodinson, Ponsford and Schönberger (2009) reported that within TBI populations, clinical thresholds of the HADS do not strongly correspond with clinical diagnoses of anxiety. The anxiety subscale had a sensitivity of 75% and a specificity of 69%. The authors recommend using a structured clinical interview, such as in the Diagnostic and Statistical Manual (DSM-5; American Psychiatric Association, 2013) to assess for anxiety post-TBI. Further research should therefore consider the validity of the anxiety measure utilised and use more comprehensive assessment measures.

It is worth noting that the current meta-analysis only looked at the reduction in anxiety symptoms using one anxiety outcome measure. Some of the included studies, where anxiety was a secondary outcome, did report significant changes in other areas. In the study by Silverberg et al. (2013) significantly fewer participants in the CBT group experienced symptoms of post-concussion syndrome (54% vs 91%). In the study by Nguyen et al. (2017) there was a significant improvement in sleep quality and reduction in fatigue for CBT group compared to TAU and Tiersky et al. (2005) reported reduced emotional distress for the CBT group. Hsieh et al. (2012) and Ponsford et al. (2016) both considered the effect of MI compared to NDC prior to the CBT intervention. The findings by Hsieh et al. (2012) demonstrated that MI and CBT resulted in a significantly greater reduction in anxiety than NDC and CBT, however Ponsford et al. (2016) did not find a significant difference.

4.1. Limitations

There were several limitations to the current meta-analysis. Firstly, it is important to note that this review was not prospectively registered, which would have allowed for valuable peer feedback on the quality of the review protocol. It was not possible to control for the variation in the severity of TBI, the location of damage and the time since injury within the sample. There was also variation in the severity of anxiety symptoms of the sample included; with some studies only including participants with a diagnosed

psychiatric disorder. However, the variation in TBI topography, and symptom profile, is reflective of the heterogeneous TBI population, and therefore difficult to control.

Additionally, due to the current lack of research into CBT interventions specifically targeting anxiety post-TBI, the current meta-analysis included a range of CBT interventions, which further increases the heterogeneity of the sample. In Waldron and colleagues' (2013) meta-analysis, when their CBT intervention was specifically targeting anxiety, larger effect sizes were reported (average effect size of 1.04). The authors concluded that CBT is more effective when aimed at a specific difficulty, and these specific improvements do not necessarily generalise to have a significant therapeutic effect on anxiety. It could however be argued, that CBT addresses anxiety, regardless of the primary focus, for example by targeting catastrophizing cognitions, automatic negative thoughts, or acting upon safety behaviours. Despite predicted heterogeneity within the sample, tests of heterogeneity were not significant.

Due to the small number of studies within this meta-analysis that included a follow up, it was not possible to conduct further meaningful analysis to consider the maintenance effect of CBT. It is important that future research considers the long-term effect of such interventions and whether improvements are maintained.

As with all meta-analyses, the risk of publication bias needs to be taken into consideration. There may be a tendency to publish statistically significant findings and not non-significant results (Zakzanis, 2001); which was coined by Rosenthal (1979) as the "file-drawer problem". Visual inspection of the forest plot produced in this meta-analysis suggested that there were a number of small studies reporting small and non-significant effect sizes; reducing the possibility that publication bias was present. It is possible that within TBI populations there is less chance of publication bias, due to general difficulties recruiting within this population.

Additionally, the interpretation of individual effect sizes must be considered carefully, as multiple factors can influence a given effect size; particularly different types of control conditions. For example, studies that compared CBT to a wait list control condition may be more likely to report a statistically significant effect size, compared to studies that used an alternative or comparable intervention. Within the current meta-analysis however, the studies with a non-significant effect size utilised a variety of control

785 groups, including both TAU/WLC and other forms
 786 of active intervention. Despite these limitations, the
 787 current meta-analysis has hopefully contributed to
 788 increasing our understanding of the role of CBT in the
 789 rehabilitation of patients who presents with anxiety
 790 after TBI.

791 Conclusion

792 Anxiety is highly prevalent, debilitating and nega-
 793 tively impacts rehabilitation and recovery following
 794 TBI. This is the first meta-analysis to consider the spe-
 795 cific question pertaining to the effect of using CBT
 796 informed interventions to reduce anxiety in the TBI
 797 population, by using evidence from RCTs. The results
 798 of this meta-analysis indicate that CBT results in a
 799 small, but potentially significant reduction in anxiety
 800 symptoms for individuals who have sustained a TBI.

801 This meta-analysis provides tentative support for
 802 the use of CBT to treat anxiety symptoms following
 803 TBI, also considering the easy to administer nature
 804 and negligible side effect profile of CBT, compared
 805 to stand-alone pharmacological interventions. It is
 806 however important that the clinical significance in
 807 addition to the statistical significance of the interven-
 808 tion is considered.

809 Future research with CBT specifically targeting
 810 anxiety in the TBI population needs to be conducted,
 811 in order to further determine its efficacy and allow
 812 increased homogeneity across studies. Additionally,
 813 in light of recent developments into other psycholog-
 814 ical interventions to treat anxiety post-TBI, including
 815 MBCT and ACT, further well-controlled research
 816 should continue investigating these alternatives to
 817 CBT, to determine the most efficacious and feasible
 818 psychological intervention in this population.

819 Acknowledgments

820 The authors are grateful for the encouragement and
 821 support they received from colleagues at the North
 822 Wales Brain Injury Service, and Bangor University
 823 during the project

824 Conflict of interest

825 This research paper was submitted in partial ful-
 826 filment of the requirements for a Doctorate Degree
 827 in Clinical Psychology (AL). None of the authors
 828 have any personal or financial affiliations with any

individuals or organisations that could influence
 the outcome of this meta-analysis. Accordingly, the
 authors report no conflict of interest.

References

- American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders DSM-5*. (5th Ed). Washington DC, American Psychiatric Association.
- Ashman, T., Cantor, J. B., Tsaousides, T., Spielman, L., & Gordon, W. (2014). Comparison of cognitive behavioral therapy and supportive psychotherapy for the treatment of depression following traumatic brain injury: a randomised controlled trial. *Journal of Head Trauma Rehabilitation*, 29(6), 467-478.
- Bandelow, B., Reitt, M., Röver, C., Michaelis, S., Görlich, Y., & Wedekind, D. (2015). Efficacy of treatments for anxiety disorders. *International Clinical Psychopharmacology*, 30(4), 183-192.
- Bedard, M., Felteau, M., Marshall, S., Dubois, S., Gibbons, C., Klein, R., & Weaver, B. (2012). Mindfulness-based cognitive therapy: benefits in reducing depression following a traumatic brain injury. *Advances in Mind-body Medicine*, 26(1), 14-20.
- Beck, J.G. (1995). *Cognitive Behavioural Therapy: Basics and Beyond*. Guildford Press, New York: USA.
- Beck, A. (1998). The Past and Future of Cognitive Behavioural Therapy. *The Journal of Psychotherapy Practice and Research*, 6, 276 - 284.
- Beck, A. T., Epstein, N., Brown, G., & Steer, R. A. (1988). An inventory for measuring clinical anxiety: psychometric properties. *Journal of Consulting and Clinical Psychology*, 56(6), 893-897.
- Bell, K. R., Fann J. R., Brockway, J. A., Cole, W. R., Bush, N. E., Dikmen, S., ... Temkin, N. (2016). Telephone problem solving for service members with mild traumatic brain injury: a randomized, clinical trial. *Journal of Neurotrauma*, 34(2), 313-321.
- Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2010). A basic introduction to fixed-effect and random-effects models for meta-analysis. *Research Synthesis Methods*, 1(2), 97-111.
- Bryant, R. A., Moulds, M., Guthrie, R., & Nixon, R. D. (2003). Treating acute stress disorder following mild traumatic brain injury. *American Journal of Psychiatry*, 160(3), 585-587.
- Bryant, R. A., Creamer, M., O'Donnell, M., Silove, D., Clark, C. R., McFarlane, A. C. (2009) Post-traumatic amnesia and the nature of post-traumatic stress disorder after mild traumatic brain injury. *J Int Neuropsychol Soc*, 15(6), 862-867.
- Bryant, R. A., O'Donnell, M. L., Creamer, M., McFarlane, A. C., Clark, C. R. & Silove, D. (2010). The psychiatric sequelae of traumatic injury. *American Journal of Psychiatry*, 167, 312-320.
- Byrne, C., Coetzer, R., & Addy, K. (2017). Investigating the discrepancy between subjective and objective cognitive impairment following acquired brain injury: The role of psychological affect. *NeuroRehabilitation*, 41(2), 501-512.
- Carpenter, J. K., Andrews, L. A., Witcraft, S. M., Powers, M. B., Smits, J. A. J., & Hofmann, S. G. (2018). Cognitive behavioral therapy for anxiety and related disorders: A meta-analysis of randomized placebo-controlled trials. *Depression and Anxiety*, 35(6), 502-514.

- 887 Coetzer, R. (2010). *Anxiety and mood disorders following traumatic brain injury: clinical assessment and psychotherapy*.
888 Karnac Books, London, UK. 948
- 889
890 Coetzer, B. R. (2004). Obsessive-Compulsive Disorder following
891 Brain Injury: A Review. *The International Journal of Psychi-*
892 *atry in Medicine*, 34(4), 363–377. 949
- 893 Cohen, J. (1988). *Statistical power analysis for the behavioral*
894 *sciences*. 2nd. Hillsdale, NJ: Erlbaum. 950
- 895 Cooper, D. B., Bowles, A. O., Kennedy, J. E., Curtiss, G., French, L.
896 M., Tate, D. F., & Vanderploeg, R. D. (2017). Cognitive rehabi-
897 litation for military service members with mild traumatic brain
898 injury: A randomized clinical trial. *Journal of Head Trauma*
899 *Rehabilitation*, 32(3), E1-E15. 951
- 900 Deacon, B. J., & Abramowitz, J. S. (2004). Cognitive and
901 behavioral treatments for anxiety disorders: A review of
902 meta-analytic findings. *Journal of Clinical Psychology*, 60(4),
903 429-441. 952
- 904 Deb, S., Lyons, I., Koutzoukis, C., Ali, I., & McCarthy, G. (1999).
905 Rate of psychiatric illness 1 year after traumatic brain injury.
906 *American Journal of Psychiatry*, 156(3), 374-378. 953
- 907 Derogatis, L. (1994). *Administration, scoring and procedures man-*
908 *ual for the SCL-90-R; symptom checklist-90-R*. Minneapolis,
909 Minn: National Computer Systems. 954
- 910 Doering, B., & Exner, C. (2011). Combining neuropsychological
911 and cognitive-behavioral approaches for treating psychological
912 sequelae of acquired brain injury. *Current Opinion in Psychi-*
913 *atry*, 24, 156-161. 955
- 914 Fann, J. R., Katon, W. J., Uomoto, J. M., & Esselman, P. C. (1995).
915 Psychiatric disorders and functional disability in outpatients
916 with traumatic brain injuries. *American Journal of Psychiatry*,
917 152(10), 1492-1499. 956
- 918 Fleminger, S., & Ponsford, J. (2005). Long term outcome after tra-
919 matic brain injury. *BMJ (Clinical Research ed.)*, 331(7530),
920 1419–1420. 957
- 921 Gainotti, G. (1993). Emotional and psychosocial problems
922 after brain injury. *Neuropsychological Rehabilitation*, 3,
923 259-277. 958
- 924 Gallagher, M., McLeod, H. J., & McMillan, T. M. (2016). A
925 systematic review of recommended modifications of CBT for
926 people with cognitive impairments following brain injury. *Neu-*
927 *ropsychological Rehabilitation*, (1), 1-21. 959
- 928 Gordon, W. A., Sliwinski, M., Echo, J., McLoughlin, M., Sheerer,
929 M. S., & Meili, T. E. (1998). The benefit of exercise in individ-
930 uals with traumatic brain injury: a retrospective study. *Journal*
931 *of Head Trauma Rehabilitation*, 13(4), 58-67. 960
- 932 Gould, K. R., Ponsford, J. L., Johnston, L. & Schonberger, M.
933 (2011). The nature, frequency and course of psychiatric disor-
934 ders in the first year after traumatic brain injury: a prospective
935 study. *Psychological Medicine*, 41, 2099-2109. 961
- 936 Headway. (2015). Acquired Brain Injury: The num-
937 bers behind the hidden disability. Retrieved from
938 [https://www.headway.org.uk/media/2883/acquired-brain-](https://www.headway.org.uk/media/2883/acquired-brain-injury-the-numbers-behind-the-hidden-disability.pdf)
939 [injury-the-numbers-behind-the-hidden-disability.pdf](https://www.headway.org.uk/media/2883/acquired-brain-injury-the-numbers-behind-the-hidden-disability.pdf). 962
- 940 Helffenstein, D. A., & Wechsler, F. S. (1982). The use of interper-
941 sonal process recall (IPR) in the remediation of interpersonal
942 and communication skill deficits in the newly brain-injured.
943 *Clinical Neuropsychology*, 4(3), 139-142. 963
- 944 Hibbard, M. R., Uysal, S., Kepler, K., Bogdany, J., & Silver, J.
945 (1998). Axis I Psychopathology in Individuals with Traumatic
946 Brain Injury. *Journal of Head Trauma Rehabilitation*, 13(4),
947 24-39. 964
- Hiott, D. W., & Labbate, L. (2002). Anxiety disorders associated
with traumatic brain injuries. *Neurorehabilitation*, 17(4), 345-
355. 949
- Hodgson, J., McDonald, S., Tate, R., & Gertler, P. (2005). A ran-
domised controlled trial of a cognitive-behavioural therapy
programme for managing social anxiety after acquired brain
injury. *Brain Impairment*, 6(3), 169-180. 951
- Hoffman, S. G., Asnaani, A., Vonk, I. J., Sawyer, A. T., & Fang,
A. (2012). The efficacy of cognitive behavioural therapy: a
review of meta-analyses. *Cognitive Therapy and Research*, 36,
427-440. 952
- Hsieh, M., Ponsford, J., Wong, D., Schönberger, M., Taffe, J.,
& McKay, A. (2012). Motivational interviewing and cogni-
tive behaviour therapy for anxiety following traumatic brain
injury: a pilot randomised controlled trial. *Neuropsychological*
Rehabilitation, 22(4), 585-608. 953
- Hyder, A. A., Wunderlich, C. A., Puvanachandra, P., Gururaj, G.,
& Kobusingye, O. C. (2007). The impact of traumatic brain
injuries: a global perspective. *NeuroRehabilitation*, 22, 341-
353. 954
- Kangas, M., & McDonald, S. (2011). Is it time to act? The poten-
tial of acceptance and commitment therapy for psychological
problems following acquired brain injury. *Neuropsychological*
Rehabilitation, 21(2), 250-276. 955
- Kendall, E., & Terry, D.J. (1996). Psychosocial adjustment follow-
ing closed head injury. *Neuropsychological Rehabilitation*, 6,
101-132. 956
- Koponen, S., Taiminen, T., Portin, R., Himanen, L., Isoniemi, H.,
Heinonen, H., ... Tenovou, O. (2002). Axis I and II psychi-
atric disorders after traumatic brain injury: A 30-year follow-up
study. *The American Journal of Psychiatry*, 159(8), 1315-1321. 957
- Lishman, W. A. (1973). The psychiatric sequelae of head injury: a
review. *Psychological Medicine*, 3, 304-318. 958
- McAllister, T. W. (2008). Neurobehavioral sequelae of traumatic
brain injury: evaluation and management. *World Psychiatry*, 7,
3-10. 959
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009).
Preferred reporting items for systematic reviews and meta-
analyses: The PRISMA statement. *PLoS Med*, 6(7): e1000097. 960
- Murrough, J. W., Yaqubi, S., Sayed, S., & Charney, D. S. (2015).
Emerging drugs for the treatment of anxiety. *Expert Opinion*
on Emerging Drugs, 20(3), 393-406. 961
- Myhr, G., & Payne, K. (2006). Cost-effectiveness of cognitive-
behavioural therapy for mental disorders: implications for
public health care funding policy in Canada. *The Canadian*
Journal of Psychiatry, 51(10), 662-670. 962
- National Institute for Health and Care Excellence (NICE)
(2011). NICE Guidelines (CG123). Common mental
health problems: identification and pathways to care.
<https://www.nice.org.uk/guidance/cg123/> 963
- Nguyen, S., McKay, A., Wong, D., Rajaratnam, S. M., Spitz, S.,
Williams, G., ... Ponsford, J. L. (2017). Cognitive behavior
therapy to treat sleep disturbance and fatigue following tra-
umatic brain injury: a pilot randomised controlled trial. *Archives*
of Physical Medicine and Rehabilitation, 98(8), 1508-1517. 964
- Norton, P. J., & Price, E. C. (2007). Meta-analytic review of adult
cognitive-behavioral treatment outcomes across the anxiety
disorders. *The Journal of Nervous and Mental Disease*, 195(6),
521-531. 965
- Nudo, R. J. (2013). Recovery after brain injury: mechanisms and
principles. *Frontiers in Human Neuroscience*, 7(887), 1-14. 966

- 1009 Perna, R. B., Bordini, E. J., & Newman, S. A. (2001). Pharmacological treatment considerations in brain injury. *Journal of Cognitive Rehabilitation*, 19(1), 4-7. 1071
- 1010 1072
- 1011 1073
- 1012 Ponsford, J., Lee, N. K., Wong, D., McKay, A., Haines, K., Always, Y., ... O'Donnell, M. L. (2016). Efficacy of motivational interviewing and cognitive behavioural therapy for anxiety and depression symptoms following traumatic brain injury. *Psychological Medicine*, 46, 1079-1090. 1074
- 1013 1075
- 1014 1076
- 1015 1077
- 1016 1078
- 1017 Potter, S. D., Brown, R. G., & Fleminger, S. (2016). Randomised, waiting list controlled trial of cognitive-behavioural therapy for persistent postconcussional symptoms after predominantly mild-moderate traumatic brain injury. *Journal of Neurology, Neurosurgery and Psychiatry*, 87, 1075-1083. 1079
- 1018 1080
- 1019 1081
- 1020 1082
- 1021 1083
- 1022 R Core Team (2018). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org/> 1084
- 1023 1085
- 1024 1086
- 1025 1087
- 1026 1088
- 1027 1089
- 1028 1090
- 1029 1091
- 1030 Reichow, B. (2011). Development, procedures, and application of the evaluative method for determining evidence-based practices in autism. *Evidence-Based Practices and Treatments for Children with Autism* (pp. 25-39) Springer. 1092
- 1031 1093
- 1032 1094
- 1033 1095
- 1034 1096
- 1035 1097
- 1036 1098
- 1037 1099
- 1038 1100
- 1039 1101
- 1040 1102
- 1041 1103
- 1042 1104
- 1043 1105
- 1044 1106
- 1045 1107
- 1046 1108
- 1047 1109
- 1048 1110
- 1049 1111
- 1050 1112
- 1051 1113
- 1052 1114
- 1053 1115
- 1054 1116
- 1055 1117
- 1056 1118
- 1057 1119
- 1058 1120
- 1059 1121
- 1060 1122
- 1061 1123
- 1062 1124
- 1063 1125
- 1064 1126
- 1065 1127
- 1066 1128
- 1067 1129
- 1068 1130
- 1069 1131
- 1070 1132
- 1133
- 1134
- 1135
- 1136
- 1137
- 1138
- 1139
- 1140
- 1141
- 1142
- 1143
- 1144
- 1145
- 1146
- 1147
- 1148
- 1149
- 1150
- 1151
- 1152
- 1153
- 1154
- 1155
- 1156
- 1157
- 1158
- 1159
- 1160
- 1161
- 1162
- 1163
- 1164
- 1165
- 1166
- 1167
- 1168
- 1169
- 1170
- 1171
- 1172
- 1173
- 1174
- 1175
- 1176
- 1177
- 1178
- 1179
- 1180
- 1181
- 1182
- 1183
- 1184
- 1185
- 1186
- 1187
- 1188
- 1189
- 1190
- 1191
- 1192
- 1193
- 1194
- 1195
- 1196
- 1197
- 1198
- 1199
- 1200
- 1201
- 1202
- 1203
- 1204
- 1205
- 1206
- 1207
- 1208
- 1209
- 1210
- 1211
- 1212
- 1213
- 1214
- 1215
- 1216
- 1217
- 1218
- 1219
- 1220
- 1221
- 1222
- 1223
- 1224
- 1225
- 1226
- 1227
- 1228
- 1229
- 1230
- 1231
- 1232
- 1233
- 1234
- 1235
- 1236
- 1237
- 1238
- 1239
- 1240
- 1241
- 1242
- 1243
- 1244
- 1245
- 1246
- 1247
- 1248
- 1249
- 1250
- 1251
- 1252
- 1253
- 1254
- 1255
- 1256
- 1257
- 1258
- 1259
- 1260
- 1261
- 1262
- 1263
- 1264
- 1265
- 1266
- 1267
- 1268
- 1269
- 1270
- 1271
- 1272
- 1273
- 1274
- 1275
- 1276
- 1277
- 1278
- 1279
- 1280
- 1281
- 1282
- 1283
- 1284
- 1285
- 1286
- 1287
- 1288
- 1289
- 1290
- 1291
- 1292
- 1293
- 1294
- 1295
- 1296
- 1297
- 1298
- 1299
- 1300
- 1301
- 1302
- 1303
- 1304
- 1305
- 1306
- 1307
- 1308
- 1309
- 1310
- 1311
- 1312
- 1313
- 1314
- 1315
- 1316
- 1317
- 1318
- 1319
- 1320
- 1321
- 1322
- 1323
- 1324
- 1325
- 1326
- 1327
- 1328
- 1329
- 1330
- 1331
- 1332
- 1333
- 1334
- 1335
- 1336
- 1337
- 1338
- 1339
- 1340
- 1341
- 1342
- 1343
- 1344
- 1345
- 1346
- 1347
- 1348
- 1349
- 1350
- 1351
- 1352
- 1353
- 1354
- 1355
- 1356
- 1357
- 1358
- 1359
- 1360
- 1361
- 1362
- 1363
- 1364
- 1365
- 1366
- 1367
- 1368
- 1369
- 1370
- 1371
- 1372
- 1373
- 1374
- 1375
- 1376
- 1377
- 1378
- 1379
- 1380
- 1381
- 1382
- 1383
- 1384
- 1385
- 1386
- 1387
- 1388
- 1389
- 1390
- 1391
- 1392
- 1393
- 1394
- 1395
- 1396
- 1397
- 1398
- 1399
- 1400
- 1401
- 1402
- 1403
- 1404
- 1405
- 1406
- 1407
- 1408
- 1409
- 1410
- 1411
- 1412
- 1413
- 1414
- 1415
- 1416
- 1417
- 1418
- 1419
- 1420
- 1421
- 1422
- 1423
- 1424
- 1425
- 1426
- 1427
- 1428
- 1429
- 1430
- 1431
- 1432
- 1433
- 1434
- 1435
- 1436
- 1437
- 1438
- 1439
- 1440
- 1441
- 1442
- 1443
- 1444
- 1445
- 1446
- 1447
- 1448
- 1449
- 1450
- 1451
- 1452
- 1453
- 1454
- 1455
- 1456
- 1457
- 1458
- 1459
- 1460
- 1461
- 1462
- 1463
- 1464
- 1465
- 1466
- 1467
- 1468
- 1469
- 1470
- 1471
- 1472
- 1473
- 1474
- 1475
- 1476
- 1477
- 1478
- 1479
- 1480
- 1481
- 1482
- 1483
- 1484
- 1485
- 1486
- 1487
- 1488
- 1489
- 1490
- 1491
- 1492
- 1493
- 1494
- 1495
- 1496
- 1497
- 1498
- 1499
- 1500
- 1501
- 1502
- 1503
- 1504
- 1505
- 1506
- 1507
- 1508
- 1509
- 1510
- 1511
- 1512
- 1513
- 1514
- 1515
- 1516
- 1517
- 1518
- 1519
- 1520
- 1521
- 1522
- 1523
- 1524
- 1525
- 1526
- 1527
- 1528
- 1529
- 1530
- 1531
- 1532
- 1533
- 1534
- 1535
- 1536
- 1537
- 1538
- 1539
- 1540
- 1541
- 1542
- 1543
- 1544
- 1545
- 1546
- 1547
- 1548
- 1549
- 1550
- 1551
- 1552
- 1553
- 1554
- 1555
- 1556
- 1557
- 1558
- 1559
- 1560
- 1561
- 1562
- 1563
- 1564
- 1565
- 1566
- 1567
- 1568
- 1569
- 1570
- 1571
- 1572
- 1573
- 1574
- 1575
- 1576
- 1577
- 1578
- 1579
- 1580
- 1581
- 1582
- 1583
- 1584
- 1585
- 1586
- 1587
- 1588
- 1589
- 1590
- 1591
- 1592
- 1593
- 1594
- 1595
- 1596
- 1597
- 1598
- 1599
- 1600
- 1601
- 1602
- 1603
- 1604
- 1605
- 1606
- 1607
- 1608
- 1609
- 1610
- 1611
- 1612
- 1613
- 1614
- 1615
- 1616
- 1617
- 1618
- 1619
- 1620
- 1621
- 1622
- 1623
- 1624
- 1625
- 1626
- 1627
- 1628
- 1629
- 1630
- 1631
- 1632
- 1633
- 1634
- 1635
- 1636
- 1637
- 1638
- 1639
- 1640
- 1641
- 1642
- 1643
- 1644
- 1645
- 1646
- 1647
- 1648
- 1649
- 1650
- 1651
- 1652
- 1653
- 1654
- 1655
- 1656
- 1657
- 1658
- 1659
- 1660
- 1661
- 1662
- 1663
- 1664
- 1665
- 1666
- 1667
- 1668
- 1669
- 1670
- 1671
- 1672
- 1673
- 1674
- 1675
- 1676
- 1677
- 1678
- 1679
- 1680
- 1681
- 1682
- 1683
- 1684
- 1685
- 1686
- 1687
- 1688
- 1689
- 1690
- 1691
- 1692
- 1693
- 1694
- 1695
- 1696
- 1697
- 1698
- 1699
- 1700
- 1701
- 1702
- 1703
- 1704
- 1705
- 1706
- 1707
- 1708
- 1709
- 1710
- 1711
- 1712
- 1713
- 1714
- 1715
- 1716
- 1717
- 1718
- 1719
- 1720
- 1721
- 1722
- 1723
- 1724
- 1725
- 1726
- 1727
- 1728
- 1729
- 1730
- 1731
- 1732
- 1733
- 1734
- 1735
- 1736
- 1737
- 1738
- 1739
- 1740
- 1741
- 1742
- 1743
- 1744
- 1745
- 1746
- 1747
- 1748
- 1749
- 1750
- 1751
- 1752
- 1753
- 1754
- 1755
- 1756
- 1757
- 1758
- 1759
- 1760
- 1761
- 1762
- 1763
- 1764
- 1765
- 1766
- 1767
- 1768
- 1769
- 1770
- 1771
- 1772
- 1773
- 1774
- 1775
- 1776
- 1777
- 1778
- 1779
- 1780
- 1781
- 1782
- 1783
- 1784
- 1785
- 1786
- 1787
- 1788
- 1789
- 1790
- 1791
- 1792
- 1793
- 1794
- 1795
- 1796
- 1797
- 1798
- 1799
- 1800
- 1801
- 1802
- 1803
- 1804
- 1805
- 1806
- 1807
- 1808
- 1809
- 1810
- 1811
- 1812
- 1813
- 1814
- 1815
- 1816
- 1817
- 1818
- 1819
- 1820
- 1821
- 1822
- 1823
- 1824
- 1825
- 1826
- 1827
- 1828
- 1829
- 1830
- 1831
- 1832
- 1833
- 1834
- 1835
- 1836
- 1837
- 1838
- 1839
- 1840
- 1841
- 1842
- 1843
- 1844
- 1845
- 1846
- 1847
- 1848
- 1849
- 1850
- 1851
- 1852
- 1853
- 1854
- 1855
- 1856
- 1857
- 1858
- 1859
- 1860
- 1861
- 1862
- 1863
- 1864
- 1865
- 1866
- 1867
- 1868
- 1869
- 1870
- 1871
- 1872
- 1873
- 1874
- 1875
- 1876
- 1877
- 1878
- 1879
- 1880
- 1881
- 1882
- 1883
- 1884
- 1885
- 1886
- 1887
- 1888
- 1889
- 1890
- 1891
- 1892
- 1893
- 1894
- 1895
- 1896
- 1897
- 1898
- 1899
- 1900
- 1901
- 1902
- 1903
- 1904
- 1905
- 1906
- 1907
- 1908
- 1909
- 1910
- 1911
- 1912
- 1913
- 1914
- 1915
- 1916
- 1917
- 1918
- 1919
- 1920
- 1921
- 1922
- 1923
- 1924
- 1925
- 1926
- 1927
- 1928
- 1929
- 1930
- 1931
- 1932
- 1933
- 1934
- 1935
- 1936
- 1937
- 1938
- 1939
- 1940
- 1941
- 1942
- 1943
- 1944
- 1945
- 1946
- 1947
- 1948
- 1949
- 1950
- 1951
- 1952
- 1953
- 1954
- 1955
- 1956
- 1957
- 1958
- 1959
- 1960
- 1961
- 1962
- 1963
- 1964
- 1965
- 1966
- 1967
- 1968
- 1969
- 1970
- 1971
- 1972
- 1973
- 1974
- 1975
- 1976
- 1977
- 1978
- 1979
- 1980
- 1981
- 1982
- 1983
- 1984
- 1985
- 1986
- 1987
- 1988
- 1989
- 1990
- 1991
- 1992
- 1993
- 1994
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000