Mindfulness, neurobehavioural functioning and sleep

by

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A thesis submitted to the University of Birmingham for the degree of

Doctor of Clinical Psychology

VOLUME I

Research Component

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June 2015

Overview

This thesis is submitted in partial fulfilment of the requirements for the degree of Doctor of Clinical Psychology (Clin. Psy. D) at the University of Birmingham. The thesis consists of two volumes.

Volume I

Volume I consists of three parts. The first part presents a systematic review exploring the effects of mindfulness based stress reduction on sleep disturbance. Second part presents an empirical paper focused on the relationship between the changes in mindfulness and changes in neurobehavioural functioning among people with acquired brain injury attending a mindfulness group. The third part is an executive summary of the systematic review and the research study.

Volume II

Volume II consists of five clinical practice reports. The first report presents cognitive-behavioural and systematic formulation of problems presented by a client with mild learning difficulty and autism. The second report presents a single case study describing results of a behavioural intervention with a lady with severe learning disability who had a problem with tooth-brushing. The third report presents a service evaluation of a dialectical behaviour service for clients with borderline personality disorder. The forth report is a case study of an intervention provided for a 18 years old young lady with low self-esteem. The last chapter is an abstract of an orally presented clinical practice leadership and consultancy report. It describes an initiative to improve access to psychological therapies for people with acquired brain injury on the local level.

Acknowledgements

I would like to thank both my supervisors Dr. Theresa Powell and Dr. Sue Wright for their patience, advice, support and practical help over the last two years. Knowing that I can turn to them helped me to stay focused and complete my work.

Also a big thank you to the clients from the brain injury rehabilitation centre who chose to participate in the study, even though it meant giving up some of their personal time.

I would also like to thank Peter and the rest of our family for putting up with me and supporting me all the way through the course.

CONTENTS

Volume I: Mindfulness, neurobehavioural functioning and sleep

Volume 1: Appendices

Research paper

Volume 1: Tables

Systematic review

Research Paper

Volume 1: Figures

Systematic review

CONTENTS

Volume II: CLINICAL PRACTICE REPORTS

Clinical Practice Report 1: Psychological Models

Assessment and formulation of psychological problems of Alan from cognitive-behavioural and systematic perspective

Clinical Practice Report 2: Single Case Experimental Design

The case of Beth, a lady with moderate to severe learning disability and autism, who presented with tooth brushing avoidance.

Clinical Practice Report 3: Service Evaluation

Evaluation of a Dialectical Behaviour Therapy Service using clients' perspective and IT audit data

Clinical Practice Report 4: Case Study

18 year old Parveen with low self esteem

Clinical Practice Report 5: Leadership and Consultancy

An initiative to improve access to psychological therapies for people with Acquired brain Injury

Volume 2: Appendices

Clinical Practice Report 1: Psychological Models

Clinical Practice Report 2: Single Case Experimental Design

Clinical Practice Report 3: Service Evaluation

Clinical Practice Report 4: Case Study

Volume 2: Tables

Clinical Practice Report 2: Single Case Experimental Design

Clinical Practice Report 3: Service Evaluation

Clinical Practice Report 4: Case Study

Volume 2: Figures

Clinical Practice Report 1: Psychological Models

Clinical Practice Report 2: Single Case Experimental Design

Clinical Practice Report 3: Service Evaluation

Clinical Practice Report 4: Case Study

Literature review

The effects of Mindfulness-based stress reduction on sleep disturbance:

A systematic review

Abstract

Introduction

Insomnia and sleep disturbance are common problems, which can have a profound impact on health and quality of life. Eight years ago Winbush, Gross and Kreitzer published a systematic review exploring the effects of mindfulness-based stress reduction (MBSR) on sleep disturbance reviewing seven studies, with only one of them a randomised control trial (Winbush, Gross, & Kreitzer, 2007). In view of a recent increase in the popularity of mindfulness interventions and growing volume of research, the aim of present study was to explore the evidence available in this area using randomised control trials published since the previous review.

Methods

The following databases were searched: CINAHL, PsycINFO, MEDLINE and Embase using criteria based on those defined by the original paper. The inclusion criteria covered: randomised control trials using MBSR programme or similar, studies using objective and/or subjective sleep outcome measures with adult population and published as full papers. A modified version of Delphi list of criteria (Verhagen et al., 1998) was used to assess quality of the papers.

Results

Initially, 181 articles were identified for review and 19 of them met the inclusion criteria. Quality of the papers varied, most of the papers achieved ranking five or more (out of eight) on the defined quality scale. Studies were divided into five groups according to the

conditions targeted by the mindfulness intervention: primary insomnia, cancer, emotional problems, long term physical health issues and stress related to workplace or caring duties. The results of the analysis did not bring clear conclusions regarding the effectiveness of MBSR for sleep disturbance. Recommendations for future studies include: use of both objective and subjective measures, inclusion of measures of mindfulness and mindfulness practice, better consistency in reporting of the results.

Introduction

Insomnia and sleep disturbance are common health concerns which significantly influence quality of life. The term insomnia covers problems with: falling asleep, staying asleep, early waking and significant daytime consequences resulting from poor sleep (American Psychiatric Association, 2013). The reported prevalence of insomnia varies depending on the symptoms measured. Whilst in the USA 6%-20% of the population suffer such difficulties (Ohayon, 2002), the reported prevalence for UK is 37% (Morphy, Dunn, Lewis, Boardman, & Croft, 2007). The links between sleep problems, stress and mental health have been well established in the past (Hall et al., 2000). They show sleep disturbance not only as a symptom, but also as a vulnerability factor for poor wellbeing (Pigeon et al., 2008).

Training in mindfulness skills has become a popular alternative approach to traditional pharmacological treatments addressing stress and various aspects of mental health by promoting mind-body awareness, calmness and relaxation (Ludwig & Kabat-Zinn, 2008). According to the literature, mindfulness is "the awareness that emerges through paying attention non-judgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2003, p. 145). It is rooted in the Buddhist tradition of meditation. One of the first protocol-based intervention programmes developed on these principles, was the Mindfulness Based Stress Reduction Programme (MBSR) originally designed for the management of stress and pain caused by chronic health conditions (Kabat-Zinn, 2013). This is a group intervention lasting 8 weeks, consisting of weekly 150 minutes long sessions with one extra full day weekend retreat. Participants are encouraged to practice the newly learned skills at home (up to 45 minutes daily) (Kabat-Zinn, 2013).

Another therapy, which was inspired by Mindfulness, is Mindfulness Based Cognitive Therapy (MBCT). In this adaptation of MBSR, the combination of the mindfulness skills with a cognitive behavioural approach helps clients to become more aware of their thoughts non-judgementally and encourages them to observe the thoughts rather than accept them as facts (Kuyken et al., 2008; Teasdale et al., 2000). The format of MBCT is the same as the MBSR. MBCT was primarily developed to help in the prevention of relapse in depression. It is hypothesised, that by teaching clients to observe rather than engage with their worries and ruminations, mindfulness is helpful for the process of "cognitive deactivation" necessary to fall asleep (Lundh, 2005).

In 2007, Winbush, Gross and Kreitzer conducted a systematic review of the effects of mindfulness-based stress reduction on sleep disturbance (Winbush et al., 2007). Their work covered seven studies (4 uncontrolled trials, 2 controlled trials and 1 randomized controlled trial (RCT)). Due to the differences between the uncontrolled and controlled trials where significant improvements were found only in uncontrolled studies, they concluded: "the value of practicing MBSR to overcome sleep disturbances remains unresolved "(Winbush et al., 2007, p. 586). Over the past 8 years, the number of published RCTs in this area grew rapidly. Therefore, the aim of the present study is to explore the evidence available in this area using recently published RCTs since the previous review by Winbush et al. (2007). In addition to one RCT, which was also used in the original study (Shapiro, Bootzin, Figueredo, Lopez, & Schwartz, 2003), the presented review covers 18 new RCTs published between 2007 and 2014.

In keeping with the original review paper by Winbush et al. (2007), in the following text, the term sleep disturbance refers to a combination of biologic, cognitive and behavioural factors which contribute to sleep complaints.

Method

Database selection

The literature search consisted of two main components i.e. “mindfulness” and “sleep” which were linked using AND. As the presented review aspires to document the recent developments in the area previously reviewed by Winbush et al (2007), the specific terms used for the search were directly taken from the original study and they included: “mindfulness based stress reduction, meditation, mindfulness” (for the “mindfulness” component); and ”sleep or insomnia” (for the “sleep” component) . In order to ensure all relevant studies would be covered, the mindfulness component contained an additional term “mind-body relaxation techniques”; and the sleep component also contained terms: “sleep problems” and “hypersomnia”. The following databases were searched: CINAHL (1937 - 2014), PsycINFO (1967 - 2014), MEDLINE (1946 – 2014) and Embase (1974 – 2014). Also, as the initial screenings suggested that the number of RCTs has rapidly increased since the Winbush study done in 2007, the present selection was limited to RCTs only. Inclusion criteria are summarised in Table 1.

Table 1: *Inclusion criteria as they were defined for the review*

1. RCTs that employed MBSR or treatment closely following the MBSR programme (e.g. MBCT) for a prolonged period of time (at least 6 weeks). Exposure (exposure to painful sensations, emotional experiences and thoughts, when meditation students are encouraged not to shift position, but instead focus careful attention directly on the sensation or emotion) is considered one of the core mechanisms explaining how mindfulness skills may lead to reduction of symptoms (Baer, 2003), therefore it is important to compare studies, which have similar timescales.
2. Studies which used subjective and/or objective measures of sleep or sleep quality
3. Studies with an adult population.
4. Full papers published in peer-reviewed journals (conference abstracts were excluded due to lack of availability of sufficient detail for review).

Following this criteria, studies' titles which resulted from the database search were filtered to remove: all duplicates; irrelevant titles; and studies with child / youth / adolescent / teenage population. Then, the abstracts were searched to check if the inclusion criteria were satisfied (see Figure 1).

Quality framework

In order to assess the quality of the reviewed studies, the Delphi list of criteria for quality assessment of RCTs (Verhagen et al., 1998) was used and adapted with additional criteria specific to the present review.

The original final Delphi list contains 9 questions, some of which would not be relevant for the review, due to the nature of the research it covers. The questions concerned include: 1b) "Was the treatment allocation concealed?"; 5.) "Was the care provider

blinded?"; and 6) "Were the patients blinded?". The latter was excluded because it is not possible to conceal allocation to treatment or blind the patients or caregivers when clients are allocated to groups providing different interventions and the answer would be always "no". Also, due to the accepted standards of scientific reporting, the answer to question 7) "Were point estimates and measures of variability presented for the primary outcome measures?" would always be "yes", therefore, this question was also omitted from the final quality criteria. The very first question of the criteria: "Was a method of randomisation performed?" would provide only the "yes" answers because the review only includes RCTs. Therefore it was modified to: "Was a method of randomisation performed after the baseline measurements?", because given that allocation cannot be concealed from the participants, their knowledge of the treatment group may have an effect on their baseline measures (Shapiro et al., 2003).

As mentioned earlier, the MBSR programme is an active intervention. In order to assess whether the results point to the effectiveness of MBSR or just an interaction with the facilitator, it is important to know whether the results of the MBSR group are compared to results obtained for an active and facilitated group or a waiting list. Another quality factor added to the original criteria was the use of a mindfulness measure. Using a mindfulness measure contributes to better understanding of whether the mindfulness component of the MBSR programme had an impact on the results. The home practice (recommended dose is up to 40 minutes twice weekly) is a major factor influencing the development of mindfulness skills in MBSR (Kabat Zinn, 1999). Therefore, the following criteria were added to the quality framework: "Active control condition included?", "Mindfulness measure included?" and "Mindfulness practice monitored?".The final list of the Quality criteria can be found in Table 2.

Table 2: *List of quality criteria used in the study*

Question
1. Was a method of randomisation preformed after baseline measurements?
2. Were the groups similar at baseline regarding the most important prognostic indicators?
3. Were the eligibility criteria specified?
4. Was the outcome assessor blinded?
5. Did the analysis include the intention – to – treat analysis?
6. Was an active control condition included?
7. Was a Mindfulness measure used?
8. Was Mindfulness practice monitored?

Results

Study selection

181 references were found in all the databases and after filtering, 19 papers met the inclusion criteria (see Figure 1).

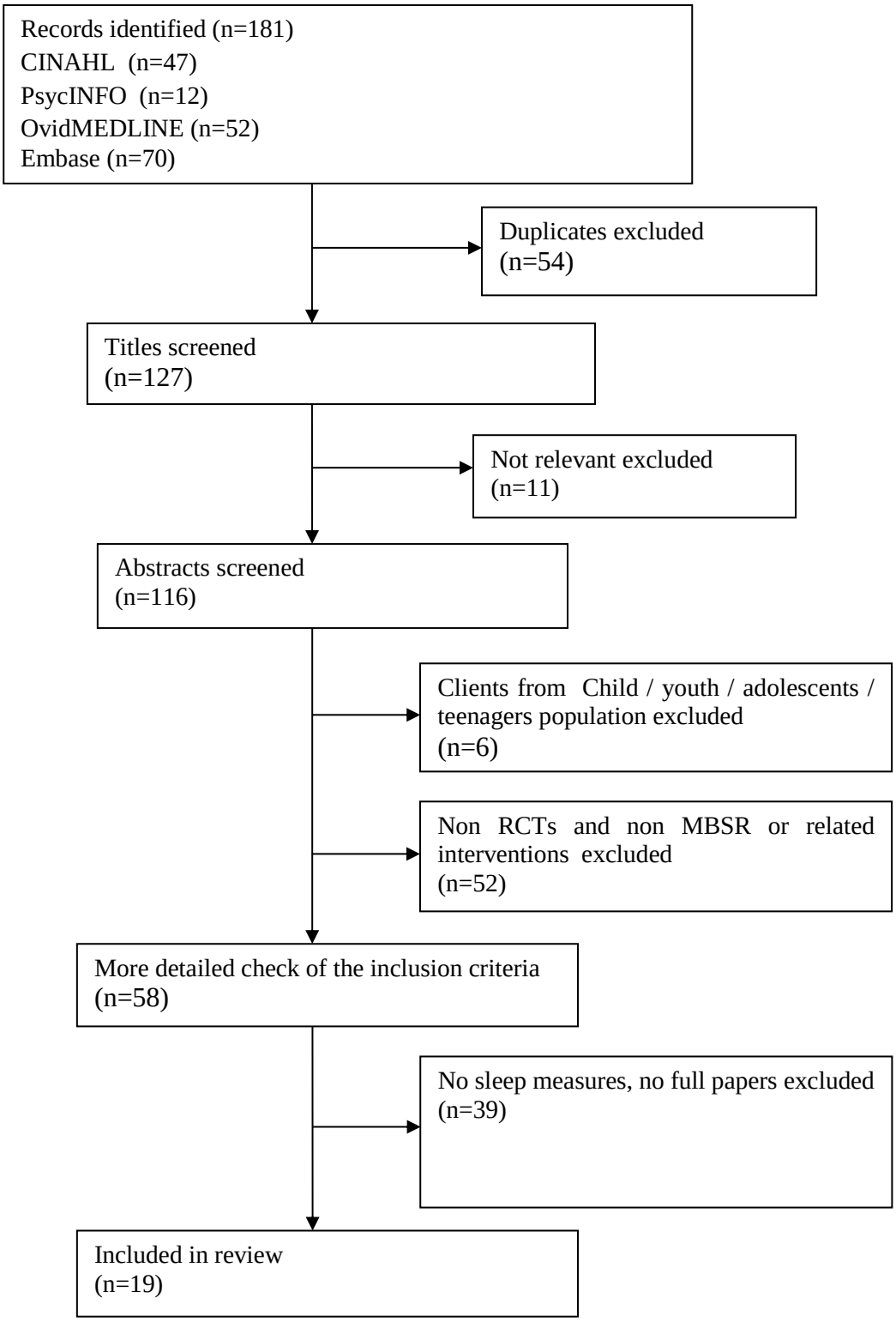

Figure 1: Summary of the review process

Brief summaries of the 19 reviewed studies can be found in Table 3. Firstly, an overview of participants; the quality of the papers; the measures used; the type of mindfulness intervention and the results; is presented. The studies are then grouped according to the targeted list of conditions and the results for each group are reported.

Table 3*: Summary of reviewed studies (Shading indicates 5 different groups of studies)*

title	subjects	RCT arms No in each arm	Intervention	Number and length of sessions	Homework?	Follow ups?	Sleep measures used	Notes
1. (Ong et al., 2013)	Adults over 21 who meet diagn. Criteria for insomnia	3 arms: 19	MBSR –	8 weekly meetings 2.5 hr + 6 hrs retreat	Daily practice 35 – 45 mins, meditation diary + sleep diary	3 months and 6 months	subjective: Sleep diaries PSAS ISI objective: laboratory PSG wrist actigraphy	
		19	MBTI –	8 weekly meetings 2.5 hr + 6 hrs retreat				
		16	Self Monitoring -	one orientation session, 8 weeks of self monitoring				
2. Gross et al, (2011)	Adults 18 – 65, ability to read and speak English, diagn of Primary Chronic Insomnia	2 arms: 20	MBSR	10 mins presentation about the sleep hygiene 8 weekly 2.5 hr + 6 hrs retreat	45 mins of meditation at least 6 days a week, followed by 20 mins / day for 3 months	5 months	Primary: Sleep diaries ISI PSQI Dysfunctional beliefs and attitudes about sleep Actigraphy	Adherence tracked electronically
		10	Pharmacotherapy	10 mins presentation about the sleep hygiene Meeting with a sleep physician				

Abbreviations: MBSR = Mindfulness-based stress reduction, MBTI = Mindfulness-based treatment of insomnia, PSAS = Pre-sleep arousal scale, ISI = Insomnia severity index, PSG = Polysomnography, PSQI = Pittsburgh sleep quality index

Table 3 – *Continued*

title	subjects	RCT arms No in each arm	Intervention	Number and length of sessions	Homework?	Follow ups?	Sleep measures used	Notes
3. Shapiro et al (2003)	63 women diagnosed with Stage II breast cancer, who were cancer-free at the time of the study	2 arms: 31	MBSR	6 weekly 2 hr sessions + 6hr silent retreat CBT coping tools + didactic material on stress	Mindfulness practice	3 months 9 months	Sleep diary	! baseline measure after randomisation – needed to adjust
		32	Free Choice	Free to choose which stress management technique to engage in each week + workbook	Monitoring stress management activities and recording in the diary daily			
4. Lengacher et al (2012)	84 women age 21 and older, stage 0, I,II or II breast cancer, completed treatment within 18 months of the study - volunteered	2 arms: 41	MBSR (BC)	Content of 8 weeks condensed to 6 weekly 2hr sessions + group support sessions focused on emotional and physical symptoms + group discussion – barriers to the practice + supportive interaction	Probably yes	none	M.D.Anderson Symptom Inventory Linkert scale 1 - 10 (Q4: "Your disturbed sleep at its worst?" Q9: "Your feeling drowsy (sleepy) at its worst?")	Clusters of symptoms addressed rather than individual symptoms Low level of symptoms
		42	Usual care	Not described				

Abbreviations: MBSR = Mindfulness-based stress reduction, MBSR (BC) = Mindfulness-based stress reduction modified for breast cancer, CBT = Cognitive behaviour therapy

Table 3 – *Continued*

title	subjects	RCT arms No in each arm	Intervention	Number and length of sessions	Homework?	Follow ups?	Sleep measures used	Notes
5. Andersen et al (2013)	336 women aged 18 – 75 in whom breast cancer stages I-III had been	2 arms: 168	MBSR	8 weekly 2 hr sessions + 5 hr silent retreat	45 mins daily (written material + CD with meditation guides)	6 months 12 months	Medical Outcome study Sleep Scale	
		168	Usual care	Not described!				
6. Garland et al. (2014)	Females and males, 18 and older (?)(36 – 88), Diagnosis of insomnia	2 arms: 47	CBT - I	8 weekly, 90 minutes sessions, total of 12 contact hours		8 weeks, 5 months	Subjective: ISI Sleep diary PSQI Objective: actigraphy	CBTI groups 6-10 MBSR groups 15-20 Almost half of the MBSR groups disengaged (those with experience excluded)
		64	MBSR	8 weekly 90 minutes sessions + 6 hour weekend intensive silent retreat, 18 total contact hours				
7. Britton et al (2010)	Antidepressant free, partially remitted, recurrent form of unipolar depression with residual sleep complaints	2 arms: 14 (12)	MBCT	8 weekly, 3 hours + all day silent retreat – aimed at depression, not insomnia	Practicing Mindfulness exercises 45 minutes a day + CD, + worksheets on stress	no	Subjective: Sleep Diary Objective: Polysomnogrphy	Correlations between results and practice of mindfulness
		12 (8)	Control Waiting list	Not described				

Abbreviations: MBSR = Mindfulness-based stress reduction, CBT – I = cognitive behaviour therapy for insomnia, MBCT = Mindfulness-based cognitive therapy, ISI = Insomnia severity index, PSQI = Pittsburgh sleep quality index

Table 3 – *Continued*

title	subjects	RCT arms No in each arm	Intervention	Number and length of sessions	Homework?	Follow ups?	Sleep measures used	Notes
8. Britton et al (2012)	Antidepressant users, partially remitted, recurrent form of unipolar depression with residual sleep complaints,	2 arms: 15 (13)	MBCT	8 weekly, 3 hours + all day silent retreat – aimed at depression, not insomnia	Practicing Mindfulness exercises 45 minutes a day + CD, + worksheets on stress	no	Subjective: Sleep Diary Objective: Polysomnogrphy	
		11 (10)	Control Waiting list	Not described				
9. Vollestad et al (2011)	Between 18 and 65, fulfil criteria for panic disorder (with or without agoraphobia), social anxiety or generalised anxiety disorder	2 arms: 39 (31)	MBSR	8 weekly, 2.5 hour sessions,+ half day meditation retreat +CD	Daily record keeping of exercises	6 months – only the MBSR group	Bergen Insomnia Scale	FFMQ used – significant treatment effect!
		37	Control Waiting list	Not described				
10 Hoge et al (2013)	18 and older, met DSM-IV criteria for current primary GAD + score 20 and above on Hamilton Anxiety Scale	2 arms: 48 (48)	MBSR	8 weekly, 2 hours, 4 hour retreat	20 minutes exercises with CD	no	PSQI	Measured only for participants not taking psychiatric medication
		45 (41)	Stress Management Education	8 weekly 2 hour classes, 4 hour "special class"	20 minute audio book recordings to listen			

Abbreviations: MBSR = Mindfulness-based stress reduction, MBCT = Mindfulness-based cognitive therapy, PSQI = Pittsburgh sleep quality index, DSM-IV = Diagnostic and statistical manual 4th edition, GAD = Generalised anxiety disorder, FFMQ = Five face mindfulness questionnaire

Table 3 – *Continued*

title	subjects	RCT arms No in each arm	Intervention	Number and length of sessions	Homework?	Follow ups?	Sleep measures used	Notes
11. Esmer et al (2010)	Patients (adults?) with persistent leg and/or back pain despite a history of lumbosacral spinal surgery within the previous 2 years	2 arms: 19 (15)	MBSR	8 weekly 1.5 – 2.5 hour sessions + additional 6 hour session	45 minutes per day with the aid of guided meditation audiotapes	12 weeks for all + 40 weeks for the MBSR group only	Abridged PSQI (5 items, 5 point yes/no)	
		21 (10)	Control	Not described (treatment as usual)	none			
12. Gross et al (2010)	Patients with a functioning solid organ transplant, age 18 and older, at least 6 months post transplant	3 arms (2 randomisations): 71	MBSR	8 weekly 2.5 hour classes + 1 daylong retreat + calls between +1 booster session	45 minutes recommended	8 weeks, 6 months, 1 year (this is for active groups only, waitlist – 8 weeks data only)	PSQI	Measured MAAS, correlation of results with practice
		66	Health education	8 weekly 2.5 hour classes + calls between + 1 booster session				
		31	Waitlist	Not described				
13. Schmidt et al (2011)	Women, aged 18 – 70, who currently had fibromyalgia	3 arms: 53	MBSR	8 weekly 2.5 hour sessions + 7 hours all day session	45 – 60 minutes recommended	8 weekd, 8 weeks short term follow up	PSQI	Measures FMI, diaries – measured practice, but not reported results on practice
		59	Active Control	8 weekly, 2.5 hour sessions	Similar to MBSR + CD with daily exercises			
		59	Waitlist	No active treatment				

Abbreviations: MBSR = Mindfulness-based stress reduction, PSQI = Pittsburgh sleep quality index, MAAS = Mindful attention awareness scale, FMI – Freiburg mindfulness inventory

Table 3 – *Continued*

title	subjects	RCT arms No in each arm		Intervention	Number and length of sessions	Homework?	Follow ups?	Sleep measures used	Notes
14. Carmody et al (2012)	Women in late menopausal transition and early post-menopause experiencing >5 moderate or severe hot flashes per day during past week	2 arms: 57		MBSR	8 weekly 2.5 hour sessions + all-day class	A variety of practices + 2 CDs of guided instruction to be practices 45 minutes for 6 days a week	8 weeks 20 weeks	Women's Health Initiative Insomnia Rating Scale (5 items subjective sleep quality scale)	Practice monitored in a diary
		53		Wait list control					
15. Klatt et al. (2009)	Age 18 – 60, BMI<=30, exercise less than 30 mins on most days, no more than 2 alcoholic and 6 caffeine beverages per day	2 arms: 24 (22)		MBSR-ld	6 weekly 60 minutes sessions	Daily 20 minutes meditation – two CD set	6 weeks	PSQI	Measured also cortisol, measured Mindfulness MAAS
		24 (20)		Waitlist control					
16. Wolever et al (2012)	Employees of a national insurance carrier, if scored 16 or higher on the Perceived Stress Scale	3 arms: 90 (76)		Viniyoga Stress Reduction Programme	12 weeks (12 hr)	Instructional handouts, + DVD for home practice	12 weeks	PSQI	CAMS-R
		96 (82)	52 (50)	Mindful ness at Work online	12 weeks (14 hr)	5 – 15 minute practices, handouts			
			44 (32)	In person					
		53 (47)		Control					

Abbreviations: BMI = Body mass index, MBSR = Mindfulness-based stress reduction, MBSR-ld – Mindfulness-based stress reduction – lower dose, PSQI = Pittsburgh sleep quality index, MAAS = Mindful attention awareness scale, CAMS-R = Cognitive and affective mindfulness scale – revised

Table 3 – *Continued*

title	subjects	RCT arms No in each arm	Intervention	Number and length of sessions	Homework?	Follow ups?	Sleep measures used	Notes
17. Malarkey et al (2013)	Subjects from faculty and staff of Ohio University with a CRP level > 3.0 mg/l and < 10 mg/l	2 arms: 93 (84)	MBI-ld	8 weekly 1 hour sessions + one 2 houts retreat	20 minutes daily recommended	8 weeks, 6 months, 12 months	PSQI	TMS + measured change as a function of practice
		93 (86)	Education Control	8 weekly 1 hour sessions + one 2 hours"retreat"	30 minutes of text reading daily			
18 Oken et al (2010)	Healthy adults age 45 – 85 caring for a close family member with progressive dementia	3 arms: 10	Mindfulness (MBSR for caregivers)	6 weekly 90 minutes sessions + 1 intro session	Written material + audio instructions for home practice	7 weeks	PSQI Epworth Sleep Questionnaire	MAAS FFNJ
		11	Education	6 weekly lectures + 1 intro session	Daily reading from the Caregiver Helpbook + action plans			
		10	Respite-only	7 weeks respite for 3 hours				
19. Dykens et al (2014)	Parents of any age who were primary caregivers of offspring with developmental disabilities	2 arms: 116	MBSR	6 weeks of 1.5 hour	Encouraged to practice at home	Mid-treatment, end of treatment, 1 month post, 3 months post and 6 months post	ISI	No manual for treatments
		127	Positive Adult Development	6 weeks	Encouraged to practice at home			

Abbreviations: CRP = inflammatory peptide CRP, MBSR = Mindfulness-based stress reduction, MBI-ld – Mindfulness-based intervention – lower dose, PSQI = Pittsburgh sleep quality index, ISI = Insomnia severity index, MAAS = Mindful attention awareness scale, FFNJ -= Measure of being non-judgemental adapted from factor five, TMS = Toronto mindfulness scale

Participants

The total number of participants in the selected studies was 2134, with the average number of the participants per study 112.3 (standard deviation 88.56). These represent 336 patients from Denmark (Andersen et al., 2013), 11 from Canada (Garland et al., 2014), 76 from Norway (Vøllestad, Sivertsen, & Nielsen, 2011), 171 from Germany (Schmidt et al., 2011), and the rest of the patients (1440) were from USA. Even though the English language was not listed in the inclusion criteria, all the reviewed studies were presented in English. The specific conditions giving rise to sleep difficulties included in this review were: primary insomnia; cancer; emotional problems; long-term physical health conditions and stress related to workplace or caring duties. The list of the conditions with the appropriate studies can be found in Table 4.

Table 4: *Division of the studies into the groups based on the condition targeted by the Mindfulness intervention*

Group	Included studies
Primary insomnia	Ong et al. (2013) Gross et al.(2011)
Cancer	Shapiro et al. (2003) Lengacher et al (2012) Andersen (2013) Garland et al. (2014)
Emotional problems	Britton et al (2010) Britton et al (2012) Vollestad et al 2011 Hoge et al (2013)
Long term physical health issues	Esmer et al (2010) Gross et al (2010) Schmidt et al (2011) Carmody et al (2012)
Stress related to work or caring duties	Klatt et al (2009) Wolever et al (2012) Malarkey et al (2013) Oken et al (2010) Dykens et al (2014)

Quality of the selected papers

The quality of the 19 identified studies was assessed using the proposed modified version of the Delphi list (Table 2). The results can be found in the Table 5.

Table 5*: Assessment of the quality of the selected studies (× = no, ✓= yes, ?= don't know)*
(Shading indicates 5 different groups of studies)

Author, date	Randomisation performed after baseline measurement	Groups similar at baseline?	Eligibility criteria specified ?	Outcome assessor blinded?	Did the analysis include an intention to treat?	Active control condition included?	Mindfulness measure included?	Mindfulness practice monitored?	SCORE
1. Ong et al., (2013)	✓	✓	✓	×	✓	✓	×	✓	6/8
2. Gross et al, (2011)	✓	✓	✓	?	?	×	×	✓	4/8
3. Shapiro et al (2003)	×	×	✓	?	?	✓	×	✓	3/8
4. Lengacher et al (2012)	✓	✓	✓	×	?	?	×	×	3/8
5. Andersen (2013)	✓	✓	✓	?	✓	?	×	×	4/8
6. Garland et al. (2014)	✓	✓	✓	✓	✓	✓	×	×	6/8
7. Britton et al (2010)	✓	✓	✓	✓	?	×	×	✓	5/8
8. Britton et al (2012)	✓	✓	✓	✓	×	×	×	✓	5/8
9. Vollestad et al 2011	✓	✓	✓	?	✓	×	✓	✓	6/8

Table 5: *Continued*

Author, date	Randomisation performed after baseline measurement	Groups similar at baseline?	Eligibility criteria specified?	Outcome assessor blinded?	Did the analysis include an intention to treat?	Active control condition included?	Mindfulness measure included?	Mindfulness practice monitored?	SCORE
10. Hoge et al (2013)	✓	✓	✓	✓	✓	✓	×	×	6/8
11. Esmer et al (2010)	?	✓	✓	✓	?	?	×	×	3/8
12. Gross et al (2010)	✓	✓	✓	?	✓	✓	✓	✓	7/8
13. Schmidt et al (2011)	✓	✓*	✓	✓	✓	✓	✓	✓	8/8
14. Carmody et al (2012)	✓	✓	✓	✓	✓	×	×	✓	6/8
15. Klatt et al (2009)	×	✓**	✓	?	?	×	✓	×	3/8
16. Wolever et al (2012)	✓	✓	✓	?	✓	✓	✓	?	6/8
17. Malarkey et al (2013)	✓	✓	✓	✓	✓	✓	✓	✓	8/8
18. Oken et al (2010)	✓	✓	✓	✓	?	✓	✓	×	6/8
19. Dykens et al (2014)	✓	✓	✓	?	?	✓	×	×	4/8

* Self-reported mindfulness higher among Mindfulness-based stress reduction participants
** Cortisol levels higher among control

With the exception of two studies (Klatt, Buckworth, & Malarkey, 2008; Shapiro et al., 2003), randomisation took place after the baseline measurements in all the reviewed studies. Gross et al. (2010) used two rounds of randomisation, when clients previously allocated to the waiting list were consequently randomised to one of the active treatment groups. As the authors claim, "patients were unaware of treatment assignment until after enrolment" therefore it is assumed, that they were completing the baseline questionnaires unaware of the group they were allocated to. Esmer et al. (2010) reports both randomisation and initial data collection "at baseline", so it is impossible to decide, in which order these two procedures were administered.

For most of the studies, the different treatment groups were similar at baseline. In Shapiro's study (2003), initial baseline differences were found and the authors attributed this to informing participants of their randomised assignment. In order to compensate for the baseline difference, a "corrective quasi-experimental procedure" was implemented. In two other studies (Klatt et al., 2008; Schmidt et al., 2011) significant differences were found between the treatment groups at baseline, but in both cases the differences were not found for the primary outcome measures (as stated by the Delphi criteria list), so quality criteria points were also given to these studies.

All of the reviewed studies clearly reported eligibility and exclusion criteria for their clients.

Only 9 of the reviewed studies explicitly stated that outcome assessors were unaware of the treatment allocation of the patients. In the remaining 10 studies, the outcome assessors are either not mentioned (the 8 studies with the question-mark) (Table 5), or it is stated that the principal investigator was involved in all three: administration, collection and evaluation

of the data (Lengacher et al., 2012; Ong et al., 2013). In Ong's study, the investigator bias was highlighted as one of the limitations of the study.

The intention to treat was included in the analysis of 10 of the studies. While in 8 of the remaining studies, the intention to treat is not mentioned, Britton et al (2012) discussed the lack of the intention to treat as one of the limitations of the study. The 10 studies which performed ITT analysis reported the ITT results in their statistical analysis, which are more stringent than the results obtained only for participants completing the treatment. In 8 studies the ITT between the groups analysis suggested a significant effect in favour of mindfulness and in one study (Garland et al., 2014), CBT-I showed significantly better results than MBSR. However, in one of the studies (Vøllestad, Sivertsen, & Nielsen, 2011) both ITT and "per protocol" analysis were reported and they differed - i.e. ITT analysis' findings were not significantly different from the control group, whereas the analysis of those completing the group was significantly in favour of mindfulness.

Nine of the studies included an active control group, which was a facilitated group intervention for the same number of hours as the mindfulness program. Three studies (Andersen et al., 2013; Esmer et al., 2010; Lengacher et al., 2012) describe the control group using the term "usual care", but do not specify, what the usual care included. The rest of the studies used waiting list controls.

Only seven studies included a mindfulness measure to evaluate changes in mindfulness before and after the intervention (Gross et al., 2010; Klatt et al., 2008; Malarkey, Jarjoura, & Klatt, 2013; Oken et al., 2010; Schmidt et al., 2011; Vøllestad et al., 2011; Wolever et al., 2012).

Ten of the studies described monitoring mindfulness practice, even though only 5 of those studies looked directly at the effects of practice on the obtained results (Britton, Haynes, Fridel, & Bootzin, 2010; Gross et al., 2011; Gross et al., 2010; Malarkey et al., 2013; Shapiro et al., 2003).

Only two of the 19 reviewed papers met all 8 quality criteria (Malarkey et al., 2013; Schmidt et al., 2011) and there were four papers which met only 3 criteria (Esmer et al., 2010; Klatt et al., 2008; Lengacher et al., 2012; Shapiro et al., 2003). Figure 2 shows the distribution of papers over the number of quality criteria they meet.

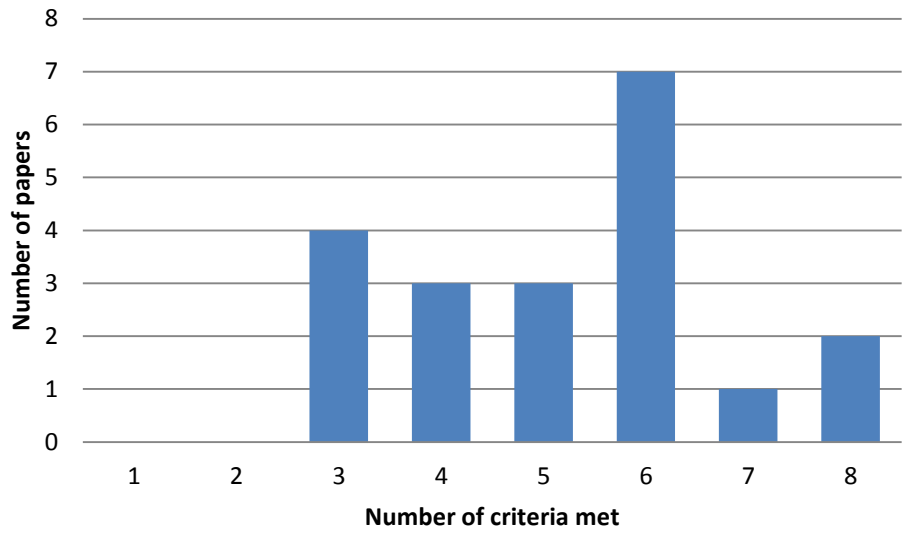

Figure 2: Distribution of the numbers of papers which fulfil given number of quality criteria

Measures

The reviewed studies used many different primary and secondary measures, but because of the limited scope of this review only the results obtained by measures directly monitoring sleep parameters and mindfulness are selected and compared. Measures about

sleep attitudes and sleep self-efficacy (Gross et al., 2011) are not included in the presented review because the focus of the review is on direct impact on sleep itself. A brief overview of the measures used in the different studies can be found in Table 6.

Table 6: *Sleep and Mindfulness measures used in the studies. (Shading indicating 5 different groups of studies)*

author	Objective sleep measures	Subjective sleep measures	Mindfulness measure
1.(Ong et al., 2013)	Polysomnography, Actigraphy	Sleep Diaries, Pre-sleep arousal scale, ISI	
2.Gross et al (2011)	Actigraphy	Sleep Diaries, ISI, PSQI	
3.Shapiro et al (2003)		Sleep Diaries, sleep quality 10 point ratings	
4.Lengacher et al (2012)		MD Anderson Symptom Inventory	
5.Andersen (2013)		Medical Outcome Study Sleep Scale	
6.Garland et al. (2014)	Actigraphy	Sleep Diaries, ISI, PSQI	
7.Britton et al (2010)	Polysomnography	Sleep Diaries	
8.Britton et al (2012)	Polysomnography	Sleep Diaries	
9.Vollestad et al (2011)		Bergen Insomnia Scale	FFMQ
10.Hoge et al (2013)		PSQI	
11.Esmer et al (2010)		Abridged PSQI	
12.Gross et al (2010)		PSQI	MAAS
13.Schmidt et al (2011)		PSQI	Freiburg Mindfulness Inventory – short version
14.Carmody et al (2012)		Women's Health Initiative Insomnia Rating Scale	
15.Klatt et al (2009)		PSQI	MAAS
16.Wolever et al (2012)		PSQI	Cognitive and Affective Mindfulness Scale - Revised
17.Malarkey et al (2013)		PSQI	The Toronto Mindfulness Scale
18.Oken et al (2010)		PSQI, Epworth Sleep Questionnaire	MAAS, Five Factor Non-judgemental
19.Dykens et al (2014)		ISI	

Abbreviations: ISI = Insomnia severity index, PSQI = Pittsburgh sleep quality index, FFMQ = Five facet mindfulness questionnaire , MAAS = Mindful attention awareness scale

Objective sleep measures

Five of the presented studies used objective sleep measures, which are the most valid and provide the most reliable outcomes for objective sleep and rest-activity pattern (Buysse, Ancoli-lsrael, Edinger, Lichstein, & Morin, 2006). These were Polysomnography (Britton et al., 2010, 2012; Ong et al., 2013) and wrist actigraphy (Garland et al., 2014; Gross et al., 2011; Ong et al., 2013).

Polysomnography (PSG) consists of simultaneous recordings of several different processes in a sleeping person using electrodes in a sleep laboratory. Usually the recordings include: electroencephalogram – measuring electrical activity of the brain; electromyogram – measuring activity of the muscles beneath the chin and electro-oculogram measuring movements of the eyeballs (Carskadon & Rechtschaffen, 2000).

Actigraphy is a method monitoring sleep and wake cycles using a small removable device (usually worn as a watch on the non-dominant arm). It does not restrict patients like PSG, therefore allows them to follow their sleeping habits more naturally. According to Ancoli-Israeli et al. (2003), results obtained by actigraphy measurements were comparable to those obtained by PSG for measuring sleep in normal healthy adults, but became less valid and reliable when monitoring sleep for patients with disturbed sleep.

Subjective sleep measures

The most commonly used subjective sleep measures were the Pittsburgh Sleep Quality Index (PSQI) (10 of the reviewed studies), Sleep diaries (6 studies) and Insomnia Severity Index (ISI) (4 studies). When there were other measures used, they were used only once.

The **Pittsburgh Sleep Quality Index (PSQI)** consists of 19 questions measuring sleep quality, latency, duration, efficiency, disturbances, use of sleep medication and daytime dysfunction in the past month (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989; Carpenter & Andrykowski, 1998). The overall score can range from zero to 21. A score higher than 6 indicates substantial sleep problems (Carpenter & Andrykowski, 1998). Most of the 10 reviewed studies report changes only in overall PSQI scores. The maximum PSQI score can be 21. Esmer et al (2010) used the Abridged version of PSQI, with only 5 "yes/no questions" assessing: sleep quality, sleep medication use, time until onset of sleep, duration of nightly sleep and restoration after sleep.

Sleep diaries are used to self-report sleep patterns and are considered standard tools for assessment of insomnia (Buysse et al., 2006). The following sleep parameters can be derived from the sleep diaries: sleep onset latency (SOL), wake after sleep onset (WASO), total sleep time (TST) and time in bed (TIB). Sleep efficiency (SE) can be then derived as a TST/TIB. Sleep diaries may also include subjective sleep quality ratings (Britton et al., 2010).

The third most commonly used sleep measure was the **Insomnia Sleep Index (ISI),** which is a seven item scale assessing severity of night time and daytime symptoms of insomnia over the past week (Bastien, Vallières, & Morin, 2001). The total scores range from zero to 28 and the clinical cut-off points for insomnia are defined for no insomnia (0-7), sub-threshold insomnia (8-14), moderate insomnia (15-21) and severe insomnia (22-28) (Bastien et al., 2001).

Mindfulness measures

Only seven of the reviewed studies used scales measuring changes in Mindfulness skills (Table 6). Three of those studies used the **Mindful Attention Awareness Scale** (MAAS) (Gross et al., 2010; Klatt et al., 2008; Oken et al., 2010). Using 15 items rated on a 6 point Likert Scale, the MAAS measures presence or absence of attention to the present moment (Brown & Ryan, 2003). Higher scores reflect more mindfulness.

Mindfulness interventions

In all of the reviewed studies, the mindfulness intervention was provided for groups of participants, rather than individually. Detailed information about the type of intervention provided in each study can be found in Table 3.

In 10 of the selected studies, the MBSR programme was used in its original form (Kabat-Zinn, 2013). Ong et al. (2013) used MBSR as well as Mindfulness-Based Therapy for Insomnia (MBTI), which was a modified MBSR. It covered equal time for intervention, but was modified for treatment of insomnia. Instead of general information on health, stress and education on meditation, participants were provided with specific behavioural strategies for insomnia. In order to provide the intervention at the workplace, Malarkey et al (2013) shortened the sessions to 1 hour, while the number of sessions remained 8 as in the original.

In five of the studies the original intervention was shortened to 6 weekly 1 – 2 hour sessions. Some of the shortened interventions were modified to provide more specific information to the targeted group of participants (breast cancer (Lengacher et al., 2012), working adults (Klatt et al., 2008), caregivers (Oken et al., 2010)).

In the two studies by Britton et al. (Britton et al., 2010, 2012) Mindfulness Based Cognitive Therapy (MBCT) was used rather than MBSR. It consisted of 8 weekly 3 hour sessions and one day silent retreat. Wolever et al. (2012), used a "Mindfulness at work" programme designed to be delivered at worksites, which consisted of 12, weekly hour-long classes and one 2 hour mindfulness intensive practice. In their study, the authors used two different ways of delivering the programme: either by a qualified trainer in a classroom or online via virtual classroom.

The fidelity of the interventions was addressed directly only in two studies. In (Andersen et al., 2013) the authors state, that a senior MBSR instructor validated adherence to the original MBSR programme, and in (Dykens, Fisher, Lounds Taylor, Lambert, & Miodrag, 2014) the high treatment fidelity was ensured by clinical supervisors, who applied specified well accepted criteria through observation and supervision. One study, (Britton, Haynes, Fridel, & Bootzin, 2012), explicitly stated, that "treatment fidelity was not formally assessed". Most of the studies provided detailed information about the manualised programme which they followed, and details of the training and years of practice of the instructors.

Reporting of the results

While most of the authors reported significant differences between the different arms of the controlled trials (between group comparisons) (e.g. comparison between the ISI score obtained by the MBSR group vs. Self Monitoring Group at the end of treatment (Ong et al., 2013)), there were some researchers (Klatt et al., 2008; Lengacher et al., 2012; Shapiro et al., 2003), who reported only significant differences for each group obtained at different stages of the study (within group comparisons) (e.g. Sleep efficiency for the MBSR group at the end of

treatment vs. baseline (Shapiro et al., 2003)). Seven other authors (Britton et al., 2010; Dykens, Fisher, Lounds Taylor, Lambert, & Miodrag, 2014; Garland et al., 2014; Gross et al., 2011; Gross et al., 2010; Klatt et al., 2008; Lengacher et al., 2012; Schmidt et al., 2011) used a combination of these two methods to report their results. Therefore the results of the reviewed RCTs are summarised in separate tables (Table 7 and Table 8). The six studies which used both methods of reporting appear in both tables.

Table 7 summarises all the reported significant differences for the **within group comparisons**. The number of lines in the row of a given study indicates the number of arms of the given study. In the given column, the first tick on the given line indicates significant difference measured for the given arm (e.g. MBSR group, Control Group, etc.) from baseline to the end of treatment, the second tick would be significant difference from baseline to 1st follow up, etc. If there was a report of no significant difference, a cross is placed at the given place.

Between groups comparisons are reported in Table 8. For each study, the number of rows represents the number of between groups' comparisons. Each row has two lines representing the compared arms of the study. If a tick is placed in any column of the table, it represents a significant difference between the given groups observed. The line in which the tick is placed indicates which arm was reported to be significantly improved. Cross indicates a report of no significant difference. Similar to Table 7, if there is more than one tick or cross on one line in a given column, these indicate comparisons at the end of treatment, 1st follow up, 2nd follow up or 3rd follow up.

Table 7: *Significant differences as reported by the authors for WITHIN THE GROUP comparisons*
(✗ = no significant result found, ✓= significant result found) (Shading is used to make the table more readable)

Study		Objective sleep measures			Subjective sleep measures					Mindfulness measure used?	Quality Ranking of the study
author	**arms**	**Sleep efficiency**	**Sleep onset latency**	**Other**	**Sleep efficiency**	**Sleep quality / PSQI**	**Sleep onset latency**	**ISI**	**Other**		
2. Gross et al (2011)	MBSR PCT	✗ ✗ ✗ ✓	✗ ✓ ✗ ✗		✓ ✓ ✓ ✓	✓ ✓ ✗ ✓	✓ ✓ ✗ ✗	✓ ✓ ✓ ✓		NO	4/8
3. Shapiro et al (2003)	MBSR FC				✗ ✗ ✗ ✗	✗ ✗ ✗ ✗				NO	3/8
4. Lengacher et a (2012)	MBSR UC								✓ MDASI ✓ MDASI	NO	3/8
6. Garland et al (2014)	MBSR CBT-I	✓	✗ ✓	✓✓ WASO, TST	✓ ✓		✗ ✓ ✓		✗ ✓ TST ✗ ✓ TST	NO	6/8
7. Britton et al (2010)	MBCT CON	✗ ✗	✗ ✗		✓ ✓		✓ ✓		✓TST ,WASO ✓TST,WASO	NO	5/8
12. Gross et al (2010)	MBSR HE					✓✓✓ ✓✓✗				MAAS - correlated	7/8
13. Schmidt et al (2011)	MBSR Act. Con waitlist					✓[a] ✓ ✗				✗ FMI ✗ ✗	8/8

Abbreviations: MBSR = Mindfulness-based stress reduction, PCT = pharmacotherapy, FC = free choice, UC = usual care, CBT-I = Cognitive behaviour therapy for insomnia, MBCT = Mindfulness-based cognitive therapy, CON = control condition, HE = health education, WASO = wake after sleep onset, TST = total sleep time, MDASI = MD Anderson symptom inventory, MAAS = Mindful attention awareness scale, FMI = Freiburg mindfulness inventory,
[a] Schmidt et al.(2011) report their results only for the comparisons between baseline and short-term follow up.

Table 7: *Continued*

Study		**Objective sleep measures**			**Subjective sleep measures**					**Mindfulness measure used?**	**Quality Ranking of the study**
author	**arms**	**Sleep efficiency**	**Sleep onset latency**	**Other**	**Sleep efficiency**	**Sleep quality / PSQI**	**Sleep onset latency**	**ISI**	**Other**		
15. Klatt et al (2009)	MBSR-ld WLC					✓* ✓				✓**MAAS** **×**	3/8
19. Dykens et al (2014)	MBSR PAD							✓ ✓		NO	4/8

Abbreviations: MBSR = Mindfulness-based stress reduction, MBSR-ld = Mindfulness-based stress reduction – low dose, WLC = waiting list control, PAD = Positive adult development, MAAS = Mindful attention awareness scale

*****Four components (Sleep sleep quality, sleep latency, sleep disturbance and daytime dysfunction) significantly better for MBSR-ld group and not for WLC group)

Table 8: *Significant differences as reported by the authors for **BETWEEN THE GROUPS** comparisons*
(✗ = no significant result found, ✓= significant result found) (Shading is used to make the table more readable)

Study author	arms	Objective sleep measures			Subjective sleep measures					Mindfulness measure used?	Quality Ranking of the study
		Sleep efficiency	Sleep onset latency	Other	Sleep efficiency	Sleep quality / PSQI	Sleep onset latency	ISI	Other		
1. Ong et al (2013)	MBSR MBTI							✓ ✗		NO	6/8
	MBSR SM			✓TWT, TST				✓	✓ TWT	NO	
	MBTI SM			✓ TWT, TST				✓	✓ TWT	NO	
2. Gross et al (2011)	MBSR PCT	✗	✗		✗	✗	✗	✗		NO	4/8
4. Lengacher et al (2012)	MBSR UC								✗ MDASI	NO	3/8
5. Andersen et al (2013)	MBSR UC					✓ ✗ ✗				NO	4/8
6. Garland et al (2014)	MBSR CBT-I	✗	✗	✗ TST, WASO	✓ ✓	✓ ✓	✓	✓		NO	6/8
7. Britton et al (2010)	MBCT	✗	✗	✗ TST, WASO	✗	**✗but trend**	**✗but trend**		✗ TST,	NO	5/8

Abbreviations: MBSR = Mindfulness-based stress reduction, MBTI = Mindfulness-based treatment of insomnia, SM = self-monitoring, PCT = pharmacotherapy, UC = usual care, CBT-I = Cognitive behaviour therapy for insomnia, MBCT = Mindfulness-based cognitive therapy, TWT = total wake time, WASO = wake after sleep onset, TST = total sleep time, MDASI = MD Anderson symptom inventory, PSQI = Pittsburgh sleep quality index

Table 8: *Continued*

Study author	arms	Objective sleep measures			Subjective sleep measures					Mindfulness measure used?	Quality Ranking of the study
		Sleep efficiency	Sleep onset latency	Other	Sleep efficiency	Sleep quality / PSQI	Sleep onset latency	ISI	Other		
8. Britton et al (2012)	MBCT	**×but trend**	×	✓TWT × WASO, TST	✓	×	×		✓ TWT, × TST, **×but trend** WASO	NO	5/8
	Control										
9. Vollestad et al (2011)	MBSR								× BIS – ITT, ✓✓ BIS	✓ **FFMQ**	6/8
	Control										
10. Hoge et al (2013)	MBSR					✓				NO	6/8
	SME										
11. Esmer et al (2010)	MBSR					✓✓**abridged**				NO	3/8
	Control										
12. Gross et al (2010)	MBSR					✓				**MAAS correlated**	7/8
	HE										
	MBSR					✓				**MAAS correlated**	
	Waitlist										
	HE					×					
	Waitlist										
13. Schmidt et al (2011)	MBSR, AC					×				× **FMI**	8/8
	Waitlist										
	MBSR					×				✓ **FMI**	
	AC										

Abbreviations: MBCT = Mindfulness-based cognitive therapy, MBSR = Mindfulness-based stress reduction, SME = Stress management education, HE = Health education, AC = active control, TWT = total wake time, WASO = wake after sleep onset, TST = total sleep time, BIS = Bergen insomnia scale, BIS-ITT = result on BIS for the intention to treat analysis, PSQI = Pittsburgh sleep quality index, FFMQ = Five facet mindfulness questionnaire, MAAS= Mindful attention awareness scale, FMI = Freiburg mindfulness inventory

Table 8: *Continued*

Study author	arms	Objective sleep measures			Subjective sleep measures					Mindfulness measure used?	Quality Ranking of the study
		Sleep efficiency	Sleep onset latency	Other	Sleep efficiency	Sleep quality / PSQI	Sleep onset latency	ISI	Other		
14. Carmody 2012	MBSR Waitlist					✓✓WHIIRS				NO	6/8
16. Wolever 2012	Mindfulness Yoga					×				× **CAMS-R**	6/8
	Mindfulness Control					✓				✓ **CAMS-R**	
	Yoga Control					✓				× **CAMS-R**	
	M– in person M- online					×				× **CAMS-R**	
17. Malarkey 2013	MBI-ld Education control					× **but in favour**				✓ **TMS**	8/8
18. Oken 2010	Mindfulness Education Respite					×			× **ESQ**	× **MAAS, FFNJ**	6/8
19. Dykens 2014	MBSR PAD							✓ **treatment slope**		NO	4/8

Abbreviations: MBSR = Mindfulness-based stress reduction, M- = mindfulness intervention, MBI-ld = Mindfulness-based intervention low dose, PSQI = Pittsburgh sleep quality index, WHIIRS = Women's health initiative insomnia rating scale, CAMS-R=Cognitive and affective mindfulness scale – revised, TMS = Toronto mindfulness scale, MAAS= Mindful attention awareness scale, FFNJ = five factor – non-judgemental

Reviewed reports according to the targeted conditions

Primary insomnia

Insomnia is characterised as a persistent difficulty falling or staying asleep causing clinically significant impairment in daytime functioning (American Psychiatric Association, 2013). It has been estimated that in the USA 6% - 20% of adults suffer from chronic insomnia (Ohayon, 2002).

There were only two RCTs that studied the effectiveness of MBSR on treatment of patients with chronic insomnia. Although chronic insomnia is often linked to many other problems (e.g. hypertension, depression, etc.), in these studies, patients with other medical or psychological co-morbidities were excluded. The quality scores of the studies were 4/8 and 6/8 for Gross (2011) and Ong (2013) respectively (see Table 5).

Gross et al (2011) compared MBSR with routinely used Pharmacotherapy (PCT) (Eszopiclone), while Ong et al (2013) compared the use of MBSR with Mindfulness based therapy for insomnia (MBTI) and self monitoring only (SM). Both studies used subjective as well as objective measures to assess the effectiveness of the tested approaches.

On *objective measures* Ong et al. (2013) found significant improvements in total wake time and total sleep time using PSG and actigraphy for clients who attended either MBSR or MBTI groups when compared with the SM group. No significant differences were found between groups by Gross et al. (2011) on objective measures (see Table 8). On objectively measured sleep efficiency however, their study did show significant improvements over time in the follow-up measurements for the pharmacological group only whereas objective sleep

onset latency was significantly different during the follow up in the MBSR group only (see Table 7).

On *subjective measures*, using the ISI, Ong et al. (2013) again found a significant difference between each of the mindfulness groups and the SM group. When the two mindfulness interventions were compared, the MBTI showed significantly better results for the end of treatment ISI scores, but the difference was not significant during the follow up measurements (see Table 8). Subjective measures did not reveal any significant differences between groups in the Gross et al. study (see Table 8), even though the scores within the groups were significantly improved over time (Gross et al., 2011) (see Table 7).

The Gross et al. study (which was identified as a relatively weak study) did not find any significant difference between outcomes reported by the mindfulness and pharmacotherapy groups, whereas the results of the study by Ong et al. which had higher quality scoring (6 out of 8), indicated, that mindfulness based interventions resulted in significant improvements on some objective measures as well as self-reported insomnia symptoms, when compared to SM only. Although Ong's is the more robust study, it is not possible to draw any conclusions based on only two papers, therefore further confirmation of the results would be beneficial.

Cancer

Insomnia is one of the most prevalent consequences of cancer, with estimated 30% - 50% of cancer patients reporting sleep problems (Savard & Morin, 2001). As non-pharmacological interventions are the preferred choice of therapy for sleep problems among cancer patients (Davidson, Feldman-Stewart, Brennenstuhl, & Ram, 2007), it is

understandable that the effects of MBSR have been increasingly evaluated for this group of patients.

Four RCTs investigating the effect of MBSR on sleep disturbance in cancer patients were identified. Three of the studies investigated patients with breast cancer only (Andersen et al., 2013; Lengacher et al., 2012; Shapiro et al., 2003); one of the studies included participants with any non-metastatic cancer diagnosis, out of which about 50% were participants with breast cancer (Garland et al., 2014).

With the exception of the Garland et al. study, none of the studies was primarily focusing on sleep disturbance. Their primary objectives were: the effects of MBSR on measures of stress (Shapiro et al., 2003); the effects of MBSR on psychological and somatic symptoms (Andersen et al., 2013); examination of symptoms and symptom clusters (Lengacher et al., 2012). The MBSR intervention was compared either to: usual care, which was not described in detail (therefore it was not considered to represent an active control) (Andersen et al., 2013; Lengacher et al., 2012); an active treatment of free choice of a variety of stress management techniques for each week (Shapiro et al., 2003) or Cognitive Behaviour Therapy for Insomnia (CBT-I) (Garland et al., 2014).

In the selected studies, *objective sleep measures* were used only by Garland et al., (quality rating 6/8 – see Table 5) and their results did not show any significant differences between the MBSR and CBT-I groups (see Table 8). However, for the within group comparisons they did show some significant improvements over time for CBT-I Sleep efficiency and Sleep onset latency (see Table 7).

Whilst the between groups comparison for *subjective sleep* quality *measures* used by Andersen et al. (quality rating 4/8 – see Table 5) showed significant improvement for the MBSR group at the end of treatment only (PSQI), in Garland's study, the CBT-I group delivered significantly better results on all subjective measures (PSQI, ISI, Sleep onset latency, Sleep efficiency) (see Table 8). Shapiro's results ((Shapiro et al., 2003), quality ranking 3/8 – see Table 5) did not show any significant improvement over time for neither MBSR nor active control for subjective sleep efficiency and sleep quality measures (see Table 7). On the other hand, using the MD Anderson Symptom Inventory (MDASI), Lengacher et al. (2012) (quality ranking 3/8 – see Table 5) reported significant improvement over time for disturbed sleep for both MBSR and usual care patients (see Table 7).

The quality of the papers in this group varies from 3/8 to 6/8 (see Table 5). The results do not allow any firm conclusion about the use of MBSR for sleep problems among cancer patients to be drawn. Although, given the good quality rating of the Garland et al study (6/8) their result showing that the CBT-I treatment may be more effective in targeting insomnia among cancer patients than MBSR should be noted.

Emotional problems

Recently, mindfulness based therapies have became popular choices of treatment among people with anxiety and depression. A meta-analysis by Hofmann, Sawyer, Witt, & Oh (2010) have shown that mindfulness therapies are moderately effective in treatment of these disorders. Sleep disturbances are not only known to coincide with depression and anxiety, but they may also remain as residual symptoms following a successful treatment with antidepressant medication and perpetuate the risk of relapse (Pigeon et al., 2008).

Four of the reviewed studies investigate the effect of Mindfulness based therapies on clients with mood problems. Two of them investigate the use of Mindfulness Based Cognitive Therapy (MBCT) with clients with depression: clients with partially remitted and recurrent depression, who did not take antidepressants at the time of the study (Britton et al., 2010) and clients who had similar characteristics to those in the previous study, but did take antidepressants (Britton et al., 2012). Two other authors studied the effect of MBSR on clients with anxiety disorders (Hoge et al., 2013; Vøllestad et al., 2011). Whilst the primary focus of the two depression studies was the sleep profiles of the clients, the aim of the anxiety studies was to investigate the potential of the MBSR intervention in general. Only one of the studies from this group used an active control (Stress Management Education (SME) (Hoge et al., 2013)), while all others compared the mindfulness intervention with a Waiting List Control (WLC). Only one of those studies (Vøllestad et al., 2011) included a mindfulness measure (Five- Facet Mindfulness Questionnaire).

The results obtained by *objective* polysomnographic *measurements* used in the two studies related to depression, did not reveal any significant differences between the MBCT and WLC groups. An exception was a significantly greater reduction in total waking time for the MBCT group in comparison to the WLC in those who were also taking antidepressants (Britton et al., 2012) (quality rating 5/8 – see Table 5). For this group of clients Britton et al. (2012) reported the same results also using *subjective measures* of total waking time and sleep efficiency (see Table 8).

Subjective measures used by Hoge et al. (2013) (quality rating 6/8 – see Table 5) also revealed that when compared with the SME group, clients with Generalised Anxiety Disorder (GAD) who attended the MBSR group, did obtain significantly better scores on the PSQI

questionnaire. Interestingly, even though the patients with anxiety disorders in the study by Vøllestad et al. (2011) (quality rating 6/8 – see Table 5) attending MBSR group did improve in their mindfulness skills, the Bergen Insomnia Scale scores were significantly better for the WLC group.

All four studies in this group achieved similar quality scores (5/8 or 6/8). When the mindfulness groups were compared with the WLC groups, (three of the studies), there was only one where a significant difference in favour of the mindfulness intervention was observed (Total Waking Time and Sleep efficacy for depressed clients taking antidepressants (Britton et al., 2012)). In one study, the WLC had better results on the insomnia scale at the end of treatment and follow up than the MBSR group (Vøllestad et al., 2011). When compared to an active intervention, clients in the MBSR group achieved better scores on the sleep quality scale (Hoge et al., 2013). Within this condition, studies with positive and negative findings have similar quality scores, therefore it is not possible to draw a clear conclusion about effectiveness of mindfulness for sleep disturbance in people with emotional difficulties.

Long Term Physical Health Issues

The common factor of the studies selected for this group is long lasting physical discomfort such as: pain caused by a failed back surgery (Esmer et al., 2010) or fibromyalgia (Schmidt et al., 2011); symptom burden e.g. hypertension or osteoporosis, related to (successful) organ transplant (Gross et al., 2010); or hot flashes linked to menopause (Carmody et al., 2011). As mentioned earlier (Introduction), the MBSR programme was

developed also with the aim of helping participants to adapt to stressors of chronic illness (Kabat-Zinn, 2013). A meta-analysis of health-related studies in which MBSR was used, has revealed that it can be beneficial for clients with both clinical and non-clinical problems (e.g. chronic pain, fibromyalgia as well as non-clinical participants who sought to improve coping with stress) (effects size approximately 0.5, $p<0.0001$) (Grossman, Niemann, Schmidt, & Walach, 2004).

Although none of the four studies in this group had sleep disturbance as a primary focus of the intervention, sleep disturbance was monitored as one of the symptoms of physical discomfort in all of the papers. That might explain, why all of the studies used only subjective sleep measures, mainly the PSQI (full or abridged version) or Women's health initiative insomnia rating scale (Carmody et al., 2011). All of the studies compare MBSR to a WLC or treatment as usual and two of the studies added an active intervention group, which was either health education (Esmer et al., 2010) or active control, controlling for the non-specific effects of MBSR (Schmidt et al., 2011).

On *subjective measures*, the between groups comparisons revealed significant improvements in the sleep quality scores for the MBSR participants when compared to the waiting lists in three out of the four studies (Carmody et al., 2011; Esmer et al., 2010; Gross et al., 2010) (see Table 8). It should be noted, however, that the quality rating of Esmer's study was low (3/8 – see Table 5). Similarly, in organ transplant, the MBSR group showed a significant improvement in the PSQI scores compared to the health education group (Gross et al., 2010), and correlated with their improvements in the mindfulness scale. These results however, are in contrast with Schmidt et al. (2011) (quality score 8/8 – see Table 5), who found no effect for patients with fibromyalgia. The mindfulness intervention in this study, did

not result in any significant differences between the groups compared to WLC or active control. Even though there was a significant improvement in mindfulness among the MBSR participants when compared to the active control (see Table 8). Here, the within group comparisons revealed improvements in the sleep quality over time in both active intervention groups at the follow-up (see Table 7), but apparently these were not large enough to result in significant differences between the groups.

Although, three out of four studies in this group present results in favour of MBSR, the Gross (2010) and Schmidt (2011) studies, which had the highest quality ratings of the group (7/8 and 8/8 respectively), contradict each other. This prevents one from drawing any clear conclusion about the effectiveness of MBSR on sleep disturbance for conditions causing physical discomfort.

Stress related to workplace or caring duties

The participants in the last group of studies were from non-clinical populations i.e. either working adults (Klatt et al., 2008; Malarkey et al., 2013; Wolever et al., 2012) or adult caregivers of children with Autism and other disabilities (Dykens et al., 2014) or carers of people with dementia (Oken et al., 2010). The aim of the mindfulness intervention in these studies was to help the participants manage stress (sometimes chronic) related to their workplace or caring duties. In this context, sleep disturbance is both a symptom of high stress levels as well as a vulnerability factor.

As mentioned earlier (Mindfulness interventions section), all of the mindfulness interventions used in this group represent modified versions of the original MBSR programme, which takes into consideration working or caring duties of the participants. Therefore, the weekly sessions were shortened to 1 hour or 1.5 hours while their number varied from 6 to 12. With the exception of one study (Klatt et al., 2008), which used the WLC, all other studies in this group used some form of active control group, which was either educational or an alternative yoga stress reduction programme. All but one study (Dykens et al., 2014) used some kind of mindfulness measure. Only subjective sleep quality measures were used (4 PSQI and 1 ISI).

Using the *subjective measures*, the between groups comparisons (see Table 8) revealed only three significant results. Two of those are in Wolever et al. (2012) (quality ranking 6/8 – see Table 5), where both mindfulness and yoga groups brought significant improvement to PSQI scores when compared to the control group even though only the mindfulness group participants showed improved mindfulness skills. The third significant improvement was on ISI scores recorded for mothers from the MBSR group when compared to Positive adult development group (Dykens et al., 2014) (quality ranking 4/8 – see Table 5). The within group comparisons showed significant improvement over time in sleep quality scores for all participants in both Klatt et al. (2008) (quality ranking 3/8 – see Table 5) and Dykens et al. (2014) studies.

The study with the highest quality score (8/8) in this group (Malarkey et al., 2013) reported the PSQI results in favour of the mindfulness intervention group, but the p-value was not significant. The other two studies with good quality ranking (6/8) report either significant improvements for both mindfulness and yoga groups (Wolever et al., 2012) or no

significant results found (Oken et al., 2010), therefore no clear conclusion can be drawn about the effectiveness of the mindfulness intervention on the sleep disturbance among the non-clinical participants attending the mindfulness stress reduction programmes.

Discussion

The aim of the present study was to systematically review the evidence for the effectiveness of MBSR on sleep disturbance in RCTs. Nineteen trials were identified. Only two of them used MBSR interventions to directly target primary insomnia (Gross et al., 2011; Ong et al., 2013), and five others addressed sleep disturbance co-morbid with other problems (sleep disturbance in cancer patients (Andersen et al., 2013; Garland et al., 2014; Shapiro et al., 2003) or in patients with depression (Britton et al., 2010, 2012)). All other studies reported changes in sleep parameters as secondary outcomes.

The selected studies were analysed in five different groups depending on the condition targeted by the mindfulness intervention. Unfortunately, they presented very mixed picture and no clear conclusions could be drawn about the effectiveness of the intervention on the sleep disturbance in any of the groups. The results of the studies are summarised in Tables 7 and 8. For the clients with chronic primary insomnia the results were positive for one of the studies (Ong et al., 2013), which had a higher quality rating, but the number of studies in this group (two) is insufficient for any firm conclusions. Similarly, the only clear finding for clients with cancer, was that a relatively good study (Garland et al., 2014) showed that CBT-I seemed to be a better alternative for treatment of insomnia in people with cancer, than MBSR. The comparison of papers reporting the use of MBSR for clients with emotional problems resulted slightly in favour for mindfulness intervention. In two out of four studies,

the MBSR group had significantly better results compared to WLC or an active control. However in one other case, the WLC group had better results on insomnia scale than MBSR group. In the group comparing the studies with clients who suffered long term physical health issues, the two highest quality ranking studies provided contradictory results. Among the studies targeting stress related to workplace or caring duties, the results of the two out of three higher quality rating papers were in favour of mindfulness and yoga interventions.

In the discussion section of their original paper, Winbush et al. (2007), formulated the following recommendations to improve quality of future studies in this area : 1) employ RCTs; 2) make an effort to create active control conditions; 3) trials should be adequately powered; 4) adhere as closely as possible to the standardised MBSR intervention; 5) better characterise the type and severity of participants' sleep complaints and 6) employ well standardised sleep measures so that cross comparisons and pooling of results can be accomplished.

The present systematic review shows that some of the recommendations were taken on board in the research community in that seven years after the original publication we were able to identify 18 new RCTs. All used some form of standardised MBSR intervention and 10 of them included also an active control. The high number of the RCTs allowed us to divide the studies into five groups targeting different conditions. Unfortunately, even these improvements did not lead to clearer conclusions on the effectiveness of the MBSR on sleep disturbance.

There are several factors that underpin the inconclusive nature of the current findings. The first two, are directly linked to the recommendations 6) and 5) of the original paper:

First, the way in which the results of the studies were measured and reported varied considerably. Only five studies used objective sleep measures and the variability of the subjective measures was high (4 validated measures and 6 different parameters derived from the sleep diaries). Also, as mentioned earlier, different authors chose to report their results differently. While some were reporting the differences between the groups at the different times of their study, others reported the changes within each group over time and some used both methods to report their results. Also, the high number of sleep parameters measured by objective measures or subjective sleep diaries in some studies added to the complexity of reporting. In general, more significant improvements were measured subjectively than objectively. Only in two studies the results were significantly better for MBSR group using objective measures: Ong et al. (2013) found significant improvement for MBSR and MBTI groups when compared with self- monitoring group in total sleep time and total wake time and Gross et al. (2011) found significant improvement in the follow up within group measure for sleep onset latency for the MBSR group.

With the exception of one study (Shapiro et al., 2003) all within group comparisons resulted in some significant improvements for the mindfulness intervention group, but very often also for the control group (Table 7). In most cases, those reporting a follow-up measurement found that significant changes were maintained. The between group comparisons gave a more varied picture (Table 8). Four of the reported studies did not find any significant changes or trends in sleep measures using between group comparisons (Gross et al., 2011; Lengacher et al., 2012; Oken et al., 2010; Schmidt et al., 2011) (Table 8). Only five studies reported a follow up between group comparison results. Significant changes for MBSR groups were maintained in two of these (Carmody et al., 2011; Esmer et al., 2010)

and in two they did not persist (Andersen et al., 2013; Ong et al., 2013). In one study persistent significant improvements were reported for the CBT-I group (Garland et al., 2014).

Second, as mentioned earlier, 12 out of 19 studies reported changes in sleep parameters as secondary outcomes thus, although sleep problems were relevant for the given conditions, the baseline levels of sleep problems were not necessarily high enough to leave a substantial room for potential improvement. Closer inspection of the studies (see Table 9) reveals that the highest baseline scores among the participants correspond to moderate insomnia and most of the PSQI scores at baseline are between 7 and 9 (the max PSQI score can be 21, with scores greater than 6 indicating some form of sleep disturbance). Therefore they are less relevant for the evidence base related to sleep disturbance. In the original review (Esmer, Blum, Rulf, & Pier, 2010), only two of the studies were focused on treatment of insomnia or sleep disturbance and two more (none of them RCTs) evaluated the impact of MBSR on sleep as a primary outcome related to quality of life. The remaining four studies evaluated sleep only as a secondary measure. The impact on the present review is that the secondary measurement techniques may not have been as rigorously applied as primary measures and could result in a lower quality rating for the study.

Other factors which limit the interpretation of the results are the lack of power analysis and the lack of information on the intention to treat (ITT) analysis in many of the studies.

Ten out of 19 studies reported the ITT data as their results (which was reflected in their higher quality ranking and therefore higher weight in the current review) and apart from two studies, these results suggested a significant effect in favour of mindfulness. However,

this needs to be balanced against the fact that the remaining 9 studies did not include ITT analysis and thus care must be taken not to present an over optimistic picture of findings.

As summarised in Table 9, the studies also differed in the way and extent to which they reported their power analysis. Only 9 papers provide detailed information about their power analysis, while two studies (Britton, Haynes, Fridel, & Bootzin, 2010; Britton et al., 2012) explicitly acknowledge that their design was not informed by the power analysis. Of those which state their power analysis, 5 were powered to identify medium to large treatment effects (d=0.5 – 1.0), while two (Dykens et al., 2014; Malarkey, Jarjoura, & Klatt, 2013) were set up to detect small to medium effects (d=0.3). The lack of information relating to the role of power analysis in the design of the remaining studies adds a further limitation to this review.

Table 9: *Power of the study, Sleep measures and their values at baseline and post intervention, monitoring of mindfulness practice (✗ = no, ✓= yes)*
(Shading indicates 5 different groups of studies)

Author, date	Power (effect size d)	Sleep measure	Baseline value	Post values	Mindfulness practice used for results	Mindfulness practice monitored?	Mindfulness measure	Quality ranking
1. Ong et al., (2013)	sufficient	ISI	15 - 18	10 - 15	Not used	✓	✗	6/8
2. Gross et al, (2011)	80% (d=0.68)	ISI PSQI	16 – 18 11	10 – 11 7 – 8.5	Practice predicts reduction in dysfunctional beliefs and activity limitation	✓	✗	4/8
3. Shapiro et al (2003)			Mild to moderate		Practice not correlated with sleep efficiency, but interaction with time significant and positive	✓	✗	3/8
4. Lengacher et al (2012)	Considered (detectable d=0.6)	MDASI Q1	3.1 (out of 10)	1.9 – 2.01		✗	✗	3/8
5. Andersen (2013)		MOS	30	24		✗	✗	4/8
6. Garland et al. (2014)	80% (4 points on ISI)	ISI	16-18	11 - 8		✗	✗	6/8
7. Britton et al (2010)	Lack of power		Some level of complaints		Practice correlated with increased PSG arousal s, ...	✓	✗	5/8
8. Britton et al (2012)	Lack of power		Some level of complaints		Not used	✓	✗	5/8

ISI = Insomnia severity scale: no insomnia (0-7), sub-threshold insomnia (8-14), moderate insomnia (15-21) and severe insomnia (22-28)
PSQI= Pittsburgh sleep quality index: maximum score 21; score higher than 6 indicates sleep difficulties
MDASI = MD Anderson symptom inventory: sleep disturbance is one of the symptoms assessed by the inventory
MOS = Medical outcome study sleep scale

Table 9: *Continued*

Author, date	power	Sleep measure	Baseline value	Post values	Mindfulness practice used for results	Mindfulness practice monitored?	Mindfulness measure used?	Quality ranking
9. Vollestad et al 2011		BIS	17.7	13 - 16	Not used	✓	✓	6/8
10. Hoge et al (2013)		PSQI		Reduction by 2.1		×	×	6/8
11. Esmer et al (2010)		PSQI - abridged	2.4	2.0		×	×	3/8
12. Gross et al (2010)	80% (medium treat. effect)	PSQI	7.2-8.3	6.9 -6.0	Practice as mediator	✓	✓	7/8
13. Schmidt et al (2011)	80% (d=0.5)	PSQI	11	10	Not used	✓	✓	8/8
14. Carmody et al (2012)		WHIIS	11 -12	Reduction by 2.68	Not used	✓	×	6/8
15. Klatt et al (2009)	80% (d=0.6)	PSQI	6.7	5.0		×	✓	3/8
16. Wolever et al (2012)		PSQI	7.6 - 8	5.2 -6.02		?	✓	6/8
17. Malarkey et al (2013)	80% (d=0.34)	PSQI	8.4 -8.7		Change as a function of practice – not significant	✓	✓	8/8
18. Oken et al (2010)		PSQI	8.7 -9.5	8 – 9.3		×	✓	6/8
19. Dykens et al (2014)	80 % (d=0.33)	ISI	12.33			×	×	4/8

ISI = Insomnia severity scale: no insomnia (0-7), sub-threshold insomnia (8-14), moderate insomnia (15-21) and severe insomnia (22-28)
PSQI= Pittsburgh sleep quality index: maximum score 21; score higher than 6 indicates sleep difficulties
BIS = Bergen insomnia scale: normal scores for men 8-9, for women 11-12
WHIIS = Women's health institute insomnia scale: insomnia cut-point 8-9

Third, ideally, in order to claim that any possible significant changes in the sleep measures could be attributed to the mindfulness part of the intervention, it is necessary to report changes in mindfulness using a validated mindfulness measure and homework practice (which according to the authors is a necessary part of the mindfulness intervention (Kabat-Zinn, 2013)). Only 7 studies, however, used any mindfulness measure. In one of them (Oken et al., 2010) mindfulness measure did not show a significant improvement following a mindfulness intervention. In another five studies, the improvement in mindfulness measure was accompanied with some form of improvement in the subjective sleep quality measure (Klatt et al., 2008; Malarkey et al., 2013; Vøllestad et al., 2011; Wolever et al., 2012) or the improvement in sleep quality measure was correlated with the measured changes in the mindfulness measure (Gross et al., 2010). In study by Schmidt (2011) subjective measure of sleep quality of the attendants of the MBSR did not show any significant improvement in comparison with an active control group in spite of improvements in their mindfulness measure. Ten studies monitored home mindfulness practice, but only five evaluated it yielding variable results (see Table 9). Although the importance of mindfulness practice has also been highlighted in the original review paper by Winbush et al. (2007), the authors of the present paper believe that the use of validated mindfulness measures should be added to the recommendations for the future research in the field.

Also, to be able to attribute possible significant changes to MBSR, the fidelity of the intervention to the original programme needs to be measured and evaluated. Only two of the reviewed studies fulfilled this condition (Andersen et al., 2013; Dykens et al., 2014). On the other hand, detailed session by session MBSR and MBCT protocols and additional materials (handouts and audio files with guided exercises) are publicly available and were reportedly

used in the reviewed studies. While availability of the protocols makes MBSR and MBCT more robust than other psychological approaches, the lack of indication of fidelity for most of the studies appears to be a significant weakness of the literature reviewed.

The link between stress and sleep disturbance has been shown in the past (Morin, Rodrigue, & Ivers, 2003), therefore, it is reasonable to expect that intervention focused on stress reduction would have a direct positive effect on sleep disturbance. However, as the results of the presented systematic review show, in order to be able to collect valid evidence, a more rigorous approach needs to be taken in future studies. In addition to the recommendations described by Winbush et al. (2007), this could be achieved by:

- Careful selection of the measured data (all three: sleep quality, mindfulness and home practice need to be measured);
- Using standardised objective and subjective sleep measures;
- Using unified set of sleep parameters;
- Reporting the results as between group comparisons, (using the within group comparisons only as addition, rather than replacement of the standard results reporting).

Based on these recommendations, the most robust studies, which would need to be considered for a contribution to the evidence base regarding sleep disturbance and mindfulness interventions could be characterised by: 1) the use of both objective and subjective measures of sleep; 2) consistent results obtained for between group comparisons on objective and subjective sleep measures; 3) the use of mindfulness measure and

improvement in mindfulness skills and 4) general quality rating of the paper more than 5. In retrospect, none of the reported papers fulfils all these criteria. Closest to fulfilling these criteria are the following three studies: Ong et al.(2013), Britton et al. (2010) and Britton et al. (2012). Whilst they fulfil three of the proposed criteria, none of them measures changes in mindfulness skills. Britton (2010) reports no significant changes for the mindfulness intervention, only positive trends in sleep quality and sleep onset latency. The other two studies report consistent improvements for total waking times for their mindfulness based intervention (MBSR, MBTI and MBCT) arms.

Mindfulness interventions are gaining rapid popularity among clinicians as well as clients. The present systematic review showed that there is growing evidence that patients find them beneficial also for their sleep problems, especially in terms of pre-post comparisons (within group). More good quality research is needed to establish its effectiveness in comparison to other psychological therapies.

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Research paper

Does improving mindfulness impact on neurobehavioural functioning?

Abstract

Training in mindfulness skills has become increasingly popular among various groups of clients. The present study aimed to contribute to the available evidence regarding the use of mindfulness techniques with people with acquired brain injury (ABI) using a mixed method approach. The quantitative part of the study (Part A) explored the relationship between changes in mindfulness skills and changes in neurobehavioural functioning, while the qualitative part (Part B) of the study explored, how individual clients with ABI made sense of their experience with mindfulness.

In Part A, the study used correlational and simple regression analysis, in Part B the results were analysed using Interpretative phenomenological analysis (IPA). Sixteen clients with ABI, who attended a mindfulness group as a part of their rehabilitation in a regional rehabilitation day service, took part in the Part A of the study and filled two pre- and post-questionnaires: Neurobehavioural Functioning Inventory (NFI) and Five facet mindfulness questionnaire (FFMQ). Four of those also participated in Part B, where they were given voice recorders and asked to make a recording whenever they found themselves using mindfulness in their everyday lives.

Results suggested that a decrease in depressive symptoms (measured by NFI) was related to improved ability to describe (measured by FFMQ). Qualitative analysis identified four themes: "pain"; "understanding / experiencing of mindfulness"; "mindfulness as a state with distinct sensory quality" and "mindfulness as a source of calmness".

Introduction

The present study explores the relationship between changes in mindfulness skills and changes in neurobehavioural functioning of clients with acquired brain injury (ABI), who attended a mindfulness group as a part of their rehabilitation in a regional rehabilitation day service. It utilises a mixed methods approach using correlational analysis and interpretative phenomenological analysis (IPA). The paper will begin however, with an introduction to concepts and a review of the literature.

Brain injury can be defined as "an injury caused to the brain since birth" (Headway, 2015). The term covers traumatic brain injury as well as other types of ABI including: stroke, viral infection, hypoxic injury and tumour. It can lead to residual impairment in: memory, executive functions and learning (Milders, Fuchs, & Crawford, 2003). About 50% of patients with brain injury report chronic pain (Lahz & Bryant, 1996) and in comparison to general neurological patients, patients with traumatic brain injury (TBI) report about twice as many pain complaints and sleep problems (falling asleep, sleep maintenance and early morning awakening) (Beetar, Guilmette, & Sparadeo, 1996). According to Jorge et al. (2004), recovery of patients with brain injury is often complicated by depression, which can be linked to executive dysfunction and anxiety symptoms. Affective disturbances following even mild TBI, have also been observed (Borgaro, Prigatano, Kwasnica, & Rexer, 2003). Research shows that there is a positive association between chronic stress, somatic symptoms and depressive symptoms during the chronic phase of recovery from TBI (Bay & Covassin, 2012). Whilst, physical problems often resolve in the first two years following TBI, social integration can still be difficult due to persistent cognitive, behavioural and psychosocial problems (Kreutzer, Marwitz, Seel, & Devany Serio, 1996). The ultimate goal of brain injury

rehabilitation is to help patients achieve the best possible functioning in their everyday lives (Prigatano, 1999). Introduction of interventions targeting more psychological and emotional problems might lead to improvements in quality of life and better rehabilitation outcomes (Bedard et al., 2003).

One of the techniques which has been gaining popularity in recent years but has not yet been part of traditional brain injury rehabilitation is training in mindfulness skills. Mindfulness was defined as: "the awareness that emerges through paying attention non-judgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2003). It can be learned through training and cultivated and developed through meditation.

The impact of mindfulness on cognition in non clinical and clinical populations

Research shows that mindfulness meditation practice in the general population can lead to improved cognitive flexibility (measured by the Stroop task and the "d2 concentration and endurance" tests) in healthy meditators vs. non-meditators (Moore & Malinowski, 2009). Using functional connectivity magnetic resonance imaging (fcMRI), Kilpatrick et al. (2011) demonstrated that mindfulness based stress reduction (MBSR) training increases functional connectivity within auditory and visual networks among healthy women. In a conceptual review of papers including healthy meditators by Lutz, Slagter, Dunne, & Davidson (2008), focused attention meditation and open monitoring meditation led to reports of improved attention regulation (expertise-related changes in attentional processing for example on a 'binocular rivalry task', furthermore fMRI findings showing activation in regions related to monitoring, engaging attention and attentional orienting). In an RCT, Jensen, Vangkilde, Frokjaer, & Hasselbalch (2012) found that selective attention improved

significantly more in a group of healthy meditators attending a MBSR group than in an inactive control group.

In a systematic review, Chiesa, Calati and Serretti (2011) report the results of 23 studies in mainly healthy populations (but also two with depressed patients, one study with patients with chronic pain and one with patients with TBI), which suggested that improvements in sustained, selective and executive attention are linked to different phases of mindfulness training. Early phases of training were associated with improvements in selective and executive attention (meaning an attentional prioritizing system, measured by the 'Attention Network Test' or the Stroop task), while the later ones were linked to improved unfocused attention, i.e. ability to sustain a broader attentional focus rather than a single focus. According to the authors, the training can also enhance working memory capacity and some executive functions. However, the evidence should be considered with caution, due to the lack of standardised meditation programmes (A. Chiesa, Brambilla, & Serretti, 2011).

The impact of mindfulness on affect in clinical and non-clinical populations

Mindfulness-based cognitive therapy has also been shown to improve affect in people with mild to moderate psychological problems (Schroevers & Brandsma, 2010). The authors report that improved positive affect was correlated with improvement in awareness and observation of daily activities, which are both aspects of mindfulness. On the other hand, decreased negative affect was linked to other mindfulness aspects, such as improved acceptance, openness and curiousness towards unpleasant activities. A meta-analytic review of 39 studies by Hofmann, Sawyer, Witt, & Oh (2010) concluded that for patients with

anxiety and mood disorders, mindfulness based interventions contributed to the improvement in anxiety and mood symptoms with effect sizes (Hodge's g) of 0.97 and 0.95 respectively.

Khoury et al. (2013) used comprehensive effect-size meta-analysis of 209 selected pre-post or controlled studies examining the effects of mindfulness-based therapy (MBT) for a wide range of physical conditions, psychological disorders and in non-clinical populations. The analysis showed that MBT was moderately effective for a variety of clinical outcomes in: pre-post studies; in studies using comparisons with a waiting control and some other active treatments (including: psychoeducation, supportive therapy, relaxation, imagery and art therapy). MBT appeared to be especially effective for reducing anxiety, depression and stress. However the effect was not apparent in comparison with traditional cognitive-behavioural therapy, behavioural therapies or pharmacological treatments.

Proposed mechanisms of mindfulness

At least five different authors have proposed models explaining the mechanism by which an improvement in mindfulness skills, leads to behaviour change and symptom reduction. Baer (2003) for example, proposes that these mechanisms include: *exposure* (exposure to painful sensations and emotional experiences, when meditation students are encouraged not to shift position, but instead focus careful attention directly on the sensation or emotion), *cognitive change* (learning new attitudes towards thoughts and feelings), *improved self-observation* (training in self-observation and self-discipline), *relaxation* and *acceptance*. The core ideas of other proposed models are based on: emotional regulation,

inhibition of pre-potent responses (or rumination), raised body awareness and attentional control (Coffey & Hartman, 2008; Hölzel et al., 2011; Phillipot & Segal, 2009).

A more encompassing theory which is therefore pertinent to the present study, is that proposed by S. L. Shapiro, Carlson, Astin, & Freedman (2006) and is based on the following three axioms: *intention, attention and attitude*. They propose that "intentionally attending with openness and non-judgementalness leads to a significant shift in perspective, which they termed *reperceiving*" (S. L. Shapiro et al., 2006, p. 377). According to the authors, intention (i.e. answer to the question why somebody practices mindfulness) has always been an important part of the Buddhist tradition of mindfulness. It has been shown, that outcomes of mindfulness meditation correlate with intentions of meditators (D. H. Shapiro, 1992). Its inclusion is therefore important for understanding of a process as a whole. The process of attention relates to the capacity to attend to one object for a long period of time, shift focus between objects as well as cognitive inhibition of secondary thoughts, processes and sensations (S. L. Shapiro et al., 2006). The axiom of attitude covers the ability to pay attention without evaluation or interpretation; it includes kindness, curiosity and openness to the experience. Reperceiving is seen as a meta mechanism, which may lead to another four mechanisms: self-regulation, values clarification, cognitive emotional and behavioural flexibility and exposure. Reperceiving is considered a natural developmental process, whereby mindfulness provides a person with increasing ability to look at their own inner experiences more objectively. By being able to observe the content of their consciousness (e.g. pain, depression, fear), people are no longer "fused" with it or defined by it. According to the authors, mindfulness gives people a choice to self-regulate rather than being controlled by states such as anxiety or fear. Also, it allows them to choose behaviours which are in line

with their needs, interests and values. This freedom of choice would also allow a more adaptive and flexible response to the environment and their life situation. As in Baer (2003), an important mechanism of reperceiving is also exposure: “Reperceiving enables a person to experience even very strong emotions with greater objectivity and less reactivity” (S. L. Shapiro et al., 2006, p. 381).

Phillipot and Segal (2009) suggest that qualitative analysis using the first person approach might provide new ways of understanding processes present during mindfulness training. The present study therefore incorporates both a qualitative and quantitative element.

Qualitative studies exploring mindfulness

A qualitative study of mindfulness by Mackenzie, Carlson, Munoz, & Speca (2007) in an oncology setting using a grounded theory approach, identified themes of “opening to change”, “self control”, ”shared experiences”, “personal growth” and “spirituality”. Using the same approach another qualitative study with depressed clients (Mason & Hargreaves, 2001), identified (among others) the category “coming to terms”. Through Interpretative Phenomenological Analysis (IPA) applied to interviews in a mindfulness based therapy group for cardiac rehabilitation, five master themes emerged: “development of awareness”, “within group experience”, “commitment”, “relating to the material” and “acceptance as an outcome” (Griffiths, Camic, & Hutton, 2009). In another study using IPA with patients with psychosis attending a mindfulness group, the following themes emerged: "experiencing distress", "group as beneficial", "mindfulness as beneficial", and "mindfulness groups as part of the process of recovery" (Dennick, Fox, & Walter-Brice, 2013). Some of the themes mentioned above resonate with mechanisms suggested by Baer (2003), Shapiro et al. (2006), or Phillipot and Segal (2009). More qualitative data collection and analysis is needed with

different patient populations to gain a better understanding of how mindfulness might relate to changes in everyday functioning.

Mindfulness studies with participants with ABI

Given the findings referred to above relating to improvements in cognitive/attentional skills and affect, it would seem important to explore how mindfulness training might impact on people with ABI. However, to date, there have been just four quantitative studies in total, using mindfulness based interventions (MBI) with this population. Two of these were randomised control trials (RCTs) with one showing no effect and one showing a significant effect (Johansson, Bjuhr, & Rönnbäck, 2012; McMillan, Robertson, Brock, & Chorlton, 2002); and two were pre/post designs (Azulay, Smart, Mott, & Cicerone, 2013; Bedard et al., 2003).

In their RCT, McMillan, Robertson, Brock, and Chorlton (2002) taught patients with TBI an attentional control technique based on mindful concentration and relaxation in five 45 min sessions. They found no differences in objective or self-report measures of cognitive function, mood or symptom reporting between treatment and control groups (physical exercise group and group with no therapist contact). In an RCT, Johansson, Bjuhr, and Rönnbäck (2012) found a significant improvement in self-reported mental fatigue and in objective measures of attention in patients with TBI, following eight weeks of MBSR.

Bedard et al. (2003) in an uncontrolled pre vs. post design, compared 10 participants who completed a 12 week MBI programme to three people who dropped out. They found significant improvements in quality of life and the cognitive-affective domain of the Beck

Depression Inventory, which were also maintained at 12 months follow up (Bedard et al., 2005). Methodological constraints however, limit any conclusions that can be drawn from this study. In a more recent study, significant improvements were noted on measures of quality of life and perceived self-efficacy among patients with TBI in an uncontrolled pre vs. post design who attended a 10 week group modelled after MBSR (Azulay et al., 2013).

Present study

One of the collaborators in this study is a clinical psychologist at the outpatient brain injury unit at a local regional Brain Injury Day Centre (the rehabilitation centre from now on). She has been running mindfulness groups for the patients in the unit for two years. The groups run for 8 weeks and many patients attend more than one group round stating they found the sessions beneficial. Studies mentioned above suggest that people attending the group are likely to experience neurobehavioural/cognitive changes alongside any increase in mindfulness skills.

Based on data collected at the rehabilitation centre, the present study aims to contribute to the available evidence regarding the use of mindfulness techniques with people with brain injury. It was designed as a mixed methods study consisting of a quantitative and a qualitative component. The combination of quantitative and qualitative components may contribute to the wider debate about the mechanisms of mindfulness and its link to changes in everyday functioning.

Aims

1. The principle aims of the quantitative component was
    - to investigate whether an improvement in mindfulness is related to improvement in neurobehavioural functioning. This was explored by using a cross-sectional design, correlating change in a self-report measure of mindfulness with change in a self-report measure of neurobehavioural functioning after attending a mindfulness group. The aim was not to measure the effectiveness of the group itself.
    - A secondary aim was to use a post-hoc analysis to explore the relationship between the demographic/cognitive factors routinely measured before the mindfulness group and changes in mindfulness and neurobehavioural functioning. Such analysis can be used to generate hypotheses concerning the factors influencing the change in mindfulness and neurobehavioural functioning.

2. The aim of the qualitative part of the study was to explore how individual participants with ABI make sense of their experience of mindfulness. Whilst all previous studies used retrospective data collected from clients by interviews, the present study has the potential to bring some new perspectives, as the data were recorded by clients "in vivo" as they used mindfulness in their everyday life.

Method

This was a cross-sectional mixed methods design exploring the relationship between changes in mindfulness and changes in neurobehavioural functioning following attendance at an 8 week mindfulness group following the programme proposed by Dunkley and Stanton

(2014). The quantitative element was correlational and the qualitative component was based on IPA of the transcripts of the recordings made by the participants between the sessions.

Participants

A convenience sample was recruited from clinical referrals from the outpatient brain injury centre over a period of 15 months. Inclusion and exclusion criteria are in Table 1.

Table 1: *Inclusion and exclusion criteria of the participants of the study*

Inclusion criteria
Attending a mindfulness group that teaches basic mindfulness techniques and practice
18-70 years of age
Acquired Brain Injury (ABI) (including TBI, stroke, brain infections or brain tumour)
at least 6 months post brain injury
sufficient command of English to understand mindfulness instructions
ability to recall how to practice mindfulness between sessions (using appropriate memory strategies if necessary)
Exclusion criteria
If a participant experienced a significant life event (e.g. stroke, bereavement) during the 8 weeks of the mindfulness group, they were excluded from the study and were not asked to fill in post- questionnaires

Measures and materials

<u>Demographic data and routine measures</u>

Demographic data were accessed either from the patients themselves or from their clinical record. Two routine cognitive assessments that had been obtained for clinical purposes prior to the study (usually within four weeks of a client starting their programme in

the unit) were also collected, i.e. a measure of delayed verbal memory and speed of information processing from the BIRT memory and information processing battery (BMIPB) (Coughlan, Oddy, & Crawford, 2007)) and the Trail making test (Reitan, 1958; Tombaugh, 2004) which is a measure of focused and alternating attention (for details on both measures see Appendix 1).

Mindfulness based intervention

The mindfulness group was focused on teaching patients mindfulness skills, using the approach described by Dunkley and Stanton (2014). It consisted of a course of 8, weekly sessions, each lasting one hour. Up to four patients could participate in a group and a new group began every two months. The group was facilitated by the collaborator who has been running the course for two years. Mindfulness skills and neurobehavioural functioning were measured before and after the group using the Five Facet Mindfulness Questionnaire (FFMQ) and Neurobehavioural Functioning Inventory (NFI), respectively. An outline of the group sessions can be found in Appendix 2.

Five Facet Mindfulness Questionnaire

The FFMQ (Baer et al., 2008) is a self-assessment tool (39 items), which was originally developed to assess five facets of mindfulness (Table 2) (Example of a questionnaire is in Appendix 3).

Table 2: *Explanation of the five facets of mindfulness measured by FFMQ*

Five facets of mindfulness	Content*
observing	paying attention to internal or external experiences (e.g. smells, sounds, emotions, ...)
describing	ability to use words to label internal experiences
acting with awareness	paying attention to the activity of the moment in contrast to doing things "on automatic pilot"
non-judging of inner experience	taking a non-judgmental stance towards own thoughts and feelings
and non-reactivity to inner experience	ability to observe and let go of the thoughts and feelings in contrast to getting caught up in them

*definitions taken from (Baer et al., 2008)

The facets were defined by factor analysis of combined results obtained from 614 students who filled other mindfulness questionnaires (five in total). The alpha coefficients (internal reliability) for all facets were in the range 0.72 – 0.92. The FFMQ questionnaire was later further validated on adults with symptoms of anxiety and depression (Bohlmeijer, Peter, Fledderus, Veehof, & Baer, 2011). So far, only one of the studies using mindfulness based interventions with patients with brain injury (Azulay et al., 2013) has used a mindfulness measure – Mindful Attention Awareness Scale (MAAS). The MAAS was not considered suitable for the presented study, because it covers only one out of the five FFMQ domains (acting with awareness).

Neurobehavioural Functioning Inventory

The NFI is an assessment tool (76 items) describing a wide spectrum of behaviours and symptoms commonly experienced by patients with brain injury in their everyday life (Marwitz, 2000). Seventy items of the inventory are organized into six factor scales (Table 3) (Example of a questionnaire is in Appendix 4).

Table 3: *Six scales measured by NFI*

Scale	Content*
Depression	hopelessness, anhedonia, social isolation and frustration
Somatic difficulties	headache, appetite difficulties, sleep disturbance
Memory / attention	problems with forgetfulness, confusion and poor concentration
Communication	difficulties with speech initiation and execution and reading and writing
Aggression	problems with being argumentative and/or verbally or physically abusive
Motor difficulties	difficulties with slowness or coordination and balance problems

*definitions taken from (Marwitz, 2000)

In addition, the NFI contains six "critical items" which identify areas that may require urgent interventions (e.g. seizures or blackout spells) (Marwitz, 2000). Validation of the scale revealed scale reliability coefficients (alphas) ranging from 0.87 – 0.95 (Kreutzer et al., 1996). The measure comprises both the patient's and the carer's versions of the questionnaire. The research shows general agreement between patient's and carer's recordings (Seel, Kreutzer, & Sander, 1997). In the present study, only the patient's version was used. In comparison with other brain injury outcome measures, the NFI shows fewer ceiling effects for patients with TBI assessed in the community for long-term follow up (Hall, Bushnik, Lakisic-Kazazic, Wright, & Cantagallo, 2001).

Procedure

Patients attending the mindfulness group were approached by the facilitator and asked whether they would like to take part in the study. Provided they expressed an interest and met the inclusion criteria, they were contacted by the researcher who answered any further

questions about the study. Participants had a choice of taking part in the quantitative study only or to opt in for both quantitative and qualitative parts.

Quantitative component (PART A)

For the quantitative component of the study, self-assessment measures (FFMQ and NFI) were collected up to two weeks prior to starting the mindfulness group and up to two weeks after the completion of the 8 weeks course of the group by the principal researcher solely for the purpose of the present study. The NFI scores of all participants were corrected on the basis of age and injury severity using normative data supplied in the manual (Kreutzer, Seel, & Marwitz, 1999).

Qualitative component (PART B)

For the qualitative component of the study, participants were asked to collect information about their use of mindfulness in everyday life between the sessions, starting from the fourth session. It was agreed with the group facilitator, that the first four sessions would give the participants enough guided practice within the group to enable them to practice confidently at home. Participants were given a personal voice recorder and instructed by the investigator on how to use the recorder.

In order to obtain the most accurate first person "in vivo" account of the experience and to compensate for memory problems often presented by people with ABI, a procedure inspired by the Descriptive Experience Sampling (DES) Method (Hurlburt & Akhter, 2006) was used to collect qualitative data. The participants were asked to record answers to a set of open questions whenever they noticed that they had used mindfulness in their everyday life between the sessions (see Appendix 5). An individual strategy was agreed with each

participant to remind them about the recordings between sessions (e.g. notices on the fridge). Following recommendations of the DES method, the investigator met the participants for a brief review after the first week to help them to understand the optimal desired level of details in their recordings.

Data analysis

For the quantitative component, the post group scores for both measures (NFI and FFMQ) were subtracted from the pre group scores in order to obtain a measure of change for each individual. Then, the data was checked for normality. Correlations between the change in mindfulness subscales' scores and the change in NFI subscales' scores were calculated. The demographic data and routine brain injury test scores were used post-hoc to address the secondary research aim of the quantitative component.

For the qualitative component, the recorded data were collected from the participants following the completion of their mindfulness group. They were transcribed by the investigator.

Several qualitative approaches are available to analyse the qualitative data. Their differences can be best understood through the research questions they are asking and their key features. As the aim of the qualitative part of the study was to understand the "lived" experience of mindfulness for a small group of people within a very specific context, it was decided, that the use of Interpretative Phenomenological Analysis (IPA) (Smith, 1996), would be the most appropriate. Other approaches were considered such as grounded theory or discursive analysis, but as the aim was not to develop an explanatory account of mindfulness or focus on the performance of mindfulness by the participants, IPA was felt to be the

method of choice (Smith, 2015). Clients with ABI form a very heterogenic group, where each individual presents with complex needs which vary according to the aetiology of their injury, time since the injury, their pre-injury level of functioning and available support (Prigatano, 1999). IPA as a methodology is suitable for such population as it is focusing on idiosyncratic enquiry, which examines each case in a detail and only after such examination, offers more general narrative. Transcripts were therefore analysed using IPA (Smith, 1996) which explores how people make sense of their experiences and what meanings these experiences hold for them. Using IPA to analyse the recording can provide a contribution to the debate about the process of mindfulness (Phillipot & Segal, 2009). It can also reveal specific issues related to the use of mindfulness by patients with ABI.

The investigator first listened to the recordings and read through the transcripts to note her initial observations and "bracket" her assumptions. Then, the transcript of each participant was annotated (for an example see Appendix 6), which led to identification of general themes for each participant. The final list of themes for the group was then generated and supported with text examples from the transcripts. Credibility of the analysis was then checked through supervision with a peer and a qualified clinical psychologist who both had previous experience using IPA.

Note – "researcher effect"

The authors were aware, that asking and reminding participants to record their experiences with mindfulness between the sessions could have improved participant's use of mindfulness skills and influence the results of the quantitative study. However, this effect was likely to be positive and beneficial for the clients (Carmody & Baer, 2008). This was felt to be acceptable as the aim of the study was not to evaluate the effectiveness of the group

sessions, but only to explore the relationship between change in mindfulness and change in neurobehavioural functioning.

Epistemological position

The manner of the study, in which participants were recording their experiences in context, with only minimal instruction and guidance from the researcher and the non-involvement of the researcher in the group itself, reflects the preference of the researcher for a post-positivist paradigm (Ponterotto, 2005). A post-positivist stance shares the same characteristics as the positivist approach in preferring an objective, detached researcher's role. However, the approach acknowledges that it is not possible to capture the "true reality". It acknowledges the impact of a researcher on the subject of research, while considering objectivity and independence between a researcher and research subject as important basis of the process (Ponterotto, 2005). This post-positivist position suits the IPA approach well as the researcher attempts to access an individual's cognitive inner world using careful and explicit interpretative methodology (Biggerstaff & Thompson, 2008).

Results – Part A

Participant demographics

Eighteen participants were recruited to participate in Part A of the study and six of them also agreed to take part in Part B. For various individual reasons (e.g. bereavement) one participant in Part A and two in Part B withdrew. One further participant in Part A was excluded as they suffered a second stroke during the study. Of the sixteen remaining Part A participants, 11 were male and their mean age was 43.3 years (SD 13.0), range 20 to 64. Further demographic details of those who completed both pre and post questionnaires are shown in Table 4.

Table 4: *Demographic data for the participants N=16*

Demographics	Values (SD) (range)
Ethnicity	
African-Caribbean	2
Asian	3
White British	11
Highest education	
Left school without qualification	2
GCSE	8
A levels	1
NVQ	3
BSc	2
Type of brain injury	
TBI	7
Stroke	5
Brain tumor	2
Anoxic brain injury	1
Arterovenous malformation	1
Time after brain injury – mean	19 months (7.58) (8 – 35)

All of the participants had been engaged in an individualized rehabilitation programme prior to the mindfulness group as well as during the study.

Self-reported measures of mindfulness and neurobehavioural functioning

Although the aim of the study was not to evaluate the effectiveness of the mindfulness group, it was assumed that attendance at the group would lead to same change in the self-reported measures. In order to explore how the scores on both self-reported measures (FFMQ and NFI) changed following the mindfulness group, paired sample t-tests were used to assess changes in measured pre-post variables (Table 5). The measured data passed the normality test (at $p > 0.05$). As the number of participants was small (16), bootstrap confidence intervals were calculated in addition to asymptotic statistical inference. The bootstrap confidence intervals are summarised in the last two columns of Table 5.

Table 5: *Pre vs post mindfulness group changes in FFMQ and NFI (N=16).*

Scale	Variable	M	SD	t	df	P	Cohen d	Bootstrap 95% conf. interval lower	upper
FFMQ[a]									
	Observe								
	pre	27.4375	6.26066						
	post	27.6250	4.60254					-2.998	2.062
	difference	-.18750	5.16680	-.145	15	.887	-0.03413		
	describe								
	pre	23.5625	7.49194						
	post	25.4375	7.22005					-4.187	0.498
	difference	-1.87500	4.89728	-1.531	15	.146	-0.25485		
	awareness								
	pre	25.0000	5.60952						
	post	28.2500	7.57628					-6.061	-0.6875
	difference	-3.25000	5.89350	-2.206	15	.043*	-0.48756		
	nonjudge								
	pre	23.0625	6.36101						
	post	22.6875	7.93909					-2.312	2.998
	difference	.37500	5.56028	.270	15	.791	0.052131		
	nonreact								
	pre	20.3750	6.45884						
	post	22.1875	5.63582					-4.1875	0.7500
	difference	-1.81250	5.52834	-1.311	15	.209	-0.29903		
NFI scaled score[b]									
	depression								
	pre	57.3750	11.06270						
	post	54.1875	10.16018					0.9375	5.811
	difference	3.18750	5.02286	2.538	15	.023*	0.300112		
	somatic								
	pre	53.5000	15.07758						
	post	52.3750	15.63276						
	difference	1.12500	4.36463	1.031	15	.319	0.073253	-0.8734	3.187

FFMQ = Five facet mindfulness questionnaire, NFI = Neurobehavioural functioning inventory

[a] increase in scores indicates improvement

[b] reduction in scores indicates improvement

*Indicates significance of the t-test for $p \leq 0.05$

Table 5: *Continued*

Scale	Variable	M	SD	t	df	P	Cohen d	Bootstrap 95% conf. interval lower	upper
NFI scaled score[b]	memory								
	pre	51.8750	11.64403						
	post	51.0000	11.62182						
	difference	.87500	6.47945	.540	15	.597	0.075218	-2.062	3.872
	communication								
	pre	54.2500	10.50397						
	post	51.4375	12.02203						
	difference	2.81250	6.04669	1.861	15	.083	0.249146	0.1250	5.625
	aggression								
	pre	54.1250	10.67630						
	post	50.9375	8.23382						
	difference	3.18750	7.06370	1.805	15	.091	0.334344	0.0625	6.747
	motoric								
	pre	55.6250	9.91211						
	post	53.0625	8.55156						
	difference	2.56250	6.18567	1.657	15	.118	0.276822	-0.625	5.248

NFI = Neurobehavioural functioning inventory
[b] reduction in scores indicates improvement.

Table 5 shows that although there was some improvement in mindfulness on all scales except for "nonjudgement", the only significant change was in "acting with awareness" ($p \leq 0.05$) on the FFMQ questionnaire, with a moderate effect size (as defined by Cohen (Howell, 2011)). Again, whilst the mean scores revealed improvements in all NFI subscales, "depression" was the only sub scale that showed a significant improvement ($p \leq 0.05$) with a small to moderate effect size (Table 5).

Consideration of the bootstrap confidence intervals highlighted two additional candidates for significant improvements on the NFI: "aggression" and "communication" scales. In neither case the bootstrap 95% confidence interval crossed 0. Bootstrapping

provides a way of accounting for the distribution distortions common in small samples that may not be representative of the population. Accordingly, the bootstrap confidence interval provides more robust estimate population parameters in small datasets that may violate parametric assumptions. Therefore it is reasonable to hypothesise, that with more data available, the paired t-test would also identify these two changes as significant (Howell, 2011).

Aim 1: Is an improvement in mindfulness related to improvement in neurobehavioural functioning?

Pearson correlation coefficient was used to calculate the relationships between the change variables calculated as the difference between the pre and post values of each scale. The results are summarized in Table 6.

Table 6: *Pearson Correlations Calculated For Changes In All Scales (N=16).*

		ch_observe	ch_describe	ch_awareness	ch_nonjudge	ch_nonreact
ch_depression	Pearson Correlation	.294	-.589*	-.404	-.091	-.316
	Sig. (2-tailed)	.269	.016	.121	.737	.233
ch_somatic	Pearson Correlation	.374	-.054	-.413	-.466	.333
	Sig. (2-tailed)	.154	.843	.111	.069	.207
ch_memory	Pearson Correlation	.286	-.174	-.046	-.187	-.353
	Sig. (2-tailed)	.283	.520	.865	.487	.180
ch_communication	Pearson Correlation	.180	.478	-.011	-.265	.426
	Sig. (2-tailed)	.504	.061	.968	.320	.100
ch_aggression	Pearson Correlation	-.151	-.269	-.466	.081	-.250
	Sig. (2-tailed)	.578	.314	.069	.765	.350
ch_motoric	Pearson Correlation	.500*	-.148	-.058	-.228	-.001
	Sig. (2-tailed)	.049	.585	.831	.397	.996

*denotes significant correlation for $p \leq 0.05$

Due to the small sample size, the following "cross-validation" procedure (resembling jackknife re-sampling procedure (Efron & Stein, 1981)) was used to evaluate the stability of the results. From the original sample 16 datasets were created by taking in turn one participant out of the sample. In other words, in each of the 16 datasets, one participant is missing. One would expect that if the measured effect on the 16 participants was significant, the effect should persist in most of the 16 datasets. Each item of Table 7 reports the number of datasets (out of 16), on which the correlation was found to be significant.

Table 7: *Cross-validation table. Each item reports the number of datasets showing significant correlations for the combination of change variables*

	ch_observe	ch_describe	ch_awareness	ch_nonjudge	ch_nonreact
ch_depression	0	16	0	0	0
ch_somatic	1	0	0	1	1
ch_memory	0	0	0	0	0
ch_communication	0	2	0	0	0
ch_aggression	0	0	2	0	0
ch_motoric	4	0	0	0	1

The most stable significant correlation was reported between the change in depression scale from the NFI and the change in ability to describe in FFMQ which was reported in all 16 datasets. Interestingly enough, although the full sample analysis in Table 6 shows correlation of 0.5 between the change in motoric complaints from NFI and the change in ability to observe on FFMQ (at $p \leq 0.05$), the significance of this result is down-weighted by the lack of stability (it could be reproduced only in 4 out of 16 subsamples).

Post-Hoc analysis

As the observed effect sizes of the pre-post changes in NFI and FFMQ were only small to medium and significant only in two cases, and the additional data (age, time after brain injury, results of BMIPB memory tests and Trials A and Trials B tests) were not

available for all of the participants, the study of predictors of change was very limited, making it impossible to draw any conclusions from this analysis. Its results can be found in Appendix 7.

Results – Part B

Participants

Originally, six of the participants opted to take home the voice recorders and take part in Part B of the study. Two of them returned the equipment without any recordings: one discontinued their participation due to personal reasons; the other did not specify their reason for non-recording. The remaining 4 participants were allocated a pseudonym. Two of them (Kelly and Rowena) attended the same mindfulness group, while Jack and Stan were attending different groups.

This section consists of demographic characteristics of each of the four participants (4 case studies) who took part in the qualitative study, together with their individual data collected for the quantitative part of the study. For each participant also a narrative account of the links between their qualitative and quantitative data is included. An overall summary bringing together quantitative and qualitative findings for the 4 participants highlighting their similarities and differences and relating these to the original aims of the study can be found at the end of the general qualitative data analysis.

Analysis of pre post changes for the four individuals

Prior to presenting the case studies, it should be noted that in order to understand any individual changes in questionnaire scores pre and post the mindfulness group, additional processing of the data needs to be carried out. Ideally, the reliable change index (Jacobson & Truax, 1991) would be used to explore the significance of any pre-post changes, but because the test-retest reliability data on the measures and their scales were not available, an

alternative approach was chosen. The process chosen focuses on giving clinical meaning to scores.

Kreutzer et al (1999) identified five categories in which the scores of an individual patient can be compared to matched peers, based on the distance from the mean expressed in terms of standard deviation (SD)(see Table 8). For the comparison purposes, a clinical rank was assigned to each category.

Table 8: *Definition of clinically meaningful ranks used in the study*

Category	**Clinical Rank**	**Scale Values and Range**	**Percentile Range**
Very High	5	> 1.5 SD above the mean	$\geq 93^{rd}$
High	4	>2/3 SD above the mean	$76^{th} – 92^{nd}$
Average	3	2/3 SD above or below the mean	$25^{th} – 75^{th}$
Low	2	>2/3 SD below the mean	$8^{th} – 24^{th}$
Very Low	1	>1.5 SD below the mean	$\leq 7^{th}$

Using the same philosophy, identical clinical ranks were computed for the scores from FFMQ, while the values of mean and standard deviation for each mindfulness facet were taken from the "Community non-meditators" sample (cite Baer, 2008).

Therefore, in addition to the scores and change in scores calculated for each participant, the three columns containing clinical ranks pre and post and change in clinical ranks are included. Please note, that while rank 5 in FFMQ means "Very High" ability, in NFI the rank 5 would denote "Very High" presence of problems. In the presented tables 9 -12, clinical changes which denote improvement are highlighted in green; those denoting a worsening are highlighted in red.

Case studies

All four participants were attending a milieu based out-patient rehabilitation service that consisted of group work and individual therapy sessions with an interdisciplinary team. All had suffered a brain injury at least 6 months before entering the study. Two participants suffered from strokes and two were victims of road traffic accidents. All of the participants were independent in personal care and daily living skills and all were independently mobile. Kelly and Rowena attended the same mindfulness group, Stan and Jack were attending different groups.

Kelly

"Kelly" was in her late forties, she had suffered a subarachnoid haemorrhage 16 months before taking part in the study. During the course of the mindfulness group she started to experience occasional seizures (around once a month), she thus also had a diagnosis of epilepsy and was receiving anticonvulsant medication. Kelly lived with her partner in their own house. Before her stroke she worked as a child-carer in an afterschool club and a child-play scheme. Her education included several O-levels, Level2 NVQ and Level 3 NVQ in childminding and other specialised child-minding trainings. Her main goals of rehabilitation included: to improve memory and social communication skills; to improve management of emotions (namely confidence, emotional lability and anxiety), management of fatigue and exploration of her vocational options. Her quantitative results are in Table 9.

Table 9: *Quantitative data measured for Kelly*

FFMQ	pre	post	change	pre clin	post clin	ch clin
observe	30	34	-4	4	5	-1
describe	27	23	4	3	3	0
awareness	20	24	-4	2	3	-1
nonjudge	27	35	-8	3	4	-1
nonreact	30	27	3	4	4	0
NFI	pre	post	change	pre clin	post clin	ch clin
depression	46	50	-4	3	3	0
somatic	63	66	-3	4	5	-1
memory	45	53	-8	3	3	0
communication	50	50	0	3	3	0
aggression	44	47	-3	3	3	0
motoric	51	61	-10	3	4	-1

According to the FFMQ data and applying the process described above by Kreutzer et al (1999), Kelly gained “very high” ability to pay attention to her experiences and improved from “low average” to “average” in her ability to act with awareness and notably improved on her ability to take non-judgemental stance towards her own thoughts and feelings. On the NFI scale her somatic problems worsened from “high” to “very high” and her motoric problems went from ”average” to “high”.

During the course of the mindfulness group Kelly started to have seizures. At the same time, according to her FFMQ results, she was getting better in her ability to pay attention to her experiences and the activity of the moment. Therefore her increase in post scores on somatic and motoric symptoms on NFI (difficulties with coordination and balance problems) might be explained by her focusing more on her somatic symptoms. Nevertheless, according to the transcripts, she felt the mindfulness exercises were helping her, and she used them in other aspects of her life i.e. to get relief when she started to have a headache, and also for relaxation before a difficult task.

Rowena

"Rowena" was in her early thirties and 35 months prior the mindfulness group she had suffered a stroke (right basal ganglia haemorrhage). She had been suffering intense nerve pain in her left arm since her stroke. She also had other health problems (diabetes and mild asthma). Before her stroke, Rowena worked as a pharmacy technician. Rowena still lived with her parents, which she identified, together with her pain as a source of stress. Her main goals of rehabilitation included: improvements in mobility, management of emotions (anxiety, self-esteem), fatigue management, improvement in domestic independence. Her quantitative results are in Table 10.

Table 10: *Quantitative data measured for Rowena*

FFMQ	pre	post	change	pre clin	post clin	ch clin
observe	23	27	-4	3	3	0
describe	24	25	-1	3	3	0
awareness	21	17	4	3	2	1
nonjudge	21	13	8	3	2	1
nonreact	13	23	-10	2	4	-2
NFI	pre	post	change	pre clin	post clin	ch clin
depression	67	69	-2	5	5	0
somatic	72	73	-1	5	5	0
memory	56	51	5	3	3	0
communication	51	45	6	3	3	0
aggression	46	42	4	3	2	1
motoric	61	57	4	4	4	0

Rowena's highest improvement on FFMQ scale is related to her ability to observe and let go of the thoughts and feelings where her ability improved from the "low" level to "high". On the other hand, her score ranks for acting with awareness and taking a non-judgemental stance towards own thoughts and feelings dropped from "average" to "low". On the NFI

scale Rowena's scores indicate an improvement in problems with being argumentative and verbally or physically abusive.

According to NFI – her depression and somatic difficulties were "Very High" (the highest of the four) and remained the same throughout the course. This was also observable from the transcripts, where Rowena used very frequently strong emotive negative words (e.g. see Appendix 6 where she talks about struggling and a lot of stress). In spite of this, she reported being less argumentative which would make sense given her improvement on FFMQ scale in ability to let go and observe her thoughts and feelings. In her recordings Rowena gave a very vivid account of the pain in her body as well as the sensory experiences related to pain during mindful meditation. She describes, how mindfulness does not get rid of the pain, it is serving more as a distraction. This might explain the lack of change in her somatic symptoms in spite of her praise for the mindfulness to give her a relief. It seems that rather than being relieved from the pain, Rowena now feels more in control of how she reacts (or chooses not to react) to it.

Stan

"Stan" was in his early fifties, he was a victim of a road traffic accident 29 months before the intervention. He suffered a closed head injury, resulting in a diffuse brain injury and many other injuries including fractures to his back and shoulders. He lived with his family in their own house. Prior to the accident Stan was working as a training officer and was also very physically active. His education included O-levels, one NVQ and several job related further qualifications. Following his brain injury, he experienced chronic pain and

insomnia. He identified the following main goals of rehabilitation: to improve his physical fitness, manage his fatigue and emotions, to improve his communication skills and explore the possibility of voluntary work. His quantitative results are in Table 11.

Table 11: *Quantitative data measured for Stan*

FFMQ	pre	post	change	pre clin	post clin	ch clin
observe	26	30	-4	3	4	-1
describe	25	27	-2	3	3	0
awareness	21	24	-3	3	3	0
nonjudge	28	21	7	3	3	0
nonreact	15	21	-6	1	3	-2
NFI	pre	post	change	pre clin	post clin	ch clin
depression	48	49	-1	3	3	0
somatic	32	40	-8	1	2	-1
memory	51	55	-4	3	3	0
communication	43	52	-9	2	3	-1
aggression	57	57	0	4	4	0
motoric	37	46	-9	2	3	-1

Stan's FFMQ scores indicate improvement in his ability to observe his internal and external experiences and a marked improvement in his ability to observe and let go of his thoughts and feelings. At the same time, the NFI scores reflect worsening of his somatic, motoric and communication problems.

Interestingly, this worsening of symptoms relates to all Stan's scores on NFI, which were initially below "average". On the other hand, the transcripts of his recordings do not reflect any increased pain or discomfort over the time. There are two possible factors which might have influenced the shift: first, the mindfulness group improved his ability to observe and pay attention to his experiences; second, attendance in the group and the rehabilitation centre might have shifted his subjective judgement of his physical difficulties. As a previously active sporting person, he might have felt that he originally underestimated his

difficulties. In contrast to Rowena, the marked 2 point improvement on the nonreact scale (from "very low" to "average") was not reflected in his aggression scores, which stayed on "high average". He also did not mention any problems with being argumentative in his recordings.

Jack

"Jack" was in his early fifties. He was struck by a car as a pedestrian 20 months before the study. He suffered a severe traumatic brain injury which included a right acute subdural haematoma and multiple brain contusions. In addition, he had other injuries which included fractures to his shoulders and spine. Prior to his accident Jack worked in the car industry in the same factory for 25 years. During the study Jack was in the process of deciding whether to accept early retirement. He lived with his wife, but his adult children were also very involved in his care. Jack identified the following goals of rehabilitation: management of his fatigue, memory and emotions (low mood), to improve communication skills and explore the possibility of return to work. His quantitative results are in Table 12.

Table 12: *Quantitative data measured for Jack*

FFMQ	pre	post	change	pre clin	post clin	ch clin
observe	26	24	2	3	3	0
describe	22	13	9	3	1	2
awareness	22	27	-5	3	3	0
nonjudge	26	31	-5	3	4	-1
nonreact	20	11	9	3	1	2
NFI	pre	post	change	pre clin	post clin	ch clin
depression	52	52	0	3	3	0
somatic	53	48	5	3	3	0
memory	51	57	-6	3	4	-1
communication	56	37	19	3	2	1
aggression	52	57	-5	3	4	-1
motoric	59	56	3	4	3	1

While before the beginning of the mindfulness group Jack's scores in all facets on FFMQ were in the "average" range, his scores after the group indicated "very low" ability to label internal experiences and observe and let go of the thoughts and "high" ability to take a non-judgemental stance towards his own thoughts and feelings. The results of the NFI questionnaire point to more problems with memory and being argumentative and less difficulties with communication and slowness and coordination.

Jack's brain injury was the most severe of all four participants in the qualitative study. Correspondingly, his understanding of the discussed topics was more literal and his communication was affected in a way that during conversations he very often went on a tangent and could be repetitive. This was also reflected in his recordings. With the exception of the "high" level of motoric problems in his pre NFI questionnaire, all other pre-scales report "average" levels. Rather than the true reflection of his abilities and difficulties this might reflect his lack of insight, which improved over the 8 weeks of the duration of the study and therefore his post scores are more accurate.

Qualitative analysis of the transcripts

Transcripts

The number and duration of short recordings from each participant are summarised in Table 13. All except one of Jack's recordings were made at home. Jack's recordings consisted mainly of broad descriptions of his activities during the day. It was therefore decided to also include his training session in the analysis (originally recorded for practice purposes only).

Table 13: *Total length of recordings for each participant*

participant	Number of recordings (total length in minutes and seconds)
Kelly	12 (19')
Rowena	5 (27' 19")
Stan	10 (17' 12")
Jack	8 (40' 6") + 1 practice (8' 23")

Findings and interpretation

The transcripts are rich in contextual information relating to participants' mindfulness practice including their expectations, the environment in which they practiced and the techniques they used. This description of context is followed by an analysis and interpretation of the main themes surrounding how they made sense of their experience of mindfulness.

Contextual information

All participants started their recordings with a description of what they expected from mindfulness (this might be linked to one of the prompts in their instruction "What did you hope to achieve?" (Appendix 5)). The most frequent expectation was that of relaxation and calmness, especially at the end of the day or during preparation for an important anxiety provoking event:

Rowena: *"[mindfulness] .. came at really really good time. Hm .. been struggling little bit with a lot of stress at the moment and I have a lot of problems at home ...", "I chosen this morning to do mindfulness ... because I've got to do some community access..."*

For some participants, calmness and relaxation lead directly to expectation of help with falling asleep and/or relief of pain. Kelly (line 2):

I chose to do mindfulness today as I was at my daughter's felt a bit overwhelmed got caught up in the moment with real bad head I thought I got to lie down on her bed which I did and I practiced mindfulness I hoped to achieve a bit of peace in my brain …I notice I was getting more relaxed as I was going there and afterwards I was much calmer with not such a bad head so it worked for me I needed to just take a bit of time out.

In all transcripts, practicing mindfulness is linked to a specific physical environment. It could be either a real or imagined room in the rehabilitation centre (Rowena and Kelly) or a specific quiet room in their house where they can have time for themselves (Rowena, Kelly, Jack). Stan always describes practicing mindfulness in his bed, lying in a very specific position, which helps to minimize pain. Stan: *"How I do this is: I'm laying in bed. I am comfortable. I have pillow between my legs I cuddle holder pillow, which enables me to be in a position that nothing aches."*

Participants mainly talk about doing a body scan and mindful (sometimes diaphragmatic) breathing (see Appendix 2) (Kelly, Stan, Rowena). Rowena also emphasized how she tried to let go of her thoughts (line 182):

I found that it was really easy today to block out all the thoughts that just kept coming. Ehm ... and normally I am very much aware of the fact that I'm trying to notice them and and then as X says, label them and then they'll just go away.

Jack describes how he turns on the TV with some waterfall or nature documentary and practices breathing.

Themes

Participants' areas of concern are reflected in the four themes summarised in Table 14. The table also shows subthemes reflecting more specific experiences of the participants.

Table 14: *Themes And Subthemes Interpreted From The Recordings Of The Clients.*

Theme	Subtheme	Participants contributing
Pain	Acting on body as a force, which can be dynamic	Jack, Rowena, Stan
	Ways of dealing with pain	Rowena, Jack, Stan, Kelly
Understanding / experiencing Mindfulness	As a treatment (similar to a pill)	Stan, Jack Rowena, Kelly
	As a physical space	Kelly, Rowena, Stan
	As a spiritual space / "zone"	Jack
	A relaxation technique	
Mindfulness as a state which has a distinct sensory quality	Sensations related to pain	Rowena
	Sensations related to mindfulness	Stan, Kelly
Mindfulness as a source of calmness and relaxation	Feeling of calm and relaxation	Rowena, Kelly, Jack
	Recharging of batteries	Kelly
	Relaxation as the main ingredient of mindfulness	Stan

Pain – acting on body as a force which can be dynamic

Participants described pain as an active force: Jack: *" the pain is now starting to get me, ...before the pain gets too much"*. Stan: *" the pain wakes me up"*. For Rowena, this force sometimes has the attributes of a living entity: *"the pain hasn't reared its head at a moment.","... My nerve pain is is struggling a bit ... does not seem very well managed ..and I'm in quite lot of excruciating pain at the moment."*.

Some of the participants describe vividly the dynamic nature of the pain, which they experience as active and changing e.g. Rowena: *"I am in quite a lot of excruciating pain. It's just almost as if the nerve pain feels as though somebody has just poured acid.. or chip fat really hot burning all over me in those places"*; and Jack: *" the pain seems to work its way up the leg, horrible, throbbing ..unbearable."*

– ways of dealing with pain

From their accounts it seems as if the pain had power over the participants and they were passively waiting, hoping for something (e.g. mindfulness, medication, injections) to take it away (e.g. Rowena: *"[I am]..in a lot and lot of pain at the moment waiting for ehm ...injections in my spine to start to get .. ehm ..give me some relief").* Only on one occasion Jack uses the words *"to kill the pain"*, which indicates an attempt of a "counterattack". Kelly also uses relatively active stance, when she talks about practicing mindfulness to take away her pain.

Rowena practices mindfulness with a hope that "it" would take the pain away. However, pain appears to be too powerful a force. When she tries to explain how mindfulness works she believes it works through distraction – it takes her mind off the pain (line 249):

> *I don't think it gets rid of the pain it just distracts me .. I think it just distracts me from from .. the constant intense feeling of pain it just takes your mind off it. Ehm ... which is great. That's what you need sometimes, isn't it. Just something to take your mind off it.*

Both Jack and Stan link their pain relief to sleep but in a different way. For Jack sleep provides an opportunity to detach from the painful reality: *"I will drop off to sleep before the pain gets too much."*, For Stan on the other hand, getting a few hours of sleep is enough to feel mentally stronger, which enables him to tolerate the pain. It almost seems that because he understands why he is in pain, he is realistic in his expectations (line 72):

I try to ...get to comfortable position that I don't have anything that aches. ...My mind feels refreshed. My body does not sometimes ... my body aches but that's that has been through all the injuries and everything bashes and bang bashed around. .. My body sometimes I ache but my mind is ehm ... quite fresh

Understanding / experiencing mindfulness – as a treatment (similar to a pill)

Participants talk about "using" mindfulness in a way which resembles using a treatment or a pill. Stan: *"I used mindfulness ... to help me relax and go to sleep"*, Jack (line 57):

I have had a nice 20 minutes session [of mindfulness] before started it's just doing a little bit of mindfulness which seems to have cleared a mind a bit. Had a couple of paracetamols because I had a headache .. but there again, not too bad.

– as a physical space, spiritual space or "zone"

When they talk about mindfulness, participants use the words like: "*going deeper into mindfulness*", "*to get into mindfulness*" (Kelly). Rowena: *"yes so I did the body scan mindfulness ...ehm... like I said last time ... I managed to get quite .. deep as I call it into ... into the session ehm", " when I when I came back out ehm ..it took me a while to get out of it .."* Here, they seem to be experiencing mindfulness as a physical space, or a kind of "zone", or "the stage of floating" (word used by Stan). Kelly (line 117):

...sort of feeling in a place where you are not actually here. Imagine ... anywhere I can describe it is it felt a bit like as if what the spirit would feel like when you're in

sort of two worlds ... you know I don't really know what's spirit is but that's what I could imagine.

For Kelly it is also a space where time passes differently: "*and [I] went into quite the deep concentrating state or I dunno what you call and mindfulness it felt like a couple of minutes but it must have been, looking at the clock, around 20 minutes*"

– as another relaxation exercise

For Jack, doing mindfulness means having relaxing time for himself, often with television on, when he ends up sleeping: *"I am just sitting here watching a bit of tele enjoying the peace and quiet."*;

Sat on a bed, ... nice and gently,... put story television on MTV and they have got a channel on there which was doing waterfalls and I thought that's quite pleasant so I sat there and listen to that for 10 minutes, and unfortunately for me I relaxed that much I fell asleep. ... An hour later my wife come and woke me up (line 4) .

Mindfulness as a state which has a distinct sensory quality

All participants (except for Jack) seem to have experience of mindfulness linked with unusual pleasant physical sensations. These sensations were either linked to their experience of mindfulness or they directly related to their pain.

– sensations related to pain

Rowena provides a very detailed description of the pleasant comforting feeling in her arm (line 192):

ehm .. I had quite a lot of the tingling ... in my left hand side where I normally get my nerve pain and quite a lot of the cold I think I have explained before I get almost like somebody's poured ice cubes into your veins is just like .. not the nasty ...it's quite a nice actually. It's just a bit of a comforting .. ehm.. just a bit of a cold chill going through your .... your veins and and specifically though. Not all over specifically to the area so like my face ehm .. quite a lot into my eye ..ehm .. halfway down my arm into my hand's fingers and a little bit one on my legs ...where I get really really chronic nerve pain.

- **sensations related to mindfulness**

Kelly describes her experience with mindfulness as a tingling, which she attributes to negative energy leaving her body (line 86):

I felt as if my arms were tingling especially at the bottom to the fingers and also in my bottom part of my leg and foot so it felt like there was negative energy leaving so maybe that's another part of it.

Stan talks about visual sensations, which are slowing down as he relaxes (line 38):

I get my eyes closed and I can see in my eyes like little shooting stars they are going across ever so quickly. These seem to over the time I am not trying to focus on them but I can see them but they get slower and less and I know then that I am slowing myself down and relaxing I need to relax I then I fall asleep.

Mindfulness as a source of calmness and relaxation

As mentioned earlier, participants frequently expressed expectations of relaxation and calmness at the beginning of their recordings. These expectations seem to be achieved and became a consistent message at the end of most recordings. The calmness and relaxation were not related to the pain in those who experience it, but rather they reflected a general state of mind.

Feeling of calm and relaxation

Rowena describes it as a powerful experience, using a paradoxical expression: *"... and I've had this overwhelming feeling of calm, which to be honest ... to be honest I still have now, which is probably about two and half hours later..."*

Recharging of batteries

For Kelly the feeling of relaxation and calmness is also linked to better concentration and a feeling of rejuvenation: *"it's around half an hour later and I do feel a lot more relaxed a bit more calmer and just concentrated at the moment in time" ; ".. 20 minutes since I practiced mindfulness and I do feel like a bit of a recharge of my batteries so it worked."*

Relaxation as the main ingredient of mindfulness

When Stan talks about his mindfulness practice he considers its main ingredients to be slowing down and allowing the relaxation to flow in*:"....it's just so simple to do as well. It's all about slowing everything down. Just you don't have to concentrate too hard on it either. Just let it happen, don't force it."*; *"It is it's all about relaxing, getting my muscles and everything just relax."*

More quotes supporting the presented themes can be found in Appendix 8.

Linking quantitative and qualitative findings for the four participants

Closer analysis of the qualitative and quantitative findings revealed much complexity in presentation of the clients and their personal understanding of mindfulness. It was surprising that the experience of pain unified the four participants; this had not been expected as pain management is not traditionally a specific aim of the group. One suffered neuropathic pain, one suffered from headaches and two suffered from overall pains from their multiple body injuries as well as headaches.

According to their recordings, pain was very prominent part of the life of the participants and management of pain was occupying a lot of their time. For all of them, management of pain was part of their narrative related to mindfulness. They either describe it as a motivation to start a mindfulness exercise (Kelly, Jack) or they describe sensations leading to relief from pain during their mindfulness practice (Rowena) or they talk about benefits of mindfulness as a tool, which helps them to tolerate the pain better (Stan). However, surprisingly, none of them identified it as one of the main goals of their rehabilitation. While Rowena and Kelly stated it in their NFI that their somatic difficulties were "very high", Jack's NFI somatic score was "average" and even Stan's clinically increased post somatic score was still only "low average". Without the qualitative part of the study the extent to which pain was linked to their mindfulness course could be underestimated.

On the other hand, all of the participants named emotion regulation and fatigue management as one of their rehabilitation goals, even though with the exception of Rowena (who scored "very high") on depression subscale; all 3 other participants scored "average" on the

depression scale. One of the reasons for this discrepancy might be the fact, that only depression symptoms (hopelessness, anhedonia, social isolation and frustration) are measured by the NFI rather than more generic emotion regulation problems which would also include worries, anxiety. The fourth theme interpreted from the recordings (Mindfulness as a source of calmness and relaxation) shows that each participant understood and used mindfulness as a tool for emotional regulation and fatigue management.

Interestingly, both Stan and Rowena (who were 29 and 30 months post injury, compared to Kelly and Jack who were 16 and 20 months post injury) improved markedly in their ability to observe and let go of the thoughts and feelings in contrast to getting caught up in them. This is in line with the post-hoc analysis finding reported in Appendix 7: the longer the post time injury the greater improvement in non reactivity.

The aim of the quantitative part of the study was to investigate whether an improvement in mindfulness is related to improvement in neurobehavioural functioning. While closer analysis of the results for the four participants revealed some individual links between improvements in FFMQ and NFI (e.g. Rowena's improvement in non-reactivity and lower scores on aggression), it was not possible to identify any commonalities in such links. On the other hand – qualitative analysis of the narratives from the four participants revealed how individual clients made sense of their experience, which fulfils the second aim of the study.

Discussion

The two main aims of the present study were to explore if there is a relationship between changes in aspects of neurobehavioural functioning and changes in different facets of mindfulness and to explore how participants made sense of their experience of mindfulness. Results suggested that a decrease in depressive symptoms was related to improved ability to describe. Qualitative analysis suggested that pain was a significant area of concern for participants and that mindfulness was associated with a distinct set of experiences.

Exploration of demographic variables suggested that initial scores on the NFI (with the exception of the depression scale) were in the "average" range based upon (Kreutzer, Seel, & Marwitz, 1999). The initial depression mean scale score fell in the "high" range. Comparison of the initial mean FFMQ scores with the four population groups used for validation of the questionnaire by Baer et al. (2008) revealed that the participants corresponded to the "community" sample of non-meditators. The only exception was the "ability to observe" scale, where the mean score was higher and closer to the "highly educated" non-meditators. A possible explanation is that in contrast to the healthy population groups studied by Baer et al., all participants of this study had an experience of a life-changing illness and had been engaged in an individual rehabilitation programme prior to their engagement in the group. Both these factors might have had an impact on their improved ability to pay attention to their internal and external experiences, a phenomenon normally observed in higher educated non-meditators of (Baer et al., 2008).

Quantitative data

Only two items showed a significant pre-post change following the mindfulness group i.e. awareness (from the FFMQ) and depression (from the NFI). Both changes indicated improvement (in skill and in symptoms respectively), albeit with small to moderate size effects. The measured significant improvement in depressive symptoms is in line with the improvements on the cognitive-affective domain of the Beck Depression Inventory (Bedard et al., 2003) and improvements in sadness / depressed feelings reported by Johansson et al. (2012).

However, when comparing our results with those of the four published studies where MBIs were used with brain injury patients, it is important to note that while they explored the effectiveness of MBIs, the presented study does not evaluate the effectiveness of the mindfulness group. Rather, it quantifies correlations between the changes in mindfulness and changes in neurobehavioural functioning. Only one of the four published studies used a mindfulness questionnaire (MAAS), but did not find any significant change (Azulay et al., 2013). We believe that using a mindfulness measure is important in order to check whether the clients understood and engaged with the concept. In the presented study participants showed improvement in four out of five domains of mindfulness, although only the change in ability to act with awareness was significant.

Only two of the four studies mentioned above (Azulay et al., 2013; Bedard et al., 2003) reported effect sizes on the selected measures. In the two studies (covering 10 and 12 weeks of MBSR programme, respectively) the reported effect sizes on the pre-post outcome measures were also in range of small to moderate.

Participants filling in the FFMQ questionnaire before attending the group might not have fully understood the questions in the same way as they did afterwards and this can be linked to small effect sizes measured in the present study. Even though the investigator was often present when the questionnaires were completed before and after the group, some participants did not ask any questions or preferred to take the questionnaires home. Furthermore, mean pre-NFI scores were mostly in the "average" range, (with the exception of depression) which might imply little room for improvement and explain the lack of change on the measure. Additionally, the emphasis of mindfulness on raising awareness could have caused higher sensitivity of the participants to their difficulties. Therefore, even though objectively their symptoms could have improved, the subjectively reported changes were relatively small.

Correlational analysis used in the present study showed that among 16 participants attending the mindfulness group, the pre-post decrease in depressive symptoms measured by NFI, was significantly correlated with an improved ability to describe (ability to use words to label internal experiences) as measured by FFMQ. This is in line with theoretical assumptions regarding mindfulness based cognitive therapy (MBCT) (Teasdale, Segal, & Williams, 1995), which state that processing based on "describing, accepting and or acknowledging the problem" may paradoxically lead to alleviation of problems in contrast to processing directly focused on solving problems. Due to the correlational nature of the presented study it is not possible to establish causal relationship between the improvements in the ability to describe and improvements in depression symptoms. However, it can be hypothesised tentatively, that an improvement in the labelling of inner experiences might be the first step towards a reduction in cognitive reactivity (ability to observe and let go of the

thoughts and feelings in contrast to getting caught up in them) to dysfunctional depressive thoughts. This reduction was shown to lead to better outcomes for people who attended a MBCT class, when compared to a maintenance antidepressant group by (Kuyken et al., 2010). Furthermore, in the present study, the ability not to react to inner experience, as measured by the FFMQ, showed a moderate effect size, even though the pre/post change was not significant.

Qualitative data

Application of IPA on qualitative data collected from four participants highlighted the presence of the following four themes: experience of pain; understanding / experience of mindfulness; mindfulness as a state with distinct sensory quality; and mindfulness as a source of calmness and relaxation.

Given that memory problems are common after ABI, a procedure inspired by the DES method (Hurlburt & Akhter, 2006) was used, instead of the more widely used semi-structured interview (Smith, 2007). Following the double hermeneutics principle of IPA, the investigator was aware that rather than conveying the "reality" of mindfulness, the themes revealed by the analysis represented her own interpretation of the participants' interpretations of the mindfulness phenomenon (Larkin, Watts, & Clifton, 2006).

The distinct identification of motives for practice of mindfulness at the beginning of each of the recordings highlights the aspect of *intention* as an axiom of mindfulness (S. L. Shapiro et al., 2006). The reported intentions to relax, to calm down, to achieve pain relief and to fall asleep are reflected in the results clients achieved with their exercises. They also correspond to the motives observed among meditators in the early stages of their practice.

Later stages would include shift towards self-exploration and self-liberation (D. H. Shapiro, 1992).

Participants described in considerable detail their experience with pain. The dominance and richness in the description of the experience of pain in the narrative of the participants was surprising and unexpected, as traditionally, rather than pain management, the aim of the mindfulness group in the ABI service was emotion regulation and relaxation. Prevalence of chronic pain among people with TBI and stroke survivors was found to be 75% and 45%, respectively (Kong, Woon, & Yang, 2004; Nampiaparampil, 2008). Participants in the present study describe pain as a force acting on them; they sometimes describe it as a separate dynamic entity, which can be (or they hope it can be) taken away from them. This is in contrast with findings of an IPA study by Smith and Osborn (2007) with patients suffering from chronic benign back pain, who were focussed on its debilitating impact on their self-concept. One possible explanation for this difference might be that people who attended the mindfulness group were better able just to "be with their pain" rather than to be defined by it. Mindfulness practice encourages the participants to observe the contents of their consciousness rather than to be embedded in it (S. L. Shapiro et al., 2006), Another possibility is that while patients with brain injury are aware of specific reasons for their pain, people with benign chronic back pain are often left with unanswered questions about its origin (Osborn & Smith, 2006).

Another theme, which became prominent in the recorded narratives was clients' personal "understanding / experiencing of mindfulness". This might be a direct result of the methodology used, where the participants were making recordings after they practiced mindfulness on their own. This isolated and repetitive nature of recordings provided a space

for the understanding of mindfulness to emerge without being influenced by a facilitator or a presence of other members of the group. Considering the length of time spent in a hospital following their brain injury, it is unsurprising that the first subtheme referred to "mindfulness as another treatment" (not dissimilar to a pill). Other presented subthemes included: mindfulness as a kind of physical space which can be "entered"; mindfulness as a spiritual "zone". Similar accounts can be found in the IPA analysis of patients with Parkinson's disease attending MBCT (Fitzpatrick, Simpson, & Smith, 2010). For example, one of their participants described her experience as "swimming with dolphins" (Fitzpatrick et al., 2010).

Interestingly, the next theme in the present study, "mindfulness as a state which has a distinct sensory quality", is quite unique among other qualitative studies of mindfulness. Three out of four participants described a positive sensory experience linked either directly to mindfulness exercise, or to their experience of pain during the exercise. This uniqueness may arise from three possible causes: (1) raised awareness of sensory experiences following mindfulness training, namely the body scan meditation (Kabat-Zinn, 2013); (2) higher alertness towards physical sensations (linked to anticipation of health problems or exaggerated sensation to touch) among people with brain injury (Headway, 2015; Mittenberg, DiGiulio, Perrin, & Bass, 1992); (3) coincidental development of a narrative of sensory experiences linked to mindfulness practice during the group sessions (both Rowena and Kelly attended the mindfulness group together) or during the discussions in the rehabilitation centre.

All participants described mindfulness as a "source of calmness and relaxation". This resonates with other studies, where, for example, participants identified "feeling peaceful" to be amongst the benefits of mindfulness (Chadwick, Newell, & Skinner, 2008; Fitzpatrick et

al., 2010). While relaxation and calmness are not primarily goals of mindfulness training, they have been reported as frequent positive "side-effects" of the practice (Kabat-Zinn, 2013).

The more comprehensive analysis of the results for the four participants using combined quantitative and qualitative methods revealed the diversity among people with ABI in terms of their presentation, understanding of mindfulness and progress they made during the eight weeks of the study. Linking information from qualitative part of the study to quantitative data led to more meaningful interpretation of the scores for each individual. However, overall, the data did not show any consistent or observable evidence for the first aim of the study, as there was no discernible link between improvement in mindfulness and improvement in neurobehavioural functioning. On the other hand, although the length of collected recordings was limited, it did provide evidence for the second aim of the study, i.e. a better understanding of how individual participants with ABI made sense of their experience of mindfulness.

Personal reflections on process

As mentioned earlier, the methodology used for collection of the qualitative data has not been used with the clients with brain injury before. Its "in vivo" nature, when the participants recorded their experiences within a short time after they happened, provided an opportunity to record authentic details which might not have been be available had the participants had to rely on their long term memory. However, the absence of an interviewer meant, that there was no opportunity to channel a narrative towards mindfulness experience when the participant became distracted (e.g. Jack's long listings of daily activities). Paradoxically, even without the interviewer present, the participants used a lot of positive

evaluations in their recordings, which give the impression that they felt they were giving feedback about the mindfulness group to the investigator who gave them the voice recorders. This is confirmed by the endings of many recordings, which contain phrases such as: “Thank you and good bye” or “See you tomorrow”.

Personal reflection on pre-conceptions

During the analysis, the author was aware of the resonance of the theme of pain with her own current personal experience with chronic nerve pain of a close member of her family. Discussions with her supervisors helped her to reflect, to become aware and to process her (sometimes physical) reactions to the narrative.

Limitations of the study

The major limitation of the presented study was the small number of participants in its quantitative component. As demonstrated in the results section, the small sample size had an impact on conclusions that could be drawn from the statistical analysis. Inconsistency in the provision of the additional information (memory tests and trails tests) meant that post-hoc analysis possibly underestimated effects of these parameters. Another limitation was linked to the use of FFMQ and NFI questionnaires. As mentioned earlier, the novelty of mindfulness concept before attending group sessions could mean that clients did not fully understand some questions in the pre-FFMQ questionnaire. Also, using only the client version of the NFI meant that the subjective results could have been negatively biased due to significantly improved awareness. Using the carer’s version of the questionnaire would provide more object information and could be used in addition, in the future.

Neurobehavioural functioning and adjustment to the brain injury improves spontaneously over time (O'Callaghan, Powell, & Oyebode, 2006). Therefore the lack of ability to control for changes in natural recovery over the duration of the mindfulness group is a major limitation of the design and it would not be possible to attribute any changes in functioning to the mindfulness intervention.

An additional limitation of the study lies in the selection of difference scores for the evaluation of change in a pre – post study. Linn & Slinde (1977) note that historically researchers were discouraged from the use of the difference score for the following three reasons:

1. The simple difference score usually has negative correlation with the pre-test score, which leads to overrepresentation of people with low initial scores among high difference scorers;
2. The difference score has a low reliability[1] and
3. ”Even when the same test is used at the pre- and post measurement at the time, it is sometimes possible that different constructs are measured at the two points in time” (Linn & Slinde, 1977),. In other words, introduction of the questions in the pre questionnaire can change the understanding and the attitude of the participants to the measured variables.

Linn and Slide (1977) recommend two other alternatives to address the first two of the listed reasons. They include the use of residual scores or estimated true change. While the use of residual scores (obtained by subtracting the predicted post-test score from the observed

[1] The word reliability in this section refers to the test-retest reliability

post-test score) resolves the first problem (because the correlation between pre-test score and residual score is zero), its reliability is still very small. The true change / gain scores can be obtained using multiple regression, given estimates of reliabilities of the pre-test and post-test measures as well as their variances and co-variances. The estimate can be improved with the use of other available measures along with the pretest and posttest measures. As the quantitative part of the study contained only very limited number of participants and measures, calculating the estimated true change was not considered as appropriate. When the change measures are used in correlational studies, Linn and Slide (1977) recommend using partial correlations rather than correlations involving difference scores.

On the other hand, Rogosa, Brandt, & Zimowski (1982) claim that the often cited deficiencies of the difference score are "more illusory than real". They claim that when "non negotiable individual differences" in the change score are observed (which is also the case for the present study – see Appendix 9), the reliability of the difference score is "respectable". These authors conclude that residual change should not be used in place of the difference score if the only motivation is the reliability and correlation with initial status (reasons 1 and 2 above). In order to improve the measurement of change they recommend the use of more than two measurements ("multi-wave data"), which would provide additional information (Rogosa et al., 1982).

Therefore, because the measured data in the qualitative part of the study show "non-negotiable individual differences", the author believes, the use of the simple difference score for the evaluation of change in the pre post measures was appropriate. However, the quality of the results could be improved by multiple measurements.

The major limitation of the qualitative part of the study was the lack of strategies to remind the participants to make recordings. Whilst these provided quite 'rich' accounts of their experiences, ideally, longer total recordings (of about 45 minutes to one hour) from each participant would provide more material for IPA analysis (Pietkiewicz & Smith, 2014).

Programs teaching clients mindfulness skills usually start with exercises such as mindful breathing or body scan (see Appendix 2). Participants are later encouraged to start using the skills also in their everyday life. The results show that all four clients recorded solely experiences with their mindfulness exercises, rather than instances where they would use mindfulness in everyday tasks. This might be a coincidence or it might be a reflection of the early stages of their training. Recordings reflecting practice of mindfulness during everyday tasks (e.g. mindful tooth-brushing) would enrich and deepen future studies.

Future suggestions

As reflected in the qualitative part of the study, pain seems to be very prominent feature of recovery from ABI. The present study suggests that attending the mindfulness group impacted on how the participants experienced and dealt with their pain. Lessons learned from the presented study could be utilised in an RCT, which could investigate the effects of mindfulness on attitudes to pain among patients with ABI. This could be achieved by: addition of quantitative measures exploring attitudes towards pain before and after the mindfulness group; addition of two control groups e.g. a treatment as usual and relaxation/active control group (to establish the unique aspects of mindfulness vs. relaxation) and randomisation to treatment conditions. In order to provide sufficient numbers of participants in a rehabilitation centre setting, the study would need to be conducted over a prolonged period of time. To increase reliability of the results and to obtain more accurate

estimate of change, multiple (more than two) measurements of the variables during the course of study are recommended. The qualitative component could be maintained for both the mindfulness and the relaxation group as this would contribute to a better understanding of the processes specific to mindfulness vs. ABI.

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PUBLIC DOMAIN BRIEFING PAPER

Executive summary

This document provides a summary of two research components (systematic review and an empirical paper) of the theses that were submitted in Partial Fulfilment of the Regulations for the degree of Doctor of Clinical Psychology at the University of Birmingham.

Overall context – Mindfulness based interventions

Training in mindfulness skills has become increasingly popular among various groups of clients. The operational definition of mindfulness is "the awareness that emerges through paying attention non-judgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2013). It can be cultivated and developed through meditation. One of the first protocol-based intervention programmes developed on these principles, was the Mindfulness Based Stress Reduction Programme (MBSR) originally designed for management of stress and pain caused by chronic health conditions (Kabat-Zinn, 2013). Another similar programme teaching clients mindfulness skills has been developed by Dunkley and Staton (2014).

There is growing evidence available documenting the effects of mindfulness on cognition and affect in various clinical and non-clinical populations. At least five different authors have proposed models explaining the mechanism by which an improvement in mindfulness skills, leads to behaviour change and symptom reduction.

The thesis consists of two parts which aim to contribute to better understanding of mindfulness in two specific areas. The first part systematically reviews available evidence regarding the effects of MBSR on sleep disturbance. The second part explores some aspects of mindfulness training with people with acquired brain injury.

Systematic review: The effects of Mindfulness-based stress reduction on sleep disturbance

Introduction

Insomnia and sleep disturbance are common problems, which can have a profound impact on health and quality of life. Eight years ago Winbush, Gross and Kreitzer published systematic review exploring the effects of MBSR on sleep disturbance. They reviewed seven studies, with only one of them a randomised control trial (Winbush, Gross, & Kreitzer, 2007). In view of recent increase in the popularity of mindfulness interventions and growing volume of research, the aim of present study was to review the evidence available of randomised control trials in this area since Winbush et al's review.

Methods

The following databases were searched in December 2014: CINAHL, PsycINFO, MEDLINE and Embase using criteria based on those defined by the original paper. Inclusion criteria covered: randomised control trials using MBSR programme or similar, studies using objective and/or subjective sleep outcome measures with adult population and published as full papers. A modified version of Delphi list of criteria (Verhagen et al., 1998) was used to assess quality of the papers.

Results

Initially, 181 articles were identified for review and 19 of them met the inclusion criteria. The quality of the papers varied, most of the papers achieved ranking five or more

(out of eight) on the defined quality scale. Studies were divided into five groups according to the conditions targeted by the mindfulness intervention: primary insomnia, cancer, emotional problems, long term physical health issues and stress related to workplace or caring duties. Unfortunately, the studies presented a very mixed picture and no clear conclusions could be drawn about the effectiveness of the intervention on the sleep disturbance in any of the groups.

Conclusions and recommendations

The study identified the following possible reasons for the inconclusive results: lack of objective sleep measures used (only five out of 19 studies used objective measures), high variability of the subjective measures which made it difficult to compare the results, baseline levels of sleep problems which were not necessarily high enough to leave a substantial room for potential improvement. Lastly, lack of the use of mindfulness measures and home practice monitoring prevented attributing possible improvements to the mindfulness intervention. Recommendations for future studies include: use of both objective and subjective sleep measures and inclusion of measures of mindfulness and mindfulness practice.

Empirical paper: Does improving mindfulness impact on neurobehavioural functioning?

Introduction

The term brain injury covers traumatic brain injury as well as other types of acquired brain injury including: stroke, viral infection, hypoxic injury and tumour. It can lead to

impairments in memory, executive functions and learning. Other possible consequences include chronic pain and problems with sleep. Whilst physical problems often resolve in the first two years following a brain injury, social integration can still be difficult due to persistent cognitive, behavioural and psychosocial problems. Training in mindfulness skills has the capacity to target both psychological and emotional problems and therefore might lead to improvements in quality of life among people with brain injury.

However, to date, there has been just four quantitative studies in total, using mindfulness based interventions (MBI) with this population. Two of these were randomised control trials with one showing no effect and one showing a significant effect (Johansson, Bjuhr, & Rönnbäck, 2012; McMillan, Robertson, Brock, & Chorlton, 2002); and two were pre/post designs (Azulay, Smart, Mott, & Cicerone, 2013; Bedard et al., 2003).

Aims

The present study aimed to contribute to the available evidence regarding the use of mindfulness techniques with people with acquired brain injury (ABI) using a mixed method approach. The quantitative component of the study (Part A) explored the relationship between changes in mindfulness skills and changes in neurobehavioural functioning, while the qualitative component (Part B) of the study explored, how individual clients with ABI made sense of their experience with mindfulness.

Methods

In Part A, the study used correlational and simple regression analysis, in Part B the results were analysed using Interpretative phenomenological analysis (IPA). Sixteen clients with ABI, who attended a mindfulness group (following the programme designed by

Dunkley & Stanton (2014)) as a part of their rehabilitation in a regional rehabilitation day service, took part in the Part A of the study and filled two pre- and post- questionnaires: Neurobehavioural Functioning Inventory (NFI) and Five facet mindfulness questionnaire (FFMQ). Four of those also participated in Part B, where they were given voice recorders and asked to make a recording whenever they found themselves using mindfulness in their everyday lives.

Results

Results suggested that a decrease in depressive symptoms (measured by NFI) was related to improved ability to describe (measured by FFMQ). The data also indicated, that the longer the time post brain injury the greater improvement in non-reactivity (FFMQ). Qualitative analysis identified four themes: "pain"; "understanding / experiencing of mindfulness"; "mindfulness as a state with distinct sensory quality" and "mindfulness as a source of calmness". The major limitations of the study were: small number of participants (16) and relatively short total recorded times per each participant in Parts A and B of the study respectively.

Conclusions / Recommendations

In future similar studies, it is recommended to use both client version and carer version of NFI, as it was hypothesised that small observed changes in NFI scales following the mindfulness group could have been caused by significantly improved awareness. As far as the authors are aware, this was the first study using qualitative approach exploring experiences of people with brain injury with mindfulness. It was observed that pain was a

significant area of concern for the participants. In possible future studies with people with brain injury the inclusion of pain attitude questionnaire would be beneficial.

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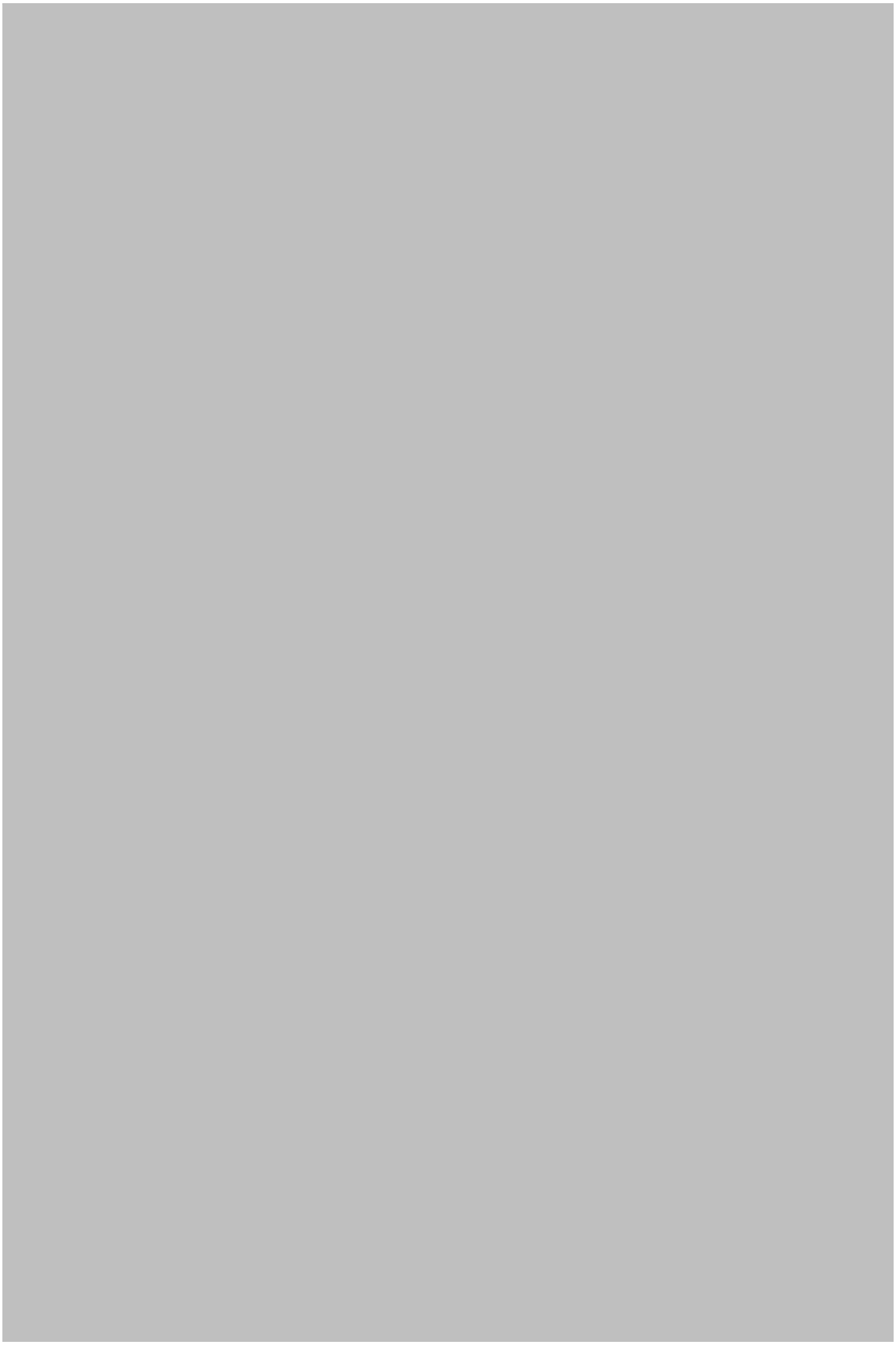
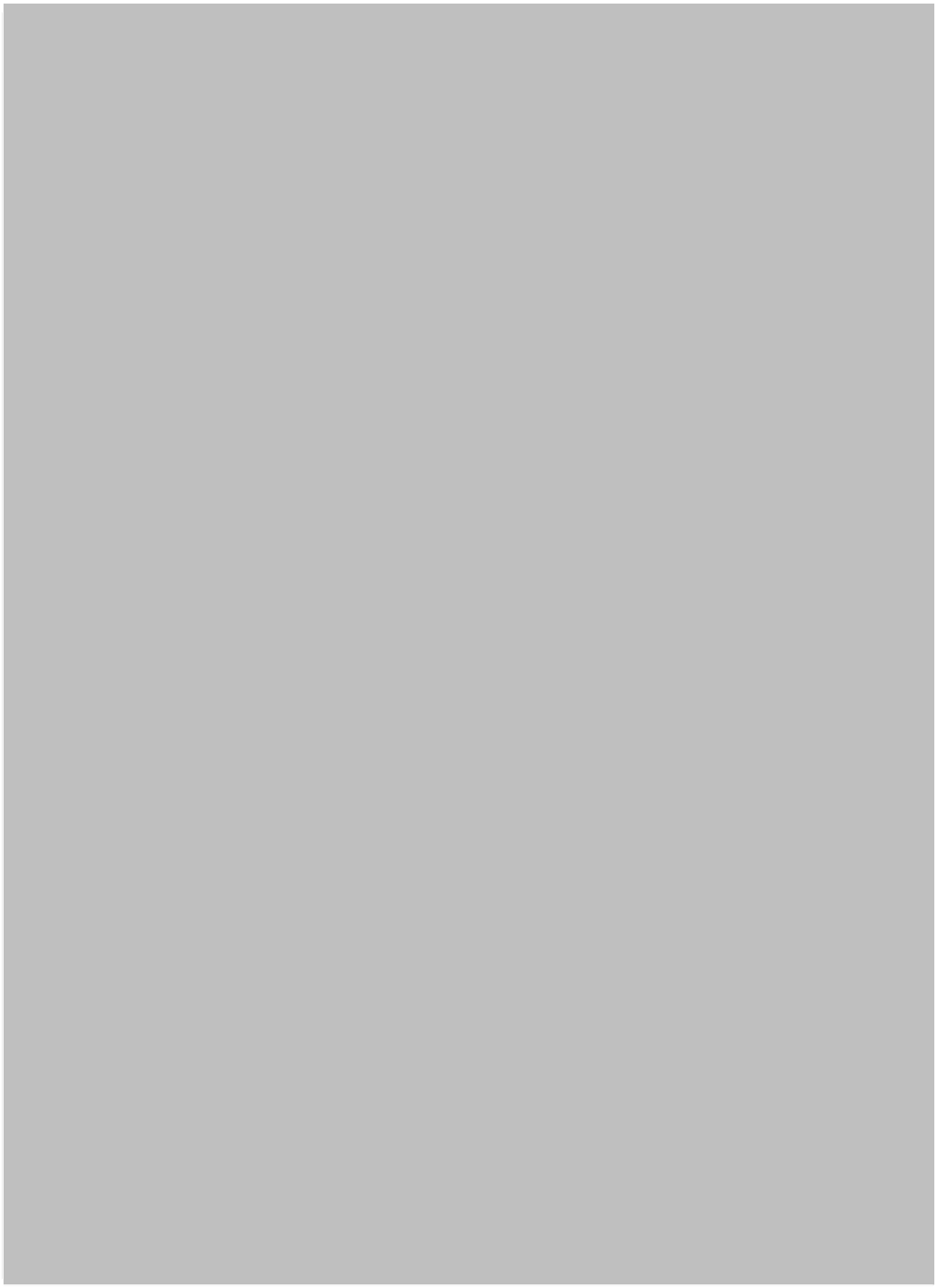
APPENDICES

Appendix i :EXPLORE guide for authors



Appendix ii: Brain Injury – guide for authors



Appendix 1 – cognitive assessments

BIRT memory and information processing battery (BMIPB)

The BMIP was developed by revising and extending the original Adult Memory and Information Processing Battery (AMIPB) (Coughlan & Hollows, 1985). It consists of three verbal memory tasks, three visual memory tasks and a speed of information processing task. UK norms were calculated using a set of 300 adults age 16 – 89, who matched the UK general population for age, education level and gender. The test-retest reliability of the tool is 0.6 – 0.89 (Coughlan et al., 2007). In the presented study only the list learning and information speed processing subtests were measured. The List learning task consists of three sub-tasks: immediate recall of a list of 15 words, using the same list five times consecutively (BMIPB A1-A5 score); immediate recall of a new list of 15 words (BMIPB B score) and delayed recall (after distraction) of the original list of 15 words (BMIPB A6 score). The Information speed processing task score reflects the speed with which the participants can complete a simple task (crossing the second highest number in a set of 6 numbers), corrected for the motoric ability to cross a number (BMIPB speed score).

Trail Making Test (TMT)

The TMT consists of two subtests; firstly the client has to connect numbers distributed across a page in ascending order (Trails A score). Secondly, alternating numbers and letters are connected (Trails B score). Normative data included 911 individuals age 18 – 89 (Tombaugh, 2004). Sanchez-Cubillo et al (2009) investigated mechanisms underlying performance on the tests and concluded that Trails A tests mainly visuo-perceptual abilities, while Trails B tests primarily working memory (secondarily for task-switching abilities). Historically, the TMT has also been seen as a correlate of the severity of brain damage (Reitan, 1958).

Appendix 2 – Mindfulness training

Brief programme of the 8 weeks mindfulness group at the rehabilitation centre based on (Dunkley & Stanton, 2014)

Mindfulness training consists of: orienting the client to the mindfulness skill; obtaining and using client feedback effectively; introducing simple mindfulness practises; teaching clients to utilise mindfulness in everyday life and case scenarios practically demonstrating the skills (Dunkley & Stanton, 2014).

Week 1: ground rules, what is mindfulness, basic body scan and mindfulness of breathing, how to practice at home

Week 2: reminder what is mindfulness, use of metaphor (clouds, leaf), practice body scan and mindfulness of breathing

Week 3: adapting mindfulness in everyday life e.g. leaf task; practice body scan and mindfulness of breathing

Week 4: adaptations to mindfulness of breathing e.g. counting the breath, practice body scan and mindfulness of breathing

Week 5: adaptations to mindfulness e.g. adding background music to help tinnitus, practice body scan and mindfulness of breathing

Week 6: further discussion of adapting mindfulness and practicing mindfulness in daily life situations, practice body scan and mindfulness of breathing

Week 7: adapting mindfulness in everyday life e.g. raisin task; practice body scan/mindfulness of breathing

Week 8: recap of 8 weeks, practice body scan and mindfulness of breathing, how to continue own practice, group evaluation

If clients attend the group for more than one timetable then more activities related to practicing and applying mindfulness during everyday life are added.

Body Scan meditation (Kabat-Zinn, 2013)

Clients practice meditation in sitting position when they attend the mindfulness group, but at home it can be practised by lying on the back and moving one's mind systematically through the different regions of the body.

The exercise starts with the left foot and the attention is slowly moved to the different regions of the foot and the left leg. During the exercise the participants are instructed to fill each region of their body with their full awareness, noticing all sensations they might encounter. This way the exercise moves the attention through to the hip, then back to the toes of the right foot up, through the torso, low back, abdomen, the upper back and chest, through the shoulder blades to the left arm and right arm.

Mindful breathing mediation (Kabat-Zinn, 2013)

Clients are encouraged to focus their attention on their breathing and focus their attention on the sensations associated with breathing. They are invited not to modify their breathing, just to pay attention, without trying to control it or think about it. If their mind starts to wonder, they areinstructed just to notice it and bring the attention gently back to their breathing.

References

Dunkley, C., & Stanton, M. (2014). *Teaching Clients to use mindfulness skills.A practical guide* East Sussex, UKNew York, NY, USA Routledge.

Kabat-Zinn, J. (2013). *Full catastrophe living, revised edition: how to cope with stress, pain and illness using mindfulness meditation*: Hachette UK.

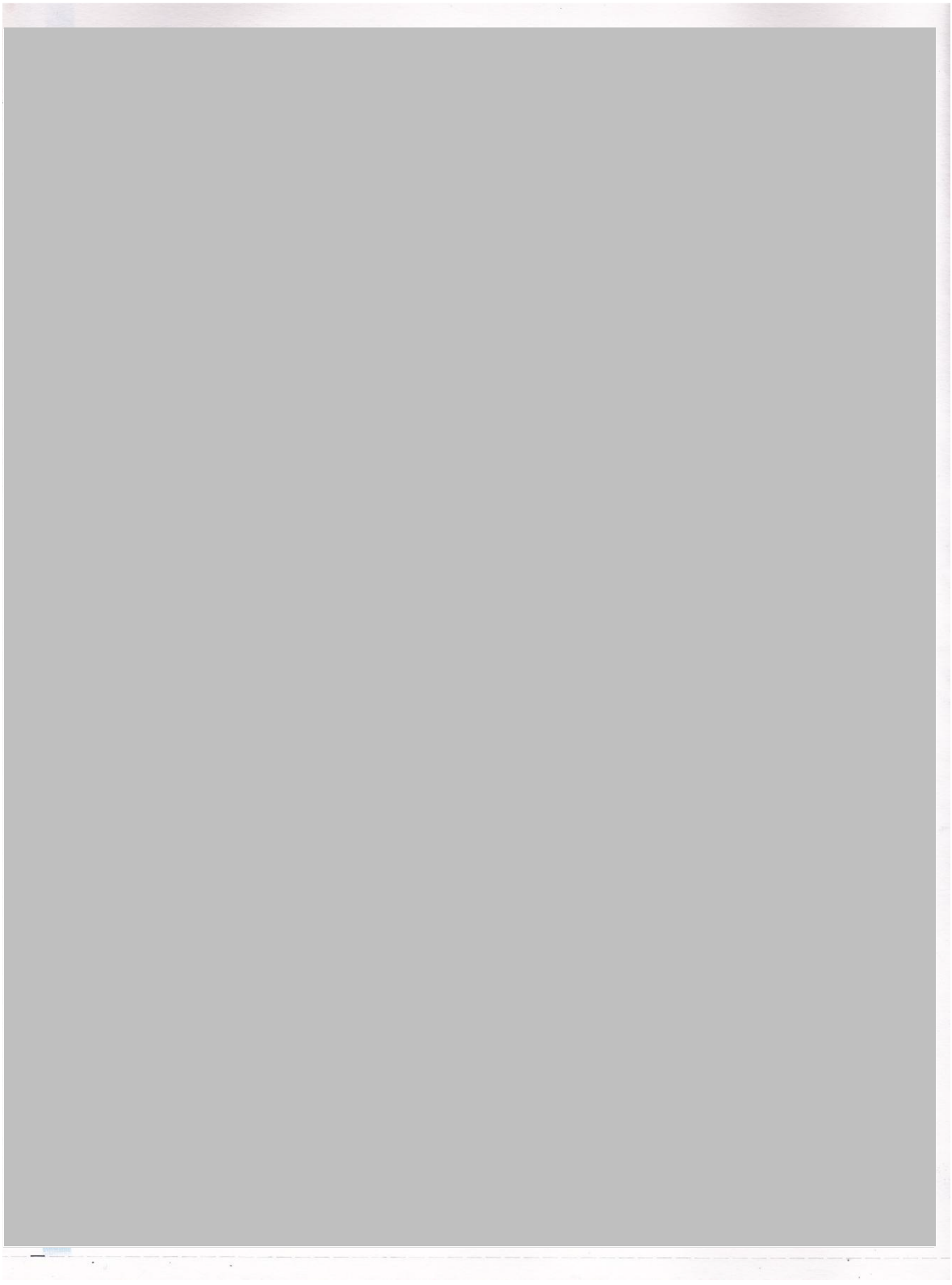
Appendix 3 Five Facet Mindfulness Questionnaire

Please rate each of the following statements using the scale provided. Place a tick in the column that best describes your own opinion of what is generally true for you.

	Never or very rarely true	Rarely true	Sometimes true	Often true	Very often true
1. When I'm walking, I deliberately notice the sensations of my body moving.					
2. I'm good at finding words to describe my feelings.					
3. I criticize myself for having irrational or inappropriate emotions					
4. I perceive my feelings and emotions without having to react to them.					
5. When I do things, my mind wanders off and I'm easily distracted.					
6. When I take a shower or bath, I stay alert to the sensations of water on my body.					
7. I can easily put my beliefs, opinions, and expectations into words.					
8. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.					
9. I watch my feelings without getting lost in them.					
10. I tell myself I shouldn't be feeling the way I'm feeling.					
11. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.					
12. It's hard for me to find the words to describe what I'm thinking.					
13. I am easily distracted.					
14. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.					
15. I pay attention to sensations, such as the wind in my hair or sun on my face.					
16. I have trouble thinking of the right words to express how I feel about things					
17. I make judgments about whether my thoughts are good or bad.					
18. I find it difficult to stay focused on what's happening in the present.					
19. When I have distressing thoughts or images, I "step back" and am aware of the thought or image without getting taken over by it.					

	Never or very rarely true	Rarely true	Sometimes true	Often true	Very often true
20. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.					
21. In difficult situations, I can pause without immediately reacting.					
22. When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words.					
23. It seems I am "running on automatic" without much awareness of what I'm doing.					
24. When I have distressing thoughts or images, I feel calm soon after.					
25. I tell myself that I shouldn't be thinking the way I'm thinking.					
26. I notice the smells and aromas of things.					
27. Even when I'm feeling terribly upset, I can find a way to put it into words.					
28. I rush through activities without being really attentive to them.					
29. When I have distressing thoughts or images I am able just to notice them without reacting.					
30. I think some of my emotions are bad or inappropriate and I shouldn't feel them.					
31. I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.					
32. My natural tendency is to put my experiences into words.					
33. When I have distressing thoughts or images, I just notice them and let them go.					
34. I do jobs or tasks automatically without being aware of what I'm doing.					
35. When I have distressing thoughts or images, I judge myself as good or bad, depending what the thought/image is about.					
36. I pay attention to how my emotions affect my thoughts and behavior.					
37. I can usually describe how I feel at the moment in considerable detail.					
38. I find myself doing things without paying attention.					
39. I disapprove of myself when I have irrational ideas.					

Appendix 4 – Neurobehavioural Functioning Inventory



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Appendix 5

INSTRUCTIONS FOR THE PARTICIPANTS

Title of Project: **Does improving mindfulness impact on neurobehavioural functioning?**

For clients participating in Part B of the study
Researcher: Maria Tinova

Thank you very much for agreeing to participate in our study. During the last two weeks you were given a personal recorder and a member of our team showed you how to use it in order to make short recordings.

We would like to ask you to use it during the week, between the sessions of your Mindfulness Group, **whenever you notice that you have used any of the mindfulness skills you learned**. When you are recording the experience, please try to answer the following five questions:

- Why did you choose this moment to use mindfulness?
- What did you hope to achieve?
- How (in what way) did you practice mindfulness just now?
- What were you noticing while you did it?
- What were you noticing afterwards?

Please remember, that there are no right and wrong answers, we are interested in your authentic experience. It may help us better understand how mindfulness affects your everyday life. You can make as many recordings as you want, and we will send you a text message twice a week to remind you to use your recorder.

Following the first week of recordings, you will have an opportunity to meet with Maria to discuss your recordings and ask any questions. We will ask you to return the recorder together with all recordings when your Mindfulness Group sessions finish. The data will be anonymised, transcribed and original recordings will be deleted.

Appendix 6 – hand annotated section of the transcript

R1

Hello this is R. Ehm ...Its Monday the 30th of June. This morning I chose to use mindfulness as it was part of my timetable but it came at really, really good time. Hm ..Been struggling a little bit with a lot of stress at the moment and I have a lot of problems at home, I am living with my parents which is quite stressful ... so it's been causing me a lot of grief and upset and I've had a really bad weekend with it I found myself very very uptight and mightered today so it felt I felt it had come at a really really good time and sometimes I struggle with mindfulness I struggle to get my head straight so that I at the point where I'm not thinking about anything else just just now ehm ... I always find that as soon as I tried not to think of anything ... all that goes through my head is everything it's not even stuff that it's important but ....that's what normally happens and today when I did it ....I did it was S and with Karen. To begin with I will be honest it was the same ... I felt I was having quite a lot of of the issues being thrown in my head but I think today I am, whether I handled it better or whether I was more in need of the mindfulness than normal but ...I've found it really really helped. Ehm ... I found that after probably about five minutes the extra thoughts and the worries and things that were drowning me a little bit started to not be as important so I would drift away a little bit so ... I felt incredibly calm and it was wonderful really and it was funny because ... normally I'm one of the first to come back around to open my eyes and be fully aware of what's going on, but today I was the last I think I got into it that deeply which was really lovely. Ehm ... and I've had this overwhelming feeling of calm which .....to be honest I still have now which is probably about two and half hours later... ehm.... when we were doing the body scan ...with S ...ehm ... I suffer from chronic nerve pain which is always a major issue for it's quite a bit stressful as no matter on what amount of medication I'm on it never seems to ease ease the pain ..... but it's something that has happened a couple of times before when I have done mindfulness and really really found that it's helped me. Ehm ... it's hard to describe I can't ... had the stroke and it

affected their left-hand side and ....to touch I can't feel anybody touching my left-hand side, but at like I said I do suffer a really chronic nerve pain but ....when I do mindfulness and when I do really really manage to relax myself and clear my mind of everything I always find that I have the strangest cold feeling as somebody just poured cold water a freezing cold water into my vains is not unpleasant ... it's quiet relaxing and calming actually. And I felt that happened today as well which .. I'm still getting the feeling of coldness and almost not tickly but very .. heightened sensation ehm..where is normally all I get is pain touch wood, the pain hasn't ~~really~~ reared its head at a moment so ...maybe and hopefully the mindfulness will get really get into it seems to be helping with the nerve pain as well. I'm only hoping that maybe it will help my sleeping I have had quite bad insomnia since I had my stroke to do with the pain and ...anxiety and things so I'm hoping that maybe since I had such a good session earlier hopefully it's ...a it might .. hah ..hopefully give me give me some relief and give me some sleep I hope so all I can do is try but now I am I am I found it probably one of the most successful sessions that I have done the body scan with S. It's probably one of that ones which I felt that I got really into and it really really affected me and a ... wee tingling and the cold feeling were my nerve pain is hasn't gone away yet which normally if it happened it's gone away quite quickly. So like I said it's probably about 3 4 hours on and ... I still got the tingling and I still got the coldness ehm ... I'm still feeling quite calm, I do have problems with headaches I can feel a headache coming on but I'm going to go to have a lie down and.. and .. hopefully do my mindfulness again to see the again before I go to bed ..ehm ...will see anyway. That's about it at the moment. Okay.

R2

Hello it's Tuesday, the 1st of July. I chosen this morning to do the mindfulness body scan because ehm ... I've got to do some community access today at my rehab so that means going out ehm ..in my case going to

Appendix 7: Post-Hoc Analysis

For most of the clients, additional data collected before their attendance of the mindfulness group were available. The data included the following factors: age, time after the brain injury (in months), results of BMIPB memory tests and Trails A and Trails B tests, measuring ability to concentrate, primary working memory and ability to switch attention between the tasks. The following post-hoc analysis was used to explore the possible relationship between these factors and the change variables. First, Pearson correlation coefficients were computed between the factors and change variables (Table 1). Then, for pairs exhibiting significant correlation, linear regression analysis was performed (Table 2). In both tables N denotes the number of participants for whom the data were available.

Table 1: *Correlations between the change variables and various factors measured prior to mindfulness. The number of participants included in the calculation of each correlation is denoted with N*

		age	time since injury	BMIPB_ A1_A5	BMIPB_ A6	BMIPB _B	BMIPB _speed	Trails _A	Trails _B
ch_observe	Pearson Correlation	-.201	.028	-.056	-.157	-.049	-.513	.793**	.685*
	Sig. (2-tailed)	.455	.918	.856	.608	.874	.129	.006	.042
	N	16	16	13	13	13	10	10	9
ch_describe	Pearson Correlation	.162	-.108	-.029	-.137	.268	.113	-.358	-.142
	Sig. (2-tailed)	.548	.691	.926	.655	.376	.757	.310	.715
	N	16	16	13	13	13	10	10	9
ch_awareness	Pearson Correlation	-.419	-.035	-.054	.120	.036	.143	-.191	-.341
	Sig. (2-tailed)	.106	.899	.861	.697	.907	.694	.597	.369
	N	16	16	13	13	13	10	10	9
ch_nonjudge	Pearson Correlation	.062	.262	.182	.473	-.526	.567	-.156	-.507
	Sig. (2-tailed)	.818	.327	.552	.103	.065	.087	.666	.163
	N	16	16	13	13	13	10	10	9
ch_nonreact	Pearson Correlation	.300	-.616*	.092	.398	.031	.041	-.288	-.350
	Sig. (2-tailed)	.259	.011	.765	.178	.919	.911	.420	.355
	N	16	16	13	13	13	10	10	9
ch_depression	Pearson Correlation	-.142	-.092	-.290	-.316	-.221	-.319	.405	.648
	Sig. (2-tailed)	.600	.736	.336	.293	.467	.368	.246	.059
	N	16	16	13	13	13	10	10	9
ch_somatic	Pearson Correlation	.018	-.328	-.240	-.107	-.319	-.235	.253	.604
	Sig. (2-tailed)	.948	.215	.429	.728	.288	.514	.480	.085
	N	16	16	13	13	13	10	10	9

BMIPB = BIRT memory and information processing battery
*denotes significance of the correlation test for $p \leq 0.05$ ** denotes significance of the correlation test for $p \leq 0.01$

Table 1: *Continued*

		age	time since injury	BMIPB_ A1_A5	BMIPB_ A6	BMIPB _B	BMIPB_ speed	Trails _A	Trails _B
ch_memory	Pearson Correlation	-.311	.012	-.240	-.250	-.147	-.360	.428	.633
	Sig. (2-tailed)	.241	.965	.431	.411	.632	.307	.217	.067
	N	16	16	13	13	13	10	10	9
ch_communication	Pearson Correlation	.241	-.049	.041	.294	-.011	.188	.541	.058
	Sig. (2-tailed)	.369	.856	.894	.329	.972	.604	.107	.881
	N	16	16	13	13	13	10	10	9
ch_aggression	Pearson Correlation	.129	.005	-.144	-.176	-.263	.000	-.003	.366
	Sig. (2-tailed)	.634	.986	.639	.566	.385	.999	.993	.333
	N	16	16	13	13	13	10	10	9
ch_motoric	Pearson Correlation	-.291	-.175	-.546	-.230	-.527	-.542	.468	.652
	Sig. (2-tailed)	.275	.517	.054	.450	.064	.106	.172	.057
	N	16	16	13	13	13	10	10	9

BMIPB = BIRT memory and information processing battery

Three statistically significant correlations were identified: correlation between (1) the speed on Trials A test and the change in observation scale in FFMQ ($p \leq 0.01$); (2) Trails B tests and the change in observation scale ($p \leq 0.05$); and (3) the time since brain injury and the change in the non-reacting scale of the FFMQ ($p \leq 0.05$).

The effect size of the change in observation scale that was used in correlations (1) and (2) was very low (Cohen d=0.03 see Table 5 in the main text). It is therefore reasonable to assume that the identified correlations reflect low numbers of participants rather than a statistically significant result. Those correlations were therefore not included in further

analysis. Stability of the significance of the correlation (3) was confirmed through the "cross-validation procedure" described above under Aim 1 (pg. 87). The correlation was found significant in all 16 subsamples. Simple linear regression was used to analyse correlation (3) and revealed a statistically significant model where time since the brain injury predicted change in non-reacting ($p<0.05$) (see Table 2, Figure 1).

Table 2: *Linear regression analysis for the significant correlation from table 8*

			ANOVA-regression		Coefficients			
Model	R	R square	F	sig.	B	St. Error	t	sig
ch_nonreact								
(Constant)					6.448	3.041	2.121	0.052
time_since brain injury					-0.435	0.149	-2.925	0.011
(N=16)	0.616	0.379	8.557	0.011				

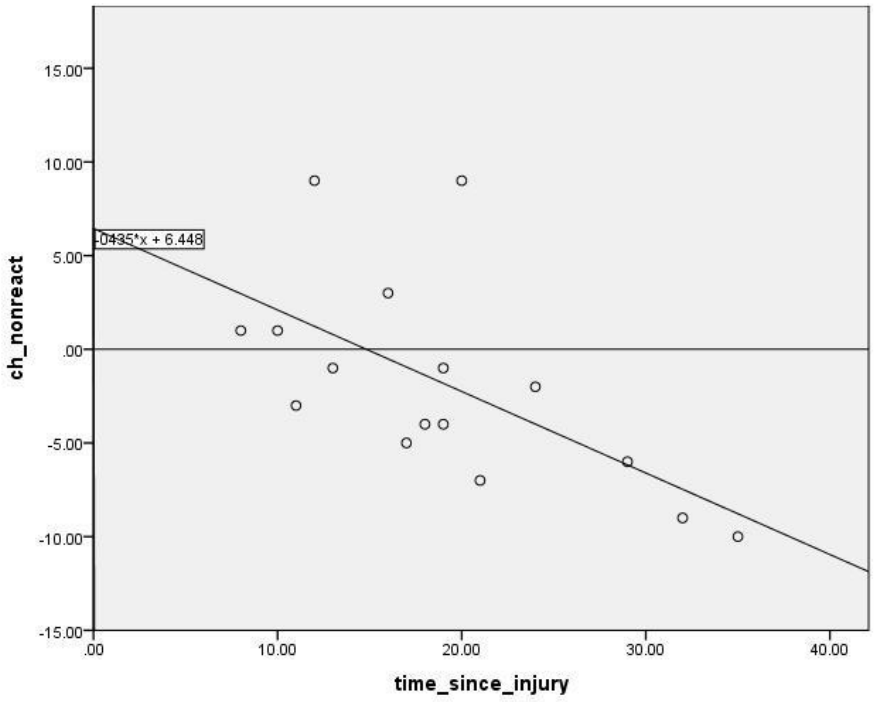

Figure 1: Post-hoc linear regression result depicting relationship between changes in ability not to react and time since injury in months. Circles denote the measured data; line is the result of the linear regression. Reduction in 'non-react' scores denotes improvement.

Appendix 8 - *Table of quotes from the qualitative component*

Theme	Notes	Quote
	Expectation – pain relief	Rowena – line 169 – *"I've ... what I hoped to getting out of this one which is pretty much always the same was ehm .. very very much based on pain relief …."*
	Expectation – to relax and go to sleep	Kelly – line 11 – *"I wanted just relax a little get it sorted in my mind and be able to relax and possibly go back to sleep."*
	Environment – on bed – imagining the room at the rehabilitation centre – part of creating the right conditions for the exercise	Kelly – line 39 –*"..I set on the bed I find if I sit up then it's better than lying down or sometimes I can lie down and do it but you are more prone to go to sleep so I sat up because I need to concentrate more. And I imagined that I am in that room at [rehabilitation centre]."* Kelly – line 72 – *"but I always imagined myself in the room at [rehabilitation centre] when I when S talks me through it but I always imagine that I am there because I always shut my eyes and I could see the chairs and the whole room"*
Pain – dealing with it	Mindfulness is getting rid of pain – by taking her mind off it	Rowena – line 127 – *"it kind of diverted the pain ... ehm ... took my mind off it ..."* *line 170 – "What I hoped of getting out of this one [mindfulness session] which is pretty much the same was ... about trying to get myself relaxed and hopefully get some of the pain relief "* *line 247 -..."there are times where I hoped or wished it would get rid of that pain a bit better ".*

Appendix 8 - *Continued*

Theme	Notes	Quote
Pain – dealing with it	Actively decided to practice mindfulness – agency in dealing with pain	Kelly – line 128 – *"my shoulder and my arm and everything sort of aches today .. huh.. so I just practiced mindfulness to sort of take some of that away and .. tried to move on a bit and it seems to have worked"*
Pain – dealing with it	Taking the tables is the most he can do, now it is just passive waiting	Jack – line 20 – *" I have taken two Tramadol a 3 Codeine tablets to try and kill the pain ... I hope these tablets start to work soon because otherwise I wanna I wanna to have the word with the wife and if this pain doesn't go away I might have to call the doctor out. .... breathing .... Starting to feel a bit tired as well. Which may be a good thing .. it will probably take my mind off the pain .."*
Mindfulness as a distinct sensory experience – related to mindfulness		Kelly – line 96 - *"Again, I had the same sensation as the other day that my arms and my lower legs to my feet felt as if there they were a bit tingly or a little bit numb, but it wasn't in a painful way it was in a really good way"*
Mindfulness as a distinct sensory experience – related to pain		Rowena – line 122 –*" I had the tingly feeling like a cold almost like you've got ice cold water in the your veins ...ehm... like a cold feeling all down my left hand side which is the side that I can't feel anything apart from chronic nerve pain ehm ...and yet again as the places where I do have my nerve pain was where it felt coldest and more tingling which was good"*

Appendix 8 - *Continued*

Theme	Notes	Quote
Mindfulness as a distinct sensory experience – related to pain	Very positive and pleasant	Rowena – line 233 – *"And ..... the usual ... cold but not scary not horrible cold not like freezing cold almost like a warm .... Sounds very silly to say cold but warm .. ehm .. I can't think of the right word to describe it ...ehm... like ice cream cold you know when it's comforting though it's not something that's threatening or freezing or horrible it's something that's really nice actually almost like somebody's damping down the burning in my arm and my face and just a lovely chill through me which like I said for a couple of hours it still there."*
Mindfulness as a distinct sensory experience – related to mindfulness		Stan – line 37 –*" at the same time I slow my breathing down and I get obviously I get my eyes closed and I can see in my eyes like a little shooting starts they are going across ever so quickly. These seem to over the time I am not trying to focus on them but I can see them but they get slower and less and I know then that I am slowing myself down and relaxing I need to relax I then I fall asleep."*
Mindfulness as a source of calmness and relaxation – feeling of calm	Emphasised that it lasted longer than the exercise itself	Rowena – line 20 – *"I felt incredibly calm and it was wonderful really and it was funny because ... normally I'm one of the first to come back around to open my eyes and be fully aware of what's going on, but today I was the last I think I got into it that deeply which was really lovely. Ehm ... and I've had this overwhelming feeling of calm which .....to be honest I still have now which is probably about two and half hours later..."*

Appendix 8 - *Continued*

Theme	Notes	Quote
Mindfulness as a source of calmness and relaxation – feeling of calm	More detail of what chilled means – able to stop worrying and stressing	Rowena – line 80 – *"but I do find that when I do mindfulness particularly the body scan ...ehm.. ...it does really helped me with ... trying to forget what else is going on. Have a very ehm .. active brain so I never only get any space without worrying and stressing about everything so ... but I'm feeling quite quite chilled at the moment. I am just sitting in the room all I can hear is the clock ticking, ehm ...which surprisingly isn't bothering me ... ehm ...I do like I said I do feel quite chilled out, quite relaxed, ehm ...planning on staying here until I need to go out. "*
Mindfulness as a source of calmness and relaxation – feeling of calm	"intense calm"	Rowena – line 226 – *"But I just felt ... ehm ... intense calm when I opened my eyes and was just sat looking ... in the room every ... at that .. each of us .. hah.. we just sat there and I think it was just such calm nice situation."*
Understanding mindfulness - Physical space		Rowena – line 119 – *"like I said last time ... I managed to get quite .. deep as I call it into ... into the session ehm ...found it incredibly relaxing when I when I came back out ehm"* Rowena – line 139 – *"But as I said I sort of went into it quite well towards the end. But ..ehm.. now I have come out of it"*
Understanding mindfulness – special "zone"	Body scan – floating, and relaxed as well	Stan – line 53 – *"While in this position I concentrate to think about myself my body and I start from the top of my head and slowly work my way down with my eyes closed feeling in my own mind the muscles and my bones and my body and just letting them all relax letting it all just go just floating I'm floating on air."*

Appendix 9:

Discussion about the suitability of the use of change variables

In their paper, Rogosa et al. (1982) use the following notation:

X_i is the measured variable for the given person at time t_i, in our case i can be only 1 or 2. Each measurement can be written as:

$$X_i = \xi_i + \varepsilon_i$$

where ξ_i denotes the "true value" of the variable and ε_i is the measurement error. The model of change in X over time is expressed through a model for the ξ_i. The straight line growth model for the given person can be then written as:

$$\xi(t) = \alpha + \beta t$$

where α is the value of the growth curve at the time t=0 and β is the slope of the ξ on the regression line. In two-wave data true change is defined as $\xi_2 - \xi_1 = \beta(t_2 - t_1)$.

Rogosa et al (1982) in their paper show, that the common objection to the use of change score due to its low reliability is true in case when the variance of β is zero, i.e. **when individual growth rates vary very little across persons**. In other words, if the scores were plotted to the graph, they would produce many parallel lines with very few crossings (Figure 1 – adapted from the original paper) and the variances of the pre scores and post scores would be equal. For such data, also the correlation between ξ_1 and ξ_2 would be high and correlation between ξ_1 and β would be low.

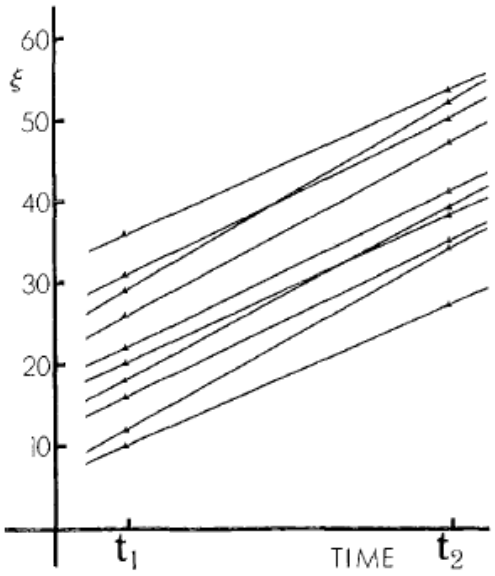

Figure 1: An example of a situation, when individual time paths show very small individual differences in change (correlation between ξ_1 and ξ_2 is 0.97 and the correlation between ξ_1 and β is 0.02).

The authors then continue arguing that in case **when individual differences in the change score are present**, the reliability of the difference score is "decent", in some cases nearly as reliable as the original measured variable X. They define the presence of individual differences in the change score using the following two examples:

1) as a the high number of crossings between the lines joining the two measured scores for each individual (Figure 2 adapted from the original paper), the correlation between ξ_1 and ξ_2 would be moderate and correlation between ξ_1 and β would be low.
2) as a configuration of individual time paths showing positive correlations between change and initial status described as *"fan spread"*. For these both correlations

between ξ_1 and ξ_2 as wel as between ξ_1 and β would be high (Figure 3 adapted from the original paper).

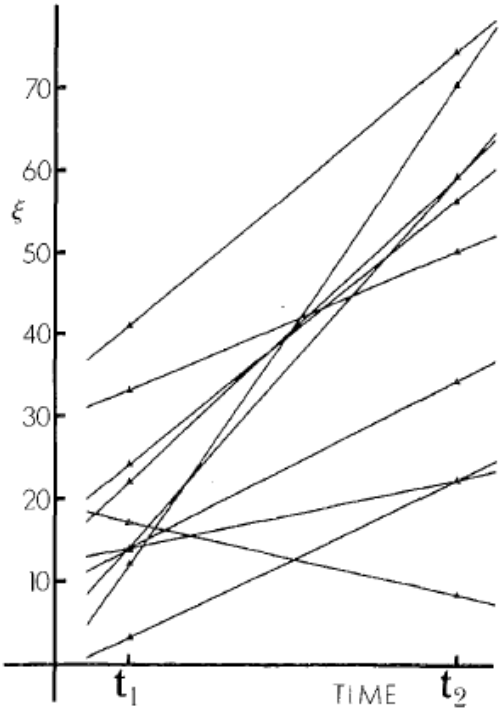

Figure 2: An example of a situation when individual time paths show appreciable differences in change and no correlation between change and initial status (correlation between ξ_1 and ξ_2 is 0.50 and the correlation between ξ_1 and β is 0.01).

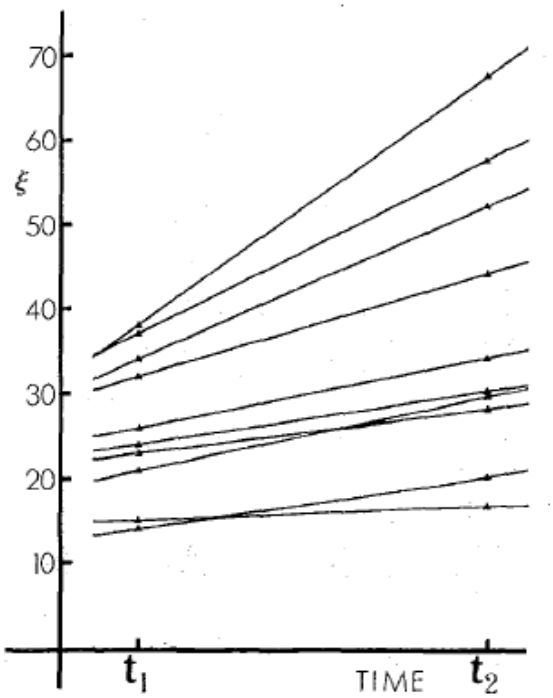

Figure 3: An example of a situation when individual time paths show differences in change and strong correlation between change and initial status (correlation between ξ_1 and ξ_2 is 0.97 and the correlation between ξ_1 and β is 0.88).

Quantitative data from the present study

Analysis of the quantitative and qualitative data revealed large individual differences between the clients which were present in the origins of their injury, their presentations and their understanding of mindfulness. It is therefore reasonable to expect that there would be

"non-negligible individual differences in change". More quantitative summary of the differences in individual changes are in Table 1.

Table 1: *Various characteristics of the pre post data used for estimation of the individual differences in change.*

	minimum		maximum		variance		Corr	Corr
	pre	post	pre	post	pre	post	X_1X_2	X_1D
observe	14.00	19.00	36.00	34.00	39.196	21.183	0.584	0.691
describe	11.00	13.00	40.00	40.00	56.129	52.129	0.779	0.381
awareness	18.00	17.00	34.00	40.00	31.467	57.400	0.637	0.133
nonjudge	15.00	13.00	39.00	40.00	40.463	63.029	0.719	0.118
nonreact	12.00	11.00	30.00	31.00	41.717	31.763	0.59	0.567
depression	36.00	37.00	80.00	75.00	122.383	103.229	0.891	0.399
somatic	32.00	32.00	90.00	89.00	227.333	244.383	0.96	0.015
memory	33.00	31.00	77.00	74.00	135.583	135.067	0.845	0.282
communication	39.00	32.00	78.00	77.00	110.333	144.529	0.864	0.019
aggression	42.00	40.00	85.00	67.00	113.983	67.796	0.75	0.637
motoric	37.00	34.00	72.00	72.00	98.250	73.129	0.785	0.517

Corr X_1X_2 is the correlation between the first measurement and the second measurement and Corr X_1D is the correlation between the first measurement and the change variable.

As can be seen from the difference between the pre and post variances and two last columns of the table, the data used in the study (probably with the exception of the somatic scale on NFI) would fulfil the criteria for the "non-negligible" individual differences and therefore the difference score could be an appropriate measure of the true individual change. An example of the plot of pre and post data on the awareness scale for the FFMQ illustrated the individual differences in the change data for the clients in Figure 4. However, the use of more than 2 measurement points would improve the accuracy and reliability of the results.

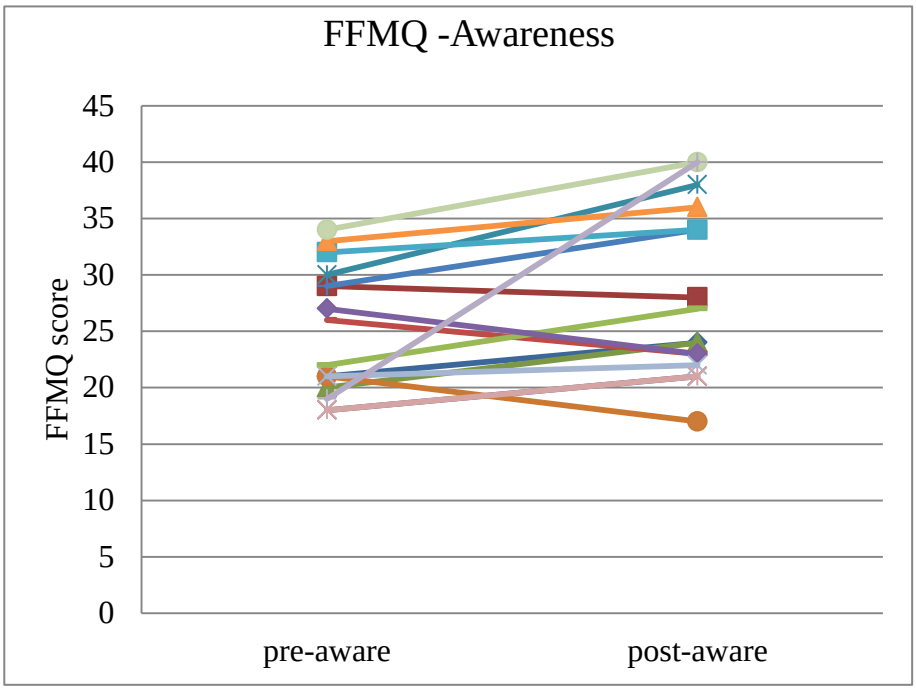

Figure 4: Changes in the awareness scale illustrating individual differences in the change data for the clients