ISSN 1577-7057

2017 Volume 17, number 1
2017 Volumen 17, número 1

ISSN: 1577-7057

IJP&PT

International Journal of Psychology & Psychological Therapy

http://www.ijpsy.com

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INTERNATIONAL JOURNAL OF PSYCHOLOGY & PSYHOLOGICAL THERAPY

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International Journal of Psychology and Psychological Therapy, 2017, 17, 1,19-37

Mindfulness for Neuropathic Pain: A Case Study

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Abstract

Neuropathic pain (NP) is a debilitating chronic pain state that affects approximately 6-8% of the general population. Limited success in pharmacological treatments has led to the rise of psychological therapy in attempts to reduce pain intensity. One such therapy is Mindfulness: a meditative practice concerned with purposeful and non-judgemental awareness of the present moment. Whilst Mindfulness has demonstrated its effectiveness in alleviating symptoms of a number of psychological disorders and symptoms of chronic pain, little evidence is available to determine whether its practice is associated with improvements in pain intensity in individuals suffering from NP. The following is a case study of a 62-year-old female (LU), who for the past 18 years has experienced chronic Neuropathic Pain (NP) as a result of a stroke. The current study examined the relationship between 12 weeks of daily Mindfulness practice and immediate, short-term and long-term self-reported pain levels. An additional goal was to explore the impact of Mindfulness on psychological functioning and well-being following the 12-week period of Mindfulness practice. LU showed a clinically meaningful reduction in pain immediately following Mindfulness practice. An overall reduction in 'Continuous', 'Neuropathic' and 'Affective' type pain was observed at post intervention but was not maintained at follow up. The results of the psychological functioning and well-being measures were mixed, with a notable reduction in in the domains of emotional reactivity, depression and stress. These results provide preliminary support for the use of Mindfulness in managing chronic pain of a neuropathic nature. The results are discussed in relation to practice factors.

Key words: mindfulness, neuropathic pain, pain management, stroke.

How to cite this paper: Brown A & Becerra R (2017). Mindfulness for Neuropathic Pain: A Case Study. *International Journal of Psychology & Psychological Therapy, 17,* 19-37.

Novelty and Significance

What is already known about the topic?

- Neuropathic pain is highly prevalent, with pharmacological intervention often ineffective.
- Research suggests Mindfulness is effective in managing symptoms of chronic pain of a nociceptive nature.
- Research suggests Mindfulness is effective in the treatment of a variety of psychological disorders.
- Research implicates emotional processes in the experience of pain.

What this paper adds?

- There is little research investigating the impact of Mindfulness on Neuropathic pain. The current paper adds to the limited data set.
- Provides evidence to suggest Mindfulness practice can have an immediate effect on pain perception.
- Suggests that Mindfulness is a useful intervention for the management of post stroke Neuropathic Pain when used independently of other intervention components.
- Highlights practice factors i.e. that Mindfulness practice must be maintained, either in duration spent practicing or regularity of practice in order to observe long term pain reduction.

The following is a case study of a 62-year-old female, who for the past 18 years has experienced chronic Neuropathic Pain (NP) as a result of a stroke. NP is a chronic pain condition that can be extremely debilitating, and difficult to manage with pain medication. This study investigates the efficacy of 12-weeks of daily Mindfulness practice in reducing the pain intensity experienced by this individual. An additional goal was to investigate if Mindfulness had an impact on the individual's psychological functioning and well-being. Pain levels, psychological functioning, and well-being were assessed at baseline, post intervention, and at a 3-month follow up.

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Neuropathic Pain (NP) is a complex chronic pain state that is defined by The International Association for the Study of Pain (IASP) as "pains resulting from disease or damage of the peripheral or central nervous systems, and from dysfunction of the nervous system" (Scadding, 2003, p. 8). The pain may be spontaneous, stimulus-evoked, or a combination of both. NP is thought to affect approximately 6-8% of the general population (Mulvey, Bennett, Liwowsky, & Freynhagen, 2014) with a higher prevalence being observed in populations with health related problems. Research suggests that 26.4% of individuals suffering from type 2 diabetes experience NP symptoms (Davies, Brophy, Williams, & Taylor, 2006), whilst 58% of individuals with Multiple Sclerosis report symptoms of neuropathic origin (Helme, 2006). In comparison to nociceptive pain, which is generally short lived and adaptive, NP is often chronic and maladaptive (Woolf, 2004). Mulvey, *et al*. (2014) state that compared to nociceptive pain, NP is associated with a higher pain levels, greater need for pain relief, sleep disturbances, and poorer physical, cognitive and social functioning impacting on daily living (Bouhassira, Lantéri-Minet, Attal, Laurent, & Touboul, 2008; Cruccu & Truini, 2010; Rayment, Hjermstad, Aass, Kaasa, Caraceni, Strasser, Heitzer, Fainsinger, & Bennett , 2013; Torrance, Smith, Bennett, & Lee, 2006). Management of NP tends to focus on pharmacological treatment, with antidepressants, anticonvulsants and opioids commonly being prescribed to patients. However, medical management of NP is often limited and can deliver unwanted side effects (Helme, 2006). In a UK study, where individuals suffering from NP were followed for a year, it was discovered that only 30-50% of individuals (this percentage varied depending on the aetiology of NP) had a stable and effective treatment regime (Hall, Carroll, Parry, & McQuay, 2006).

Considering the chronic nature and prevalence of NP and its impact on quality of life, it is concerning that traditional pain management approaches are falling short of effectively reducing pain of a neuropathic origin. Several psychological treatments have been suggested for the treatment of chronic pain (Turk, Swanson, & Tunks, 2008). Recent developments point to the efficacy of Mindfulness Based Interventions (MBI's) in the treatment of chronic pain conditions.

Mindfulness is an ancient practice, which derives from Buddhism but is also found in many other Eastern philosophies. Mindfulness is predominantly concerned with becoming aware of current thoughts, feelings and sensations, and has been defined as "paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally" (Kabat-Zinn, 1994, p. 4). In recent decades Mindfulness has been adapted for secular use within a variety of formats within Western society including Mindfulness-Based Stress Reduction (MBSR) (Kabat-Zinn, 1982), Mindfulness-Based Cognitive Therapy (MBCT) (Segal, Williams, & Teasdale, 2002), Dialectical Behaviour Therapy (DBT) (Linehan, 1993a, 1993b) and Acceptance and Commitment Therapy (ACT) (Hayes, 1999).

As a therapeutic intervention, Mindfulness based approaches are increasingly becoming recognised as techniques that can be applied to a range of medical and psychological disorders, and have shown to be an effective intervention in managing symptoms associated with clinical disorders, such as stress (Morone, Lynch, Losasso, Liebe, & Greco, 2012), depression (Finucane & Mercer, 2006), anxiety (Call, Miron, & Orcutt, 2013), and eating disorders (Kristeller, Wolever, & Sheets, 2014).

Research suggests that Mindfulness is also associated with improvements in emotional state, with practice correlated with reduction in symptoms of subclinical depression and anxiety (Schreiner & Malcolm, 2008), reduction in negative mood (Zeidan, Johnson,

Gordon, & Goolkasian, 2010) and lower rates of return to depressive thinking following sad mood induction (Kuyken, Watkins, Holden, White, Taylor, Byford, Evans, Radford, Teasdale, & Dalgleish, 2010). Additionally, Mindfulness practice has been correlated with components of emotional processing, including increased emotional awareness (Baer, Smith, & Allen, 2004), reduced reactivity (Britton, Shahar, Szepsenwol, & Jacobs, 2012; van den Hurk, Janssen, Giommi, Barendregt, & Gielen, 2010) and greater emotional regulation (Arch & Craske, 2006).

The connection between emotion and pain has been long established, with positive emotional states being linked to reduced pain, and negative affect associations with increased sensations of pain (Connelly *et al*., 2007; Meagher, Arnau, & Rhudy, 2001). Additionally, research suggests that greater pain is associated with limited emotional awareness (Glaros & Lumley, 2005), and poor emotional regulation (Ruiz Aranda, Salguero, & Fernández Berrocal, 2010).

Whilst research is in it's infancy in understanding the underlying mechanisms of Mindfulness for pain, research suggests that this link between emotion and pain may be relevant in understanding the underlying processes associated with Mindfulness for pain reduction. Kabat-Zinn, Lipworth, and Burney (1985) noted improvements in mood disturbance and psychological symptomatology associated with pain following Mindfulness practice. In line with this theorists suggest that the practice of Mindfulness may be valuable in improving the psychological correlates of pain without impacting on pain intensity (Reiner, Tibi, & Lipsitz 2013).

Although reducing pain is not an explicit goal in Mindfulness practice, research suggests that Mindfulness may also be effective in reducing the subjective experience of pain, including pain unpleasantness and intensity associated with acute nociceptive pain (Brown & Jones, 2010; Grant & Rainville, 2009). Furthermore, brain imagery studies have demonstrated multiple processes associated with reduced pain intensity ratings when practicing Mindfulness whilst receiving noxious stimuli, and suggests that subjective pain experiences may be mediated by areas of the brain involved in affective regulation and cognitive reframing of sensory stimulation (Zeidan, Martucci, Kraft, Gordon, McHaffie, & Coghill, 2011).

Researchers have proposed various mechanisms for the effects of Mindfulness on pain, however many do not consider subjective pain as a variable, instead focusing on broader outcomes such as psychological functioning and quality of life (Reiner *et al*., 2013). One traditional view is that acceptance of pain via the practice of Mindfulness promotes reductions in avoidance behaviours and an increase in valued behaviours, leading to improvements in quality of life (McCracken, 1998). In a recent review of Mindfulness for chronic pain, Reiner *et al*. (2013) theorised two alternative perspectives in which pain intensity is factored 1) Reductions in pain intensity are mediated by more valued action and thus improved quality of life and/or 2) Reductions in pain intensity are mediated by detaching of emotional correlates of pain, which in turn mediates self-regulation and improved quality of life.

Although research outlines the effectiveness of Mindfulness for pain symptoms and depressive symptoms (Chiesa & Serretti, 2011), there is little research that simultaneously investigates the application of Mindfulness practice on both pain intensity and the emotional processes associated with this.

Additionally, few studies have investigated the subjective pain experiences with present moment Mindfulness. Evidence suggests that when nociceptive pain is induced experimentally, pain tolerance is increased, and pain intensity reduce when Mindfulness

is practiced simultaneously (Kingston, Chadwick, Meron, & Skinner, 2007; Zeidan, Gordon, Merchant, & Goolkasian, 2010). To our knowledge there are no studies that investigate the immediate Mindfulness-induced pain intensity ratings of individuals with chronic forms of pain such as NP.

The majority of research in Mindfulness for chronic pain focuses on fibromyalgia or non-specific chronic pain populations. Whilst Mindfulness research has been conducted with the post-stroke population (Lazaridou, Philbrook, & Tzika, 2013), no research has been found which investigates the practice of Mindfulness for post-stroke pain.

Several studies evaluating the effectiveness of Mindfulness-based interventions (MBI's) for chronic pain utilise variants such as Mindfulness Based Stress Reduction (MBSR) and Acceptance and Commitment Therapy (ACT) (Reiner *et al*., 2013). Whilst the fundamental principles of such MBI's encompass Mindfulness practice, additional strategies are often utilised as part of the treatment e.g. MBSR includes yoga practice, whilst ACT works with values based behavioural change (Reiner et al., 2013). Few studies solely research the practice of Mindfulness independent of other treatment variables.

In order to address some of these limitations and to add to the existing knowledge base for NP management, the current study had 2 purposes. Firstly the study aimed to identify if Mindfulness practice was effective in minimising chronic NP pain intensity immediately, in the short-term, and long-term. This aim was achieved by measuring daily pain ratings immediately before and after Mindfulness practice over the course of a 12-week Mindfulness program, and through more extensive pain assessments prior to the intervention phase, at post intervention and at a 3 month follow up. Research suggests that MBI's are associated with chronic pain reduction, and in some cases with reductions in pain neuropathic in nature (Chiesa & Serretti, 2011). Consequently, it was hypothesised that there would be a reduction in pain following Mindfulness meditation.

A second aim of the study was to identify if the practice of Mindfulness was effective in managing psychological processes and states associated with pain, including psychological well-being, emotional processing, emotional state, and clinical symptomatology. This was achieved by conducting a battery of psychological and well-being assessments at pre Mindfulness intervention, post intervention and follow up. These measures included assessment of the following domains: Quality of life, emotion regulation, emotional reactivity, and symptoms of depression, anxiety and stress. Whilst evidence implicates MBI's in improvements on the aforementioned domains (Baer *et al*., 2004; Britton *et al*., 2012; Call *et al*., 2013; Finucane & Mercer, 2006; Morone *et al*., 2012; Nyklicek & Kuijpers, 2008; Ruiz Aranda *et al*., 2010), to our knowledge there are no studies to date that assess Mindfulness, independent of additional treatment factors, for the management of psychological factors associated with post stroke NP. Due to the uniqueness of this case study, no directional hypothesis was made for the second research question.

METHOD

Participant

The following information was collected from LU's medical records. LU is a right-handed female born in 1953. She completed 10 years of schooling and approximately 2 years of further education completing a course in travel consultancy. LU has experience working in a bank, as a travel agent, and bookkeeper. In July 1996 she suffered an

intracerabral haemorrhage as a result of an Arterio Venous Malformation (AVM) in the right parietal temporal region. She subsequently underwent right parietal craniotomy and excision of AVM in August 1996. LU remained as an inpatient for seven weeks, and was discharged to a home assistance program for four weeks. She subsequently received 25 weeks of outpatient Occupational Therapy then was referred onto the State Head Injury Unit.

Following the stroke LU suffered left side hemiparesis and NP. The hemiparesis predominantly affected LU's left arm and hand, whereas the pain was experienced predominantly in her left leg and foot. LU reported the pain to radiate from her foot initially, and then moved up towards her hip, eventually causing pain in the whole left leg. LU trialled various pain medications, most of which she reported to have side effects of drowsiness, weight gain, and dizziness. LU suffered from symptoms of depression following her stroke, and subsequently began taking antidepressants (Aurorix), which she continued for 11 years and then ceased with the support of a Clinical Psychologist and her GP. Six months after the stroke LU returned to work as a bookkeeper for one day per month. She found that she was easily tired and needed more time to complete simple tasks. Following the closure of this company LU ceased working. Several years later she began volunteering for two local charities: one as a receptionist and another in an administrative role.

An independent neuropsychological assessment (not associated with the current study) was conducted on 04/03/1997 and again on 03/03/1998 investigating LU's intelligence, processing speed, executive functioning, spatial processing, memory and learning (assessed using the short form of the Revised edition of the Wechsler Adult Intelligence Scale-R -WAIS-R-, Symbol Digit Modalities Test -SDMT-, Trail Making Test -TMT-, Austin Maze Learning Test, Wechsler Memory Scale -WMS). The 1997 assessment results indicated intact IQ, but marked deficits in visuospatial functioning and mild deficits in verbal fluency. The results from the 1998 assessment phase also indicated intact IQ. Whilst some improvement had been noted in LU's visuospatial functioning at the 1998 assessment phase, this did not increase markedly, and was still considered to be below the normal range. A mild improvement in verbal fluency was indicated at this testing phase, which placed LU's verbal fluency score firmly within age-based norms.

LU reported that her pain continues to predominantly affect her left foot and leg, up to her hip. She stated that the pain can be exacerbated by too much, or too little activity. LU currently takes 25mg of Lyrica per day (in the evening). She reported to take Panamax and Norspan patches as required, although stated that she limits her use of these to when the pain is extreme. LU continues to volunteer as a receptionist two days per week and in an administrative role one day per week. Her other activities include weekly hydrotherapy, and visiting her elderly mother. LU has practiced, and continues to practice Brahma Kumaris Meditation on a weekly basis.

Materials and Procedure

The participant, a former client of the secondary author volunteered to take part in the current case study. The primary author completed all assessments and intervention, and completed the case study as the research component of a Masters in Clinical Psychology. A Research Ethics Committee granted ethical approval for the study. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

The assessor made initial contact with the participant by telephone and met with the participant once prior to commencement of the assessment phase. The participant was provided with an information letter detailing the purpose of the study and the researchers' reasons for conducting the study, and signed a consent form accordingly. This study followed a case study methodology with repeat observations and comprised of the following stages: Cognitive screening; Baseline 1; Baseline 2, Intervention; Post intervention assessment; Follow up assessment. No visual or audio recordings were made of the assessment or intervention phases.

Cognitive screening. A series of cognitive assessments were administered prior to intervention in order to estimate LU's cognitive functioning and ensure she was able to follow instructions. These assessments included measures of intelligence (verbal comprehension, processing speed, fluid reasoning), and executive functioning. Testing was conducted on the 16/09/14, included short breaks, and took place in a quiet room in the participant's home. This took approximately 2 hours to complete. No other individuals were present at the time of assessment.

Baseline 1 and 2. Initial assessment comprised of psychological and well-being measures, and pain measures. These scales measured LU's: Emotional functioning, Quality of life, Negative emotional states, and Pain. Baseline 1 testing was conducted on the 16/09/14, included short breaks, and took place in a quiet room in the participant's home. In order to obtain reliable baseline data all assessments were re-administered approximately one month later on 14/10/14 (Baseline 2). Each testing phase lasted approximately 1 hour. No other individuals were present at the time of assessment.

Intervention. Approximately one week after the second baseline assessment the participant began the twelve-week intervention phase (Mindfulness). The practice of Mindfulness took place between 26/10/2014 and 17/01/2015 and involved 25 minutes of Mindfulness, practiced every day using a guided breath counting exercise. The Mindfulness exercise is described below. The assessor met with the participant on a weekly basis for approximately 30 minutes-1 hour to discuss practice difficulties and support the individual to schedule daily practice. Pain ratings from the previous week were collected, discussed and relevant information noted by the assessor.

Post intervention assessment. The day of completion of the twelve-week Mindfulness practice, the participant was re-administered the battery of psychological and well-being measures, and pain measures. Testing was conducted on the 17/01/15, included short breaks, and took place in a quiet room in the participant's home. This took approximately 2 hours. No other individuals were present at the time of assessment.

Follow-up assessment. Approximately 26 weeks after the initial baseline assessment (and twelve weeks after the end of the Mindfulness intervention phase), the participant was re-administered the battery of psychological and well-being measures, and pain measures. Testing was conducted on the 12/03/15, included short breaks, and took place in a quiet room in the participant's home. This took approximately 1.5 hours. Practice difficulties were discussed and noted by the assessor. No other individuals were present at the time of assessment.

Instruments

All assessments are described in further detail below, as is the intervention instrument. The standard administration procedure was utilised for each assessment, unless otherwise stated in the corresponding table.

Cognitive Measures:

- *Woodcock Johnson -3rd Edition (Brief Intellectual Ability)* (WJ-III-BIA; McGrew & Woodcock, 2001). The WJ-III (BIA) is a brief screener of overall intellectual ability that comprises of three subtests. Performance on these subtests provides information on ability in three specific

areas of cognitive functioning. These areas are Comprehension-Knowledge (Gc) or verbal ability, Fluid Reasoning (Gf) or thinking ability, and Processing Speed (Gs) or efficiency in performing cognitive tasks. Combined performance in all three subtests provides an overall level of intellectual functioning (BIA). The WJ-III (BIA) has shown to correlate with other major intelligence tests, supporting construct validity of the BIA as a screener of cognitive functioning (McGrew & Woodcock, 2001).

- *Trail Making Test* (TMT; Reitan, 1955). Part A of the TMT consists of 25 circles distributed on a sheet of paper. The circles are numbered from 1-25 and the participant is required to join lines between the circles in an ascending pattern. The test is timed, and performance based on the time taken to correctly join the 25 circles (Reitan, 1955). The less time taken to complete this task indicates better performance (Strauss, Sherman, & Spreen, 2006). Part A of the TMT has demonstrated adequate reliability (Dikmen, Heaton, Grant, & Temkin, 1999), and is regarded as a valid measure of multiple cognitive functions including visual scanning, attention, and conceptual reasoning (Groth-Marnat, 2000). Part B of the TMT is administered immediately after part A, and also consists of 25 circles distributed on a sheet of paper. The circles contain either numbers or letters. The participant is required to join lines between the circles in an ascending pattern whilst alternating between numbers and letters as an added task (For example 1, A, 2, B, 3, C). As in part A, the test is timed, and performance based on the time taken to correctly join the circles (Reitan, 1955). Part B of the TMT has demonstrated adequate reliability (Dikmen *et al*., 1999), and like part A is regarded as a valid measure of multiple cognitive functions including visual scanning, attention, and conceptual reasoning (Groth-Marnat, 2000). The additional requirement of alternating between letters and numbers, Part B requires cognitive flexibility and has been identified as a valid and reliable measure of executive functioning (Groth-Marnat, 2000).
- *Controlled Oral Word Association Test* (COWAT/Word Fluency Test; Benton, 1994). The COWAT is a measure of an individual's ability to spontaneously name words that begin with a particular letter, or name words within a given category (e.g. animals) (Groth-Marnat, 2000). Individuals are allocated a time limit to verbalise words within the given constraints. Performance is based on age norms (Groth-Marnat, 2000). The COWAT requires language proficiency and word knowledge. However, it is considered to be a measure of executive functioning as performance has been found to be impaired if an individual is unable to maintain attention span, devise task based strategies, access semantic knowledge and monitor for error correction (Davidson, Gao, Mason, Winocur, & Anderson, 2008). Research suggests that COWAT performance is affected by brain injury, in particular where lesions to the frontal lobe are evident (Henry & Crawford, 2004a, 2004b).

Pain Measures:

- *Short-Form McGill Pain Questionnaire-2* (SF-MPQ-2; Dworkin, Turk, Revicki, Harding, Coyne, Peirce-Sandner, Bhagwat, Everton, Burke, Cowan, Farrar, Hertz, Max, Rappaport, Melzack, 2009). The SF-MPQ-2 is a self-report measure developed to assess nociceptive and NP intensity and pain quality experienced. Users of the questionnaire rate the extent to which they experienced each of 22 pain descriptors in the past week using an 11-point numeric rating scale (no pain= 0 to worst possible pain= 10) The SF-MPQ-2 is comprised of four summary scales: (1) continuous descriptors (throbbing pain, cramping pain, gnawing pain, aching pain, heavy pain, and tender), (2) intermittent descriptors (shooting pain, stabbing pain, sharp pain, splitting pain, electric-shock pain, and piercing), (3) neuropathic descriptors (hot-burning pain, cold-freezing pain, pain caused by light touch, itching, tingling or 'pins and needles', and numbness), and (4) affective descriptors (tiring-exhausting, sickening, fearful, and punishing-cruel). A total pain score is calculated by taking an average score of a participant's ratings across all questions. Pain scores for each of the summary scales are obtained by taking an average score of the ratings to the questions within each given scale (Lovejoy, Turk, & Morasco, 2012). The SF-MPQ-2 has demonstrated excellent validity and reliability (Lovejoy *et al*., 2012), and demonstrated sensitivity towards nociceptive and NP (Katz, 2011). Additionally, the SF-MPQ-2 holds good internal consistency on subscales (Cronbach's α ranging between .83 and .87) as well as overall score (Cronbach's α= .95) (Dworkin *et al*., 2009).

- *Pain Intensity Numerical Rating Scale* (PI-NRS). The PI-NRS is an 11 point scale used as a self-reporting measure of pain intensity. The scale comprises of numbers 0-10 plotted on a line, with 0= no pain and 10= worst possible pain. The PI-NRS has adequate inter-rater reliability (Hjermstad et al., 2011), and is a reliable and valid measure of change in pain intensity (Hawker, Mian, Kendzerska, & French, 2011; Jensen, Turner, Romano, & Fisher, 1999). The PI-NRS has shown excellent internal consistency (Cronbach's α= .87-.88) (Herr, Spratt, Mobily, & Richardson, 2004).

Psychological and Well-being Measures:

- *Difficulties in Emotion Regulation Scale* (DERS; Gratz & Roemer, 2004). The DERS is a 41 item self-report measure developed to assess clinically relevant difficulties in emotion regulation. The measure comprised the following six domains: difficulties engaging in goal directed behaviour, impulse control problems, nonacceptance of emotional responses, lack of emotional awareness, emotional clarity, and access to emotion regulation strategies (Gratz & Roemer, 2004). Each item is rated in frequency on a 5-point scale ranging from one (almost never) to five (almost always). Overall and subscale score are obtained, with higher scores indicated greater difficulty in regulating emotions (Gratz & Roemer, 2004). The DERS has demonstrated high internal consistency (Cronbach's α= .93), good test-retest reliability, and adequate construct and predictive validity (Gratz & Roemer, 2004).
- *Perth Emotional Reactivity Scale* (PERS; Becerra & Campitelli, 2013). The PERS is a self-report questionnaire designed to assess emotional reactivity. It contains 30 items and addresses three dimensions of emotional reactivity: activation, duration, and intensity. The measure also includes three questions about the awareness of physiological changes in emotional reactivity, however, these are not included in the scoring process (Becerra & Campitelli, 2013). The PERS has substantial internal consistency (Cronbach's α= .87), split half reliability (.93) and validity (Scott-Pillow, 2013).
- *SF-36 Health Survey* (Ware & Sherbourne, 1992). The SF-36 is a self-reported measure designed to assess health-related quality of life. It comprises of 36 items within eight health domains: physical functioning, role limitations caused by physical health problems, role limitations caused by emotional problems, social functioning, psychological well-being, vitality, bodily pain, and general health perceptions. Physical and mental health summary scores are also obtainable from the 36 items. The 36 questions are transformed into a scaled score of 0-100, with a higher score indicating a higher quality of life. A score of 50 is considered average, with a standard deviation of 10 (Saris-Baglama *et al*., 2011). The SF-36 is shown to be a reliable instrument with good internal consistency (Cronbach's α ranging from .81-.92) and adequate test-retest reliability (Sanson-Fisher & Perkins, 1998), as well as good construct validity (McHorney, Ware, Lu, & Sherbourne, 1994).

Clinical Symptomatology (Depression, Anxiety, Stress):

- *Depression Anxiety Stress Scale* (DASS21; Lovibond & Lovibond, 1995). The DASS-21 is a 21 item self-report questionnaire designed to measure the severity of negative core symptoms common to depression, anxiety and stress. Participants rate the presence of a symptom over the previous week on a scale from 0-3. High scores indicate the presence of a symptom. The DASS21 demonstrated an interpretable factor structure and a high internal consistency with Cronbach's α= .94 for Depression, .87 for Anxiety, and .91 for Stress (Antony, Bieling, Cox, Enns, & Swinson, 1998).

Intervention Instruments:

- *Mindfulness CD*. The CD track is a 25 minutes long mindfulness meditation activity which describes the practice of breath-focussed attention. The track begins by describing to listeners how to position their body for the breath counting exercise. It then instructs listeners how to count their exhalations from 1-10 and then return back to 1 again, and to focus on the autonomous motions of the body that arise through breathing, such as the rise and fall of the stomach. The listener is encouraged to focus on counting their breathing rather than controlling their breathing, letting go of all other thoughts, and are instructed to restart their counting at '1' if they become distracted. Prior to commencing the practice the listener is given guidance on how to end the Mindfulness exercise -by opening their eyes at the end of

the meditation, stretching their arms, mindfully standing up and going about their day. The commencement of the practice begins with the sound of 3 bells. The end of the practice is signalled again by the sound of 2 bells. In between the beginning and end bells there are no further instructions provided.

RESULTS

All assessments were scored by the primary author, and discussed with the co-author. Data was recorded in Microsoft Excel and graphs generated accordingly.

The results of the screening cognitive assessments are shown in Table 1 and are described below. Descriptive information is based on ratings identified by the test developer. Normative data was obtained as part of the description where test developer ratings were not available.

Table 1. LU's Scores on All Cognitive Measures at Pre Intervention Screening Phase.

Domain/ Measure		Score	Percentile	Description
Intelligence	WJ-III BIA	98	45	Average
	Verbal Comprehension	96	40	Limited to Average
	Concept Formation	112	79	Advanced
	Visual Matching	92	31	Limited
Processing Speed	TMT Part A*	30	60	Unimpaired
Executive Functioning	TMT Part B*	53.5	90+	Unimpaired
COWAT	Letter Total (FAS)*	35	50	Unimpaired
	Animal Total*	16.5	25-50	Unimpaired

Notes: BIA= Brief Intellectual Ability; A percentile rank of 75 indicates that LU scored equal to or better than 75% of her same aged peers (percentile ranks for each test are based on normative data from the following sources: WJ-III, McGrew and Woodcock, 2001; TMT, Tombaugh, 2004; COWAT, Tombaugh, Kozak, & Rees, 1999); *= Denotes that an average of baseline data (two time points) was recorded.

LU's Brief Intellectual Ability score on the Woodcock Johnson Brief Intellectual Ability (WJIII-BIA) was categorised as "Average" overall intellectual functioning. LU demonstrated an "Average" score across the domains of Verbal Comprehension and Visual Matching, whilst obtaining a "High Average" on the Concept Formation subscale. These scores suggest that at the time of assessment LU did not have an intellectual impairment.

LU's total score on letter categories F, A, and S on the COWAT correlated with age based norms and were within 1SD of normative data (Rodríguez Aranda & Sundet, 2010). These scores suggest that at the time of assessment LU's executive functioning was within the normal range.

LU's time taken to complete Part A and B of the TMT was within the range of age-based norms (Tombaugh, 2004). This suggests that at the time of assessment LU's visual scanning, attention, conceptual reasoning and executive functioning (as assessed by the TMT) were within the normal range.

Pre and post intervention assessment measures were categorised based on the domain they assessed and notably fell into one of two categories: Pain, and Psychological and Well-being. Consequently, the results have been presented based on these domains.

Prior to treatment, the participant identified that there was considerable changeability in her day to day pain levels, and reported that this depended on various external variables, such as exercise levels, and activity participation. In order to obtain a reliable representation of the participant's pre-intervention scores, a mean of the two baseline time points (16/09/2015 and 14/10/15) was calculated for all pain and psychological and well-being measures.

For ease of comparison, the results of the Pain assessments are displayed together in Table 2 and are described below. Data obtained from the pain ratings was considered clinically informative if a pain rating moved higher or lower on the applicable scale and where a trend in data was observed.

Table 2. LU's Scores on All Pain Measures at Pre Intervention, Post Intervention and Follow Up.

Domain/Measure		Pre intervention	Post intervention	Follow up
		Mean individual Score	Mean individual Score	Mean individual score
SF-MPQ-2	Continuous pain	2.13	0.5	3.25
	Intermittent pain	5.67	6.67	8.17
	Neuropathic pain	3.17	2.83	3.5
	Affective pain	2.5	1.25	3.75
	Total pain	3.55	3.27	4.68
PI-NRS	Mean pain score	Immediately before Mindfulness 8.45*	Immediately after Mindfulness 7.34*	

Note: *Marks significant level of change <0.05 between reported pain ratings before and after Mindfulness practice in a paired sample t-test.

Figure 1 displays LU's pain ratings on the PI-NRS immediately before and after practicing Mindfulness on a daily basis, over a 12-week period. Figure 2 displays the mean score before and after Mindfulness across the 12 weeks of practice. LU's mean score was on average 1.1 points lower after practicing Mindfulness. This suggests, that LU experienced a clinically meaningful reduction in pain intensity at post intervention. This is confirmed in the plot as shown in Figure 1.

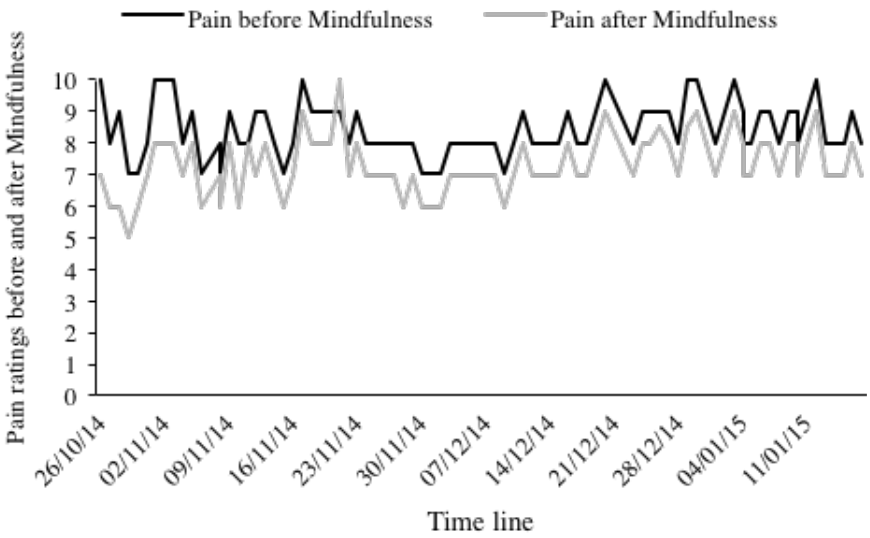

Figure 1. LU's pain ratings immediately before and after daily Mindfulness practice from 26/10/14 to 17/01/15.

There are 22 pain descriptors within the SF-MPQ-2. Each falls into one of 4 subscales. These pain subscales are Continuous, Intermittent, Neuropathic, and Affective. Figure 3 displays LU's pain ratings on the four subscales of the SF-MPQ-2. A reduction in pain was observed on the Continuous, Neuropathic, and Affective subscales between

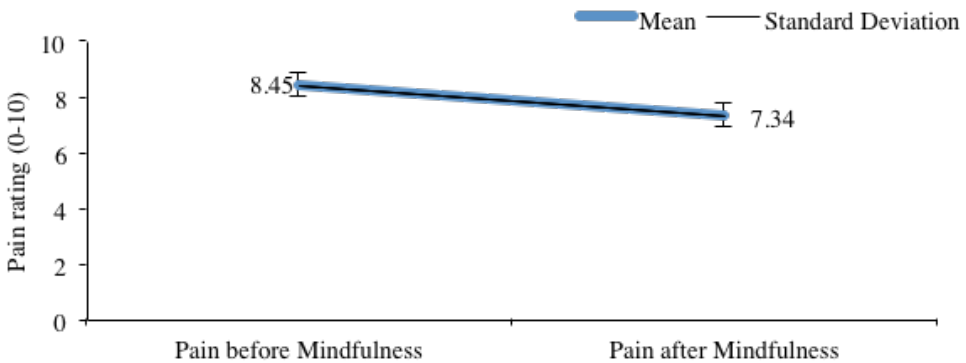

Figure 2. LU's mean pain ratings immediately before and after Mindfulness practice from 26/10/14 to 17/01/1.

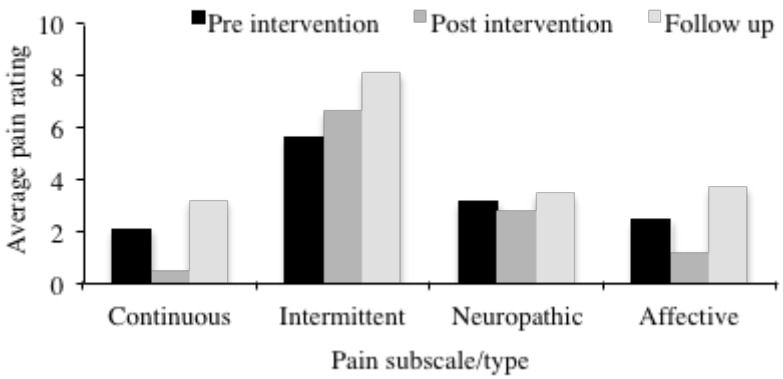

Figure 3. LU's subscale scores on the SF-MPQ-2 pre intervention, post intervention and follow up.

pre and post intervention. This reduction was not maintained at follow up. An increase in Intermittent type pain was observed between pre and post intervention. This subscale showed further increases in pain at follow up.

For ease of comparison, the results of the psychological and well-being assessments are displayed together in Table 3. Score changes across testing periods were considered positive if they shifted in the direction of improvement. Changes in test developer

Table 3. LU's Scores on All Psychological and Well-being Measures at Pre Intervention, Post Intervention and Follow Up.

Domain/Measure		Pre Intervention		Post Intervention		Follow up	
		Score	Description	Score	Description	Score	Description
Emotion Regulation DERS Total Score		73	Unimpaired	72	Unimpaired	83	Unimpaired
Emotion Reactivity PERS Total Score		41.5		36		46	
Quality of Life SF-36	PCS	32.56	Below Average	28.45	Below Average	33.1	Below Average
	MCS	44.77	Average	49.54	Average	33.54	Below Average
Clinical symptomatology DASS21	Depression	11.5	Severe	10	Moderate	20	Extremely Severe
	Anxiety	3.5	Normal	6	Moderate	5	Mild
	Stress	10.5	Moderate	7	Normal	12	Moderate

Notes: PCS= Physical Component Score; MCS= Mental Component Score, [a]= Denotes that an average of baseline data (two time points) was recorded. Descriptive categories for each test are based on those outlined in the following sources: DERS (Gratz & Roemer, 2004); PERS (Becerra & Campitelli, 2013); SF-36 (Saris-Baglama *et al*., 2011); DASS (Lovibond & Lovibond, 1995).

assigned categories were also noted where a move from one category to another was observed e.g. from severe to moderate.

Figure 4 displays LU's DASS21 scores, which indicated "Severe" Depression, "Normal" Anxiety and "Moderate" Stress scores at pre-intervention assessment. At post-intervention DASS21 scores reduced to "Moderate" Depression and "Normal" Stress, whilst Anxiety increased into the "Moderate" range. At follow-up the Depression scores increased to "Extremely Severe", Anxiety reduced into the "Mild" range, and Stress increased into the "Moderate" range.

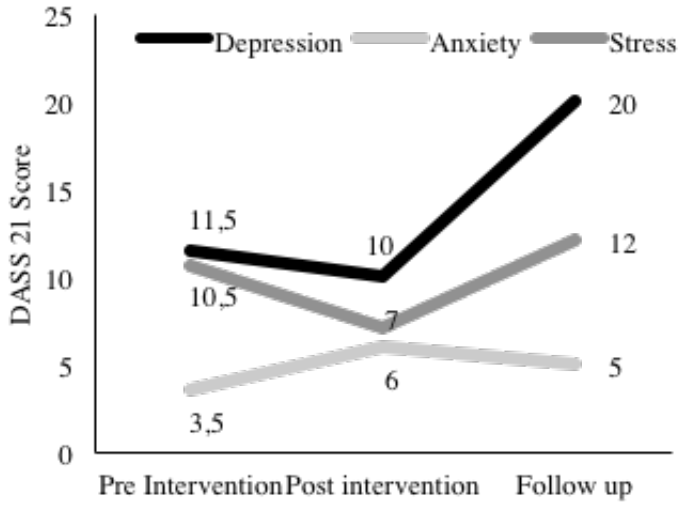

Figure 4. LU's scores on the DASS21 pre intervention, post intervention and follow up.

Figure 5 displays LU's overall PERS score, which indicates a notable reduction in emotional reactivity between pre and post intervention time points. This observed reduction in reactivity appeared to return to pre intervention levels at follow up.

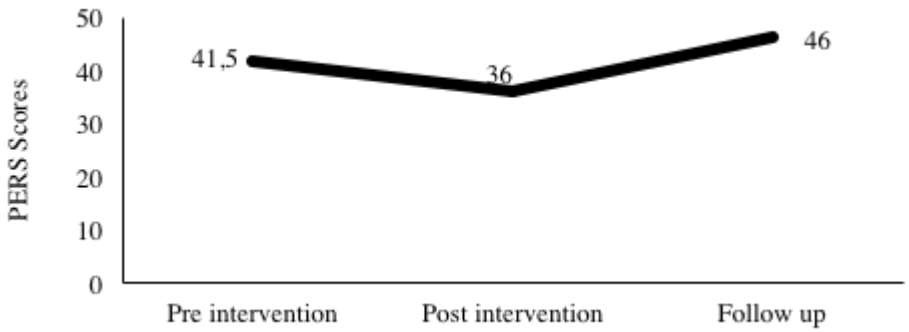

Figure 5. LU's scores on the PERS pre intervention, post intervention and follow up.

Figure 6 displays LU's overall DERS scores. Results indicate a small reduction in overall difficulties in emotion regulation between pre and post intervention. At follow up scores increased to a level notably higher than pre intervention scores. Figure 7 displays LU's scores on the two overall components of the SF-36. A small improvement was

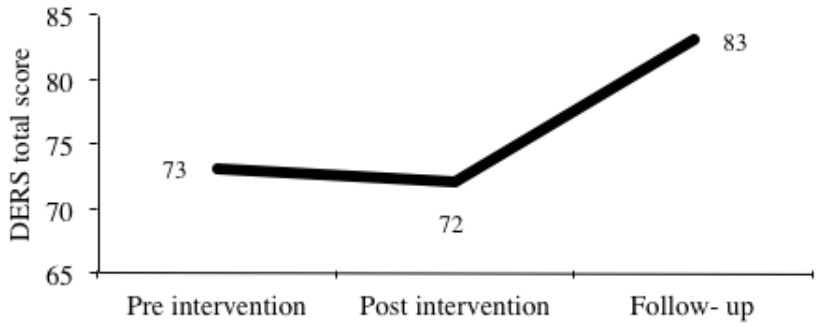

Figure 6. LU's scores on the DERS pre intervention, post intervention and follow up.

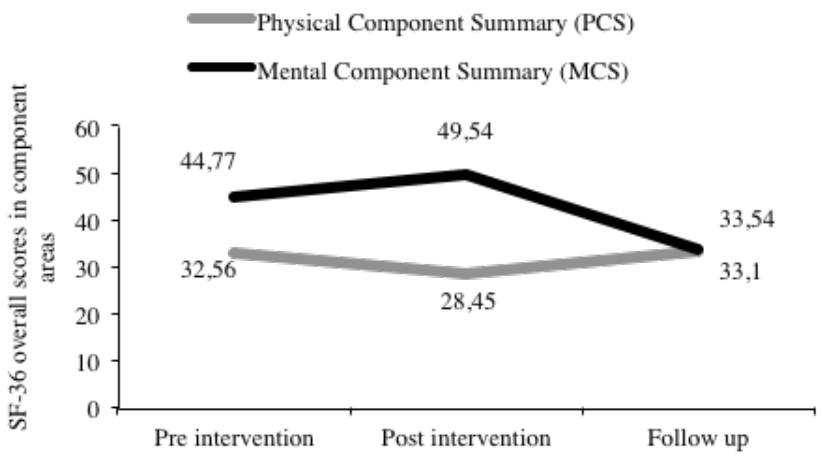

Figure 7. LU's scores on the SF-36 (PCS and MCS) pre intervention, post intervention and follow up.

observed in the Mental Component Summary (MCS) between pre and post intervention. This score was 'Average' at both pre and post intervention. This declined to 'Below Average' at follow up. The Physical Component Summary (PCS) showed a small decline at post intervention with a small improvement in score at follow up. However, PCS score maintained a 'Below Average' score at all time points.

DISCUSSION

Research suggests that Mindfulness practice is effective in reducing nociceptive pain intensity (Brown & Jones, 2010; Grant & Rainville, 2009) and chronic pain (Reiner *et al*., 2013), however few studies have investigated the effects of Mindfulness on post stroke NP. It was the primary purpose of this study to identify if Mindfulness was effective in minimising pain intensity levels immediately, in the short-term and long-term. This was achieved by assessing the pain levels in an individual, who 18 years ago suffered from an intracerabral haemorrhage, and has since experienced chronic NP. Pain intensity data was obtained before and after a 12-week period of daily Mindfulness practice. Pain intensity data was also recorded immediately before and after Mindfulness

practice each day.

The results indicate that there was an immediate effect of pain reduction following Mindfulness practice. This pain reduction appeared to be consistent across daily practice and was clinically relevant to the present study. There are a few studies that investigate the present moment effects of Mindfulness on pain, however studies have focussed on experimentally induced pain (Reiner *et al*., 2013) and have subsequently failed to assess this immediate effect on chronic NP. The present study suggests that there may be an immediate effect of Mindfulness specifically on Neuropathic type pain intensity.

Furthermore, the results indicate a short-term reduction in pain ratings on the subscales of Continuous pain, Neuropathic pain and Affective pain on the SF-MPQ-2. This is in line with the literature which shows a short-term improvement in pain intensity ratings following MBI programs (Reiner *et al*., 2013).

Long-term pain intensity reduction was not evident at follow up, suggesting that the positive effects of Mindfulness on pain reduction were short lived. It is worth noting that LU ceased regular Mindfulness practice following the 12-week study, suggesting that Mindfulness requires long-term practice commitment in order for gains to be maintained. In line with this, there is a growing body of literature that suggests positive effects of Mindfulness are related to practice factors. Research suggests that these gains may be mediated by increased experience of practice (Lazar *et al*., 2005; Taylor *et al*., 2011) or increased time spent on formal Mindfulness practice (Carmody & Baer, 2008). Other research implicates regularity of practice in mediating the effects of Mindfulness. In a study of MBCT participants, Munshi, Eisendrath, and Delucchi (2013) found no correlation between total practice time and depression outcomes, and concluded that observed effects may have been more related to regularity of practice than specific quantity. Additionally, Bergomi, Tschacher, and Kupper (2015) found that self-reported mindfulness is specifically associated with continued practice in the present, rather than with accumulated practice over years. The absence of maintained pain reduction in this present study, coupled with the existing literature suggests that in order to observe long-term pain reduction, Mindfulness practice must be maintained, either in duration spent practicing or regularity of practice. Given that research is limited in the long-term effects of Mindfulness on pain intensity (Reiner *et al*., 2013), this study adds to the limited data set and highlights the need for further research into the long-term effects of Mindfulness for pain.

Although the primary purpose of this study was to investigate the effectiveness of Mindfulness for NP reduction, an additional goal was to investigate the impact of Mindfulness on psychological processes and states associated with pain. This was achieved by assessing the participant's psychological functioning and well-being before and after a 12 week period of daily Mindfulness practice. Whilst it is acknowledged that a focus on only one case limits the ability to generalise results, examining the pain and psychological profile of this type of individual has seldom been performed, and is therefore valuable in obtaining information on the challenges that may be faced by this population.

The present study found a reduction in emotional reactivity, and a small reduction in difficulty in emotion regulation at post intervention. The results showed mixed outcomes of Mindfulness on emotional state, with improvements observed in symptoms of Depression and Stress on the DASS21 at post intervention. This is supported by the literature which suggests Mindfulness is associated with improvements in symptoms of depression (Finucane & Mercer, 2006), and stress (Morone *et al*., 2012). Contrary to

the literature, which suggests Mindfulness demonstrates improvements in symptoms of anxiety (Call, Miron, & Orcutt, 2013), this study suggested an increase in anxiety at post intervention.

Interestingly both Depression and Stress scores increased at follow up. This pattern was replicated in the Mental Component Score in the quality of life measure, which demonstrated an improvement in emotional quality of life at short-term only. The decline in these domains at follow-up further supports the suggestion that Mindfulness requires continued practice in order to maintain its positive effects. In contrast, some research suggests that Mindfulness has long term effects on emotional states (Khoury, Sharma, Rush, & Fournier, 2015). However, the literature is sparse and lacks comparability. This study adds to the limited data set and highlights the need for further research into the long-term effects of Mindfulness on emotional processes.

There were several limitations to this study. Firstly, the design of this study does not allow us to discern whether Mindfulness is effective in reducing the pain intensity of all types of NP, nor does it allow us to generalise effectiveness of intervention to the post stroke population. Additionally, as the participant's level of Mindfulness was not assessed, it is impossible to identify how effective the intervention was at creating a state of Mindful awareness, or whether the pain reduction was related to this. This would have been a useful tool given the participant at times reported difficulties in maintaining Mindfulness during practice. Lastly, LU noted that particular activities would exacerbate her symptoms and that her activities varied on a day-to-day basis. Consequently more assessment time points would have been useful given the participant's pain variability.

Given the variability of the psychological and well-being assessment results, it is difficult to discern if there was a mechanism of change to the observed pain reduction. However, LU's continued commitment to engaging in valued activities both pre, during and post intervention suggests that the pain reduction at post intervention was not mediated by more valued action, as proposed by Reiner *et al*. (2013). In contrast, given that LU demonstrated gains in emotional domains, in conjunction with pain reduction, the alternative proposal that emotional factors mediate pain intensity (Reiner *et al*., 2013) could be considered in the context of this study.

Although the present study suggests Mindfulness is an effective tool in the reduction of NP intensity, further research is recommended to investigate the mechanisms behind the pain reduction. Consideration of other moderating variables could also be considered in exploring pain reduction, such as valued activity engagement, and practice factors such as regularity or duration of practice. Further studies investigating the immediate and longer-term effects of Mindfulness on chronic NP would add to the limited literature. Additional research within this population would allow for more generalisability, and potential customisation of MBI's towards managing NP in post stroke patients.

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Received, June 9, 2016
Final Acceptance, December 30, 2016