

Title. Internet-based instructor-led mindfulness for work-related rumination, fatigue and sleep: assessing facets of mindfulness as mechanisms of change. A randomised waitlist control trial.

Abstract. This study aimed to extend our theoretical understanding of how mindfulness-based interventions exert their positive influence on measures of occupational health.

Employing a randomised waitlist control study design, we sought to: (1) assess an Internet-based instructor-led mindfulness intervention for its effect on key factors associated with ‘recovery from work’, specifically, work-related rumination, fatigue and sleep quality; (2) assess different facets of mindfulness (acting with awareness, describing, non-judging, and non-reacting) as mechanisms of change; and (3) assess whether the effect of the intervention was maintained over time by following up our participants after three and six months.

Participants who completed the mindfulness intervention (N=60) reported significantly lower levels of work-related rumination and fatigue, and significantly higher levels of sleep quality, when compared with waitlist control participants (N=58). Effects of the intervention were maintained at three and six month follow-up with medium to large effect sizes. The effect of the intervention was primarily explained by increased levels of only one facet of mindfulness (acting with awareness). This study provides support for online mindfulness interventions to aid recovery from work and furthers our understanding with regards to how mindfulness interventions exert their positive effects.

Keywords. Work-related rumination, fatigue, sleep, mindfulness, online intervention.

Introduction

This study aimed to extend our theoretical understanding of how mindfulness-based interventions exert their positive influence on measures of occupational health. Employing a randomised waitlist control study design, we sought to: (1) assess an Internet-based instructor-led mindfulness intervention for its effect on key factors associated with ‘recovery from work’, specifically, work-related rumination, fatigue and sleep quality; (2) assess different facets of mindfulness (i.e., acting with awareness, describing, non-judging, and non-reacting) as mechanisms of change; and (3) assess whether the effect of the intervention was maintained over time by following up our participants after three and six months.

Mindfulness

For centuries, the benefits of mindfulness have been extolled. Mindfulness can be defined as the receptive attention to – and awareness of – external (e.g., sounds, sights) and internal (e.g., thoughts, emotions) present-moment states, events and experiences (Brown & Ryan, 2003; Dane, 2011). Mindfulness promotes receptive experience, which involves remaining experientially open by being non-evaluative and non-defensive, processing information about one’s experiences without judging their emotional value (Bishop, Lau, Shapiro, Carlson, Anderson, Carmody et al., 2004; Brown, Ryan & Cresswell, 2007). At its heart, mindfulness involves consciously attending to one’s moment-to-moment experience (Brown & Ryan, 2003), and meditation practice operates as “scaffolding” to enable the development of the state (or skill) of mindfulness (Kabat-Zinn, 2003).

Mindfulness training has been shown to systematically reduce psychological and physical symptoms of stress (for review, see Chiesa & Serretti, 2009), and to reduce negative affect and rumination (Chiesa & Serretti, 2009), burnout (Geller, Krasner, & Korones, 2010; Hulsheger, Alberts, Feinholdt, & Lang, 2013), and illness symptoms (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008). It has also been shown to confer benefits on various wellbeing

related outcomes; for example, coping capabilities, purposefulness in life and the experience of positive emotions (e.g., Fredrickson et al., 2008). With regard to occupational health, mindfulness has been shown to be effective in: reducing daily hassles, psychological distress, and medical symptoms (Williams, Kolar, Reger, & Pearson, 2001; Dane, 2011); reducing emotional exhaustion and improving job satisfaction (Hulsheger et al., 2013); increasing employee engagement (Leroy, Anseel, Dimitrova, & Sels, 2013); improving sleep quality (Wolever, Bobinet, McCabe, Mackenzie, Fekete, Kusnick, et al., 2012; Hulsheger, Lang, Depenbrock, Fehrmann, Zijlstra, & Alberts, 2014; Hulsheger, Feinholdt, & Nubold, 2015); reducing perceived stress (Wolever et al., 2012); and increasing psychological detachment from work and satisfaction with work-life balance (Michel, Bosch, & Rexroth, 2014). Furthermore, a recent meta-analysis found support for using mindfulness-based interventions in occupational settings to reduce psychological distress (Virgili, 2015).

The majority of mindfulness interventions are conducted face-to-face (in groups) facilitated by mindfulness trainers. Developers of mindfulness-based interventions suggest that the presence of others is an important part of the learning process because, not only do other group members provide social support, they also learn from engaging in investigative dialogue (between the teacher and group members) at the end of each class (Kabat-Zinn, 1990; Segal, Williams, & Teasdale, 2002). However, this format increases the cost for organisations because employees must ‘take time out’ of their working day to attend the courses (thereby having a potential impact on productivity), and the organisation invariably pays for the cost of venue hire and mindfulness trainers. Furthermore, the relatively high costs associated with traditional face-to-face formats of mindfulness training, and the limited number of sessions that can be offered within any given timeframe, tend to limit the offer of these types of interventions to a select group of employees (e.g., leadership). As such, finding novel and effective ways for employees to learn mindfulness (e.g., through online courses

they can complete in their own time) may help to decrease associated costs and increase accessibility. While in theory online mindfulness interventions may be a cost-effective way forward for organisations seeking to support employees' health and wellbeing, there is little research assessing the veracity of online mindfulness interventions (although see Wolever et al., 2012; Michel et al, 2014).

The question of whether or not mindfulness and mindfulness training work is no longer at the forefront; instead the important question to address is: how or through what mechanism/s does mindfulness work? (Brown et al., 2007). Relatively few studies have assessed the mechanisms by which mindfulness-based interventions exert their positive effects (Gu, Strauss, Bond, & Cavanagh, 2015), and there are several reasons why establishing the mechanisms of these types of interventions is crucial. Specifically, to be able: (1) to distinguish between specific and non-specific effects of treatment; (2) to maximise the effectiveness of interventions by enhancing active components; (3) to identify moderators in order to match treatments to individuals; and (4) to inform theory development and interpretation of results (Kazdin, 2007).

Shapiro, Carlson, Astin, & Freedman (2006) suggest two approaches to assessing mechanisms of change in mindfulness-based intervention studies. Firstly, they suggest that dismantle (tease apart) studies are necessary in order to separate and compare various active ingredients in mindfulness-based interventions. Secondly, they recommend the design of studies enabling an examination of the central construct of mindfulness to establish whether the development of "mindfulness" (or different facets of mindfulness) leads to the positive changes that have been observed. This step can be facilitated by employing valid and reliable measures of mindfulness in studies for use in statistical models of mediation. While there is still a relative scarcity of studies designed to assess the mechanisms of change, some authors have been testing different theoretical models (involving measures of mindfulness) via

mediation analysis. In most of these types of studies, the authors treat mindfulness as a unidimensional construct with results suggesting an increase in mindfulness mediates the effect of mindfulness-based interventions on psychological functioning and well-being (for review, see Gu et al., 2015). However, the authors know of one study from the clinical literature which has characterised mindfulness as a multi-faceted construct, assessing different facets of mindfulness as mediators (Boden, Bernstein, Walser, Bui, Alvarez, & Bonn-Miller, 2012). Boden et al. (2012) found that changes in only two of the four mindfulness facets included in their study mediated the change in their outcome variables, post-treatment posttraumatic stress disorder (PTSD) severity (mediator = acting with awareness) and post-treatment depression severity (mediator = non-judging).

In the current study, we adopted both of the approaches advocated by Shapiro et al. (2006). Firstly, we used a multi-faceted measure of mindfulness to assess whether different facets of mindfulness operated independently as mechanisms of change; and secondly, we removed the possibility of participants simply benefitting from social interaction inherent in taking part in group-based face-to-face programmes. To the authors' knowledge this is the first time that different facets of mindfulness (i.e., acting with awareness, describing, non-judging, and non-reacting) have been assessed as independent mechanisms of change when considering the effect of a mindfulness-based intervention on measures of recovery from work. The authors' interest in assessing these different facets of mindfulness (instead of considering mindfulness as a unidimensional construct) was driven by a desire to understand if one, multiple, or all, facets of mindfulness account for the positive effects of mindfulness interventions. If only one, or multiple, of the facets explain the effect of the intervention, this will extend our theoretical understanding of how mindfulness works and may provide foundation for developing more targeted mindfulness interventions, potentially reducing associated costs. Furthermore, if Internet-based instructor-led mindfulness interventions

produce effects sizes to rival those of traditional face-to-face group-based interventions, this may suggest that the social support component is not a necessary ingredient which could also influence the development and delivery of mindfulness interventions in the future.

Finally, while we know that mindfulness interventions exert positive effects immediately after treatment has been completed, what we are less certain of is whether or not those treatment effects are maintained over time. While many studies assessing mindfulness-based interventions in the clinical literature include more substantial follow-up periods for example, 6 months or more (e.g., Vollestad, Sivertsen, & Nielsen, 2011; for review, see Hofmann, Sawyer, Witt, & Oh, 2010), most studies conducted in the workplace do not assess change beyond the end of the intervention or assess with a very short follow-up period; therefore, it is difficult to establish whether or not positive effects are maintained. For example, a recent meta-analysis — assessing mindfulness-based interventions to reduce psychological distress in working adults — reported that moderate treatment effects were maintained over follow-up periods ranging from 4 to 20 weeks with a mean of 8.3 weeks ($SD=6.5$) and a median of 5 weeks (Vigili, 2015); and another recent meta-analysis of mindfulness-based stress reduction (MBSR) interventions for healthy individuals concluded that moderate treatment effects were maintained over an average follow-up period of 19 weeks (Khoury, Sharma, Rush, & Fournier, 2015). The current study sought to assess the maintenance of effects over time by employing a design in which participants were followed-up after three and six months.

Work-related rumination and recovery from work

When an individual goes to work, he or she must expend emotional, physical and cognitive effort to meet the demands experienced. When the individual then returns home from work, rest is required in order for emotional, physical and cognitive systems to be replenished (Meijman & Mulder, 1998). This process of replenishment is called *recovery* and

there is a large, and ever growing, body of literature concerning mechanisms that aid, or interfere with, recovery from work. Optimising recovery is an important goal because research has shown that inadequate recovery from the demands of work is associated with poor health outcomes including: elevated risk of cardiovascular disease (Suadicani, Hein, & Gyntelberg, 1993); negative mood states (Pravettoni, Cropley, Leotta, & Bagnara, 2007); compromised sleep (Akerstedt, Fredlund, Gillberg, & Jansson, 2002; Nysten, Melin, & Laflamme, 2007); and increased levels of fatigue (Cropley, Dijk, & Stanley, 2006; Querstret & Cropley, 2012).

A mechanism which may interfere with our ability to adequately recover (e.g., by interfering with sleep) is work-related rumination. Work-related rumination refers to the tendency for some people to think about ('ruminate' about or ponder over) work-related issues and events outside of work (Querstret & Cropley, 2012). In jobs that are more physically (than psychologically) demanding, it is relatively easy to see when a stressor ends such that recovery processes can begin; however, this is not so simple for jobs which are psychologically taxing (Sonnentag, 2011). For psychological stressors (e.g., high workload, social conflict at work, role ambiguity) it is more difficult to determine when the demands exerted by the stressor cease to place demands on the individual. Specifically, the demands of these types of stressors may be maintained outside of work if the individual continues to think about them, or to ruminate, when they are no longer at work (Brosschot, Gerin, & Thayer, 2006). Therefore, it is not sufficient to simply be away from the working environment, the individual must also disconnect (or detach) from work mentally (Sonnentag, 2011).

The current study was interested in two distinct (but related) forms of work-related rumination: affective rumination and problem-solving pondering (Cropley & Zijlstra, 2011). According to Cropley & Zijlstra, the main difference between these two forms of

perseverative thinking about work lies in the amount of emotional response they evoke. When thinking about work-related issues results in a negative emotional response (e.g., frustration, annoyance, feeling emotionally fatigued), people are said to be engaging in affective rumination. Often the focus of this kind of thinking is not about solving issues but is more akin to rumination found in the clinical literature whereby the person is caught up in a negative emotional response loop, unable to arrest the process. In contrast, problem-solving pondering is focused on finding solutions to work-related problems, or planning how to tackle an uncompleted task at work the next day, and the emotional response is purportedly not evoked. Problem-solving pondering could even be a positive experience, especially if a solution is arrived at.

Rumination is not a new concept and research in this area has been dominated by clinical/health psychology. In this context rumination has been implicated in the development of a number of psychological disorders, for example, depression and anxiety (Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998; Mellings & Alden, 2000). It is also associated with increased physical symptom reporting (Hazlett & Haynes, 1992), intrusive off-task thoughts (Sarason, Pierce, & Sarason, 1996), negative self-evaluations, diminished feelings of control and feelings of helplessness (Lyubomirsky, Kasri, & Zehm, 2003). Furthermore, laboratory studies have shown prolonged physiological arousal and delayed recovery in individuals who ruminate (Roger & Jamieson, 1988) and many studies show that rumination interferes with sleep (Akerstedt et al., 2002; Berset, Elfering, Luthy, Luthi, & Semmer, 2011; Cropley et al., 2006; Querstret & Cropley, 2012; Thomsen, Mehlsen, Christensen, & Zachariae, 2003; Thomsen, Mehlsen, Hokland, Viidik, Olesen, Arlund et al., 2004; Zoccola, Dickerson, & Lam, 2009).

Fatigue, sleep and recovery from work

Fatigue, driven by increased psychophysiological workload and reduced sleep, has been recognised as a major consequence of increased work intensity (Harma, Kompier, & Vahtera, 2006). The term fatigue is used in many different ways and there is no single accepted definition, however the literature consistently distinguishes between acute and chronic fatigue. Acute fatigue is short-lived and signals to the individual that they need to make space for recovery. In the work context, acute fatigue - or 'need for recovery' - represents the sense of urgency that people feel to take a break from work demands (Kinnunen, Feldt, Siltaloppi, & Sonnentag, 2011). In contrast, chronic fatigue is persistent and could be considered to be the consequence of continuing to tax already overburdened systems (Winwood et al., 2007). Fatigue that is acute and modifiable by rest and/or by task moderation is generally adaptive and not inevitably stressful (Winwood, Lushington, & Winefield, 2006). However, persisting with activity while already fatigued - because of perceived internal or external pressures - may be experienced as stress inducing (Aaron & Buchwald, 2001; Baker, Mendenhall, Simbartl, Magan & Steinberg, 1997; Bultmann, Kant, Kasl, Schroer, Swaen, & van den Brandt, 2002). Chronic fatigue could be considered the consequence of continuing to tax already overburdened systems.

Research has shown that psychomotor and cognitive functioning, mood and motivation are affected by fatigue (Williamson, Lombardi, Folkard, Stutts, Courtney, & Connor, 2011). Fatigue has been linked to increased reaction times, decreased vigilance (ability to detect and react to unexpected events), memory impairment, compromised decision making, and reductions in information processing capacity (Lyznicki, Doege, Davis, & Williams, 1998). Furthermore, increased levels of fatigue in the work environment can have serious consequences, for example, fatigue in nurses has been linked to increased medication errors, higher numbers of work-related injuries, decreased productivity and

cognitive impairment (Kunert, King, & Kolkhorst, 2007). Given the real world consequences of work-related fatigue, it is important to identify possible causal mechanisms and to develop interventions which may aid recovery from work. Arguably the most important mechanism to prevent fatigue accumulating is sleep.

The value of good quality sleep for effective recovery is well established. The brain requires sleep in order for energy stores to be restored (Porkka-Heiskanen, Kalinchuk, Alanko, Urrila, & Stenberg, 2003) and research has shown an association between chronic poor sleep and a multitude of different health impairments, such as self-reported coronary heart disease (Schwartz, Anderson, Cole, Cornin-Huntley, Hays, & Blazer, 1999), gastrointestinal problems, high blood pressure, neurological disorders (Taylor, Mallory, Lichstein, Durrence, Riedel, & Bush, 2007), cardiovascular disease (CVD), diabetes, obesity and depression (Akerstedt, 2006). Performance is also negatively impacted by sleep loss and sleep disturbance and sleep loss can result in increased fatigue, mood changes, and impairment of the immune system (Harrison & Horne, 1999; Rogers, Szuba, Staab, Evans, & Dinges, 2001). One of the consequences of sleep disturbance is sleepiness during activity periods which can lead to result in an increase in work-related accidents (Lauber, & Kayten, 1988), with potential work-related injuries and loss of productivity (Kantermann, Juda, Vetter, & Roenneberg, 2010). Furthermore, sleep debt and problems getting to sleep, are known to compromise memory consolidation (Karni & Sagi, 1993) and decrease attention, performance and mood (Dinges, Pack, Williams, Gillen, Powell, Ott, et al., 1997).

Having sufficient time between work shifts for sleeping does not necessarily mean that adequate restorative sleep will occur (Winwood et al., 2007) and the reality for many workers with stressful occupations is that sleep quality is frequently below that which is required, due to the persistence of stress-response brain arousal in non-work time (Akerstedt et al., 2002; Linton, 2004; Strine, & Chapman, 2005). While there are several cross-sectional

studies (Akerstedt et al., 2002; Geiger-Brown, Trinkoff, & Rogers, 2011), and a few longitudinal studies (Burgard & Ailshire, 2009; de Lange, Kompier, Taris, Geurts, Beckers, Houtman, et al., 2009) demonstrating an association between work-related stress and sleep, the mechanism/s by which occupational stress influences sleep remain uncertain. However, the sleep literature agrees that one of the factors thought to interfere with sleep is perseverative thinking (e.g., rumination, worry), with self-reported sleep disturbance showing a strong association with work-related worries and rumination (Akerstedt et al., 2002; Cropley et al., 2006).

Mindfulness to aid recovery from work

Finding ways to help employees disconnect, or switch off, from work-related rumination would be very helpful in the context of the negative health consequences associated with it (e.g., poorer sleep and increased levels of fatigue). In a recent study, Michel et al. (2014) suggested that mindfulness could prove to be an effective remedy for rumination because it would provide an effective cognitive-emotional segmentation strategy to help shape boundaries between work and home lives. Furthermore, learning mindfulness may enable people to accept (without judgement) their thoughts and feelings. For example, a typical formal mindfulness meditation consists of the individual focusing his or her full attention on the breath as it flows in and out of the body. Focusing on each breath in this way is thought to enable the individual to observe their thoughts and feelings as they arise in their mind and, little by little, this helps them to let go, and stop struggling (or engaging) with them (Williams & Penman, 2011). As such, mindfulness allows people to catch negative thought patterns before they become perseverative, enabling them to exercise control over their thinking (Brown et al., 2007). Essentially, it could be considered a method of mental training and therefore may prove extremely effective in reducing work-related rumination.

Previous research suggested that affective work-related rumination may be more detrimental to recovery than problem-solving pondering (e.g., by increasing work-related fatigue; Querstret & Cropley, 2012); however, as problem-solving pondering may share the same cognitive process as affective rumination (Brosschot et al., 2006), it seems reasonable to posit that a mindfulness intervention may have an effect on both forms of work-related rumination. While this is the first study to consider the impact of a mindfulness intervention on work-related rumination, previous studies reported in the clinical literature have concluded that mindfulness is effective for the reduction of depressive rumination and worry (for review, see Querstret & Cropley, 2013); and as work-related rumination may share a similar cognitive process with these other forms of perseverative cognition (Brosschot et al., 2006), it would seem logical that a mindfulness intervention may be effective. In addition, previous research has shown that mindfulness interventions may also reduce occupational fatigue in the form of emotional exhaustion (Hulsheger et al., 2013) and burnout (Geller et al., 2010); and there is evidence from empirical studies (e.g., Wolever et al., 2012; Hulsheger et al., 2014; Hulsheger et al., 2015), and systematic reviews of the literature (for review, see Winbush, Gross, & Jreitzer, 2007) to suggest that mindfulness may positively affect sleep.

Study hypotheses

Change in outcome variables

We predicted that participants who completed the online mindfulness course would report...

...significantly lower levels of affective work-related rumination (H1)

...significantly lower levels of problem-solving pondering (H2)

...significantly lower levels of chronic work-related fatigue (H3)

...significantly lower levels of acute work-related fatigue (H4)

...significantly higher levels of sleep quality (H5)

Change in mediation variables (mindfulness facets)

Operationalising mindfulness. Mindfulness has been characterised as a multi-faceted construct and five facets have been identified: acting with awareness, describing, non-judging (of inner experience), non-reacting (to inner experience), and observing (Bohlmeijer, ten Klooster, Fledderus, Veehof, & Baer, 2011). *Acting with awareness* involves attending to (paying attention to) one's activities in/of the moment (the opposite of 'acting on automatic pilot'); *describing* reflects the ability to label internal experiences (e.g., feelings, emotions) with words; *non-judging* (of inner experience) involves taking a non-evaluative stance towards thoughts and feelings; *non-reacting* (to inner experience) enables the individual to allow thoughts and feelings to come and go without getting caught-up or carried away with them; and *observing* involves noticing or attending to internal and external experiences. Baer, Smith, Hopkins, Krietemeyer and Toney (2006) showed that acting with awareness, describing, non-judging and non-reacting substantially loaded onto a higher order mindfulness construct; however, observing was only predictive in samples of participants with previous meditation experience. As participants in the current study were required to be naive to mindfulness and other forms of meditation (see the eligibility criteria in the Methods section), the observing facet of mindfulness was not assessed. Instead, the four facets of mindfulness which have been shown to load onto a higher order mindfulness facet in samples of participants naive to meditation (Baer et al., 2006), were measured and assessed. Therefore, we predicted that participants who completed the online mindfulness course would report...

...significantly higher levels of acting with awareness (H6)

...significantly higher levels of describing (H7)

...significantly higher levels of non-judging (H8)

...significantly higher levels of non-reacting (H9)

Methods

Ethical approval

Ethical approval was granted by the University of Surrey Ethics Committee (Reference: EC/2013/71/FAHS).

Experimental design

A randomised waitlist control design was employed. Participants were assessed pre-treatment (T1) and post-treatment (T2) and were followed up at three months (T3) and six months (T4) post-treatment.

Procedure

Recruitment. Details of the study were circulated to organisations with which the University had relationships to request they promote the study to their staff. In addition, the study was promoted via social media and was also advertised on an online professional networking site (www.Linkedin.co.uk).

Screening. Individuals were sent, via email, a link to an online screening questionnaire. To be eligible for inclusion, participants had to meet the following criteria: 1) 18 years of age or older; 2) working a minimum of 30 hours per week; 3) ability to commit two hours (minimum) per week for the duration of the course; 4) access to the Internet at home; 5) not receiving any other form of psychological therapy and no plans to start any other form of psychological therapy during the study; 6) no previous experience of mindfulness or meditation; 7) living and working in the United Kingdom (UK); and 8) reporting moderate to high levels of work-related affective rumination. Affective work-related rumination was chosen as an inclusion criterion because previous literature suggests it is more damaging to recovery than other forms of work-related rumination (see, e.g., Querstret & Cropley, 2012). In order to assess levels of affective rumination, participants completed the work-related rumination questionnaire (WRRQ; Cropley, Michalianou,

Pravettoni, & Millward, 2012) and their affective rumination score had to be 15 or higher. The cut-off score for affective rumination was based on data reported in a recent large-scale cross-sectional study (N=719; Querstret & Cropley, 2012), and participants' scores had to fall a minimum of one standard deviation above the mean reported in that study.

Randomisation process. Randomisation was stratified by gender because previous research has shown that women typically report higher levels of rumination than men (Johnson & Whisman, 2013). Block-randomisation was used, with block sizes of 4 for both men and women. A random number generator programme (Urbaniak & Plous, 2013) was used to allocate participants to either the intervention (INT) or waitlist control (WLC) group. Participants were blinded to group membership as they were not able to choose which group they were allocated to and they were not aware that the study was designed as a waitlist control trial. They were simply informed there were two course start dates. Furthermore, participants had no contact with each other because all recruitment was conducted online, participants came from all over the UK, and all communication with participants was conducted via personal email. Study personnel were not blinded to participant allocation.

Incentives for participation: In order to increase participation and adherence throughout the study, participants were offered £50 worth of Love2Shop vouchers which can be used in over 20,000 well known high-street stores in the UK.

Online mindfulness course

The online mindfulness course assessed in this study comprised elements of mindfulness-based stress reduction (MBSR; Kabat-Zinn, 1990) and mindfulness-based cognitive therapy (MBCT; Teasdale, Segal, Williams, Ridgeway, Soulsby, & Lau, 2000). The course is run by the Mental Health Foundation (UK) and Wellmind Media (UK) and was developed in conjunction with leading UK mindfulness instructors (Krusche, Cyhlarova, King, & Williams, 2012). The online course usually costs £60 per person, however

participants in this study were able to complete the course for free. The online course follows a similar class sequence to traditional 8-week mindfulness programmes but it is marketed as a 4-week course. In the current study, participants were asked to complete the course within four weeks if possible. Participant completion was tracked throughout the course in order to ensure that participants were regularly accessing the course and were progressing through the weeks. It was possible to see which day and week of the course participants were up to and it was also possible to see when they last accessed the course (date and time). It was not possible to see whether participants had accessed specific course elements (e.g., videos or audio files). Participants were sent reminder emails when they had not accessed the course for more than a week.

To complete the course, participants access instructional videos that guide formal meditations, through a website: <http://www.bemindfulonline.com> (Krusche et al., 2012). The course is led by two highly experienced mindfulness instructors (one male and one female); and consists of 10 interactive sessions through which participants learn to use both formal meditation skills (e.g., body scan, mindful movement, sitting meditation, and three minute breathing space), and informal mindfulness techniques that they can incorporate into daily activities (e.g., mindful eating, mindful walking, mindfully brushing teeth) (Krusche et al., 2012). Each week participants are asked to complete at least one formal exercise (using audio and video clips that are provided), such as the body scan (for 30 minutes), or mindful movement (lasting 10 minutes); and also to complete one informal exercise in their own time (e.g., eating a meal mindfully) (Krusche et al., 2012). The instructional components of the course are supplemented with embedded content on webpages to support learning about mindfulness. Participants do not have any personal contact with the mindfulness instructors at any point during the course. All instructional video and audio files are embedded within the website.

The format of each week of the course is consistent and begins with a short video (usually 3 minutes) with one, or both, of the mindfulness instructors explaining the theme for the week and introducing the formal and informal practices. The participants then have an opportunity – through a short video – to practice the formal practice (e.g., body scan) with the instructor. However, the formal practice audios used for daily practice are longer (usually between 20 and 30 minutes). Participants are encouraged to practice the formal techniques daily, however it is entirely up to them to decide how often, and for how long, they practice. Importantly, participants cannot access the supporting audio files until they have viewed the instructional video showing how to correctly practice the formal technique. Furthermore, participants cannot progress to the next week of the course until they have completed all practice elements of the current week; however, all materials from previous weeks are available to participants throughout the course. In this way, a library of video and audio files accumulates over the length of the course which the participants can revisit.

In week one of the course, participants are introduced to the concept of mindfulness and are provided with an overview of the course and its format. This week they are asked to practice a *body scan* exercise (30 minutes), carry out a routine activity ‘with awareness’ (e.g., brushing teeth) and to eat one of their meals during the week ‘mindfully’. In week two of the course, participants are introduced to *mindful breathing* and *mindful movement* techniques and are encouraged to become more aware of their thoughts and feelings by keeping an events diary. In this diary, they record their responses (e.g., thoughts, feelings) to different events in their daily lives. They are also asked to practice *mindful breathing* and *mindful movement* over the course of the week. In week three of the course, participants are introduced to the concept of ‘working with difficulties’. They are encouraged to acknowledge difficult thoughts and emotions in order to understand that these thoughts and emotions are not facts (and that they are transient) and to complete a difficult thoughts checklist which is

embedded in the website. This week, participants are introduced to *sitting meditation* and the *three minute breathing space* technique and they focus on developing an awareness of their reaction to stress without attempting to change that reaction. They are asked to practice *sitting meditation* daily and to practice the *three minute breathing space* at predetermined times (of their choosing) during the week.

In the final week of the course, participants work on: 1) developing an awareness of their personal patterns (e.g., how they get into stress or negative moods); 2) identifying changes in their body and mind when stressed; and 3) creating a “stress indicators” list which they can then use to become more aware of stress in their lives. During this week, there is also a focus on developing strategies for managing stress by identifying factors which are unhelpful (e.g., too much caffeine, not eating, avoidance, alcohol, overworking, etc.) and which are helpful (e.g., listening to music, practicing meditation, exercising, speaking with friends/family, having a bath, etc.). This week participants are introduced to *mindful walking* and can choose which formal practice (from the previous weeks) they wish to practice. They are also asked to practice the *three minute breathing space* at predetermined times (of their choosing). At the end of the course participants have an opportunity to reflect on what they have learned and to identify factors that will be most important to them moving forward.

Participant details

One hundred and twenty seven participants were randomised into either the intervention (INT; N=63) or waitlist control (WLC; N=64) group. However, before the study started three participants from the INT group and six participants from the WLC group dropped out, so the sample at the start of the study was comprised of 118 participants (INT=60; WLC=58). Please see Figure 1 for the participant flow from screening to follow-up.

[Insert Figure 1 about here]

The sample was comprised of 118 working adults (female = 80.5%; $n = 95$) with an age range of 21-62 years ($M = 40.68$, $SD = 10.45$). The majority of participants (94.9%; $n = 112$) worked full-time for a mean of 45.12 ($SD = 14.84$) hours/week in jobs they had held for a mean of 7.09 ($SD = 7.12$) years. Eighty five participants (72%) were married or had a partner. Fifty nine participants (50%) reported having dependent children. One hundred and two participants (86.4%) worked a traditional 9am-5pm (Mon-Fri) pattern, with the remaining 16 participants (13.6%) working shifts. Many job roles were represented in the sample with participants from nursing/medicine ($n=31$) representing 26.3% of the sample, followed by healthcare (e.g., dieticians, physiotherapists; $n=24$; 20.3%), administration ($n=23$; 19.5%), education ($n=17$; 14.4%), management ($n=10$; 8.5%), police ($n=8$; 6.8%), and other ($n=5$; 4.2%). Roughly two thirds of the sample were University educated ($n=81$; 68.6%). Sample specifics for each of the study groups are presented in Table 1.

[Insert Table 1 about here]

Measures

Work-Related Rumination. The Work-Related Rumination Questionnaire (WRRQ, Cropley et al., 2012). Two of the subscales were analysed: affective rumination and problem-solving pondering - each with 5-items. Included in the affective rumination subscale are items such as, “Are you annoyed by thinking about work-related issues when not at work?”, and the problem-solving pondering subscale includes items such as, “After work I tend to think of how I can improve my work-related performance.”. Items are responded to against a 5-point Likert scale ranging from 1 (Very seldom/never) to 5 (Very often/always), and each subscale

yields a total score which ranges from 5 to 25, with higher scores representing higher levels of the factor in question. In a previous study, Cronbach's alphas have been reported as: affective rumination=.90; problem-solving pondering=.81 (Querstret & Cropley, 2012). Cronbach's alphas for the current study were as follows: affective rumination (T1=.85, T2=.87, T3=.89, T4=.89); problem-solving pondering (T1=.70, T2=.74, T3=.71, T4=.78).

Work-related fatigue. The Occupational Fatigue Exhaustion Recovery scale (OFER, Winwood, Bakker, & Winefield, 2007). Two of the subscales were analysed: chronic fatigue (CF) and acute fatigue (AF). The CF and AF subscales were both measured and analysed because the impact of the intervention on fatigue which represents a short-term end-of-day need for recovery (AF), and on fatigue which is more persistent/long-term (CF), was of interest. Typical items for CF include, "I often dread waking up to another day of my work"; and for AF include, "After a typical work period, I have little energy left". Each item is responded to on a seven point Likert scale ranging from 0 (Completely disagree) to 6 (Completely agree). Each subscale yields a total score that ranges from 0-100 ($score = \left[\sum (itemscore) \div 30 \right] \times 100$). Cronbach's alphas in a previous study have been reported as .86 (CF) & .84 (AF) (Winwood et al., 2006). Cronbach's alphas for the current study were as follows: chronic fatigue (T1=.83, T2=.86, T3=.86, T4=.87); acute fatigue (T1=.81, T2=.90, T3=.90, T4=.91).

Sleep quality. The Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds III, Monk, Berman, & Kupfer, 1988) is a validated questionnaire comprised of 19 items assessing sleep quality and disturbances over a one-month interval. Seven component scores are summed together to yield a global PSQI score, ranging from 0 to 21. Higher scores reflect poorer sleep quality (Buysse et al., 1988). Cronbach's alpha for this scale has been reported in a previous study to be: 0.83 (Carpenter & Andrykowski, 1988). Cronbach's alphas for the current study were T1=.73, T2=.70, T3=.73, T4=.76.

Mindfulness. Five Facet Mindfulness Questionnaire Short form (FFMQ-SF; Bohlmeijer et al., 2011) is a 24-item questionnaire that measures five facets of mindfulness: *observing* (OBS; 4 items, e.g., I notice the smells and aromas of things), *describing* (DES; 5 items, e.g., I'm good at finding the words to describe my feelings), *acting with awareness* (AA; 5 items, e.g., It seems I am "running on automatic" without much awareness of what I am doing), *non-judging* (NJ; 5 items, e.g., I criticise myself for having irrational or inappropriate emotions), and *non-reacting* (NR; 5 items, e.g., I watch my feelings without getting lost in them) (Bohlmeijer et al., 2011; Baer et al., 2006). Participants are asked to rate the degree to which each statement is true for them. Items were scored on a 5-point Likert scale ranging from 1 (never or very rarely true) to 5 (often or always true). Facet scores were computed by summing the scores on the individual items.

The four subscales which have shown to be facets of a broad mindfulness construct in samples naïve to meditation were analysed (Baer, Smith, Lykins, Button, Krietemeyer, Sauer, et al., 2008). Facet scores ranged from 5 to 25, with higher scores indicating more mindfulness. These facets of mindfulness have shown good internal consistency in a previous study, yielding the following Cronbach's alphas: .73 (NR), .86 (NJ), .86 (AA), and .91 (DES; Bohlmeijer et al., 2011). Cronbach's alphas for the current study were as follows: DES (T1=.84, T2=.85); AA (T1=.79, T2=.86); NJ (T1=.78, T2=.87); NR (T1=.82, T2=.83). We did not assess mindfulness facets at three month and six month follow-up because they were included to be assessed as mediators and the mediation models could not be tested beyond post-treatment due to the waitlist control group commencing the mindfulness intervention.

Cronbach's alphas for variables in the current study (stated above) were calculated on data from the whole sample (INT & WLC groups combined); and the WLC group data was based on data collected after the post-waitlist period (immediately before participants in this group started the intervention).

Control variables

Single items were included for gender (1=female; 2=male), age, children (1=yes, 0=no), level of education (1=no university; 2=university educated); work pattern (1=traditional [9am-5pm Mon-Fri], 2=shift work); work type (1=full-time, 2=part-time) and hours worked per week.

Results

Statistical analysis

Multiple imputation for missing data. The dropout rate in the current study (25%; see Figure 1) was comparable to other studies (for review, see Swift & Greenberg, 2012). Resultant missing data was imputed (5 iterations) using the automatic imputation process in SPSS version 21 (IBM Corp, 2012). Intention-to-treat (ITT) results are reported throughout this paper and are used for interpreting the findings in the study; however, where per protocol (PP) results differ significantly from the ITT results, both ITT and PP results are reported.

Analytic approach

There were three steps in our analytic strategy. In the first step, two Multivariate Analysis of Covariance (MANCOVA) analyses were conducted. The first MANCOVA, assessed the degree to which the intervention affected the recovery variables (affective rumination, problem-solving pondering, chronic fatigue, acute fatigue, sleep quality); and the second MANCOVA assessed the degree to which the intervention affected the mindfulness variables (describing, acting with awareness, non-judging, non-reacting). In the second step, Analysis of Covariance (ANCOVA) analyses were conducted to assess the effect of the intervention on each of the recovery, and mindfulness, variables individually. The MANCOVA and ANCOVA analyses sought to assess the effect of the intervention by comparing the intervention and waitlist control groups against each other; therefore, the

outcome variables in these analyses were assessed after the intervention group completed the intervention, and after the waitlist control group completed their waitlist period.

Analyses in steps one and two were conducted in SPSS version 21 (IBM Corp, 2012). In the third step, which aimed to understand the mechanism/s of change for the main study variables, mediation analyses were performed using the PROCESS macro (Hayes, 2013). PROCESS enables researchers to conduct mediation analyses using bootstrap confidence intervals for indirect effects (Hayes, 2013). In our bootstrap analysis, we specified 10,000 resamples and 95% confidence intervals with confidence intervals including zero indicating a null effect (Mooney & Duval, 1993).

Below, we firstly present the MANCOVA and ANCOVA results for the recovery variables (H1 – H5), then we present the MANCOVA and ANCOVA results for the mindfulness variables (H6 – H9), and finally, we present results for the mediation analyses.

Analysis of recovery variables

MANCOVA analysis: recovery variables. A MANCOVA was run with time 2 (T2) scores for affective rumination, problem-solving pondering, chronic fatigue, acute fatigue, and sleep quality entered as dependent variables; T1 scores and relevant control variables as covariates; and group (INT vs. WLC) as the factor. We only included control variables in the analysis which were correlated with one or more of the recovery variables. Specifically, we included *Age* and *Hours Per Week* as covariates in the analysis because they were correlated with *Problem-solving pondering* at T2. A significant multivariate main effect for group was found, Wilks' $\lambda=0.69$, $F(5, 98)=8.50$, $p<.001$, $\eta_p^2=0.30$. According to Cohen's (1988) guidelines partial eta squared (η_p^2) values of .01, .06, and .14 constitute small, medium, and large effect sizes respectively; therefore, the effect size was large.

ANCOVA analysis: recovery variables. Individual ANCOVA's were conducted to assess the effect of the intervention on each of the recovery variables. For each ANCOVA

analysis, T1 scores and relevant control variables were entered as covariates in the model. We included *Age* and *Hours Per Week* as covariates in the analysis for *Problem-solving pondering*. Results showed a significant effect of the intervention on affective rumination, $F(1,107)=13.75$, $p<.001$, $\eta_p^2=0.11$; problem-solving pondering, $F(1,106)=16.01$, $p<.001$, $\eta_p^2=0.13$; chronic fatigue, $F(1,107)=33.70$, $p<.001$, $\eta_p^2=0.24$; acute fatigue, $F(1,106)=30.79$, $p<.001$, $\eta_p^2=0.26$; and sleep quality, $F(1,107)=20.63$, $p<.001$, $\eta_p^2=0.16$. Specifically, those participants who completed the online mindfulness course reported significantly *lower* levels of affective rumination, problem-solving pondering, chronic fatigue and acute fatigue — and significantly *higher* levels of sleep quality — than participants who did not complete the online mindfulness course. The effect sizes for chronic fatigue, acute fatigue and sleep quality were large; and the effect size for affective rumination and problem-solving pondering were medium (Cohen, 1988) and consistent with Hypotheses 1-5.

Analysis of mindfulness variables

MANCOVA analysis: mindfulness variables. For the mindfulness variables (acting with awareness, describing, non-judging, non-reacting), time 2 (T2) scores were entered as dependent variables; T1 scores and relevant control variables (those that were correlated with one or more of the mindfulness variables) as covariates; and group (INT vs. WLC) as the factor. *Job type* and *pattern of work* were entered as covariates because they were correlated with *non-judging*. A significant multivariate main effect for group (with large effect size; Cohen, 1988) was found, Wilks' $\lambda=0.77$, $F[4,109]=7.97$, $p<.001$, $\eta_p^2=0.23$.

ANCOVA analysis: mindfulness variables. ANCOVA's were conducted to assess the effect of the intervention on each of the mindfulness variables individually. For each ANCOVA analysis, T1 scores and relevant control variables were entered as covariates. *Job type* and *pattern of work* were entered into the analysis for *non-judging*. Results showed a significant effect of the intervention on *acting with awareness*, $F(1,115)=42.94$, $p<.001$,

$\eta_p^2=0.27$; describing, $F(1,115)=5.76$, $p=.02$, $\eta_p^2=0.05$ (ITT) [$F(1, 100)=2.47$, $p=0.12$ (PP)]; and non-judging, $F(1,115)=26.13$, $p<.001$, $\eta_p^2=0.19$. However, the intervention did not affect the non-reacting facet of mindfulness, $F(1,115)=1.71$, $p=.19$. In summary, participants who completed the online mindfulness course reported significantly *higher* levels of acting with awareness, non-judging and describing, than participants who did not complete the online mindfulness course. The effect sizes for *acting with awareness* and *non-judging* were large, and the effect size for *describing* was small (Cohen, 1988). These findings are consistent with Hypotheses 1-8 though not with Hypothesis 9. Means and standard deviations can be viewed in Table 2 (recovery variables) and Table 3 (mindfulness variables).

[Insert Table 2 about here]

[Insert Table 3 about here]

Mediation analysis

The previous two stages of analysis showed that the intervention had an effect on the recovery, and mindfulness. The next stage in the analysis aimed to understand the mechanism/s of change for the recovery variables; that is, how the intervention worked to reduce affective rumination, problem-solving pondering, chronic fatigue, acute fatigue, and to improve sleep quality. We were specifically interested in whether the change in one, or multiple, or the mindfulness variables accounted for the effect of the intervention on the recovery variables.

Firstly, separate multiple parallel mediation models were tested (see Table 4) whereby the three mindfulness variables affected by the intervention (describing, acting with awareness, non-judging) were entered simultaneously to assess whether they mediated the

effect of the intervention on each of our recovery variables. As can be seen in Table 4, only *acting with awareness* operated as a mediator for the effect of the intervention on affective rumination, chronic fatigue, acute fatigue, and sleep quality; and none of the mindfulness facets explained the effect of the intervention on problem-solving pondering. Table 4 shows that an increase in *acting with awareness* fully mediated the effect of the intervention on affective rumination and sleep quality (as the direct effect [INT (D)] was no longer significant for these variables once the mediators were included in the model), and it partially mediated the effect of the intervention on both forms of work-related fatigue. Bias corrected bootstrap confidence intervals for the indirect effect of acting with awareness on affective rumination (95% CI [-1.51, -0.19]), sleep quality (95% CI [-2.22, -0.25]), chronic fatigue (95% CI [-10.64, -1.43]), and acute fatigue (95% CI [-10.84, -0.78]), did not include zero; therefore, these were significant effects.

[Insert Table 4 about here]

Group membership influenced chronic fatigue and acute fatigue independent of its effect on acting with awareness because the direct pathways remained significant with the mediators in the model (see Table 4). Furthermore, the effect of the intervention on problem-solving pondering was not explained by any of the mindfulness facets. We therefore sought to examine other potential mediation models. Given that the effect of the intervention on affective rumination was fully mediated by its effect on acting with awareness; and in light of previous research suggesting affective rumination may be causal for acute and chronic work-related fatigue (e.g., see Querstret & Cropley, 2012), we examined affective rumination as a mediator for both forms of work-related fatigue in a serial mediation model with acting with awareness (see Table 5). In addition, in light of the fact that the two forms of work-related

rumination share high levels of variance (Querstret & Cropley, 2012), we also assessed a serial mediation model involving acting with awareness and affective rumination for problem-solving pondering as the outcome.

Table 5 shows that an increase in acting with awareness and subsequent reduction in affective rumination mediated the effect of the intervention on chronic fatigue and problem-solving pondering. Bias corrected bootstrap confidence intervals for the indirect effect of acting with awareness and affective rumination on chronic fatigue (95% CI [-13.24, -4.43]) and problem-solving pondering (95% CI [-1.03, -0.25]), did not include zero; therefore, these were a significant effects. As the direct effect of the intervention for chronic fatigue and problem-solving pondering was no longer significant with the mediators in the model, this represents a total mediation effect¹. For acute fatigue, Table 5 shows that the serial mediation pathway and the simpler pathway through acting with awareness alone were both significant. Analysis showed that these pathways were not significantly different to one another; therefore the more parsimonious pathway was retained (Hayes, 2013), and the remaining effect of the intervention on acute fatigue cannot be explained by including affective rumination in the mediation model.

[Insert Table 5 about here]

¹ In light of the sequential mediation effect through acting with awareness and affective rumination on problem-solving pondering, and given the high level of covariation shared between the two forms of work-related rumination (see Querstret & Cropley, 2012), another serial mediation model was run. In this subsequent model we assessed whether problem-solving pondering operated as part of a serial mediation model with acting with awareness for the effect of the intervention on affective rumination. However, the sequential mediation pathway was non-significant; so it appears the effect of the intervention on affective rumination was fully mediated by its impact on acting with awareness alone.

Impact of course completion time.

This analysis was run after all participants (from both the INT and WLC groups) had completed the mindfulness course (N=87). As discussed above, participants were encouraged to complete the course within four weeks of their start date. Vouchers were provided at various points throughout the course to encourage adherence; however, there was variation with regards to time taken to complete the course. The average time to complete the course was 6 weeks and 5 days, and all participants completed the course within 12 weeks. Post-treatment (T2) data was collected from each participant on the day they completed the course. In order to assess whether there were differences in the effect of the intervention due to time taken to complete the course, the sample was split into those who completed within 6 weeks (N=50), and those who took longer than 6 weeks to complete (N=37). A series of t-tests were performed to assess differences at course completion for all study variables. Results showed there were no significant differences between the groups for any of the variables immediately after course completion.

Analysis of change over time

Repeated measures ANOVA results. Finally, we wished to assess whether the positive effects of the mindfulness course were sustained at three month and six month follow-up. The waitlist control group completed the mindfulness course after the waitlist period ended; therefore, we assessed the effect of the intervention over time for the recovery variables for both the intervention group and for the waitlist control group. Table 6 shows that for the both the intervention and waitlist control groups there was a significant main effect of the mindfulness intervention over time for all of the outcome variables (with large effect sizes; Cohen, 1988). Figure 2 shows that the gains made for each of the outcome variables were maintained over time.

[Insert Table 6 about here]

[Insert Figure 2 about here]

Discussion

The purpose of this study was to assess the effect of a 4-week Internet-based instructor-led mindfulness intervention on work-related rumination (affective rumination, problem-solving pondering), fatigue (acute fatigue, chronic fatigue) and sleep quality. We also sought to add to the mindfulness literature, understanding ‘how’ it exerts its positive effects, by assessing different facets of mindfulness as mechanisms of change. Results showed that participants who completed the online mindfulness course reported significantly lower levels of affective rumination, problem-solving pondering, chronic fatigue and acute fatigue, and significantly improved sleep quality, when compared with participants who did not complete the course (immediately after course completion) consistent with Hypotheses 1 – 5. Importantly, the effect of the intervention was maintained for all of the outcome variables at three month and six month follow-up.

A number of authors have called for research designed to understand how (or by what mechanism/s) mindfulness exerts its positive influence (Brown et al., 2007; Glomb, Duffy, Bono, & Yang, 2011; Kazdin, 2007). In this study, the results clearly showed that the Internet-based instructor-led mindfulness course exerted its effect on the outcome variables through only one facet of mindfulness; that is, increased levels of *acting with awareness*. This finding is in line with previous research showing that individual facets of mindfulness appear to operate independently of one another; specifically, *acting with awareness* was the only mindfulness facet explaining the effect of a mindfulness intervention on post-treatment PTSD

severity in a study by Boden et al. (2012). Acting with awareness involves consciously attending to one's moment-to-moment experience with meditation practice operating as "scaffolding" to enable its development (Brown & Ryan, 2003; Kabat-Zinn, 2003). This increased attendance to, and awareness of, thoughts and emotions is purported to enable the individual to observe their thoughts and feelings as they arise in the mind without engaging with them; thereby allowing greater control over thinking (Williams & Penman, 2011). Shapiro et al. (2006) suggested that mindfulness results in a shift of perspective – which they labelled 'reperceiving' – which facilitates a capacity for individuals to see situations as they are in the moment, responding accordingly; instead of with reactionary thoughts and emotions triggered by prior habit.

The reduction in affective rumination, problem-solving pondering, chronic fatigue and sleep quality may all be explained by increased control over thinking which could theoretically be facilitated by the increased levels of *acting with awareness*. If participants were able to gain control over their thoughts such that they would not become perseverative, this would arrest the process of rumination; hence the reduction in affective rumination, problem-solving pondering and subsequent reduction in chronic fatigue (as evidenced in the serial mediation results). Theoretically, the improvement in sleep quality could also be explained by the increased levels of *acting with awareness* leading to a reduction in perseverative cognition and associated down-regulation of physiological systems (Brosschot et al., 2006). We know from previous research that mindfulness interventions exert a positive effect on sleep (for review, see Winbush et al., 2007); however, previous studies considering the effect of mindfulness-based interventions on sleep have not assessed the different facets of mindfulness as mechanisms of change.

The fact that the intervention exerted its effect via *acting with awareness* suggests that interventions designed to target only this facet may be useful. In order to achieve this we

would need to understand which components of mindfulness-based interventions are linked to the development of different facets of mindfulness. Nonetheless, given that the traditional format of mindfulness interventions is 8-weeks in length covering many different aspects (e.g., MBCT; Segal et al., 2002; MBSR, Kabat-Zinn, 1982); this finding offers a tantalising prospect of reducing the required length of interventions by only targeting the *acting with awareness* facet of mindfulness. If mindfulness programmes could be reduced in length and still prove effective, this seems a worthy avenue for development. However, the findings in this study need to be replicated through further empirical research because they may be sample specific, and/or may only hold true for the specific outcomes assessed here. For example, it is possible that for different outcomes, other facets of mindfulness may be more important; and indeed in the study by Boden et al. (2012), the authors found that while *acting with awareness* was the mediator for the change in one of their outcomes (post-treatment PTSD severity), another facet of mindfulness - non-judging - operated as the mediator for their other outcome (post-treatment depression severity).

Furthermore, while the intervention worked to increase levels of other facets of mindfulness (*describing & non-judging*), these facets did not mediate the change in the recovery variables and the *non-reacting* facet of mindfulness did not appear to be affected by the intervention. These findings are of interest for a number of reasons. It is curious that the mindfulness intervention did not affect all of the mindfulness facets; however, it is possible that some of facets of mindfulness take longer to develop than others, or that the different facets develop sequentially. For example, it is possible that *acting with awareness* develops first and that this skill then lays the foundation for the other facets to develop. The mindfulness facets were included in our study to assess them as mediators in the multiple parallel mediation models, but the relatively short waitlist period (six weeks) meant that the waitlist control group commenced the mindfulness course immediately after the intervention

group finished the mindfulness course, thereby precluding assessment of the mediation model over a longer time period. The six week waitlist period in the current study was chosen to maximise our ability to retain participants. Studies with longer waitlist periods would be able to assess the stability of the mediation model over time; for example, if non-judging develops later than acting with awareness it may contribute to the mediation model at a later date (e.g., 3 months after course completion). However, our theorising with regards to the potential sequential development of the different mindfulness facets is speculative and requires further empirical work.

Traditional mindfulness interventions are usually delivered face-to-face (in groups), and the developers of mindfulness-based interventions suggest that the presence of others is an important part of the learning. The findings in the current study challenge the assertion that mindfulness should be delivered face-to-face and in groups as participants completed the mindfulness course online without interacting with other study members; and the effect sizes in the current study were all moderate to large which is comparable to other studies considering more traditional mindfulness formats (e.g., Shapiro, Oman, Thoresen, Plante, & Flinders, 2008; van Aalderen, Donders, Gionni, Spinhove, Barendregt, & Speckens, 2012; Volledstad et al., 2011; for reviews, see Khoury et al., 2015 & Virgili, 2015). Furthermore, these effects sizes were maintained over three and six month follow-up. Therefore, this study provides support for delivering mindfulness online and to individuals.

One of the most intriguing (and unexpected) findings in this study was the serial mediation model accounting for the effect of the intervention on problem-solving pondering. While the intervention did not affect problem-solving pondering directly via its effect on increased levels of mindfulness, a full mediation effect was found when *acting with awareness* and affective rumination were entered as serial mediators in the model. Specifically, the intervention appears to have exerted its effect by increasing levels of *acting*

with awareness which in turn reduced affective rumination which in turn reduced problem-solving pondering. These findings suggest a causal relationship between the two forms of rumination, with affective rumination causing problem-solving pondering about work. Theoretically it might be expected this pathway would be the other way round. Specifically, an individual engaging in problem-solving pondering who is unable to solve the problem, or arrive at a solution, may become frustrated and then start ruminating affectively. Instead, it appears that people who engage in problem-solving pondering might do this predominantly because they are negatively affected by their work. However, it is important to note that individuals were selected into the study on the basis of their affective rumination scores. As such, it is possible that individuals engaging in high levels of affective rumination attempt to arrest this process by adopting a more problem-solving approach. Furthermore, as the two forms of rumination were measured at the same point in time we need to be careful about the strength of any causal claims; nonetheless, when we ran the reverse serial mediation model (with problem-solving pondering as one of the mediators), the results were not significant which may offer some support to our (tentative) contention of a causal pathway through affective rumination to problem-solving pondering. Further empirical work is warranted to explore the relationship between these different forms of work-related rumination; the findings in this study suggest that interventions targeting the more emotional form of rumination about work (affective rumination) may ultimately reduce all forms of work-related rumination.

Limitations

An inherent limitation in waitlist control designs is that they do not allow for multiple treatments to be assessed against each other; therefore the effects in this study may reflect a general treatment effect. However, the intention of this study was to provide evidence for the efficacy of an Internet-based instructor-led mindfulness intervention on measures associated

with recovery from work, and the effect sizes in this study are comparable to those in studies considering mindfulness in randomised controlled trials (e.g., Feldman, Greeson, & Senville, 2010; Robins, Keng, Ekblad, & Brantley, 2012; Shapiro et al., 2008; van Aalderen et al., 2011; Volledstad et al., 2011). A next step would be to design and conduct a randomised control trial assessing this intervention against other interventions.

Data concerning the amount of meditative practice participants engaged in over the course of the study (e.g., number of hours per day; number of days per week) was not collected which makes it difficult to assess whether the amount of practice participants engaged in was a mechanism of change. For example, the moderate to large effect sizes found in the current study may be an artefact of a very motivated cohort, practicing consistently many hours and days a week. This would be useful information to have when deciding on the optimal level of practice required for the intervention to be successful and for results to be maintained over time.

Related to issue of large effect sizes arising from highly motivated participants, the present study has been able to demonstrate some significant mediation effects with a relatively modest sample size of $N = 118$. However, the failure to detect more modest mediation effects may have been the result of relatively low power for such complex mediational analyses rather than the effects themselves not existing. This is clearly an empirical question for future research so it is premature to conclude that only acting with awareness is the active ingredient in mindfulness interventions of this sort.

Another limitation in the design on the study lies in its reliance on only one form of data (self-report questionnaire data). This use of only one method for collecting data may have resulted in some degree of common method variance explaining the relationships between variables. However, the effects of common method variance should have been minimised because the questionnaires completed by participants included multiple measures

(beyond those of interest in the particular study) which spanned a variety of different constructs; and scales were varied which should have minimised the chance that individuals responded "by rote" (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).

Finally, we need to exercise caution in claiming causal mediating relationships since assessment of change was based on changes in variables measured at the same time points. We cannot entirely rule out the possibility that changes in our outcome variables caused the changes in our putative mediators. Ideally future mediation studies should attempt to show that changes in the mediators occur temporally prior to changes in the outcomes.

Future research

Given the findings in this study showing the only one facet of mindfulness (*acting with awareness*) accounted for the effect of the intervention on the outcome variables, it would be useful to replicate this study in different samples, and with different outcome variables, to assess the stability of these findings. We speculated earlier in the discussion that there may be a temporally sequenced relationship between the different facets of mindfulness such that *acting with awareness* develops early and possibly provides the foundation for the other facets. As such, designing studies in such a way as to assess the causal relationship between the different facets of mindfulness, and designing studies with longer waitlist periods to assess the stability of the mediation model, would also be useful. The development of further mindfulness interventions delivered via the Internet would also seem a worthwhile endeavour because the effect sizes in this study were comparable to those in studies in which mindfulness has been delivered (traditionally) face-to-face and in groups; and importantly, the effect sizes were maintained through three and six month follow-up. For future online mindfulness interventions of this type, developers should ensure data related to practice can be effectively 'mined' from the Meta data collected in the website because this would enable an objective assessment of amount of practice to be taken into account in analyses. It would

also be beneficial to collect data from participants regarding any major life changes that may occur over the course of the study in order to control for this in the analysis. Additionally, while we have speculated about cost savings associated with online, versus face-to-face group-based interventions, simulation studies demonstrating these proposed cost savings would be useful.

Furthermore, because the results showed no difference between participants who took less than six weeks to complete the course and those who took longer than six weeks; developing shorter interventions may be fruitful. Future research exploring the relationship between affective rumination and problem-solving pondering would be interesting. Finally, much research in the clinical and health literature shows that perseverative cognition (e.g., rumination, worry) is associated with physiological activation (e.g., increased HR, low HRV, and compromised immune function) which may interfere with recovery processes (Brosschot et al., 2006); therefore, including physiological measures of stress and compromised recovery would strengthen the design of this study considerably. However, their inclusion would also increase study complexity and burden on participants.

Conclusions

This study provides support for the effectiveness of a 4-week Internet-based instructor-led mindfulness course for the reduction of work-related rumination and fatigue, and for improvement in sleep quality. Results showed that one facet of mindfulness, *acting with awareness*, operated as the mechanism of change, thus extending our understanding with regards to how mindfulness works. In the context of the recovery from work literature, offering Internet-based mindfulness interventions could reduce costs to organisations and increase availability to a larger number of employees.

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Table 1*Demographic variables for study groups*

Demographics	INT	WLC
Total number of participants	60	58
Total number females (%)	48 (80%)	47 (81%)
Age range in years	21-62	21-60
(M; SD)	(41.67; 10.57)	(39.66; 10.33)
Number working full-time (%)	55 (91.7%)	57 (98.3%)
Number working traditional pattern (%)	54 (90%)	48 (82.8%)
Mean hours per week (SD)	42.12 (12.84)	44.04 (13.81)
Mean years in current role (SD)	7.32 (7.59)	6.85 (6.65)
Number married/living with partner (%)	41 (68.4%)	38 (65.5%)
Number with children (%)	34 (56.7%)	25 (43.1%)
Number university educated (%)	44 (73.3%)	37 (63.8%)

INT = intervention group; WLC = waitlist control group; Job types (N [%]): INT group – nursing/medicine (11 [18.3%]), healthcare (14 [23.3%]), administration (13 [21.7%]), education (11 [18.3%]), management (3 [5.0%]), police (5 [8.3%]), psychology (2 [3.3%]), other (1 [1.7%]) ; WLC group – nursing/medicine (15 [25.9%]), healthcare (10 [17.2%]), administration (10 [17.2%]), education (6 [10.3%]), management (7 [12.1%]), police (3 [5.2%]), psychology (4 [6.9%]), other (3 [5.2%]).

Table 2

Means (SDs) for outcome variables

	Affective rumination			Problem-solving pondering			Sleep quality		
	INT group	WLC group		INT group	WLC group		INT group	WLC group	
Before treatment (T1)	N 60 Mean (SD) 20.18 (2.90)	N 58 Mean (SD) 19.62 (3.07)		N 60 Mean (SD) 18.35 (2.72)	N 58 Mean (SD) 18.14 (2.70)		N 60 Mean (SD) 11.72 (3.81)	N 58 Mean (SD) 10.79 (5.07)	
After treatment (T2)	45 16.46 (4.74)	58 18.27 (3.15)		45 15.49 (2.87)	58 16.86 (2.52)		45 8.22 (5.79)	58 10.45 (5.07)	
After treatment (T2 ^a)	- -	42 14.95 (3.55)		- -	42 14.63 (3.22)		- -	42 7.24 (4.41)	
3 month FU (T3)	44 16.21 (4.87)	41 14.73 (3.07)		44 15.22 (3.46)	41 14.44 (2.78)		44 8.16 (4.65)	41 6.71 (4.04)	
6 month FU (T4)	43 14.97 (7.25)	40 13.89 (5.30)		43 15.11 (6.26)	40 14.62 (4.49)		43 7.85 (5.52)	40 6.72 (4.71)	
Chronic Fatigue			Acute Fatigue						
Before treatment (T1)	60 75.88 (17.75)	58 70.92 (18.52)		60 77.06 (22.06)	58 73.28 (18.25)				
After treatment (T2)	45 55.68 (25.03)	58 70.05 (18.25)		45 53.43 (27.12)	58 71.89 (18.04)				
After treatment (T2 ^a)	- -	42 54.76 (21.22)		- -	42 59.43 (24.66)				
3 month FU (T3)	44 56.13 (27.16)	41 55.13 (22.44)		44 54.18 (27.13)	41 58.00 (22.91)				
6 month FU (T4)	43 56.09 (29.18)	40 50.14 (26.77)		43 51.71 (27.56)	40 54.52 (23.13)				

INT = intervention; WLC = waitlist control; T2 = after mindfulness course (INT group), after waitlist period and before mindfulness course (WLC group); T2^a = after mindfulness course completion (WLC group); FU = follow-up

Table 3

Means (SDs) for mindfulness variables

Describing	Acting with awareness					
	INT group		WLC group		INT group	
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)
Before treatment (T1)	60	14.60 (4.07)	58	14.50 (2.37)	60	12.12 (3.39)
After treatment (T2)	45	16.72 (3.84)	58	15.36 (4.22)	45	15.77 (4.52)
After treatment (T2 ^a)	-	-	42	17.12 (4.18)	-	-
Non-judging						
Before treatment (T1)	60	11.38 (2.96)	58	17.75 (2.93)	60	12.82 (3.61)
After treatment (T2)	45	13.29 (5.42)	58	12.75 (3.96)	45	16.03 (4.76)
After treatment (T2 ^a)	-	-	42	15.77 (4.43)	-	-
Non-reacting						
Before treatment (T1)	60	11.38 (2.96)	58	17.75 (2.93)	60	12.82 (3.61)
After treatment (T2)	45	13.29 (5.42)	58	12.75 (3.96)	45	16.03 (4.76)
After treatment (T2 ^a)	-	-	42	15.77 (4.43)	-	-

INT = intervention; WLC = waitlist control; T2 = after mindfulness course (INT group), after waitlist period and before mindfulness

course (WLC group); T2^b = after mindfulness course completion (WLC group)

Table 4

Unstandardised Betas (Standard Errors) and explained variance (R^2) for the indirect effects of the mindfulness intervention on the outcome variables via the mindfulness variables

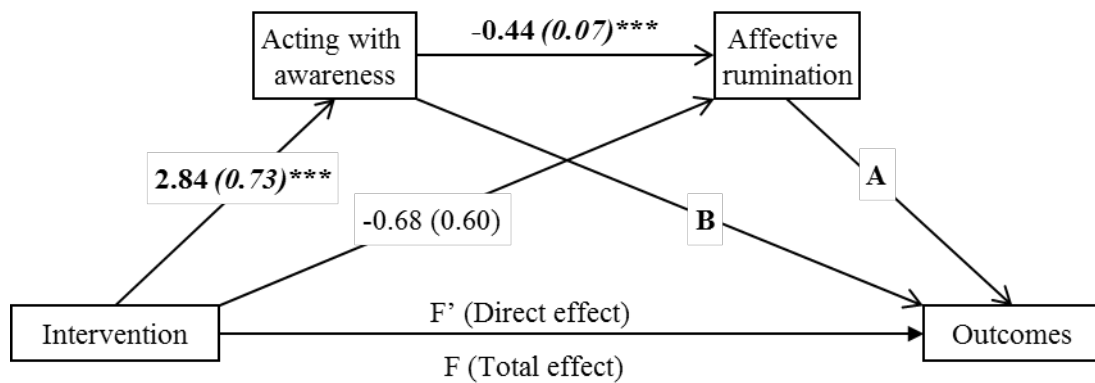
<pre> graph LR Intervention[Intervention] -- "1.34 (0.85)" --> Describing[Describing] Intervention -- "2.84 (0.73) ***" --> Acting[Acting with awareness] Intervention -- "0.97 (0.89)" --> NonJudging[Non-judging] Intervention -- "F' (Direct effect)" --> Outcomes[Outcomes] Describing -- "A" --> Outcomes Acting -- "B" --> Outcomes NonJudging -- "C" --> Outcomes Intervention -- "F (Total effect)" --> Outcomes </pre>					
Outcome variables					
Predictors	Affective rumination	Problem-solving pondering	Chronic fatigue	Acute fatigue	Sleep quality
A: DES	0.03 (0.07)	-0.07 (0.06)	0.53 (0.48)	-0.47 (0.45)	-0.19* (0.09)
B: ACT	-0.25** (0.08)	-0.15 (0.07)	-1.77** (0.59)	-1.55** (0.56)	-0.35** (0.12)
C: NJ	-0.33 (0.06)	-0.06 (0.06)	-1.26** (0.47)	-0.48 (0.44)	-0.18 (0.79)
F': INT (D)	-0.95 (0.55)	-0.79 (0.50)	-9.14* (3.98)	-8.85* (3.77)	-1.08 (0.79)
F: INT (T)	-1.93** (0.65)	-1.36** (0.49)	-14.68*** (4.14)	-14.35*** (3.85)	-2.50** (0.87)
R^2 (D)	0.07	0.06	0.10	0.11	0.07
R^2 (T)	0.43	0.19	0.29	0.27	0.34

DES = Describing; ACT = Acting with awareness; NJ = Non-judging; INT (D) = Intervention (Direct effect); INT (T) = Intervention (Total effect); R^2 (D) = Explained variance (Direct effect); R^2 (T) = explained variance (Total effect)

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 5

Unstandardised Betas (Standard Errors) and explained variance (R^2) for the indirect effects of the mindfulness intervention on chronic fatigue, acute fatigue and problem-solving pondering via a serial mediation through acting with awareness and affective rumination



Predictors	Outcome variables		
	Problem-solving pondering	Chronic fatigue	Acute fatigue
A: Affective rumination	0.43*** (0.06)	3.56*** (0.54)	2.59*** (0.54) ^a
B: Acting with awareness	-0.04 (0.06)	-0.71 (0.48)	-0.99* (0.47) ^a
F': Intervention (Direct effect)	-0.42 (0.43)	-5.81 (3.49)	-6.53 (3.46)
F: Intervention (Total effect)	-1.36** (0.49)	-14.68*** (4.14)	-14.35*** (3.85)
R^2 (Total effect)	0.39	0.45	0.38

no significant difference between the pathways A and B, therefore the most parsimonious (B) is retained

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 6*Repeated measures ANOVA results and within group effect sizes for outcome variables*

	INT group		WLC group	
	F	η_p^2	F	η_p^2
Affective rumination	24.74***	.29	20.78***	.27
T1 vs. T2	34.68***	.37	35.63***	.38
T1 vs. T3	36.31***	.38	46.79***	.45
T1 vs. T4	30.99***	.34	32.16***	.36
Problem-solving pondering	14.11***	.19	12.56***	.18
T1 vs. T2	36.62***	.38	40.42***	.41
T1 vs. T3	42.39***	.42	49.02***	.46
T1 vs. T4	17.03***	.22	14.46***	.20
Chronic fatigue	17.06***	.22	23.34***	.29
T1 vs. T2	53.11***	.47	33.47***	.37
T1 vs. T3	44.86***	.43	32.35***	.36
T1 vs. T4	26.26***	.31	30.09***	.34
Acute fatigue	24.88***	.30	14.94***	.21
T1 vs. T2	39.01***	.39	15.15***	.21
T1 vs. T3	29.21***	.33	20.07***	.26
T1 vs. T4	42.35***	.42	25.09***	.31
Sleep quality	11.78***	.17	26.54***	.32
T1 vs. T2	13.96***	.19	36.24***	.38

T1 vs. T3	19.84***	.25	49.31***	.46
T1 vs. T4	24.13***	.29	40.95***	.42

INT = intervention; WLC = waitlist control; T1 = Before treatment; T2 = after treatment; T3 = 3 month follow-up; T4 = 6 month follow-up

***p<.001

Figure 1

CONSORT flow diagram

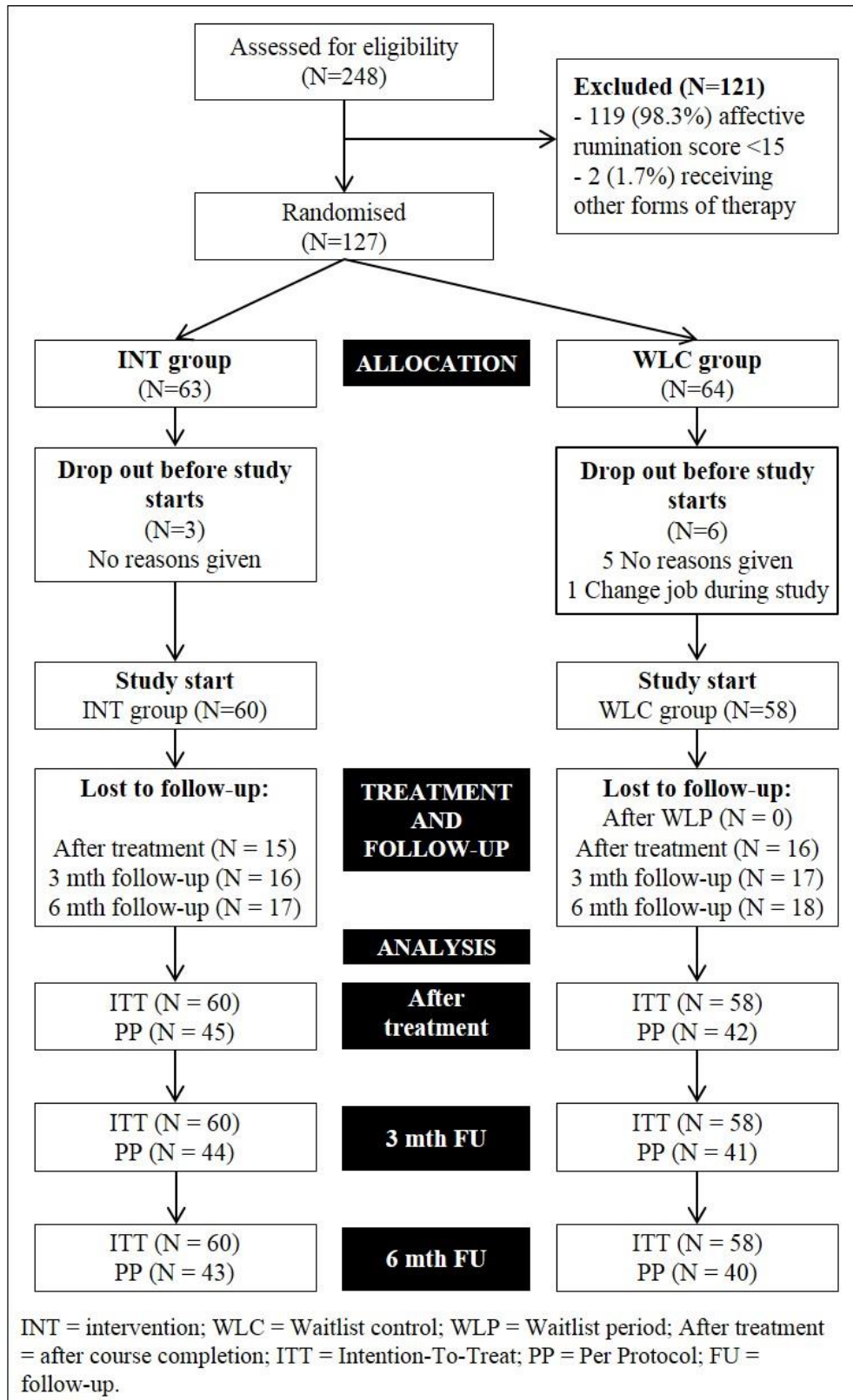
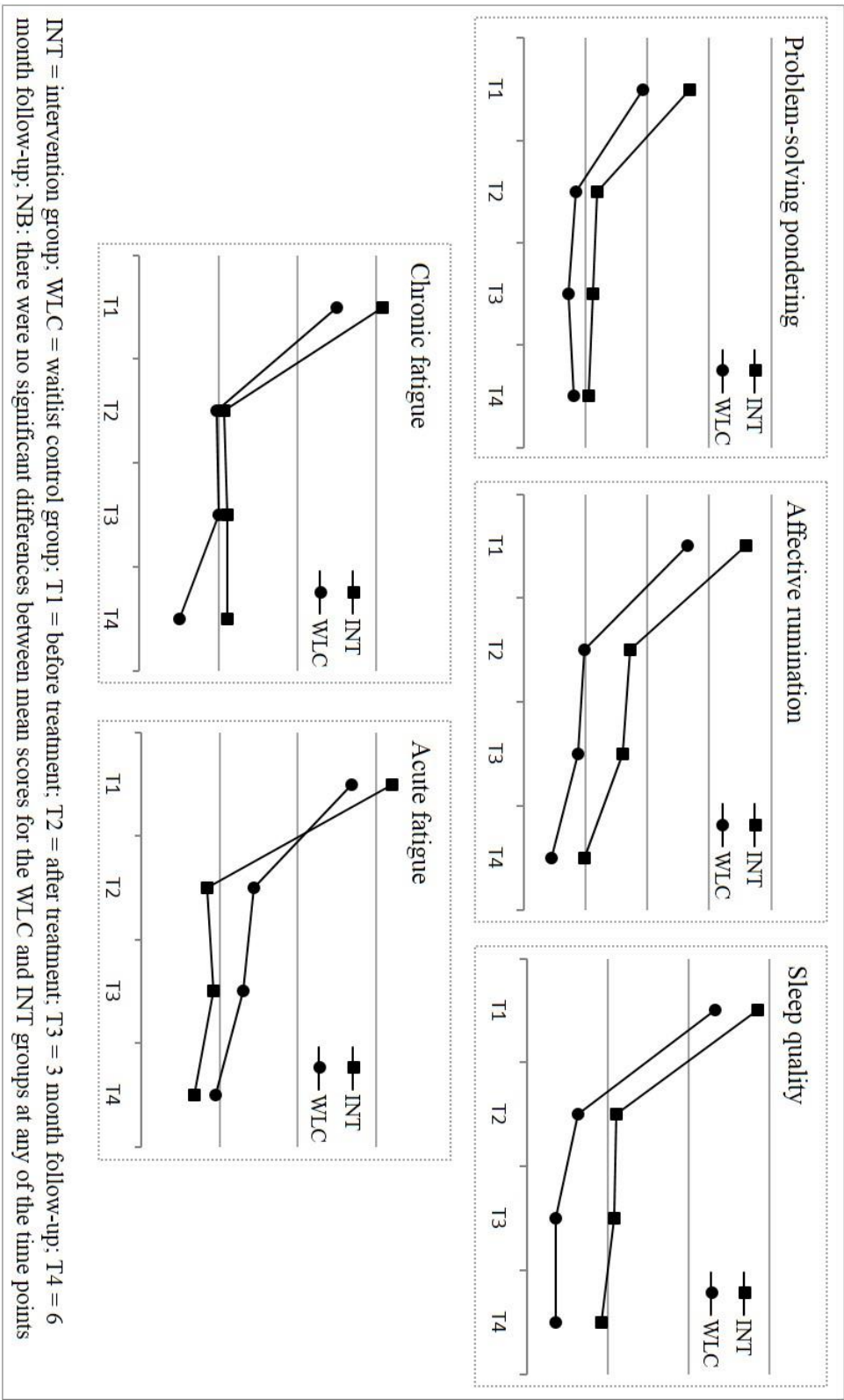


Figure 2

Mean scores for intervention and waitlist control groups for change in recovery variables before (T1) and after (T2) course completion and at 3month (T3) and 6month (T4) follow-up



INT = intervention group; WLC = waitlist control group; T1 = before treatment; T2 = after treatment; T3 = 3 month follow-up; T4 = 6 month follow-up; NB: there were no significant differences between mean scores for the WLC and INT groups at any of the time points