

# The effect of mindfulness training on coping in a student population

*Results from a two-centre randomized controlled trial*

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Hovedoppgave ved Psykologisk Institutt

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# **The effect of mindfulness training on coping in a student population**

Results from a two-centre randomized controlled trial – the empowering effect of learning to sit still.

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The effect of mindfulness training on coping in a student population. Results from a two-centre randomized controlled trial.

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IV

# Sammendrag

The effect of mindfulness training on coping in a student population. Results from a two-centre randomized controlled trial

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Medisin- og psykologistudenter opplever høy grad av stress. Dette har en negativ innvirkning på deres helse og livskvalitet. Noen er mer robuste i forhold til stress, bl.a. fordi de bruker hensiktsmessige mestringsstrategier. Individuer med høy grad av nevrotisisme ser ut til å være spesielt sårbare i forhold til stress og bruker i større grad uhensiktsmessige mestringsstrategier. Denne gruppen vil derfor kanskje ha spesielt god nytte av strategier som kan bedre deres mestring av stress. Ved å analysere data fra et pågående forskningsprosjekt<sup>1</sup> undersøker denne studien effekten av oppmerksomhetstrening (mindfulness training) på selvrapporterte mestringsmål (coping). Forskningshypotesene var som følger: 1) Oppmerksomhetstrening (mindfulness training) vil føre til mer adaptiv mestring av stress, 2) Endring i mestring vil medieres av styrket oppmerksomt nærvær (mindfulness) og 3) Nevrotisisme vil moderere effekten av intervensjonen på mestring. Forfatteren av denne oppgaven ble invitert til å være med å utforme intervensjonen, delta i rekrutteringsarbeid av studenter, levere intervensjonen som kursleder for enkelte grupper (i samarbeid med prosjektleder) og analysere et utvalg av data.

Medisin- og psykologistudenter fra Universitetet i Oslo (UiO) og Universitetet i Tromsø (UiT) ble invitert til å delta i et forskningsprosjekt som involverer trening i mentale og fysiske øvelser for å bedre kunne mestre stress. Analyse av data fra før (T0) og ettermålinger (T1), viste at intervensjonsgruppen, relativt til kontrollgruppen, styrket mål på tilnæringsfokusert mestring og at denne bedringen var mediert av økning i oppmerksomt nærvær. I tillegg modererte nevrotisisme effekten av intervensjonen på to andre mestringsvariabler, slik at personer med høy grad av nevrotisisme hadde utbytte både i forhold til redusert

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<sup>1</sup> Forskningsprosjektet drives av Nasjonalt kunnskapssenter ved helsetjenesten i samarbeid med Universitetet i Oslo (UiO) og Universitetet i Tromsø (UiT).

unngåelsesfokusert mestring og økt villighet til å søke sosial støtte (relativt til kontrollgruppen).

Studien viser at oppmerksomhetstrening kan hjelpe studenter, spesielt individer med høy emosjonell sårbarhet, å utvikle mer hensiktsmessige strategier for å mestre stresset i deres studiesituasjon og, kanskje, i deres senere arbeid som leger og psykologer.

# Forord

Jeg vil begynne med å takke Michael de Vibe, Ida Solhaug og forskningsgruppen ved Universitet i Oslo (UiO) og Universitet i Tromsø (UiT) som sjenerøst har inkludert meg i deres forskningsprosjekt: "Mindfulness training for stress management: A two-centre randomised controlled study of medical and psychology students with long-term follow up ". Jeg er svært takknemlig for alt jeg har lært gjennom å delta i denne forskningsprosessen. Jeg ønsker å takke mine veiledere professor Annika Melinder og forsker ved folkehelseinstituttet Eivind Ystrøm, som begge har gitt solid veiledning. En spesiell takk går også til Kim Rand-Hendriksen for hans rause bidrag til prosjektet. Mange har bidratt med gjennomlesning de siste dagene før innlevering, inkludert Jon Anders Lone, Andreas Segrov, Stine Møthe og Torbjørn Sandvik. Tusen takk til dere.

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Oppgaven er dedikert min kjære Stine og familie.

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## Introduction

Students of psychology and medicine demonstrate significant clinical symptoms of mental distress (e.g., stress, burnout, and depression) and low levels of life satisfaction (Dyrbye et al., 2006; Hudson & O'Regan, 1994; Kjeldstadli et al., 2006; Peluso, Nicholas, & Asmundsen, 2011), possibly because of the high workload and pressure to perform. This considerable stress will most likely continue as they enter demanding careers as providers of health care after graduating (Shapiro, Astin, Bishop & Cordova, 2005). Stress is associated with increased risk of physical and psychological disease, such as cardiovascular disease and depression (Shirom, 2003). Furthermore, by impairing attention and decision making skills, stress may also be detrimental to their effectiveness as students and professionals (Shapiro et al., 2005). However, there are important individual differences in how individuals manage stress that can reduce or enhance its effect on psychological functioning (Skinner, Edge, Altman & Sherwood, 2003). Studies have found that students using coping strategies characterized by avoidance or disengagement (such as wishful thinking) are more prone to low levels of life satisfaction during medical school (Kjeldstadli et al., 2006) and postgraduate mental health problems (Tyssen, Vaglum, Grønvold & Ekeberg, 2001). Conversely, students using coping strategies characterized by engagement (such as problem-solving) have been found to have fewer depressive symptoms (Mosley et al., 1994). Given the importance of coping in modifying the effect of stress on health, implementation of interventions that could improve coping would be of great value for this group.

Mindfulness training has been advocated as a viable intervention to help students (Palmer & Rodger, 2009) and health care professionals (Shapiro et al., 2005) to better cope with their experienced stress. Mindfulness training represents a relatively new approach to dealing with life stressors, at least in the western part of the world. A core element in this approach is the cultivation of a willful, present-oriented and non-judging quality of attention, called mindfulness, through various sitting and movement-based meditative practices (Baer, 2003). Traditionally research on meditation has focused on relaxation effects to explain its health promoting effects, but such processes do not adequately explain the effects of mindfulness training (Garland, Gaylord & Park, 2009). Cultivating mindfulness has been claimed to increase psychological and behavioral flexibility (Brown, Ryan & Creswell, 2007), which is central to adaptive coping with stress. This kind of improvements in self-regulation is theorized to come about through a greater willingness to be in contact with reality as it is, without reacting automatically to internal or external events (Brown et al., 2007). Although

meta-analytic studies have demonstrated that mindfulness-based interventions are an effective approach to increasing well-being and decreasing mental distress (Chiesa & Serretti, 2009; Grossman, Niemann, Schmidt & Walach, 2004; Hofman, Sawyer Witt & Oh, 2010; de Vibe, Bjørndal, Hammerstrøm & Kowalski, 2012), few studies have investigated the effect of mindfulness training on coping. The majority of studies on the effect of mindfulness training on coping have been conducted in a clinical context with female patients. It is therefore problematic to generalize this research to a student population. Furthermore, no randomized controlled trial (RCT) (known to the author) has been conducted to investigate whether improvements in coping following mindfulness training are associated with changes in quality of attention characterized by mindfulness. In other words, there is little empirical evidence that cultivation of a present-oriented contact with reality facilitate coping. Until such an association has been established, changes in coping following mindfulness training could equally well be attributed to other non-specific aspects of mindfulness-based interventions (e.g., group support, didactic teaching).

There is also a need to identify who would benefit most from mindfulness training. Research has demonstrated that individuals are differentially vulnerable to stress (Carver & Connor-Smith, 2010), indicating that some students could benefit more from enhancing coping capabilities as compared to less vulnerable students. Neuroticism is a personality characteristic that has received much research attention in terms of stress-vulnerability. Research have shown that higher levels of neuroticism predicts higher levels of experienced stress in medical school (Tyssen et al., 2007) and lower life satisfaction for doctors (Tyssen, et al., 2009). Thus, students with higher neuroticism have potentially much to gain from stress management training (Tyssen et al., 2009). Consistent with this assertion, research has shown that individuals high in neuroticism demonstrated stronger improvements in psychological functioning (Jacobs et al., 2011), including greater reduction in perceived stress (Lane, Seskevich & Pieper, 2007) following meditation interventions. The elevated stress-vulnerability in individuals high in neuroticism is also reflected in high use of maladaptive, potentially health damaging, coping strategies (Carver & Connor-Smith, 2010). Thus, if mindfulness training can change (mal) adaptive coping, this may be especially beneficial for students high in neuroticism. On the other hand, higher neuroticism has been related to poorer treatment outcomes following psychotherapy (Quilty et al., 2008) and lower adherence to meditation practice (Delmonte, 1988), indicating that high neuroticism may predict less benefits from mindfulness training. This inconsistency needs to be addressed before

recommendations can be made about the feasibility of mindfulness training for students with high in neuroticism

The aim of the current investigation is to address several of the above-mentioned gaps by investigating the effect of mindfulness training on coping among 288 students of medicine and psychology, by analyzing data from a RCT conducted at the University of Oslo (UiO) and the University of Tromsø (UiT) in Norway. More specifically, this study represents an attempt to expand the current research on mindfulness training and coping by investigating the following questions: 1) Is mindfulness training related to more adaptive forms of coping? 2) Is increased tendency to be mindful the mechanism of change in mindfulness training? 3) Is the beneficial effect of mindfulness training stronger in persons with a high level of neuroticism? Before addressing these questions, the key concepts of mindfulness, coping and neuroticism will be discussed.

### **Mindfulness and Mindfulness Meditation**

The conceptual and operational definition of mindfulness is evolving within the field of psychology and mind-body medicine (Brown et al., 2007), with different theorists highlighting different aspect of the concept. A much cited definition of mindfulness, in the context of western mind-body medicine, is “paying attention in a particular way: on purpose, in the present moment, and non-judgmentally” (Kabat-Zinn, 2005, p.4). Willful deployment of attention to internal and external reality as it is unfolding in the present moment is central to this definition. Mindfulness meditation can be described as a process that cultivates this way of paying attention (Shapiro, Calson, Astin & Freedman, 2006). In one common form of mindfulness meditation, the meditator is instructed to pay attention to the incoming and outgoing breath and calmly return to the breath every time he gets distracted (Hölzel et al., 2011). More generally, the meditator is instructed to focus his attention on aspects of his/her experience in the moment (e.g., thoughts, emotions or body-sensations) and bring back her attention every time it wanders off (e.g., gets absorbed in analyzing or creating narratives about what is being experienced) (Kabat-Zinn, 1990).

Given this emphasis on attention regulation in mindfulness meditation, one would expect enhanced attentional control following mindfulness training. A number of studies have demonstrated enhanced attentional performance in meditators using standardized laboratory assessments (see Hölzel et al., 2011 for an overview). Furthermore, there has been found

increased cortical thickness in brain areas associated with executive attention (anterior cingulate cortex, ACC) in experienced meditators, as compared to controls (Hölzel et al., 2011). These structural changes may be the neurological underpinning of enhanced attentional control following mindfulness training.

The above definition also highlights mindfulness as involving a particular attitude towards one's experience; namely non-judgment. This attitude has also been characterized as curiosity and acceptance (Bishop et al., 2004). An accepting stance towards experience involves not trying to change current thoughts, feelings or sensations. This process of accepting one's own mental and emotional state can be understood as an important aspect of self-compassion, broadly defined as being open to one's own suffering and generating the desire to alleviate it (Neff, 2003).

Some scholars have highlighted that mindfulness represents a specific way of processing information. Mindfulness can be described as a mental state where the attention is directed towards the stream of impulses from the senses, as well as arising emotions, thoughts and images in the mind, without conceptual processing of this information (Siegel, Germer & Olendzki, 2009). This can be contrasted with processing where judgments, ideas, labels and concepts are imposed on everything that is encountered (Brown et al., 2007). In the words of cognitive science, mindfulness emphasizes bottom-up (experiential), rather than top-down (schematic) processing of information. Studies into the neurobiology of mindfulness meditation support the notion that this practice promotes changes in the function and structure in brain areas involved in sensory processing (Hölzel et al., 2011). Studies of experienced meditators have demonstrated greater cortical thickness and greater gray matter concentration in the right anterior insula, relative to controls. The insula is an area of the brain that is commonly activated during tasks of interoceptive awareness and its gray matter volume correlates with interoceptive accuracy and visceral awareness (Hölzel et al., 2011). The association between meditation experience and structural changes in the brain related to sensory processing has been interpreted as empirical support for the close conceptual link between mindfulness and bottom-up processing.

The present-centered and acceptance-based mode of relating to experience, termed mindfulness, has been shown to be related to mental health and well-being (Brown & Cordon, 2009). Much of this research utilizes a psychometric methodology, with the underlying assumptions that mindfulness is an inherent disposition of human functioning that varies

between individuals in a way that can be measured (Brown & Ryan, 2003). Several self-report measures have been developed in attempts to assess “trait mindfulness”, defined as the frequency of mindful states (Brown & Ryan, 2003) or the general tendency to be mindful in daily life (Baer, Walsh & Lykins, 2009). Higher scores on trait-based measures of mindfulness are associated with higher pleasant affect, lower unpleasant affect, lower levels of emotional disturbance (depressive symptoms, anxiety and stress) and higher satisfaction with life (e.g., vitality) (Brown & Cordon, 2009). Trait mindfulness predicts measures of well-being after controlling for neuroticism (Brown & Ryan, 2003; Feltman, Robinson & Ode, 2009) and the association cannot be explained away by social desirability bias (Brown & Cordon, 2009).

Intervention research has been another approach to investigating the effect of mindfulness on mental health. At present mindfulness-based interventions meets the American Psychological Associations Division 12 designation as *probably efficacious* (Didonna, 2009). The most researched mindfulness based-intervention is a structured 8 week program termed mindfulness-based stress reduction (MBSR), developed by the University of Massachusetts Medical Center in 1979 (Kabat-Zinn, 1990). MBSR is delivered in a group format with weekly sessions lasting 2.5 hours (Grossman et al., 2004). Each session consist of meditation practice and didactic teaching that cover topics related to stress and coping. Between sessions participants are asked to complete 45 minutes of daily meditation practice throughout the duration of the 8 week program. One recent meta-analytic study based on 26 RCTs concluded that MBSR have a “moderate and consistent positive effect on mental health outcomes”, (hedges`g = .53) (de Vibe, Bjørndal, Hammerstrøm & Kowalski, 2012, p.6). These studies included participants with somatic health problems (patients diagnosed with cancer, multiple sclerosis, rheumatoid arthritis, cardiovascular disease, fibromyalgia, HIV and chronic musculoskeletal pain), people with mild to moderate psychological problems (generalized social anxiety, alcohol abuse, aggression, chronic fatigue syndrome, pregnant women experiencing mood problems), and participants recruited from community settings (healthy adults, non-distressed couples, hospital staff, healthcare professionals, students, university faculty and staff, employees of knowledge work organizations, community volunteers). The same meta-analysis also found a positive effect of mindfulness interventions on somatic health indicators (self-reported physical health and somatic measure related to antibodies, heart rate and respiratory functions), but the effect size was somewhat smaller (hedges`g = .31).

## **Coping**

The definition of coping is continuously debated (Skinner et al., 2003). Many distinctions and grouping of different coping strategies have been attempted (Carver & Connor-Smith, 2010; Skinner et al., 2003), but there is no apparent consensus at present. Here coping will be defined as “efforts to prevent or diminish threat, harm and loss or to reduce associated distress” (Carver & Connor-Smith, 2010, p.685). Threat, harm and loss are related to the experience of stress. One influential model states that stress is experienced when people are confronted with a situation (threat, harm or loss), real or imagined, that 1) is perceived to tax or exceed their ability to manage them and 2) is perceived as important to his or her well-being (Lazarus & Folkman, 1984). As seen in this definition, perceptual processes play a central role in understanding individual differences in how people respond to potential stressful situations.

One useful way to organize coping strategies for the purpose of this investigation may be in relation to the basic properties of self-regulation. Evolutionary theory posits that humans are born with the biological tendency to approach desirable objects and to avoid dangerous objects and situations (Carver & Connor-Smith, 2010). The avoidance and approach tendencies are probably supported by functions in distinct areas of the brain and the sensitivity of these areas differ across individuals (Carver & Connor-Smith, 2010). These approach and avoidance tendencies are related to the distinction between what Carver & Connor-Smith (2010) term engagement and disengagement coping. Disengagement or avoidance coping entails efforts to escape the source of stress or threat and related negative emotions. Engagement or approach coping represent a set of responses oriented towards the stressor or one’s reactions to the stressor (Connor-Smith & Flachsbart, 2007). These two global strategies and their possible health consequences will be discussed in turn.

The aim of disengagement coping is associated with escaping feelings of distress accompanying stress (Connor-Smith & Flachsbart, 2007). Examples of coping through disengagement are wishful thinking, substance abuse, denial, isolation, hiding emotions from one self or others, fantasizing, and other forms of experiential, affective or behavioral avoidance (Carver & Connor-Smith, 2010). Disengaged coping may be effective in reducing negative affect (e.g., nervousness for an upcoming exam) in the short term, but does not support the person’s health and well-being in the long term (Carver & Connor-Smith, 2010). Avoidance may even be harmful (Penley, Tomaka & Wiebe, 2002). First, not dealing with a

chronic stressor or threat may lead to a prolonged biological and psychological stress response. A prolonged neurobiological stress response has a number of harmful effects on the body, including suppressing effects on the immune system (Dhabhar, 2011) and negative effects on cognitive functioning (Pechtel & Pizzagalli, 2011). Second, a problem with strategies such as thought suppression is that such efforts to avoid negative thought content actually can increase the frequency of the same unwanted thoughts (Bach & Hayes, 2002). Relatedly, efforts to control one's feelings through suppression may lead to an intensification of negative mood and anxiety and increase sympathetic arousal (Carver & Connor-Smith, 2010; Gross & Levenson, 1997). Finally, when drugs or alcohol is used to avoid thinking about problems or experiencing associated feelings, this strategy can create problems of its own (e.g., addiction) (Grunberg, Berger & Hamilton, 2011)

Engagement coping consists of active attempts to change the stress-inducing situation or attempts to adapt to a stressor to create a better fit between one self and the environment (Carver & Connor-Smith, 2010). Strategies include problem solving (active attempts to resolve the situation through planning, logical analysis, staying organized or implementing solutions), seeking emotional and instrumental social support (comfort, advice) and cognitive coping (identifying benefits arising from the situation or finding another way of looking at the situation) (Carver & Connor-Smith, 2010). Consistent with the view that the experience of stress is interwoven with perceptual processes (Lazarus & Folkman, 1984), cognitive coping can be seen as a special case of coping where the perceptual situation is shifted so that the experience of stress is moderated. In contrast with the other strategies of engagement coping, cognitive coping is not primarily aimed at controlling or change the situation, but represents a healthy adaptation to the environment (Connor-Smith & Flachsbart, 2007). Engagement coping predict better physical and psychological health outcomes, as compared to disengagement coping (Penley et al., 2002).

## **Neuroticism**

Neuroticism can be conceptualized in terms of negative emotional reactivity processes (Feltman et al., 2009). It is contrasted to emotional stability and even-temperedness (John, Naumann & Soto, 2008) and includes a greater tendency to experience fear, sadness and distress (Carver & Connor-Smith, 2010). Neuroticism is associated with intense emotional reactivity to stress (Connor-Smith & Flachsbart, 2007). On a biological level neuroticism is

associated with greater brain reactivity to negative stimuli and stress inductions (Feltman et al., 2009) and slower cardiovascular recovery from stress (Carver & Connor-Smith, 2010). Because higher neuroticism is associated with unpleasant arousal, this group of individuals may be highly motivated to tame their reactions by disengagement coping (Connor-Smith & Flachsbart, 2007). Consequently, neuroticism has been described as grounded in an avoidance temperament (Connor-Smith & Flachsbart, 2007). A meta-analytic study using 2.653 effect sizes from 165 samples found that neuroticism predicted disengagement strategies such as wishful thinking, avoidance, denial and withdrawal (Connor-Smith & Flachsbart, 2007). Neuroticism also predicted less problem solving efforts, cognitive coping and acceptance. For individuals with high stress reactivity, the short term benefit of disengaging and thereby reducing unpleasant arousal may reinforce the tendency to use disengagement in the future (Connor-Smith & Flachsbart, 2007). This might explain why individuals high in neuroticism continue to use strategies that produce poor long term results.

### **Mindfulness Training and Coping**

In the following segment the three questions posed in the introduction will be discussed in light of the existing research literature: 1) Is mindfulness training related to more adaptive forms of coping? 2) Is increased tendency to be mindful the mechanism of change in mindfulness training? 3) Is the beneficial effect of mindfulness training stronger in persons with a high level of neuroticism?

#### **Is mindfulness training related to more adaptive forms of coping?**

Correlational studies have shown an association between trait mindfulness and adaptive coping. Across four studies Weinstein, Brown & Ryan (2009) found that more mindful students made more benign stress appraisals and used more adaptive coping strategies (less avoidant and more approach based coping strategies). Palmer & Rodger (2009) found similar associations in their study of 135 first-year university students. In this study, the self-reported general tendency to be mindful was negatively associated with avoidant coping and positively associated with rational coping (a measure of engagement coping). Correlational research does not allow causal interpretations (Field, 2009). Stronger support on how mindfulness training might improve coping, comes from intervention research.

One indication that individuals might relate to stressors in a different way following mindfulness training come from research on sense of coherence (Kabat-Zinn, 1990). Sense of coherence refers to a tendency to perceive the world as understandable, manageable and meaningful (Antonovsky, 1979), and having greater sense of coherence may facilitate greater flexibility when responding to stressors (Weissbecker et al., 2002). Individuals with higher sense of coherence are confident that they can make sense of their internal and external experience, that they can manage the demands they encounter and that they can find meaning in the face of stress (Kabat-Zinn, 1990). Although sense of coherence has been associated with stable personality structures, measures of sense of coherence have been shown to improve following mindfulness training (Kabat-Zinn, 1990; Weissbecker et al., 2002, Henderson et al., 2012; Matousek & Dobkin, 2010; Dobkin & Zhao, 2011).

There have also been reported improvements in more direct measures of coping following mindfulness training, including enhanced supportive coping and optimistic coping (Witek-Janusek et al., 2008), positive reappraisal (Garland, Gaylord & Fredrickson, 2011) active behavioral coping and active cognitive coping (Henderson et al., 2012), distraction coping (Matousek & Dobkin, 2010) and other positive strategies for coping (Walach et al., 2007). These enhancement reflect efforts to create meaning when faced with stressful events (Namir, Wolcott & Fawzy, 1987), and to attach this meaning to personal growth (Garnefski, Kraaij & Spinhoven, 2001), as well as maintaining a positive outlook and making positive comparisons (Jalowiec, Murphy & Powers, 1984). Thus, results indicate that cultivating a different way of *paying attention* to reality may lead to a different pattern of *thinking* about reality. In addition to improvements in cognitive coping, the results also indicate more involvement in activities, expression of thoughts and feeling, information seeking and reliance on others (Namir, Wolcott & Fawzy, 1987). The increase in distraction coping reported by Matousek & Dobkin (2010) reflects engagement in activities that prevent the mind from dwelling on illness, and should not be considered as disengagement *per se*. In sum, these different improvements reflect a tendency towards more engagement coping following mindfulness training.

Research has also demonstrated a reduction in cognitive and behavioral avoidance coping (e.g., refuse to think about problems, drink more than usual) following mindfulness training (Henderson et al., 2012). In addition Tacón, McComb Caldera & Randolph (2003) found that reactive coping was significantly diminished following mindfulness training.

Reactive coping represent emotional and cognitive activities that distort problem solving activities and are related to wishful thinking and self-criticism (Paul, Cook, Wright & Johnson, 1995). Taken together these studies indicate that mindfulness can reduce disengagement coping.

Mindfulness training have also been associated with improvements in sick leave (de Vibe & Moum, 2006), the degree a person engage in life activities (Morone, Greco & Weiner, 2006) and the degree important activities are limited by disease (Pbert et al., 2012). Positive effects on these more behavioral oriented measures of functioning, lend further support to a positive association between mindfulness and adaptive coping.

Although preliminary findings are promising, there have also been reported several non-significant findings. Usually studies include several measures of coping, and although many are significantly improved, several measures (of both engagement and disengagement coping) typically remain unchanged (Cha, Yoo & Choo, 2012; Sears & Kraus, 2008; Tacón et al., 2003; Witek-Janusek et al., 2008). Non-significant findings may reflect low statistical power due to low sample sizes in these studies (Cohen, 1992), or that effect of mindfulness training is specific to some sub-categories of coping. Witek-Janusek et al. (2008) have suggested that mindfulness training is specific to promoting better use of support systems and promoting a more positive outlook on one's life, including finding benefits in the face of adversity. However, aggregating across studies is made difficult by the fact that few studies employ the same conceptualization and measure of coping. This reflects the general lack of consensus on the core categories of coping and how these should be measured (Skinner et al., 2003).

The conclusions that can be drawn from the studies cited above are also limited by the study design applied. Few of the studies cited here employ RCT-designs<sup>2</sup> that can rule out rival, plausible explanations other than the effect of the intervention (vs. control), thus making way for claims of cause and effect (Solomon, Cavanaugh & Draine, 2009). Also, since the research has been conducted mostly within the context of treatment of somatic diseases, it is problematic to generalize this research to non-clinical populations such as students or health care professionals.

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<sup>2</sup> The recent study by Henderson et al. (2012) being a notable exception.

## **Is increased tendency to be mindful the mechanism of change in mindfulness training?**

Several authors (Brown & Ryan, 2003; Garland et al., 2009; Shapiro et al., 2005; Weinstein et al., 2009, Garland et al., 2011) have provided rationale for why improvements in trait mindfulness might increase the use of adaptive coping strategies and decrease non-adaptive strategies. These different theories have in common that they view mindfulness as a way of empowering the individual by interrupting habitual reactivity to stress, and thus result in greater flexibility in behavior, thought and emotional expression. One description of how this “interruption” occurs is through a shift in perspective that Shapiro et al. (2005) calls “reperceiving”. Reperceiving is the act of stepping back from one’s own experience and simply witness it, “rather than being immersed in the drama of our personal narrative” (p.377). The process of observing what goes on in the mind may thus lead to a partial decoupling between mental and external events and ones conditioned reactions to those events (Walach et al., 2007). From the vantage point of reperceiving at least two processes might facilitate adaptive coping: 1) insight and 2) exposure. These will be discussed in turn.

***Insight.*** Mindfulness (and reperceiving) involves taking an empirical stance towards reality, in that attention is open to all aspects of one’s inner and outer world in the present moment (Brown et al., 2007), and conclusive judgments about the situation is suspended (Martin, 1997). From the vantage point new perception of stressful events, as potentially benign, beneficial and/or meaningful may arise (e.g., thinking that one will learn something from a difficult situation) (Garland et al., 2009). These perceptions may arise either through reflection or as a more automatic process, referred to as spontaneous insight (Garland et al., 2009). In this way mindfulness training may lead to a form of cognitive coping when confronted with stress that includes identifying benefits arising from the situation or finding another way of looking at the situation. It is important to note that mindful processing does not imply getting rid of automatic appraisal processes, but being attentive to conceptual thoughts arising and seeing thoughts as thoughts (as opposed to accurate factual representations of reality) (Brown et al., 2007). Cognitive coping can be the first step towards a productive reengagement with the stressful event (Garland et al. 2011), for example through facilitating problem solving or seeking social support. In this way mindfulness training may support finding meaning in a stressful situation, which in turn can empower the individual to take active steps to resolve the situation.

**Exposure.** Another possible explanation for how mindfulness might improve adaptive coping, could be through an increased willingness to stay in contact with uncomfortable realities and experiences. According to Shapiro et al. (2005) the process of dispassionately observing the contents of one's consciousness (reperceiving) enables a person stay in contact with strong emotions with less reactivity. Through direct exposure to negative emotional states, one can learn that these are not life-threatening and need not to be feared, but that they eventually can pass away on their own. The non-judging quality of mindfulness and self-compassion may also play an especially important role in this regard. Emotional awareness, acceptance and letting go of negative thoughts, all related to mindfulness practice, represent adaptive emotion regulatory strategies (Cordon, Brown & Gibson, 2009). These accepting processes may make it possible for more mindful individuals to be aware of and not avoid unpleasant realities and experiences. If mindfulness increases the willingness to allow exposure to unpleasant feelings and realities, it should reduce the need to rely on disengaged coping to handle unpleasant experiences.

Even though insight seems more related to engagement coping, and exposure seems most related to disengagement coping, this might not be the case. For example, increased willingness to stay in contact with uncomfortable realities and experiences is a prerequisite to engage in active coping efforts such as planning and problem solving (Carver & Connor-Smith, 2010). Conversely, insight may change the affective valence of an experience (Hölzel et al., 2011), which may reduce the need to rely on disengagement coping. The joint effect of the two processes discussed above could be a reduction in the influence from habitual reactions and processes, and an increase in the capacity to actively choose a response to arising situations (Shapiro et al., 2005), which in itself could improve engagement coping efforts and decrease disengagement (Carver, Scheier & Fulford, 2009).

In general, research on the mechanisms of how mindfulness training promotes psychological functioning is still relatively sparse (Hölzel et al., 2011). However, several studies are beginning to include mediator variables. A mediator represent the generative mechanism through which an independent variable (e.g., mindfulness training) influence the dependent variable (e.g., coping) (Baron and Kenny, 1986). Some efforts of exploring mediation in the context of mindfulness research include demonstrating that self-reported changes in mindfulness skills are related to improve psychological functioning. This is commonly investigated by assessing trait mindfulness through self-report before and after the

intervention, and use statistical techniques to test if the change in outcomes are related to improvements in trait mindfulness. Several improvements in psychological functioning following mindfulness training have been related to increases in the general tendency to be mindful (Bränström, Kvillemo, Brandberg & Moskowitz, 2010), including reduction in perceived stress (Baer, Carmody, & Hunsinger, 2012) and increased quality of life (Nyklíček, & Kuijpers, 2008). These results indicate that the more mindfulness training improve the general tendency to be mindful, the stronger the effect on outcomes.

Very little research has been conducted on mediation variables in relation to mindfulness trainings effect on coping. However, the few studies that have been conducted report positive findings. Increase in trait mindfulness following MBSR has been significantly related to increases in sense of coherence (Dobkin & Zhao, 2011). Improvements in self-reported mindfulness have also been related to increases in cognitive coping following mindfulness training (Garland et al., 2011). Although the lack of control group in this latter study precludes attributing this finding to the intervention, the few studies conducted indicates that increases in the general tendency to be mindful is the generative mechanism driving improvements in coping, at least in terms of cognitive coping.

### **Is the beneficial effect of mindfulness training stronger in persons with a high level of neuroticism?**

Traditionally attempts have been made to tailor treatment interventions and psychotherapy to different categories of mental disorders, such as those presented in the Diagnostic and Statistical Manual of Mental Disorders (DSM) (Norcross, 2001). However, large-scale studies into the effect of different treatment interventions have found few differences in outcome for different disorders (Clarkin & Levy, 2004). Recent research shows that it might be just as important to consider the influence of non-diagnostic characteristics on outcome (Norcross & Wampold, 2011).

Knowledge about moderators that influence treatment outcome has the potential to bridge the gap between clinical research and clinical practice. A moderator of a treatment effect can be defined as any pretreatment or baseline variable that identifies subgroups of patients within the population who have different effect sizes (Kraemer, Frank, & Kupfer 2006, p.1286). First, knowledge about predictors of differential efficiency will make it possible to select individuals that will be most likely to benefit and allocate resources accordingly (Kraemer et

al., 2006). Second, knowledge about moderators could guide clinicians about what kind of adaptations are needed to meet the needs of individual patients (Kazdin, 2008).

Carver & Connor-Smith (2010) have pointed out that since emotional, cognitive and behavioral avoidance is a way of coping with unpleasant affect, individuals with high emotional-reactivity (e.g., high neuroticism) would benefit from improving emotion regulation so that (maladaptive) disengagement becomes less tempting. Mindfulness training may be one approach to developing emotion regulation (Hölzel et al. 2011), predicting that mindfulness training will be especially potent in reducing disengagement for sub-groups high in neuroticism. At the same time neuroticism is inversely related to trait mindfulness, which indicates that emotional-reactivity may be antithetical to the development of a present-oriented state of mind (Feltman et al., 2009). The focus of mindfulness meditation is to be experientially open, even when faced with difficult emotions and experiences. As indicated by a negative relationship between meditation adherence and neuroticism (Delmonte, 1998), this might be especially challenging for individuals with high emotional reactivity. A study by Cordon et al. (2009) may have captured these contradicting findings in the literature. Cordon et al. (2009) found that insecurely attached individuals, characterized by high stress vulnerability (Wallin, 2007), had higher drop-out from mindfulness training, but those who completed benefitted more as compared to securely attached individuals in terms of reduction in perceived stress. This may suggest that mindfulness training is more beneficial for individuals with high stress-reactivity who are willing to “stick it out” (Cordon et al. (2009), as compared to students who are less emotionally vulnerable.

### **The Present Investigation**

This study addresses several gaps in the literature, by investigating the effect of mindfulness training on coping in a non-clinical student population. Statistical analysis of baseline (T0) and follow-up (T1) data from a RCT (N=288) will be used to test the following hypothesis:

1. Mindfulness training has a significant positive impact on adaptive coping
2. Any effects of mindfulness training on coping will be mediated by increases in trait mindfulness
3. Neuroticism will moderate the effect of mindfulness training on coping

## **Method**

### **Recruitment**

Medical and psychology students from the University of Oslo (UiO) and University of Tromsø (UiT) were invited to participate in a research project involving training in mental and physical exercises to better manage stress. Information about the study was provided during lectures by the project manager and, in some cases, the author. The author participated to give a student's-view of the benefits of participating in the course. Potential participants were offered a book voucher for answering the baseline and follow-up questionnaire (\$ 100 for those in the control group, \$ 60 for those in the intervention group). The students were informed about the length of the training program and the potential benefits of participating, both personally (e.g., increased well-being) and professionally (e.g., better patient care). They were also given the opportunity to ask questions. After the students were given this information, they received an e-mail with an invitation to participate. The invitation contained a web-address, where students could learn more about the study. If they decided to participate they could give their consent electronically. There were no exclusion criteria. A computer program randomly assigned students willing to participate to either the intervention group or to the control group. To secure an equal number of medical and psychology students in each class, the randomization was completed separately for each class. Students in the control group will receive the training program after the completion of the research project.

### **Participants**

Of 704 people enrolled in the medical and psychology classes, 293 students gave their consent to participation. All the students were in their second or third semester of study and 179 (62 %) of the participants were women. Age ranged from 19 to 46 ( $M = 23.8$ ,  $SD = 5.1$ ,  $Median = 22.0$ ). Most participants (80 %) were in their early to mid twenties. Seventy percent of the participants described themselves as single, 25% percent reported co-habituating with a partner and 5 % were married. Most participants (93 %) did not report having children.

## **Procedure**

After giving their consent to participate in the study, participants were asked to complete an online questionnaire (T0) with a number of self-report measures, including assessment of mindfulness and coping, as well as demographic questions. Two weeks before the intervention started the participants received an e-mail informing them of which of the two groups they had been assigned to. A second questionnaire (T1) with the same self-report measures was e-mailed to the participants in the control and intervention group within two weeks after the completion of the intervention. The control group continued with their studies without participating in the MBSR program.

## **Ethics**

To ensure that all participants remained anonymous, the online questionnaires could not be coupled with the student's identities. The Regional Committee for Medical and Health Research Ethics in Norway and the Norwegian Data Inspectorate approved the study. The training program was considered to have no adverse effects.

## **Description of the Intervention**

The intervention was based on the MBSR-program developed at the University of Massachusetts Medical Center (Kabat-Zinn, 1990). Some changes were made following focused group interviews with senior medical and psychology students. These students recommended shortening the program to fit the busy schedule of the target population. Thus the numbers of sessions were reduced from 8 to 6, and the length of the weekly sessions was reduced from 2.5 hours to 1.5 hours. A full day of practice, which is part of the original program was retained, but reduced from 7 to 6 hours. Home practice assignments were reduced from 45 to 30 minutes. A description of the intervention week by week is included in appendix 1.

## **Level of Professional Training**

The project manager ran all the MBSR-courses for students at UiO. He has practiced mindfulness for 40 year and has received his training in MBSR at UMass Medical School, CFM. In one of the groups a female psychologist with training from CFM participated as co-instructor. In two groups a male psychology student (the author) with teacher training from

CFM and Bangor University co-instructed. Both co-instructors had trained mindfulness for four years. The MBSR-courses at UiT were instructed by the local principal project manager. She has practiced mindfulness for six years and is a trained MBSR-instructor from CFM. A male psychiatric nurse and a trained MBSR instructor from CFM, also a psychiatric nurse, participated as co-instructors. Both have practiced mindfulness meditation for several years.

## Measures

In addition to gathering information about demographic variables and measuring relevant outcome, moderating and mediating variables, compliance to the intervention was assessed in the form of course attendance and self-reported home practice. Several measures collected as part of the study is not included in this investigation, including measures of empathy, perceived social support, life events, regulatory focus and the personality factors conscientiousness and extroversion.

**Ways of Coping Checklist (WCCL; Vitaliano, Russo, Carr, Maiuro & Becker, 1985)** was used to measure coping. WCCL is intended to measure five dimensions of coping (problem focused, self-blaming, seeking social support, wishful thinking and avoidance) using a 5-point Likert scale (*0=does not describe me at all* and *4=describes me in most situations*). WCCL have been shown to predict mental health and well-being (Vitaliano et al., 1985; Kjeldstadli et al., 2006). Other studies using the WCCL have not been able to replicate the original five-factor structure (Edwards & Baglioni, 1993). A Principal component analysis (PCA) was run to investigate if the five-factor structure of WCCL would hold for the current sample. Appendix 2 gives a detailed description of the PCA. The PCA resulted in a three component factor solution for WCCL. The three factors were named: “problem focused coping” (e.g., “Made a plan and followed it”, “Changed or grew as a person in a good way”), “avoidance focused coping” (e.g., “Hoped a miracle would happen”, “Tried to make myself feel better by eating, drinking, smoking, taking medications”) and “seeking social support” (e.g., “Talked to someone to find out about the situation”, “Accepted the sympathy and understanding from someone”).

The three scales “problem focused coping”, “avoidance focused coping” and “seeking social support” all had adequate reliabilities following PCA at baseline, with Cronbach  $\alpha$  .79, .82 and .86 respectably. Deletion of individual items would only lead to minor increases in reliability, and all items were retained following reliability analysis in the interest of maintain

the scales breadth and content validity. The three-factor solution is similar to that found by Kjeldstadli et al. (2006) in their study of the relationship between coping and life satisfaction among medical students in Norway.

In conclusion, the PCA resulted in three factors for further outcome analyses; “problem focused coping”, representing engagement coping, “avoidance focused coping”, representing disengagement coping, and “seeking social support”, representing engagement coping.

**Five Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer & Toney, 2006)** was used to measure 5 facets of trait mindfulness: a) observing (e.g., “I pay attention to how my emotions affect my thoughts and behavior”), b) describing (e.g., “I can easily put my beliefs, opinions, and expectations into words”), c) acting with awareness (e.g., “it seems I am running on automatic without much awareness of what I am doing”, reversed item), d) non-judging of inner experience (e.g., “I tell myself I shouldn’t be thinking the way I am thinking”, reversed item) and e) non-reactivity (e.g., “I perceive my feelings without having to react to them”) to inner experience. FFMQ has 5-point Likert scale answer format (*1=never or very seldom true* and *5=very often or always true*). The Norwegian version of the FFMQ has been translated in a forward-backward procedure at the University of Bergen and has been used in a study on MBSR for anxiety, with a reliability of a Cronbach  $\alpha$  of .90 (Vøllestad, Sivertsen & Nielsen, 2011). In the current study, the Cronbach  $\alpha$  was .79. To reduce the number of tests performed and thereby reducing the chance of making type I errors, only the aggregated total score of the FFMQ will be used.

**Basic Character Inventory (BCI; Torgersen, 1980)** was used to measure the personality characteristic of neuroticism (27-item version). BCI also measures conscientiousness and extroversion. The three factor structure of the BCI has been replicated in several studies (Vollrath, Torgersen & Alnes, 1995). This questionnaire asks respondents to indicate whether self-relevant statements are correct or incorrect using a dichotomous response choice (agree/do not agree). The instrument is grounded in psychoanalytic personality theory (Neilands, Silvera, Perry, Richardsen & Holte, 2008), and closely resembles the classic neuroticism scale (Tyssen et al., 2009). Higher scores on the neuroticism dimension of BCI have been related to lower life satisfaction (Tyssen et al., 2009), higher experience of work stress (Tyssen et al., 2005), and use of maladaptive coping strategies

(Vollrath, Torgersen & Alnes, 1995). In the current study, the internal consistency of the scale was  $\alpha = .75$  at baseline.

### **Statistical analyses**

**Variable transformation.** Most psychometric scales are set on an arbitrary metric. To put the outcome variables in the current study on a meaningful metric, T0 (baseline) scores and T1 (follow-up) scores was subtracted from the average level at T0 and divided by the standard deviation at T0. The mediating variable (trait mindfulness) was subjected to the same transformation, as was the moderating variable (neuroticism). Unstandardized residuals are used as the measure of change for the outcome variables and the mediating variable. T1 was regressed on T0 and unstandardized residuals were saved. The unstandardized residual is the individual deviation from the regression line and the observed score, and is hence on the same metric as the original variable. The resulting outcome variables represents change in coping that is not predicted from baseline values (Cronbach & Furby, 1970).

**Preliminary analysis.** Randomization was used to reduce sources of systematic variation that cannot be attributed to the intervention (Field, 2009). However as gender had not been accounted for by stratified randomization, the number of men and women was not equally distributed across groups. See Appendix 3 for a discussion on how unequal distribution of gender was handled in the current investigation.

Investigation of assumptions of parametric tests, revealed non-normality and indicated unequal variance across group allocation. Bootstrapping will be used for all analysis to get around the problem of non-parametric data. Investigation of assumptions of parametric tests and rationale for using bootstrapping are detailed in Appendix 3.

**Statistical analysis hypothesis 1 (Mindfulness training has a significant positive impact on adaptive coping).** Linear regression analysis will be used to test the main effect of mindfulness training on the three outcome variables. Group (intervention vs. control) will be regressed on the coping variables standardized residual change scores (SRCS), in three separate analyses. A significant positive effect of the intervention (vs. control) on seeking social support SRCS and problem focused coping SRCS, and a negative effect of the intervention on avoidance focused coping SRCS, will be consistent with hypothesis 1. Two-

tailed hypothesis testing will be employed. A discussion of one- vs. two-tailed hypothesis testing is included in Appendix 4. Cohen's *d* will be used to indicate the practical/clinical significance of the results. Cohen's *d* will be calculated by dividing the difference between group means (on the outcome variable) by the pooled standard deviation. Values used for interpreting effect size are 0.2 (small), 0.5 (moderate) and 0.8 (large) (Kirk, 1996)

**Statistical analysis hypothesis 2 (Any effects of mindfulness training on coping will be mediated by increases in trait mindfulness).** To test if any effect of the intervention on changes in coping are mediated by improvements in trait mindfulness, the steps proposed by Baron and Kenny (1986) will be followed. The procedure is described in Appendix 4. A procedure described by Fraizer, Tix & Barron (2004), which is based on the writings of Kenny and colleagues (Baron & Kenny, 1986; Kenny, Kashy & Bolger, 1998), will be used to test significance of the mediated effect. The first step of this procedure is to multiply the unstandardized regression coefficients representing the effect of the predictor (group) on the mediator (trait mindfulness SRCS) with the unstandardized regression coefficients representing the effect of the mediator (trait mindfulness SRCS) on the outcome variable (coping outcome variable). In the second step, this product is divided by a standard error term<sup>3</sup>. This procedure yields a z-score representing the mediated effect. This z-score can be converted to percentiles to determine if the effect is significant. If the z-score is greater than 1.96 the effect significant at the .05 level.

**Statistical analysis hypothesis 3 (Neuroticism will moderate the effect of mindfulness training on coping).** There are three conditions necessary to demonstrate moderation of a treatment effect. First, the moderator must be a pre-randomized characteristic that varies within the study population (Kraemer et al., 2006). Neuroticism meets this criterion. Second, the moderator should be uncorrelated with the predictor to provide a clearly interpretable interaction term (Baron and Kenny, 1986). In this case this means that the level neuroticism must not differ across treatment conditions and this will be tested in the preliminary analysis as part of the randomization check. And last, the effect of the intervention on outcome must be demonstrated to change as a function of the level of the moderator variable (Baron and Kenny, 1986). This will be tested using a procedure suggested by Baron and Kenny (1986). This procedure is described in detail in Appendix 4.

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<sup>3</sup> the square root of  $b^2sa^2 + a^2sb^2 + sa^2sb^2$ , where *a* and *b* are the unstandardized regression coefficients and *sa* and *sb* are their standard errors

## Results

### Participant flow and adherence to the program

5 students (2%) completed less than 10 % of the questionnaire at T0 and will not be included in the analysis of the data. Out of the 7 possible sessions, the average course attendance was 5.3 (SD = 1.86). Six students did not attend any sessions, but was included in the analysis, consistent with an intention to treat approach (Holiss & Campbell, 1999). The last observation carried-forward (LOCF) method of imputation was used for missing data from five students (3%) in the intervention group and seven students (5%) in the control group. At T1 46.5 % in the intervention group reported doing home practice at least once a week for the last four weeks. Most participants (75.7 %) reported that a typical home practice lasted for 0 – 10 minutes, 14.6 % reported 21 – 30 minutes, and 9.7 % reported more than 45 minutes.

### Results hypothesis 1 (Mindfulness training has a significant positive impact on adaptive coping)

The three outcome variables were regressed on group in three separate analyses. Results are displayed in table 1. The unstandardized coefficients, denoted B, can be interpreted directly as the outcome variables are already standardized. T-statistic was used to test if the B-values were significantly different from 0.

The intervention (vs. control) had a significant effect on change in problem focused coping ( $t(286) = 2.444, p < .05$ ). The unstandardized regression coefficient indicates that mean residual change score in the intervention group was .22 standard deviation higher than in the control group. The effect size of the predictor-outcome relationship was .30, which is considered a relatively small effect size. A path diagram for the direct effect is displayed in figure 1. The effect of group on change in avoidance focused coping was not statistically significant ( $t(286) = 1.303, p = .067$ ). The effect of group on change in seeking social support was also, marginally, non-significant ( $t(286) = 1.951, p = .053$ ).

### **Results hypothesis 2 (Any effects of mindfulness training on coping will be mediated by increases in trait mindfulness)**

The first step in establishing mediation, to test if the predictor (group) has a significant effect on the outcome variable(s) (coping change), was carried when testing hypothesis 1. Group had a significant impact on change in problem focused coping, and consequently only this variable will be included in further analysis. The second step, to test if the predictor has a significant effect on the mediator, was investigated by regressing the mediator (trait mindfulness change) on the predictor (group). Change in trait mindfulness was significantly associated with group ( $t(286)=4.151, p < .01$ ), such that the mean change score in the intervention group was .23 standard deviation higher than in the control group. Thus, the condition for Step 2 was met. The results are displayed in Table 2.

A multiple regression analysis was carried out to estimate the effect of the mediator on the outcome variable (step 3) and to evaluate the effect of the predictor on the outcome variables when the mediator was included in the model (step 4). The results are displayed in table 3. The coefficient representing the relation between trait mindfulness change and problem focused coping change, controlling for group, was significant ( $t(286) = 7.1666, p < .001$ ), confirming the criterion specified by Step 3. Furthermore, after entering the mediator into the model, the relationship between group and change in problem focused coping became non-significant. Step 4 is thus also confirmed and the results are consistent with a complete mediated model. A path diagram for the mediated model is displayed in figure 2. The significance of the difference between the direct model (path c in figure 1) and the mediated model (path c' in figure 2), was assessed by calculating a z-score of the mediated effect. This was calculated by dividing the product of path a and b in Figure 2 by the standard error term described above. The resulting z-score representing the indirect effect was 3.53 . Converting the z-score to percentile shows that the drop in predictor outcome relationship from the direct to the mediated model is significant at the .05 level.

### **Results hypothesis 3 (Neuroticism will moderate the effect of mindfulness training on coping)**

Three regression analyses were run to test for the presence of interactions. Results are displayed in table 4. The results show that baseline neuroticism moderates the effect of group on change in avoidance focused coping ( $t(284)=2.648, p > .05$ ), and change in seeking social

support ( $t(284)=2.092, p>.05$ ). Pathway models for moderated effects are displayed in figure 4 – 5. The significant interactions are investigated further below.

**Avoidance focused coping.** Significance testing of individual slopes and calculation of effect sizes at different levels of neuroticism was carried out by dividing the participants into three groups: participants scoring 1SD above the mean (high), participants within +/- 1 SD from the mean (average) and participants scoring lower than 1SD from the mean (low). Results are displayed in table 5.

The results from these sub-group analysis show a significant effect of group on change in avoidance focused coping for respondents with high neuroticism ( $t(52)=2.670, p < .01$ ), but not for average ( $t(176)=.550, p=.57$ ) or low neuroticism ( $t(54)=.310, p=.75$ ). For participants with high neuroticism, the mean change score was .60 standard deviations higher in the intervention group compared to the control group (in a negative direction). The effect size of the predictor-outcome relationship was .76, which is considered a relatively large effect size.

To further investigate neuroticism as a moderator for the relationship between group and change in avoidance focused coping, the interaction effect was graphed (graph 1). Average predicted change scores for avoidance focused coping are plotted separately for the sub-group of students scoring above 1SD from the mean (high) and the sub-group of students scoring below -1 SD from the mean (low) on neuroticism. In the control group, participants high in neuroticism display an increase in avoidance focused coping, whereas the graph indicates a small decrease for participants with low neuroticism. Conversely, the opposite pattern is observed in the intervention group. Participants in the intervention group with high neuroticism display a greater negative change score on avoidance focused coping, as compared to individuals with low neuroticism. To investigate neuroticism's predictive power within the two groups, avoidance focused coping SRCS was regressed on neuroticism separately for the intervention and control group. Neuroticism was significantly associated with change in avoidance focused coping in the control group ( $t(142) = 2.813, p < .01, B=.16$ ), so that higher scores neuroticism was associated with increases in avoidance focused coping over time. Within the intervention group neuroticism was not related to change in avoidance focused coping ( $t(142) = 1.208, p=.31, B=.07$ ).

**Seeking social support.** The results of sub-group analysis for the effect of the intervention on change in seeking social support across levels of neuroticism are displayed in table 6. Group had a significant effect on change in seeking social support for participants with high neuroticism ( $t(52)=2.133, p < .05$ ), but not for participants with average ( $t(176)=1.451, p=.15$ ) or low neuroticism ( $t(54)=.489, p=.65$ ). For students with high neuroticism the mean change score in the intervention group was .42 standard deviations higher than in the control group. The effect size of the predictor-outcome relationship was .58, which is considered a medium effect size.

To further investigate the nature of this interaction effect, average predicted change scores for seeking social support are plotted separately for students high and low in neuroticism (graph 2). Graph 2 indicates that both students high and low neuroticism display a decrease in seeking social support over time in the control group, but students high in neuroticism seems to show a greater decrease. In the intervention group, the graph indicates that students low in neuroticism experience a decrease in seeking social support, and that students high in neuroticism display an increase. Follow-up analysis indicated that neuroticism was associated with change in seeking social support in the intervention group ( $t(142)=1.962, p < .05, B=.10$ ), but did not have predictive power within the control group ( $t(142)=1.127, p=.28, B= -.06$ ).

## Discussion

In accordance with hypothesis 1, mindfulness training enhanced problem focused coping amongst psychology and medical students, relative to controls. The associated effect size was relatively small. The effect of the intervention (vs. control) on change in avoidance focused coping and change in seeking social support was in the expected direction, but did not reach statistical significance. In accordance with hypothesis 2, improvements in problem focused coping was mediated by improvements in trait mindfulness, which is consistent with the view that increased tendency to be mindful is the generative mechanism of change. Testing of hypothesis 3 revealed moderated effects. The intervention (vs. control) reduced avoidance focused coping only for students high in neuroticism (above +1 SD from the mean). The associated effect size was relatively large. Also, the intervention (vs. control) enhanced seeking social support only for students with high neuroticism. The associated effect size was medium.

### **Support for increased engagement coping following mindfulness training**

The current investigation has demonstrated that engagement coping can be enhanced through mindfulness training in terms of increased problem focused coping. In this study “Problem focused coping” consisted of items relating both to problem solving (active attempts to resolve the stressor through planning or implementing solutions) and cognitive coping (identifying benefits from the situation or finding another way of looking at the situation). Since items related to the two forms of coping are collapsed into one scale, it is not known whether cognitive coping and problem solving were differently influenced by the intervention. With this limitation in mind, this finding seems to agree with previous research demonstrating that mindfulness training can lead to more empowering interpretations of stressful events and increase efforts to resolve stressful situations (Garland et al., 2011; Henderson et al., 2012; Jacobs et al., 2011).

It is difficult to evaluate the clinical importance of these results, as there are no meaningful cut-offs for coping. However, meta-analytic studies have demonstrated that coping is an important determinant for physical and psychological health (Penley et al., 2002). Consistent with Lazarus and Folkman’s (1984) definition of stress, change in perceptual process may change the affective valence of stressors (Helgeson, Reynolds & Tomich, 2006) and improve psychological and physical health (Jacobs et al., 2011). An example of how

finding benefits (cognitive coping) in the face of stress might be an important contribution to health following mindfulness training is found in a recent study by Jacobs et al. (2011). Jacobs et al. (2011) studied the effects of a 3 month mindfulness meditation retreat on telomerase activity. Telomerase is an enzyme that has the capacity to add DNA sequences to the protective DNA sequences of chromosomes (telomeres). The study found greater telomerase activity in the retreat group, as compared to a passive control group. In addition, improvements in sense of purpose (sense of meaningfulness and directedness) mediated the improvements in telomerase, so that the more the participant's sense of purpose increased, the higher the post-retreat telomerase activity (Jacobs et al., 2011).

Inconsistent with hypothesis 1, the intervention did not demonstrate a significant main effect on seeking social support or avoidance focused coping. Thus, in accordance with previous research, the intervention did not have a wide-ranging impact on all coping variables included in the study. There can have been several reasons for the modest effects of the intervention on coping. First, students reported spending little time at home practicing meditation. Greater adherence could have led to larger improvements in trait mindfulness and consequently enhanced coping<sup>4</sup>. Second, the number of group-sessions and length of each session was reduced to accommodate the busy schedule of the student population. This reduced the opportunities for the students to ask questions and explore the sitting and movement-based meditative practices. Consequently the quality of the practice might have been reduced. Third, the measure of coping (WCCL) was not specifically designed to assess short term changes in coping. Rather, the questionnaire measures coping as a general disposition (Vitaliano et al., 1985). If the questionnaire had been specifically designed to measure recent coping efforts, the results might have been different. Fourth, there are some indications that participants in mindfulness-based intervention continue to improve post-treatment, so that assessment of psychological functioning short after the completion of the training does not adequately reflect the potential gains. For example, a study of Krasner et al. (2009) showed that several improvements that were not apparent at the conclusions of an 8 week-intensive mindfulness-based intervention, developed over the long term (3-month follow-up assessment). These long-term changes included improvements in burnout (depersonalization), depression and fatigue and changes in personality variables (conscientiousness and emotional stability).

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<sup>4</sup> Assuming that increased trait mindfulness is indeed the mechanism of change

There are some inconsistencies in the research on long-term effect of mindfulness training. Research by Henderson et al. (2012) has shown that mindfulness training may have significant short term-effects on coping, but that these improvements are not maintained (at 12-month follow-up). However, the same study indicated that the positive effect of mindfulness training on spirituality was maintained at long-term follow-up (12 months). Spirituality can be understood as a sense of meaning in one's life, harmony, peacefulness, and a sense of strength and comfort from one's faith (Brady, Peterman, Fitchett, Mo & Cella, 1999). This has been interpreted as indication of the long-term shift in viewpoint that one would expect following mindfulness training (Henderson et al. 2012).

In summary, important questions about the specificity and long-term effect of mindfulness training on coping and subsequent health gains remains open for future research.

### **Support for increased trait mindfulness as the mechanism of change in enhancing engagement coping**

The result from the mediation analysis was consistent with the view that increases in trait mindfulness is the generative mechanism of change enhancing problem focused coping. The positive correlations indicates that the more trait mindfulness increase, the more problem focused coping improve. This result is in line with findings from Garland et al. (2011) observational study that demonstrated that increases in trait mindfulness mediated improvements in cognitive coping (positive reappraisal of stressful situations). Taken together, these results give clinicians increased confidence that investing time in cultivating qualities of attention characterised by mindfulness (for example through meditation practises), can lead to empowering interpretations and increase engagement with challenging life circumstances.

It is important to note that demonstration of statistical mediation is only an indication of the mechanisms at work (Kazdin, 2008). The psychology of *how* trait mindfulness increase coping still needs to be explained. This study was not designed to unravel these precise psychological and neurological mechanisms. As noted above, it has been suggested that stepping back from one's own experience and simply witnesses it (reperceiving) may allow new perception of stressful events to arise (insight) (Garland et al., 2009). Recent neuroscientific findings allow speculations about the neurobiological changes that may support insight and cognitive coping. A necessary prerequisite for finding another way of

looking at a situation is to disengage from the initial appraisal of the stressor (Garland et al., 2011). Jha, Krompinger & Baime (2007) have demonstrated that following a 8-week mindfulness training program, participants had greater ability to shift focus from one object to the next (orienting attention), relative to controls. These findings have been interpreted to indicate that more mindful individuals also have greater ability to cognitive switch between different perspectives (Garland et al., 2009). Related, mindfulness training have been shown to enhance sensory processing (Hölzel et al., 2011), indicating that being in a mindful state allow for a refocusing of attention from the conceptual to the sensory aspects of experience (Garland et al., 2011). From this “non-conceptual seeing into the nature of mind and world” (Kabat-Zinn, 2003, p.146), new insights or perspectives of the situation may arise. Supporting these speculations, trait mindfulness has been found to predict performance on insight problem solving, which is hindered by automated verbal-conceptual processes (Ostafin & Kassman, 2012). In addition to insight, one could also speculate about the role of exposure in enhancing cognitive coping. Since negative affectivity may hinder active coping efforts (Connor-Smith & Flachsbart, 2007), increased willingness to stay in contact with uncomfortable realities and experiences may also play a role in increasing engagement coping.

Although, there are preliminary evidence for the mediating role of increases in trait mindfulness, the precise psychological and neurological changes that allow for increased engagement coping remains unclear and open for future empirical investigation.

### **Support for neuroticism as a moderator of the effects of mindfulness training on coping**

Moderation analyses revealed that students high in neuroticism benefitted disproportionately from the intervention in terms of reduced avoidance focused coping, relative to controls. Follow up analyses illuminated the nature of this interaction. In the control group higher neuroticism predicted increased use of avoidance focused coping from T0 to T1. It is likely that the stress inherent in studying medicine and clinical psychology increase during the semester, and that the increase in avoidance focused coping reflect this build-up of stress. The increase in avoidance focused coping among students high in neuroticism replicates a robust finding from meta-analytic studies; When confronted with stress, individuals high in neuroticism are highly motivated to reduce their emotional distress through avoidance focused strategies (Connor-Smith & Flachsbart, 2007). The present finding

is in line with Bolger's (1990) claim that "coping is personality in action under stress" (p.525).

Interestingly neuroticism did not have any predictive power in relation to avoidance focused coping within the intervention group. This result indicates that mindfulness training can decouple the association between increased stress and avoidance focused coping. This corroborates one recent study by Feltman et al. (2011) who found that neuroticism – outcome relations were weaker at high levels of trait mindfulness. Specifically, they found that neuroticism was not a consequent predictor of anger and depression at higher levels of trait mindfulness.

A key to understanding these findings might be to consider the effect of mindfulness training on emotional processing. Neuroscientific findings indicate that regulation of emotions depend on prefrontal control systems (lateral prefrontal cortex, PFC) modulating emotiongenerative systems (e.g., the amygdala) that is responsible for the detection of affectively arousing stimuli (Hölzel et al., 2011). Relative to those with lower self-reported mindfulness, higher trait mindfulness is associated with lower reactivity to threatening emotional stimuli, as measured by amygdala activation (Creswell, Way, Eisenberger & Lieberman, 2007). In association with trait mindfulness and mindfulness practice, a few studies have also found improved prefrontal control over amygdala responses (Hölzel et al., 2011). Furthermore, structural changes in the brain following mindfulness training have been related to increased body awareness (Hölzel et al., 2011). Body awareness play a crucial role in the experience of emotions, and awareness of one's emotions is a precondition for effective emotion regulation (Hölzel et al., 2011). In addition to neuroimaging data, a variety of other approaches have demonstrated a positive association between mindfulness and emotion regulation capacity, including experimental studies, self-report and peripheral physiological assessment (Hölzel et al., 2011; Brown & Cordon, 2009). These findings are in accordance with the assertion that mindfulness may allow for greater exposure (increased willingness to stay in contact with uncomfortable realities and experiences). According to Shapiro et al. (2005) it is the dispassionate observation of the content of one's consciousness (reperceiving) awarded by mindfulness training that facilitates exposure. Although founded on a very small empirical base, increased acceptance and self-compassion probably also plays an important role in this regard (Hölzel et al., 2011; Brown & Cordon, 2009). In many forms of mindfulness training, including MBSR, gentleness, kindness, acceptance and self-compassion

is interwoven into the meditation instructions. Cultivation of feelings of kindness toward oneself in instances of suffering (e.g., when experiencing difficult emotions) is an act of emotion regulation, relying on executive functions. Henderson et al. (2012) have found that mindfulness training does indeed enhance acceptance of emotional states, and that this improvement endures at 24-month follow-up. To let oneself be affected by uncomfortable emotional experiences and refrain from one's usual response, can lead to an extinction of the avoidance behaviour previously elicited by these stimuli (Shapiro et al., 2005; Hölzel et al., 2011).

In sum, mindfulness training seems to facilitate psychological and neurobiological processes that support the ability to stay in contact with difficult emotions. For individuals with high emotional reactivity (high neuroticism) these changes may reduce the neurotic tendency to manage challenging experiences through disengagement. If exposure is achieved mainly through re-perceiving, acceptance or other processes related to emotion regulation is an empirical question.

Students scoring high on neuroticism also displayed a significant increase in seeking social support, relative to the control group. In this study "Seeking social support" consisted of items relating both to seeking instrumental and emotional support. Some items were directly related to avoiding talking about one's problems with others and hiding one's feelings from others. This may indicate that this moderated effect also reflects a greater willingness to stay in contact with unpleasant realities (together with others), for students with high emotional reactivity.

The differential effectiveness predicted by neuroticism corroborates other studies that have shown greater benefits of meditation for students high in neuroticism (Jacobs et al., 2011; Lane et al., 2007). These findings are important in two ways. First, neuroticism might be used as criteria for selecting students that could benefit from mindfulness training. Second, these findings are important as they may illuminate mechanisms of change in mindfulness training. The moderation effects support the notion that central mechanisms in mindfulness-based interventions are related to a greater willingness to exposure to unpleasant events. Stated differently, enhanced emotion regulation may play an important role in avoiding avoidance. More research is needed to better illuminate the relationship between mindfulness, emotional regulation, exposure and extinction. Important cognitive mechanisms may well be the executive functions that help regulate emotional states and processing (e.g., Hölzel et al.,

2011). The above speculations about the underlying psychological and neurobiological mechanisms of change hinge on the assumption that the effect of mindfulness training on avoidance focused coping is mediated by enhanced trait mindfulness. As no mediation analysis was performed for the moderated effects in the current investigation, the claim that the effect of the intervention on avoidance focused coping was caused by increased trait mindfulness cannot be substantiated.

Self-regulation may be a useful concept for integrating findings on the interplay between coping, neuroticism and mindfulness. The ability of self-regulation, including controlling habits of mind, behavior and emotions, hinge on being fully informed by what is occurring (Brown et al., 2007). This includes “looking inside” to understand what is occurring in terms of mental processes, impulses and bodily reactions. In other words, it involves taking one’s experience as an object of attention. Failing to take oneself or one’s experience as an object of attention tends to foster habitual, overlearned, impulsive or automatized reactions. In contrast, the self-knowledge awarded by being fully informed facilitates greater choice. When practiced over time, mindfulness meditation may foster self-knowledge in the form of being aware of mental, emotional and physical experience as they are occurring in daily life (Kabat-Zinn, 1990). This increased awareness may undercut habitual reactions, including reactive ways of relating to emotions and impulses towards avoidance. Thus, from a self-regulation perspective mindfulness can be a protective factor in relation to reactivity (avoidance coping) inherent in high neuroticism. Greater attentional control, executive functioning and emotional regulation probably all play an important part in improving self-regulation following mindfulness training (Hölzel et al. 2011). This is a perspective that deserves further empirical and theoretical attention.

### **Strengths and limitations**

A major strength of this investigation is that it addressed several gaps in the research literature. Whereas most research on mindfulness-based intervention and coping have been conducted on clinical populations without adequate control group design; this investigation employed a RCT-design with a non-clinical population. Furthermore, mediation analysis was included in an effort to learn more about the mechanism of change in mindfulness training in relation to coping. Last, moderation analysis was performed to investigate whether neuroticism influenced the effect of mindfulness training in terms coping. Also, the attrition

level was low and electronic administration of questionnaires reduced the potential influence of assessors.

There were several limitations. The investigation relied greatly on self-report, which are susceptible to problems like memory and response bias. The intervention requires a certain investment of time and energy on behalf of the participants, and so cognitive dissonance could introduce bias in self-reported improvements (Homer, Sheard & Jones, 2000). Also, self-report methods can be subject to demand characteristics (e.g. attempting to please the investigator) (Baer et al., 2009). There are also some specific problems related to measurement of coping and mindfulness. First, it is unclear if semantic knowledge about one's own tendency to be mindful accurately reflects this attentional quality in real time (Brown & Cordon, 2009). Second, self-report of coping are influenced by difficulty aggregating across events and poor insight (Connor-Smith & Flachsbart, 2007).

The study employed a self-selected sample which may influence the generalizability of the results. Students who volunteer may differ from the general student population. For instance, they could be more motivated to engage in mindfulness-based practices as compared to students in general. Generalization to the student population as a whole must be done with this caveat in mind. The generalizability of the results to other populations is limited in that this sample is a well-educated and relatively young.

Last, there are problems related to the statistical analysis and study design employed. First, the large number of statistical tests performed increases the chance of spurious findings of statistical significance (Kraemer et al., 2006). Second, men and women were not equally distributed across groups. The results should be interpreted bearing in mind that the uneven distribution could contribute to some of the observed differences between the groups. Third, the investigation of change in trait mindfulness as a potential mediator was limited by how data was collected; trait mindfulness was assessed at the same time as the outcome variable, while evidence of mediation requires mediators to be measured prior to the outcome (Kazdin, 2007). Last, the study did not include a comparable control condition in which the same amount of didactic teaching and regular participation was provided within a supportive group of fellow students. Thus, it is not possible to rule out the possibility that processes other than training in mindfulness, such as group support, caused improvements in mindfulness and coping.

This investigation did not test the hypothesis that neuroticism may be related to drop-out or low adherence to mindfulness practises. Although results indicate high benefits for students with high emotional vulnerability, the current investigation cannot rule out the possibility that these students were more likely to drop-out or practice less, as have been indicated in previous studies.

### **Future research**

There is a proliferation of coping measures based on self-report with structures that cannot be replicated (Carver & Connor-Smith, 2010; Parker, Endler & Bagby, 1993). A prerequisite for moving this research field forward is to use validated measures of coping that are sensitive to short term change. These measures should include measures of emotional, psychological and behavioural strategies of disengagement and engagement coping. In addition to questionnaires reliant on self-report, behavioural assessment of coping such as laboratory tasks, daily coping reports and proxies to coping, such as sick leave and exam results, should be considered. Similarly, researcher may consider non-self-report methods for measuring mindfulness, such as laboratory- and computer based tasks which performance reflect the tendency or ability to be mindful (Baer et al., 2009).

By including mediator and moderator variables in future research we would gain further insight in to the mechanisms of action responsible for change following mindfulness training. Furthermore, employment of ‘dismantle design’ could prove useful (Chiesa & Serretti, 2010). In a dismantle design a standardised treatment approach is compared to the same approach with some components removed. For example one could compare MBSR to MBSR without meditation practices, to assess the specific effect of mindfulness meditation on coping. Using an active control group would not only give more information about the critical components of MBSR; it would also be stronger evidence for the efficacy of this treatment approach. A second approach to understand the mechanism of change could be to systematically manipulate the “dose” of mindfulness meditation, to establish a dose – response relationship (Kazdin, 2007). As an example participants could be randomized to treatment conditions with different emphasis on home meditation practise. Following the intervention the effect of these different conditions on change in trait mindfulness and coping could be assessed. This approach is superior to investigating the correlation between treatment adherence and outcome, as is common in mindfulness research; adherence may not

be randomly distributed, which means that any association between treatment adherence and improvements in coping could be spurious.

Mediation analysis and dismantling designs may be suited to determine which components are required to induce change, but they are not suited to unravel the precise processes behind any observed change (Kazdin, 2007). One approach to gain a better understanding of what mechanisms are at work in mindfulness training would be to include neuroimaging methodology. This would allow investigation of how functional and structural changes in the brain might mediate the effect of mindfulness training on coping. Given the importance of executive attention in emotion regulation and self-regulation (Hölzel et al., 2011), assessment of executive functioning may also be illuminating. Furthermore, efforts should be made to investigate whether cultivation of different aspects of mindfulness are important for improving different kinds of coping. For example cognitive coping might rely on the ability of attention control, whereas disengagement coping might be more related to reduced emotional reactivity and increased acceptance.

Finally, there is a need to understand for whom mindfulness training might be most helpful. In addition to neuroticism, other individual characteristics, such as extroversion and consciousness, should be considered. How individuals respond to stress (including coping efforts) is not influenced by any single trait in isolation, but by the whole of personality at once (Carver & Connor-Smith, 2010; Lau, Hem, Berg, Ekeberg & Torgersen, 2006). Future research could consider the joint influence of traits in relation to mindfulness training and coping.

## Conclusion

A growing number of studies demonstrate that mindfulness training not only helps individuals relax, but also promotes change in pattern of thinking, behaving and feeling that can be empowering. In relation to coping, most research has focused on the effect of mindfulness on efforts to create meaning and find benefits when faced with stress (cognitive coping). There seem to be consensus in that mindfulness meditation can improve qualities of attention characterized by a present-centered and non-judgmental awareness, which in turn change perceptual process leading to increased mental and physical health.

The results from the present investigation indicate that mindfulness training might be helpful for students of psychology and medicine in helping them cope with their considerable stress. Mindfulness training did not demonstrate a short term wide-ranging impact on coping, but a main effect was found in relation to a measure of problem focused coping, reflecting both increased problem solving and cognitive coping. Mediation analysis indicated that improvements in trait mindfulness was responsible for this change, so that the more mindfulness was enhanced, the greater the improvement in coping. Students high in neuroticism also benefitted in terms of two additional measures of coping; seeking social support and avoidance focused coping. More specifically, the results indicated that the avoidant reactivity of emotional vulnerable students can be reduced by the intervention. This is a quite new perspective on neuroticism and how it functions, which deserves more investigation.

More adaptive coping responses following the intervention may have a positive effect on these students health and, possibly, their academic performance. Furthermore, these students have selected challenging professions with high risk of burnout at the beginning of their careers (Olaussen, Skaar, Hauge & Skogstad, 2010; Peisah, Latif, Wilhelm, & Williams, 2009; Rubert & Morgan, 2005). Cultivating more adaptive coping strategies before graduation can be one way of preparing these students for the stress inherent in providing health care. In addition to improving health, increased mindfulness and more adaptive coping might contribute to stronger relationships with patients (Krasner et al., 2009; Ryan, Safran, Doran & Muran, 2012; Shapiro et al., 2005) and lower rates of medical errors (Fahrenkopf et al., 2008; Shanafelt et al., 2010). Thus, such an intervention may not only be of help to the individual students, but also benefit their future patients.

By including measures of stress-reactivity, executive functioning and attentional control, future studies will come closer to describing the precise neurobiological and psychological processes underlying improvements in coping. This will be a very interesting field to follow in the years to come.

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## **Appendix 1: The 7-week MBSR intervention week by week.**

The following description of the intervention is based on the resource manual for professional training in MBSR developed by the University of Massachusetts (UMass) Medical School, Center for Mindfulness in Medicine, Health Care, and Society (CFM) with the adaptations made by the project manager taken into account.

*Class one: Mindfulness and the power of being present.* Participants were introduced to what it means to be mindful both on a theoretical level through didactic teaching and experientially through the “raisin exercise”, physical anchoring exercises and the body scan. The focus of the class was on causes and consequences of having an absent mind, and some of the benefits of being present with one’s own experience. An important distinction was made between seeing thoughts as facts and being aware of thoughts as objects of observation. The home practice was to do the body-scan once a day for six days, and to choose one daily activity to be done with full awareness every day for the coming week. Suggestions for daily activities to do mindfully were given in the workbook, including: washing hands, stopping in the traffic at a red light, taking a shower, eating dinner, answering the telephone and getting dressed.

*Class two: Perception – how we perceive reality.* In the second class participants were guided in sitting meditation with focus on breathing. The theme of the class was how perceptual processes shape experience. The participants were introduced to information about how earlier experience and expectation shape perception. Mindfulness was highlighted as a mode of perception that is both curious and open, thereby making new interpretations and actions possible. The home practice assigned for the next week was practicing the body scan once a day for six days, practicing sitting meditation 5 – 15 minutes every day, and to choose a new activity to do mindfully every day. In addition participants were asked to notice one pleasant event during the week, and to note any sensations, thoughts and feelings associated with the event.

*Class three: Stress and how it affects us.* Two new formal mindfulness exercises were practiced in class three: slow stretching exercises from the hatha yoga tradition and walking meditation. The class was centered on the concept of stress, and how stress is manifested in the mind and body. The following home practices for week three were given: To alternate between lying yoga and the body scan for six days, in addition to practicing sitting meditation

for 15 minutes every day and to take notice of sensations, thoughts and feelings associated with unpleasant events.

*Class four: Coping with stress.* Hatha Yoga, sitting meditation and walking meditation were practiced during class four. The theme of the class was how the capacity to be aware of the mind and body in stressful situations, without immediately reacting, makes it possible to adapt effectively to challenges and stressors. The breath was highlighted as an important point of anchoring one's awareness. The following week the participants were invited to alternate between sitting meditation and the body scan or exercises in hatha yoga, every day, for six days. As part of their home practice participants were also asked to pay attention to their breathing both in everyday situations, and especially to open up to new ways of responding in stressful situations.

*Class five: Communication.* Class five consisted of sitting and walking meditation, and exercises in hatha yoga. The emphasis of the class was on interpersonal mindfulness. Interpersonal reaction patterns and habits of emotional expression/suppression were discussed. Mindfulness was in this context highlighted as the capacity to stay aware of one's own experience, including interpretations, focus of attention, emotions and behavioral impulses during communication. The home practice between class five and six was to do one formal mindfulness practice every day, choosing between the body scan, sitting meditation and hatha yoga. The participants were also instructed to pay close attention to how they communicated with others the following week, accepting their own reactions without necessarily trying to change anything. Finally they were asked to pick one activity to do with full awareness every day.

*Class six: Self-reliance.* Class six consisted of guided practices in sitting and walking meditation. The focus of this class was on acceptance and trust in one-self and life. Difficulties in accepting oneself and forgiving others were discussed. Participants were asked to do the same formal exercises' as last week. In addition they were invited to experiment with trust, openness and acceptance towards one-self, others and life in general.

*Class seven: six-hour mindfulness session.* The participants were invited to practice mindfulness a whole day in silence in week 7. Instructions in formal practices were given, interrupted by a silent meal. The last 45 minutes consisted of group reflection and evaluation of the program.

## **Appendix 2: Principal component analysis (PCA) of WCCL**

The suitability of data for factor analysis was assessed prior to conducting the factor analysis. Sample size adequacy was assessed by consulting the Kaiser-Meyer-Okin (KMO) test of sampling adequacy. KMO was .828, exceeding the recommended value of .6 (Kaiser, 1974). All KMO values for individual items were  $>.503$ , which is just above the recommended limit of .5 (Field, 2009). Bartlett test of sphericity was significant ( $p=.000$ ), supporting the factorability of the correlation matrix. An initial analysis was run to obtain eigenvalues for each component in the data. PCA revealed the presence of twelve components with eigenvalues exceeding 1. This solution was dropped because several components had only 1 item with strong factor loading. The scree-plot was then consulted as a criterion for factor extraction. The scree plot showed inflexions that justified retaining 3 components. When extracting 3 factors using oblimin rotation, items that make up the “problem focused coping” sub-scale in the original WCCL loaded most strongly on Component 1. Items that make up the three sub-scales of WCCL relevant to an avoidant style of coping (blame self, wishful thinking and avoidance) had strongest loading on Component 2. Items from the “seek social support” subscale of WCCL loaded most strongly on Component 3. 3 items from the avoidance sub-scales (item number 12, 35 and 38) relating to avoidance of social contact or hiding ones feelings from others, also loaded on component 3. These items were consequently considered part of the underlying construct represented by component 3 in further analysis, and the scoring was reversed. Item 18 (“Accepted the next best thing to what I wanted”) from the problem focused coping scale was deleted because of low factor loadings ( $<.04$ ) . Item 27 (“Got mad at the people or things that caused the problem”), originally an item in the avoidance sub-scale, had a low and almost equal factor loading on all three components (.2-.3). As a consequence this item was not included in further analysis. The PCA was rerun after deleting items number 18 and 27. KMO statistics ( $KMO=.834$ ) and Bartlett test of sphericity (.000) confirmed the data was still suitability for factor analysis. All KMO values for individual items were  $>.624$  . All three components showed a number of strong loadings and most variables loaded substantially on only one component. According to Field (2009) a factor solution is stable if each factor has 10 or more loadings greater than 0.4 in a sample that exceeds 150. The three component factor solution for WCCL in this sample is very close to fulfilling this criterion as component 1, 2 and 3 had 10/13, 14/17 and 8/9 factor loading above .4, respectively. The correlations between factors were .210 (1 and 3), .077 (1 and 2) and .199 (2 and 3).

### Appendix 3: Preliminary analyses

*Randomization checks and implications for statistical analyses.* There were no significant differences between the intervention and control group at T0 on the three outcome measures, moderators or the mediating variable. However, the Chi-square test (with Yates Continuity Correction) indicated that the number of men and women was not equally distributed across groups,  $X^2(1, n = 288) = 4.897, p = .027$ . There were no significant differences on other demographic variables. Splitting the data by gender would allow analyses without danger of confounding of gender and other variables of interest. However, the power of such analyses would be largely determined by the number of respondents in the smallest group, which is quite low for men in the intervention group. Some researchers advocate including variables that are not evenly balanced across conditions as covariates in subsequent analysis, however including these variables will not "control for" or "balance out" these differences (Miller and Chapman, 2001). Since it is impossible to statistically separate the effect of the intervention from the effect of gender, the randomized distribution was handled 'as is', and analysis was performed without controlling for gender. The results should be interpreted bearing in mind that the uneven distribution could contribute to some of the observed differences between the groups.

*Investigation of assumptions of parametric tests.* In regression analysis, outcome variables must be normally distributed for the significant testing to be valid. The outcome scores for "problem focused coping",  $D(144) = 0.09, p < .01$  and the mediating variable,  $D(144) = .08, p < .05$  were both significant non-normal in the control group. As a consequence of the sample distribution being non-normal we cannot know if  $p < .05$  is the appropriate criterion level for determining statistical significance (Field, 2009). By employing a bootstrapping procedure we get around this problem. Bootstrapping works by treating the sample data as a population which smaller random samples can be taken (Field, 2009). The sample distribution is estimated from these smaller samples. From the standard error of the estimated sampling distribution the standard error of the statistics of interest can be computed. Subsequently confidence intervals and significance tests can be computed from the standard error of the statistic. Bootstrapping, or empirical sampling, is also a way of handling data where the variance in the outcome variable is not equal across the level of the predictor. If mindfulness training is a cause of the outcome variables, we would expect unequal variance in the intervention group as compared to the control group. Furthermore, the unequal share of men and women across the conditions could also impose unequal variance

across the conditions. Unequal residual variance in the error terms of a linear regression analysis is called heteroscedasticity, and leads to flawed p-values and confidence intervals. Bootstrapped linear regression is robust to heteroscedasticity. Bootstrapping will be used for all analysis to get around the problem of non-normality and unequal variance across group allocation.

Last, an assumption of parametric tests, is that scores from different participants are independent. Since the intervention was delivered in a group format, it cannot be ruled out that the participant's behavior influenced each other within the groups. To investigate whether the effect of the intervention on outcome variables is dependent on class, multiple regression analysis was carried out with class as a categorical predictor. Dummy coding was used to represent the groups using only zeros and ones. Student class did not significantly predict mean differences in the outcome within the intervention groups. This indicates that scores of one individual within a group tell us nothing about the scores of other in the same class. Stated differently, these results are consistent with the assumption that the effect of the intervention is not differentially affected by class.

#### **Appendix 4: Considerations and extended description of statistical analysis**

*One vs. two-tailed hypothesis testing.* Hypothesis 1 specifies a clear directionality of the expected effect of group (intervention vs. control) on the outcome variables, and this could justify one-tailed significant testing (Cho & Abe, 2012). One-tailed hypothesis testing ensures a logical consistency between the directional research hypothesis and the statistical hypotheses testing. However, since one-tailed significant testing have been much debated and there is little agreement on the issue (Ringwalt, Paschall, Gorman, Derzon & Kinlaw 2011, Ruxton & Neuhäuser, 2010), results from two tailed hypothesis testing will be reported.

*Analytic procedure for testing mediation.* There are four steps necessary to establish mediation and these can be carried out through a series of three linear regression (Baron and Kenny, 1986). In the first step a significant relationship must be established between the predictor (intervention vs. control) and outcome variable (coping change). This analysis will be carried out when investigating hypothesis 1. Only the outcome variables that are significant influenced by group in the expected direction will be included in further analysis of mediation. In the second step a significant relationship must be established between the predictor (intervention vs. control) and the mediator (trait mindfulness change). This step will be investigated by regressing trait mindfulness change on group. The third step is to estimate the strength of the effect of the mediator (trait mindfulness change) on the outcome variable(s) (coping change), controlling for the effect of the predictor (group). This relationship must be significant for the mediated model to hold. The fourth step is to investigate whether the strength of the relationship between the predictor and the outcome variable(s) are significantly reduced when the mediator (trait mindfulness change) is entered into the model. Step 3 and 4 will be carried out in the same regression analysis. In this analysis, both the predictor (intervention vs. control) and the mediator (trait mindfulness change) will be entered as independent variables, and coping (change) will be entered as the dependent variable(s). If the effect of the intervention (vs. control) on coping change becomes non-significant or is significantly reduces when the mediator (trait mindfulness change) is included in the model, this would be consistent with the hypothesis that change in trait mindfulness is responsible for the effect of mindfulness training on change in coping. To substantiate that the mediated effect is significant, it is not sufficient to show that there is a drop in the strength between the predictor and outcome (Fraizer et al., 2004). The procedure to test the significance of the mediated effect is described in the text.

*Analytic procedure for testing moderation.* Assuming that there is a linear gradual change in the effect of the predictor depending on the level of the moderator, moderation can be examined by including the product of the moderator and the predictor variable as an interaction term in a multiple hierarchical regression. Consistent with the recommendations of Fraizer et al., (2004) all variables will be centered and standardized using z-scores prior to creating the interaction term. In the regression analysis the outcome variables (coping change) will be regressed on group, the moderator variable (neuroticism) and the interaction term. The different variables will be entered in two steps and separate analysis will be carried out for each outcome variable. In the first step group and neuroticism (the moderator variable) will be entered. The interaction term will be entered in second step. Some researchers recommend raising the conventional alpha level of .05 to .1 when probing for interactions (Fairchild & MacKinnon, 2009). This increases the power of the test, but because of the dangers of inflating the type 1 error rate, the traditional level of .05 will be retained. A significant interaction term indicates that the effect of mindfulness training is dependent on a pre-treatment variable (moderator).

A significant interaction term does not tell us whether the slope of the predictor-outcome relationship is significantly different from zero at different values of the moderator variable (Fraizer et al., 2004). Stated differently, a significant interaction term does not tell us whether the effect of mindfulness training is statistically significant at different levels of the pre-treatment variable. Furthermore, moderation analysis does not tell us anything about the effect size of the predictor-outcome relationship at different levels of the moderator (neuroticism). Significance testing of individual slopes and calculation of effect sizes at different levels of the moderator can be carried out by stratifying the moderating variable and then running a separate analysis for each stratum. Furthermore, to closer examine the nature of significant interaction effects, outcome variables will be regressed on neuroticism separately for the intervention and control group. This will tell us something about the predictive power of neuroticism in relation to change in coping in the intervention and control group separately. A significant moderator – outcome relationship in the intervention group would be consistent with the thesis that the neuroticism is causing students to be more or less responsive to the active ingredients in mindfulness training. A significant moderator – outcome relationship in the control group indicate that the neuroticism is an important variable in explaining how the individual respond to life as a student. A comparison between the moderator – outcome relationships in the intervention versus the control group might be

informative in understanding the basis of the interaction. The problem with the subgroup and follow-up analysis outlined above, is that it increases the probability of false-positive tests (Kraemer et al., 2006), and this must be considered when evaluating the results.

## Tables

Table 1: Results hypothesis 1

| Predictor | Outcome variables           |      |            |           |                               |      |             |           |                             |      |            |           |
|-----------|-----------------------------|------|------------|-----------|-------------------------------|------|-------------|-----------|-----------------------------|------|------------|-----------|
|           | Problem focused coping SRCS |      |            |           | Avoidance focused coping SRCS |      |             |           | Seeking social support SRCS |      |            |           |
|           | B                           | SE B | 95% CI     | Cohen's d | B                             | SE B | 95% CI      | Cohen's d | B                           | SE B | 95% CI     | Cohen's d |
| Group     | .22*                        | .09  | [.05, .39] | .30       | -.15                          | .08  | [-.32, .01] | .22       | .15                         | .08  | [.00, .30] | .23       |

Note. Group was coded 0 for the control group, 1 for the intervention group.  
 Bootstrap for coefficients displayed (bootstrap results are based on 1000 bootstrap samples)  
 CI= Confidence interval, SRCS =Standardized Standardized residual change score  
 \*p<.05

Table 2: Results hypothesis 2 (step2)

| Predictor | Outcome variable       |        |            |     |
|-----------|------------------------|--------|------------|-----|
|           | Trait mindfulness SRCS |        |            |     |
| B         | SE B                   | 95% CI | Cohen's d  |     |
| Group     | .23**                  | .05    | [.07, .39] | .30 |

Note. Group was coded 0 for the control group, 1 for the intervention group.  
 Bootstrap for coefficients displayed (bootstrap results are based on 1000 bootstrap samples)  
 CI= Confidence interval, SRCS =Standardized residual change score  
 \*\*p< .01

Table 3: Results hypothesis 2 (step 3 and 4)

| Predictor              | Outcome variables           |        |             |
|------------------------|-----------------------------|--------|-------------|
|                        | Problem focused coping SRCS |        |             |
| B                      | SE B                        | 95% CI |             |
| Group                  | .12                         | .08    | [-.03, .28] |
| Trait mindfulness SRCS | .43***                      | .06    | [.31, .55]  |

Note. Group was coded 0 for the control group, 1 for the intervention group.  
 Bootstrap for coefficients displayed (bootstrap results are based on 1000 bootstrap samples)  
 CI= Confidence interval, SRCS =Standardized residual change score  
 \*\*\*p< .001

Table 4: Results hypothesis 3

| Predictor     | Outcome variables           |      |             |                |                               |      |              |                |                             |      |             |                |
|---------------|-----------------------------|------|-------------|----------------|-------------------------------|------|--------------|----------------|-----------------------------|------|-------------|----------------|
|               | Problem focused coping SRCS |      |             |                | Avoidance focused coping SRCS |      |              |                | Seeking social support SRCS |      |             |                |
|               | B                           | SE B | 95% CI      | R <sup>2</sup> | B                             | SE B | 95% CI       | R <sup>2</sup> | B                           | SE B | 95% CI      | R <sup>2</sup> |
| <b>Step 1</b> |                             |      |             |                |                               |      |              |                |                             |      |             |                |
| Group         | .23**                       | .09  | [.06, .41]  |                | -.16                          | .08  | [-.32, .01]  |                | .15                         | .08  | [-.01, .31] |                |
| Neuroticism   | -.06                        | .05  | [-.15, .03] |                | .05                           | .05  | [-.04, .13]  |                | .02                         | .04  | [-.06, .10] |                |
| <b>Step 2</b> |                             |      |             |                |                               |      |              |                |                             |      |             |                |
| Group         | .23**                       | .09  | [.06, .40]  |                | -.16                          | .08  | [-.31, .00]  |                | .16                         | .08  | [-.01, .30] |                |
| Neuroticism   | -.06                        | .05  | [-.15, .03] |                | .04                           | .05  | [-.04, .14]  |                | .02                         | .04  | [-.06, .09] |                |
| Interaction   | .13                         | .09  | [-.03, .32] |                | -.23*                         | .09  | [-.40, -.07] |                | .16*                        | .08  | [.01, .31]  |                |

Note. Group was coded -.5 for the control group, .5 for the intervention group.

Bootstrap for coefficients displayed, (bootstrap results are based on 1000 bootstrap samples)

CI= Confidence interval, SRCS =Standardized residual change score

R<sup>2</sup> is based on the non-bootstrapped model summary

\*p<.05, \*\*p<.01

Table 5 Results hypothesis 3, follow-up analysis (avoidance focused coping)

| <b>Effect of intervention on avoidance focused coping SRCS at different levels of neuroticism</b> |                                |      |                |           |                                    |      |             |           |                               |      |             |           |  |
|---|--------------------------------|------|----------------|-----------|------------------------------------|------|-------------|-----------|-------------------------------|------|-------------|-----------|--|
| Predictor   | <b>High neuroticism (N=54)</b> |      |                |           | <b>Average neuroticism (N=178)</b> |      |             |           | <b>Low neuroticism (N=56)</b> |      |             |           |  |
|   | B                              | SE B | 95% CI         | Cohen's d | B                                  | SE B | 95% CI      | Cohen's d | B                             | SE B | 95% CI      | Cohen's d |  |
| Group   | -.60**                         | .22  | [-1.07, -0.16] | .76       | -.06                               | .10  | [-.26, .14] | .08       | -.05                          | .16  | [-.38, .25] | .08       |  |

Note. Group was coded 0 for the control group, 1 for the intervention group.  
 Bootstrap for coefficients displayed (bootstrap results are based on 1000 bootstrap samples)  
 CI= Confidence interval, SRCS =Standardized residual change score  
 \*\*p< .01

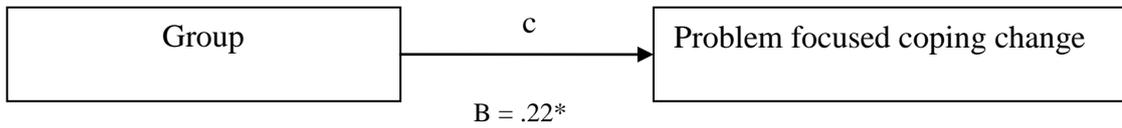
Table 6 Results hypothesis 3, follow-up analysis (seeking social support)

| <b>Effect of intervention on seeking social support SRCS at different levels of neuroticism</b> |                                |      |            |           |                                    |      |            |           |                               |      |             |           |  |
|---|--------------------------------|------|------------|-----------|------------------------------------|------|------------|-----------|-------------------------------|------|-------------|-----------|--|
| Predictor   | <b>High neuroticism (N=54)</b> |      |            |           | <b>Average neuroticism (N=178)</b> |      |            |           | <b>Low neuroticism (N=56)</b> |      |             |           |  |
|   | B                              | SE B | 95% CI     | Cohen's d | B                                  | SE B | 95% CI     | Cohen's d | B                             | SE B | 95% CI      | Cohen's d |  |
| Group   | .42*                           | .20  | [.03, .08] | .58       | .13                                | .09  | [-.4, .31] | .21       | -.08                          | .16  | [-.42, .23] | .13       |  |

Note. Group was coded 0 for the control group, 1 for the intervention group.  
 Bootstrap for coefficients displayed (bootstrap results are based on 1000 bootstrap samples)  
 CI= Confidence interval, SRCS =Standardized residual change score  
 \*p< .05

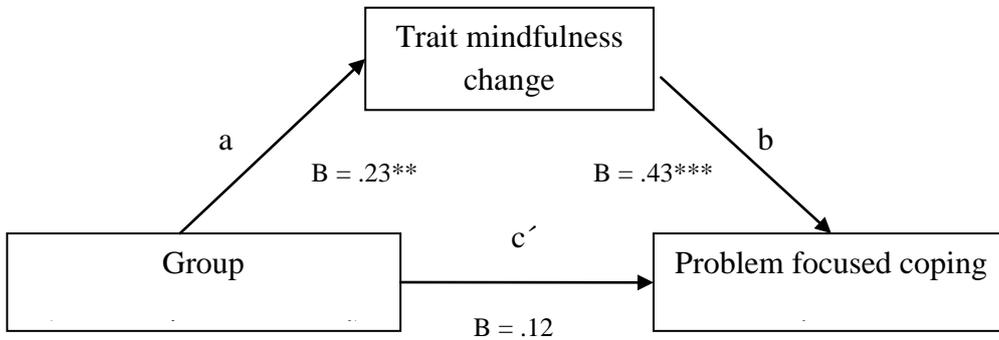
## Figures

*Figure 1: Direct pathway model for the effect of the intervention on change in problem focused coping*



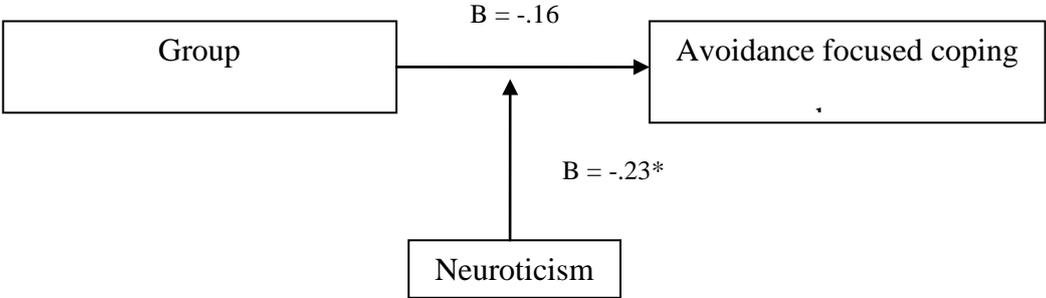
\* $p < .05$

*Figure 2: Mediated pathway model for the effect of the intervention on change in problem focused coping*



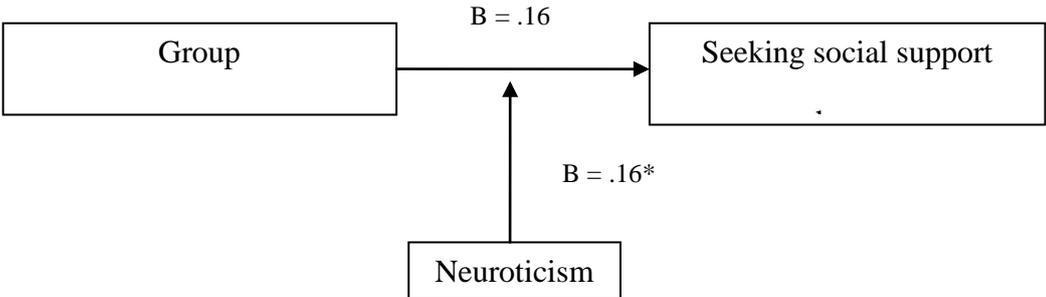
\*\* $p < .01$ , \*\*\* $p < .001$

Figure 4: Pathway model for the effect of the intervention on change in avoidance focused coping moderated by neuroticism



\* $p < .05$

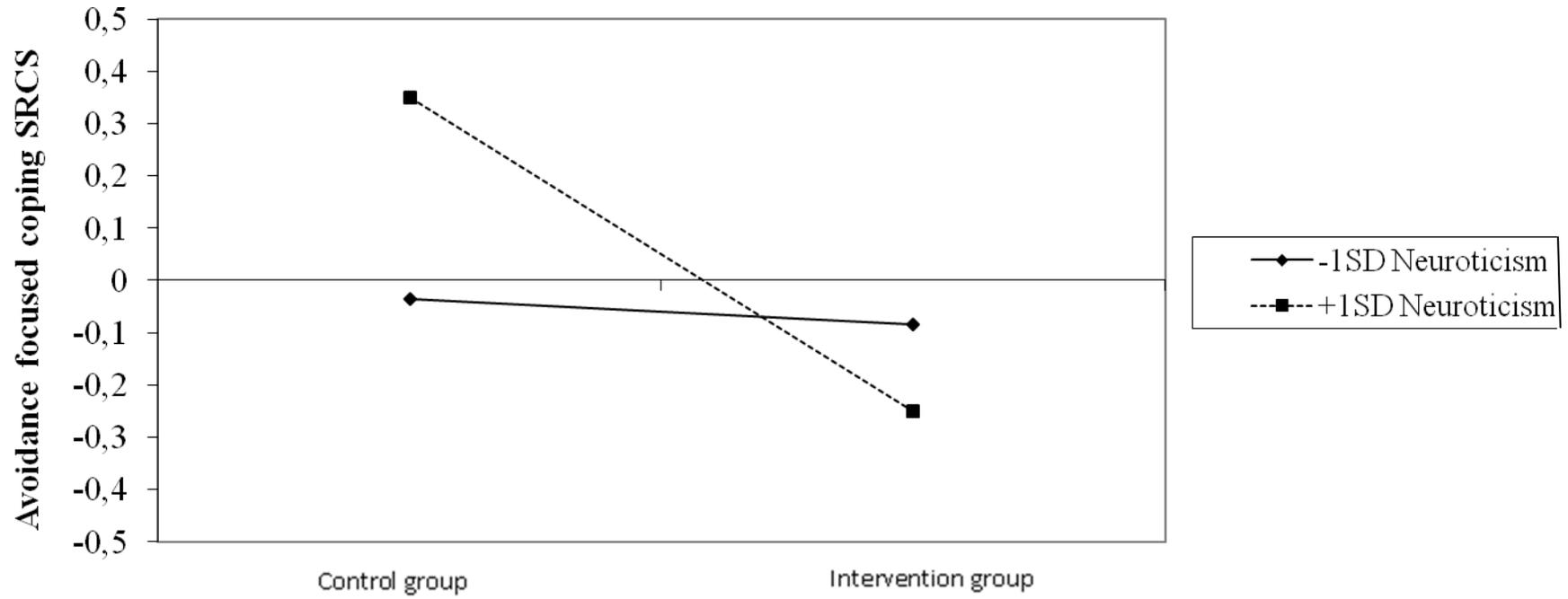
Figure 5: Pathway model for the effect of the intervention on change in seeking social support moderated by neuroticism



\* $p < .05$

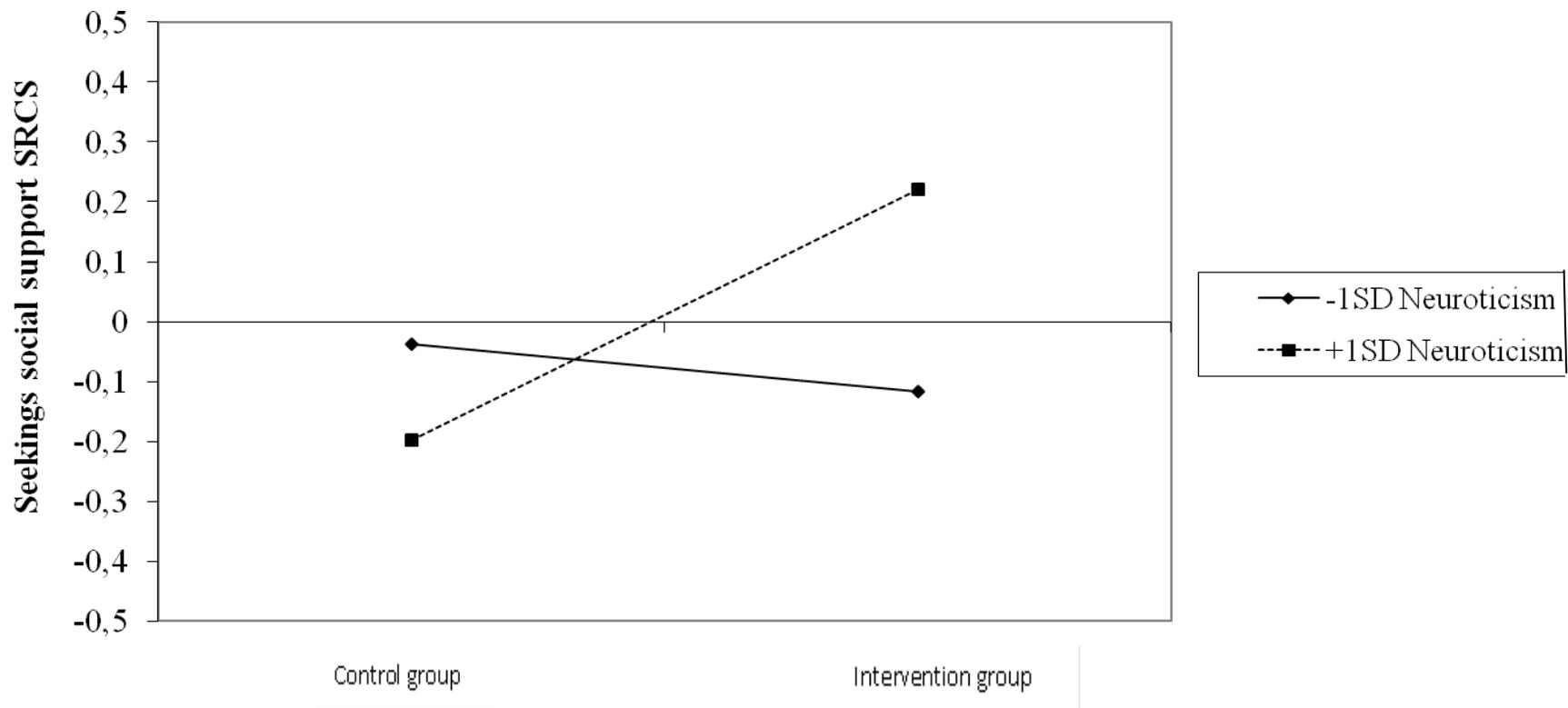
## Graphs

Graph 1: Predicted average change scores for avoidance focused coping for high and low neuroticism



SRCS= Standardized residual change score

Graph 2: Predicted average change scores for seeking social support for high and low neuroticism



SRCS= Standardized residual change score