DOCTORAL THESIS

Attention, depressive symptoms, and mindfulness: a look at their mutual relations and a test of mindfulness-based intervention.

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ABSTRACT

Depression is one of the most common psychiatric disorders, affecting approximately 5% of society and leading to impaired social and work performance and the development of many comorbid conditions. According to cognitive models of depression, this psychiatric disorder is associated with difficulties in disengaging attention from negative content, reduced attention to positive information, and sustained attention to negative stimuli. These specific cognitive biases are called attentional biases. They occur in both depressed and at-risk-of-depression groups.

Mindfulness practice has been described as effective in reducing depressive symptoms and improving attentional processes in several health conditions, including depression and anxiety. It is defined as paying non-judgmental attention to the present moment. Mindfulness promotes decentring, self-compassion, and a reduction in self-focused attention which are described as features somehow opposite to depressive symptoms.

The aim of our work was to describe mutual relations between attention, depressive symptoms and mindfulness. We examined these relations in a complex way both in depressed and healthy participants at risk of developing depression. Since anxiety is often comorbid with depression, we controlled anxiety measures in each of the conducted studies.

First, we examined the relationship between depression, anxiety and mindfulness in students of different faculties using Polish versions of mindfulness questionnaires. Second, we examined perceptual biases in depression in the detection of emotional content in complex social stimuli that resembled the participants' everyday environment. We also examined the influence of the comorbidity of depression and anxiety on the nature of those biases. It was also our intention to investigate associations between perceptual biases and levels of mindfulness, but this was not possible in our sample due to a large drop-out rate. In addition, we examined the

effectiveness of mindfulness training on the change of self-descriptive symptoms of depression, anxiety trait, mindfulness trait, and advancement in mindfulness as well as on visual attention in a group of medical students at risk of developing depression.

Our work suggests the existence of a highly distinctive form of attentional bias in simultaneously more severely depressed and anxious patients that cannot be captured by examining biases for each disorder separately. We describe it as 'attentional sharpening', which involves a narrowing of the attentional field and selective and thorough detection of negative content. Thus, our research shows that to fully understand the perceptual biases in depression, it is essential to study it jointly with the usually co-occurring anxiety.

We also demonstrated a negative relationship between depression and anxiety and both naturally occurring mindfulness and mindfulness developed through mindfulness training. Our work also suggests that in groups at risk of depression, mindful observation may be an important determinant of changes in visual attention and that mindfulness training may lead to affective improvement in groups at risk of depression, even if it does not lead to changes in attention.

To our knowledge, our work is the first to address the issue of investigating changes in visual attention to complex emotional stimuli in a group at risk of depression participating in mindfulness training. Furthermore, it significantly complements the line of research on mindfulness in groups at risk of depression, such as medical students, by combining self-descriptive measures with eye-tracking. Finally, it is one of the first attempts in Poland to measure the relationship between anxiety and depression symptoms and mindfulness using Polish versions of mindfulness questionnaires.

STRESZCZENIE (SUMMARY IN POLISH)

Depresja jest jednym z najczęściej występujących zaburzeń psychicznych, dotykającym około 5% społeczeństwa i prowadzącym do upośledzenia funkcjonowania społecznego i zawodowego, rozwoju wielu chorób współistniejących, takich jak zaburzenia lękowe i problemy kardiologiczne, a także nagłej śmierci samobójczej. Zgodnie z poznawczymi modelami depresji, ta choroba wiąże się, między innymi, z trudnościami w odangażowaniu uwagi od negatywnych treści, zmniejszoną uwagą na pozytywne informacje i zwiększonym utrzymywaniem uwagi na negatywnych bodźcach. Te specyficzne zniekształcenia poznawcze (*cognitive biases*) nazywane są zniekształceniami uwagowymi (*attentional biases*). Występują one zarówno w grupach osób z depresją, jak i zagrożonych jej wystąpieniem.

Praktyka uważności została opisana jako skuteczna w zmniejszaniu objawów depresji i poprawie procesów uwagi w wielu schorzeniach, w tym depresji i lęku. Uważność (*mindfulness*) definiuje się jako zwracanie nieoceniającej uwagi na chwilę obecną. Mindfulness promuje decentrację, współczucie dla siebie i redukcję uwagi skupionej na sobie, które są czasami opisywane jako cechy w pewnym sensie przeciwne do objawów depresji.

Celem naszej pracy było opisanie wzajemnych relacji między uwagą, objawami depresji i uważnością. Zbadaliśmy te relacje w sposób złożony zarówno u osób z depresją, jak i u zdrowych uczestników z ryzykiem rozwoju depresji. Ponieważ lęk często współwystępuje z depresją, w każdym z przeprowadzonych badań kontrolowaliśmy również miary lęku.

Po pierwsze, zbadaliśmy związek między depresją, lękiem i uważnością u studentów różnych kierunków za pomocą polskich wersji miar uważności. Po drugie, zbadaliśmy zniekształcenia percepcyjne w wykrywaniu treści emocjonalnych na złożonych bodźcach społecznych, które przypominały codzienne środowisko uczestników. Zbadaliśmy również wpływ współwystępowania depresji i lęku na charakter zniekształceń. Naszym zamiarem było również

zbadanie związków między zniekształceniami percepcyjnymi a poziomem uważności, ale nie było to możliwe w naszej grupie badawczej z powodu wysokiego wskaźnika rezygnacji z badania. Ponadto w grupie studentów medycyny zagrożonych rozwojem depresji zbadaliśmy skuteczność treningu uważności w zakresie zmiany samoopisowych objawów depresji, cechy lęku, cechy uważności oraz zaawansowania w uważności, a także zmiany uwagi wzrokowej.

Nasza praca sugeruje istnienie niezwykle interesującej formy zniekształceń uwagi u pacjentów, u których współwystępują wysokie objawy depresji jak i lęku, której nie można uchwycić, badając zniekształcenia w każdym z zaburzeń osobno. Opisujemy je jako "wyostrzenie uwagi", które obejmuje zawężenie pola uwagowego oraz selektywne i dokładne wykrywanie negatywnych treści. Nasza praca podkreśla, że wpływ często współwystępującej depresji i lęku powinien być zawsze badany jednocześnie, w tym w przyszłych badaniach wpływu poziomów cech uważności na uprzedzenia percepcyjne w depresji.

W naszych badaniach wykazaliśmy również negatywny związek między depresją i lękiem a naturalnie występującą uważnością, jak i uważnością rozwiniętą w ramach treningu uważności. Nasza praca sugeruje również, że w grupach zagrożonych depresją uważna obserwacja może być ważnym czynnikiem determinującym zmiany uwagi wzrokowej, a trening uważności może prowadzić do poprawy afektywnej w grupach zagrożonych depresją, nawet jeśli nie prowadzi do zmian w uwadze wzrokowej u wszystkich uczestników.

Zgodnie z naszą wiedzą, nasza praca jest pierwszą, która porusza kwestię badania zmian uwagi wzrokowej na złożone bodźce emocjonalne w grupie zagrożonej depresją uczestniczącej w treningu uważności. Co więcej, nasze badania znacząco uzupełnia linię badań nad uważnością w grupach zagrożonych depresją, łącząc pomiary samoopisowe z eye-trackingiem. Wreszcie, jest to jedna z pierwszych w Polsce prób pomiaru związku między objawami lęku i depresji a uważnością przy użyciu polskich wersji kwestionariuszy uważności.

1. GENERAL INTRODUCTION

1.1 Cognitive models of depression

Depression is one of the most prevalent and burdensome recurrent psychiatric conditions among the global population of adults and the leading cause of disability worldwide (Hawton et al., 2013; Kessler, 2012; Remes et al., 2021). It affects approximately 5% of society, leading to impaired social and work performance, the development of many comorbid illnesses such as anxiety disorders and cardiac problems, as well as sudden suicidal death (Gotlib & Joormann, 2010; Hawton et al., 2013; Kessler, 2012; Remes et al., 2021). As stated in the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2013) depression is characterized by, for instance, low mood, anhedonia, fatigue, feeling of worthlessness, suicidal thoughts, changes in weight and sleep patterns, disruptions in psychomotor activity, and a constellation of cognitive dysfunctions. As mentioned before, depression is frequently comorbid with anxiety. According to data, 42-78% of depressed patients are plagued by co-occurring anxiety (Gaspersz et al., 2018; Goldberg & Fawcett, 2012). In line with DSM-5 (American Psychiatric Association, 2013), anxiety is not described as a core symptom of depression. However, it includes the specifier 'with anxious distress' characterising possible symptoms of anxiety in depression. The specifier is there understood as the occurrence of at least two of five anxiety symptoms such as feeling keyed up or tense, feeling unusually restless, having difficulties with concentrating because of worry, fear that something awful might happen, feeling that the individual might lose control of himself or herself. Consequently, symptoms of anxiety as altering the clinical image of depression must be taken into consideration in the diagnosis and treatment of this psychiatric condition (for a review see Gaspersz et al., 2018; Tiller, 2012).

According to the cognitive models of depression, cognitive deficits are crucial to the onset and maintenance of depressive episodes (LeMoult & Gotlib, 2019). The pioneer concept in the topic

of cognitive models of depression was developed by Beck (1967) who described depressed persons as maintaining negative perceptions of self, the world, and the future (cognitive triad). Beck posited that the development of the triad, and finally, of the negative information processing bias, is contributed by the occurrence of mood-congruent self-schemas (associated with, e.g. a sense of loss and worthlessness) developed due to adverse early life events. Moreover, according to his model, negative self-schemas might become latent even in formerly depressed people, and later could be triggered by internal or external negative events and then lead to negative automatic thoughts and depressive mood (Beck, 1967; LeMoult & Gotlib, 2019).

In the years following the publication of *Depression: Clinical, experimental, and theoretical aspects* (Beck, 1967), Bower, Ingram, and Teasdale (Bower, 1981; Ingram, 1984; Teasdale, 1988) proposed their elaborations on Beck's cognitive model. Bower (1981) described the semantic-network approach, positing that each of the distinct emotions is stored in memory as a node. According to his work, each node gathers many aspects of a particular emotion, such as its autonomic response pattern, semantic labels to describe it or recollections of situations evoking this emotion that are associated with it within a network. On this basis, activation of the emotion facilitates retrieval of affectively congruent memories (mood congruity effect). Later, this theory was applied by Ingram (1984) to analyse information processing in depression. He assumed that the activation of the depression node is provoked by the subjective interpretation of life events mainly connected with loss. In accordance with Ingram (1984), depression node triggers the network of loss-related contents and causes higher cognitive accessibility of its various components. Further, the spread of activation of the network begins to promote currently stronger (depressive) linkages, leading to the occurrence of the loop of depressive themes through the awareness. A few years later, Teasdale (1988) formulated his differential activation hypothesis, which finally supplemented the majority of statements of

Beck's cognitive model. This hypothesis suggested that individual differences in the cognitive constructs and processes such as the intensity of negative self-thoughts, which became accessible and activated in mildly depressed mood, could contribute to the severity of eventual depressive episodes and increase the probability of their persistence (Teasdale, 1988). Moreover, Teasdale also supported Beck's claim regarding latent negative self-schemas, positing that aforementioned constructs and processes might not be observable in non-depressed state. Both Ingram and Teasdale emphasized the role of cognitive biases in emotional processing such as mood-congruent biases in: self-referential processing, attention, memory, and in the interpretation, for the onset, persistence and recurrence of depression (Ingram, 1984; LeMoult & Gotlib, 2019; Teasdale, 1988).

In accordance with Ingram and Teasdale (Ingram, 1984; Teasdale, 1988), current empirical findings posit that negative self-referential biases occur in persons at risk for depression, depressed, and formerly depressed ones (LeMoult & Gotlib, 2019). Furthermore, these types of cognitive biases co-occur with attentional biases which together influence the development of upcoming depressive episodes (Disner et al., 2011; LeMoult et al., 2017). Prior to the implementation of eye-tracking into cognitive science, attentional biases in depression have been measured by emotional Stroop task or dot-probe procedure (Koster et al., 2005; for a review see LeMoult & Gotlib, 2019). However, each of those procedures had strong methodological drawbacks regarding the precision of the measurement and reliability (Chapman et al., 2019; Schmukle, 2005). Firstly, in the case of the emotional Stroop task, it was impossible to disentangle assessed attentional bias from other biases such as bias in initial attention or in the selection of responses (LeMoult & Gotlib, 2019). Secondly, in the case of the dot-probe procedure, it was problematic to detach initial orienting towards negative stimuli from difficulty to detach attention from it (Grafton et al., 2012; Grafton & MacLeod, 2014; LeMoult & Gotlib, 2019).

For this reason, in order to measure biases more precisely and knowing that visual stimuli elicit more consistent results regarding attentional biases when compared with word stimuli (Armstrong & Olatunji, 2012; LeMoult & Gotlib, 2019), eye-tracking was incorporated into dot-probe procedures. The tasks were initiated by the probe occurring on the screen centre, to which participants were obliged to react. Later, (1) pairs of the human face photographs (negative and neutral or positive and neutral) or (2) sets of four images (one neutral and three valenced e.g. positive, threatening, and dysphoric) were displayed alternatingly with the probe (Caseras et al., 2007; Eizenman et al., 2003; Kellough et al., 2008; LeMoult & Gotlib, 2019). The positions of valenced images were changed in the course of the task (left/right screen side). During the procedure, eye movements were constantly traced. Finally, it was confirmed that attentional biases in depressed patients include (1) difficulty to disengage attention from negative content such as negative images (Caseras et al., 2007; Eizenman et al., 2003; LeMoult & Gotlib, 2019), (2) decreased attention to positive information (less time spent on positive images compared to healthy participants) as well as (3) sustained attention to negative stimuli (more time spent on negative images compared to healthy participants) (Kellough et al., 2008; LeMoult & Gotlib, 2019).

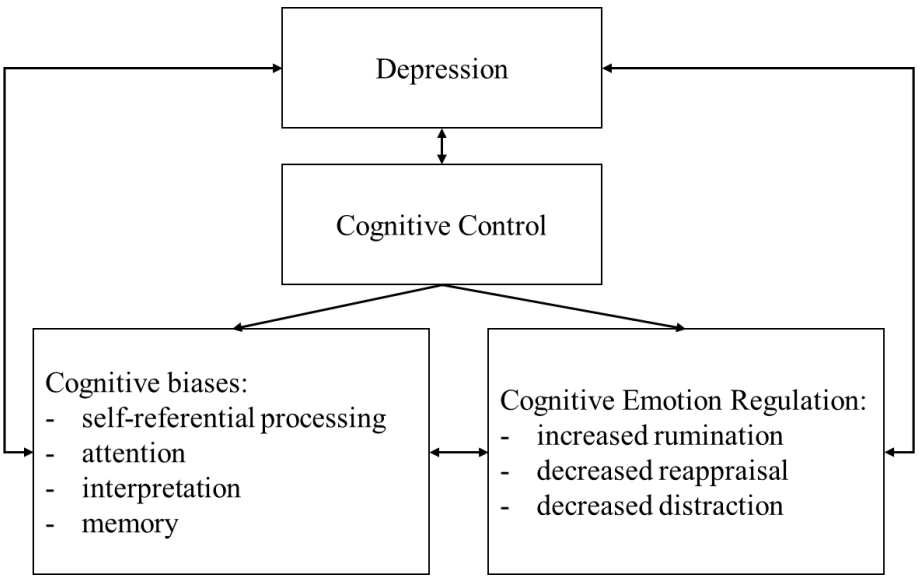
In line with the large body of research on remaining cognitive biases in depression, depressive patients exhibit a bias for preferentially retrieving negative material from both implicit and explicit memory (memory bias) (Gaddy & Ingram, 2014; Matt et al., 1992) and a negative bias of interpreting ambiguous information (interpretation bias) (Lee et al., 2016; Wisco, 2009) in social and non-social situations (LeMoult & Gotlib, 2019; Voncken et al., 2007). Moreover, the occurrence of interpretation bias was confirmed in non-depressed persons with a history of depressive episodes (Wenzlaff & Bates, 1998) as well as in groups at risk for depression (Everaert et al., 2017). However, it is worth noting that there were several studies of interpretation bias in depressed individuals which did not corroborate those outcomes or

brought mixed results (Bisson & Sears, 2007; Hindash & Amir, 2012; Lawson & Macleod, 1999).

Interestingly, according to the hypothesis by Everaert and colleagues (2014), the maintenance of depression is associated with the interaction of attention, interpretation, and memory biases which might together influence depressive symptoms. The conceptualisation of depression by LeMoult and Gotlib (2019) broadens the perspective outlined by Everaert (2014) and adds more factors contributing to this illness. According to the authors, depression occurs as a consequence of the interaction of disrupted cognitive control over mood-congruent contents with (1) cognitive biases in self-referential processing, attention, interpretation and memory, as well as with (2) maladaptive emotion regulation patterns such as increased rumination, diminished reappraisal and decreased ability to use distraction. Consequently, all those factors influence each other, causing the maintenance and aggravation of depressive symptoms.

Fig. 1. 1

Theoretical model of depression by LeMoult and Gotlib (2019)



1.2 Modification of attentional biases

Modification of the depressive attentional biases is now used in order to reduce the likelihood of the onset or relapse of depression. This is currently possible, for example, with real-time feedback attention bias modification (ABM) paradigms developed using eye tracking (Woolridge et al., 2021). Real-time feedback ABM is an adaptation of classical dot-probe ABM, which is aimed at diminishing attention towards negative stimuli and increasing attention to positive content. It is achieved by pairing the spatial position of the probe, for which a response is required, with the position of stimuli of particular valence. Most frequently, probe occurs immediately after positive or neutral stimuli, and less frequently after negative ones. The novel approach described by Woolridge and colleagues (2021) not only applied eye-tracking to standard AMB, enabling accurate measurement of visual attention, but also provided participants with immediate feedback regarding the accuracy of their responses. Initial results suggest that reward-based ABM training diminishes attentional biases in depression (Woolridge et al., 2021). Moreover, the authors posited that the effect of training generalises also to other cognitive faculties, such as recall for affective information.

It is important to note that according to Armstrong and Olatunji (2012), individuals with cut-off depression scores exhibit weaker attentional bias towards negative stimuli than depressed patients. However, research by Sanchez-Lopez and colleagues (2019) suggested that also in a non-depressed sample of undergraduates, eye-tracking-based feedback – similar to Wooldrige et al. (2021) but using words instead of faces – elicits sustained attention towards positive stimuli and reduces state rumination after viewing negative scenes which were a part of emotion regulation task. Taking into account the aforesaid relationship between the presence of attentional bias and the risk of developing depression (Disner et al., 2011; LeMoult et al., 2017), the issue of attentional bias reduction in non-depressed and subclinical populations at risk of depression appears to be a topic worth further investigation. Given that the described attention

bias modification training can suppress negative attentional biases in populations at risk of depression, as suggested by early results on the subject, it might possibly contribute to the development of a large-scale program of preventing depression.

1.3 Risk of depression in medical students

Medical students are the group commonly described as being at risk of depression with a 27% prevalence rate of depression or its symptoms, including 11% with suicidal ideations (Rotenstein et al., 2016). Furthermore, this group is described as exhibiting significantly higher level of anxiety than the general population in similar age (Rotenstein et al., 2016; Suarez et al., 2021). Lastly, numerous academic duties, pressure and stress faced by undergraduates constantly influence their mental as well as physical health (Ungar et al., 2022) causing an increase in their psychiatric morbidity during the process of medical education (Fauzi et al., 2021; Pham et al., 2019; Silva et al., 2017). According to the line of research examining the mental health of medical, they exhibit greater susceptibility to mental illnesses than students of other faculties students (Dyrbye & Shanafelt, 2011; Heinen et al., 2017; W. Zeng et al., 2019). There is a growing body of research on improving students‘ contentment during the course of studies and on promoting their mental health (Lun et al., 2018; Ungar et al., 2022).

According to recent studies, factors supporting the psychological well-being of medical students are associated with their lifestyle (exercise pattern, quality of sleep) as well as personal and psychosocial variables (optimistic outlook on the future, satisfaction with academic performance and social interactions, reason for choosing medical career, level of academic burnout) (Dyrbye et al., 2019; Lun et al., 2018; Silva et al., 2017). Consequently, current research unanimously emphasizes the importance of developing scientifically proven methods to reduce the incidence of depression and other mental illnesses among medical students

(Dyrbye et al., 2019; Fauzi et al., 2021; Hamasha et al., 2019; Lun et al., 2018; Pham et al., 2019; Rotenstein et al., 2016).

As stated by Ungar and colleagues (2022), significant factors in arranging preventive programs for medical students are as follows: supporting self-efficacy and resilience, increasing empathy, coping and self-regulation strategies as well as mindfulness and self-compassion. According to their review (Ungar et al., 2022), effective online procedures to strengthen the mental health of medical students involved short meditations (enhancement in resilience and empathy) and peer support (increase in ability to adapt to stressful situations). Mindfulness interventions also proved to be effective in improving the well-being of medical students in face-to-face procedures by reducing anxiety and depression, and improving self-efficacy as well as empathy (Chmielewski et al., 2021; De Vibe et al., 2018; McConville et al., 2017). Moreover, they were also described as a potential depression-preventing factor in cross-sectional studies on medical students (Alzahrani et al., 2020; Xiong et al., 2021). In line with existing literature, the effects of mindfulness-based interventions appear as worth further investigation in order to improve depression prevention programs and diminish psychiatric morbidity in medical students.

1.4 Mindfulness interventions

Mindfulness practice has been documented to be effective in diminishing depressive symptoms in various health conditions, such as depression, anxiety, and chronic pain (for reviews see Hilton et al., 2017; Hofmann & Gómez, 2017; Zhang et al., 2021). It is increasingly used in groups exposed to elevated stress and pressure in order to promote behavioural and mental strategies, reducing the risk of developing depression and/or anxiety and enhancing resilience (da Silva et al., 2023; O'Connor et al., 2023; Zhang et al., 2021). Mindfulness meditation is defined as "non-judgmental paying attention to the present moment" (Kabat-Zinn, 1990). During mindfulness meditation, participants are encouraged to gently and kindly focus, for

example, on their breath and/or their body without judging their naturally wandering mind and their overall experience. Practicing mindfulness is associated with the reduction of stress, depression and anxiety; it supports the increase of resilience and well-being in healthy people and clinical groups such as people suffering from depression, cancer, chronic pain and anxiety syndromes, etc. (Kabat-Zinn, 1990; Khoury et al., 2013; Tang et al., 2015; Vignaud et al., 2018).

It has been demonstrated that even a few days of practicing mindfulness improve self-reported well-being (Serrão & Alves, 2019). Moreover, neuroimaging studies show that practicing mindfulness is associated with the change in activation of the brain regions involved in self-regulation of attention (e.g. greater activation of the anterior cingulate cortex and fronto-insular cortex) as well as emotional regulation (enhanced dorsolateral prefrontal cortex activation and diminished activation of the amygdala) (Tang et al., 2015). The functioning of these regions is disturbed in individuals with diagnosed clinical depression and anxiety, as well as in people at risk of depression (Albert et al., 2017; Beevers et al., 2015). On this basis, it might be assumed that mindfulness intervention, as having an impact on brain centres related to attention and emotional processing, whose impaired performance is associated with the development of depressive symptoms, should reduce attentional and perceptual biases in the aforementioned groups.

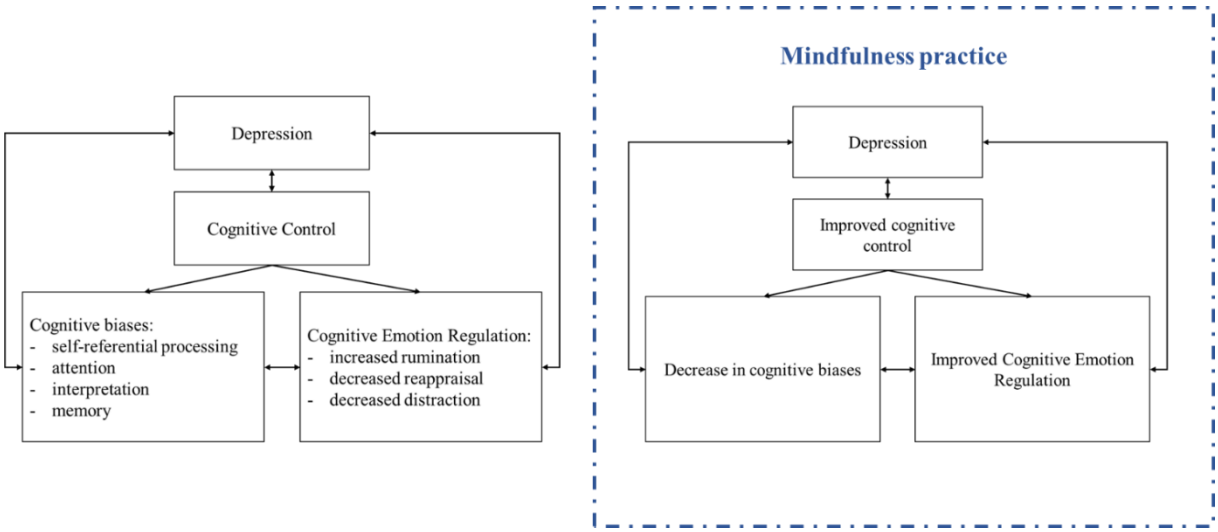
The very first evidence of it was demonstrated by Holas and his team (2020). In their study which used eye-tracking to measure the effects of mindfulness intervention, it was shown that a mindfulness intervention leads to a reduction in depressive symptoms and attentional biases in a group of people suffering from depression. Their research extended the understanding of the effects of mindfulness practice on depressive attentional biases previously studied only

using methods based on reaction time measurement (De Raedt et al., 2012; Verhoeven et al., 2014) whose drawbacks were described in section 1.1.

These results are supported by the fact that, according to the model of mindfulness state by Holas and Jankowski (2013), mindfulness promotes decentration, self-compassion, and reduction of self-focused attention which are sometimes described as features somehow opposite to depressive symptoms such as increased self-referential processing and tendency to ruminate (Albert et al., 2017; Beevers et al., 2015; LeMoult & Gotlib, 2019; Tang et al., 2015). Namely, being more mindful is associated with the ability to notice and observe internal and external states with openness, acceptance and without judgement (Baer et al., 2008; Kabat-Zinn, 1990). Conversely, in anxious and depressive states observing oneself is associated with increased negative self-attention and ruminative thinking (Baer et al., 2008).

Fig. 1.2

The demonstrative model of mindfulness influence on depressive symptoms presented on the theoretical model of depression by LeMoult and Gotlib (2019)



The impact of mindfulness intervention can be assessed with declarative measures such as mindfulness questionnaires. For example, the Toronto Mindfulness Scale (TMS) (Lau et al., 2006) measures the *state of mindfulness*, and the Five Facet Mindfulness Questionnaire (Baer et al., 2006) measures the *trait of mindfulness* (also known as *dispositional mindfulness*). *Mindfulness as a state* refers to a *state* practiced during mindfulness meditation (Lau et al., 2006). On the other hand, *mindfulness as a trait* refers to the capacity of paying and maintaining attention to present-moment experiences with an open and non-judgmental attitude (Brown & Ryan, 2003; Tang & Tang, 2020). This trait varies inter-individually in the general population (Makowski et al., 2019) but also, according to Kiken and colleagues (2015), responds to training. Meditation-based interventions, which repeatedly induce mindfulness states, might lead to relatively stable changes in *trait mindfulness* (Kiken et al., 2015).

The growing popularity of mindfulness practice in various contexts creates a greater demand for mindfulness interventions tailored to the needs of specific groups. Therefore in research,

specific interventions are applied in accordance with the specificity of the experimental group. The most popular forms are 8-week interventions such as (1) Mindfulness-Based Cognitive Therapy (MBCT) (Segal et al., 2013) designed for people with recurrent depression, (2) Mindfulness-Based Stress Reduction (MBSR) (Kabat-Zinn, 1990) organised especially for people suffering from chronic pain and cancer, and (3) Mindfulness Training (Williams & Penman, 2011) designed for healthy people with an intense lifestyle, exposed to an increased risk of depression or at risk of burnout, such as medical students. As mentioned before, research shows that in students of medicine or other faculties exposed to academic stress the mindfulness intervention contributes to the reduction of depressive symptoms and anxiety, and leads to an increase in well-being (Alzahrani et al., 2020; De Vibe et al., 2018; Malpass et al., 2019; Serrão & Alves, 2019; Shapiro et al., 1998).

1.5 Research questions

In our project, we examined two aspects of depressive symptoms: the self-reported depressive state and the attentional and perceptual biases, in order to make a new inquiry into the possible attenuation of these two aspects of depression by mindfulness practice. Moreover, we examined self-descriptive symptoms of anxiety which in 42-78% of cases co-occurs with depression (Gaspersz et al., 2018; Goldberg & Fawcett, 2012). We also examined the relationship between depressive and anxiety symptoms and *mindfulness as a trait* as well as the *advancement in mindfulness*. In our research, we focused mainly on the student populations, especially medical students, who are at high risk of depression.

Firstly, we tested the hypothesis that self-reported depressive and anxiety symptoms correlate negatively with *advancement in mindfulness*, and *mindfulness as a trait*. Secondly, we studied the link between self-reported depressive and anxiety symptoms and a bias in the perception of the emotional content of visual stimuli. Lastly, we assessed the effectiveness of a mindfulness-based intervention, i.e. an 8-week Mindfulness Training (Williams & Penman, 2011), in

improving self-reported *mindfulness* well as in reducing both self-reported depressive and anxiety symptoms and perceptual and attentional biases linked to a depressive state. The last step investigated whether mindfulness training can affect not only the declarative depressive symptoms in a group at risk of depression but also its attentional counterparts, such as increased attention engagement by negative visual stimuli and difficulty in disengaging from them.

In our research, we addressed four research questions:

Q1: Are the *mindfulness trait* or the *advancement in mindfulness* associated with depression and anxiety scores in the population of Polish students?

Q2: Do depressed people show biases in terms of detection of emotional content of complex images?

Q3: Would participation in mindfulness training cause a change in *mindfulness trait* and *advancement in mindfulness* as well as depression and anxiety scores in a group of people at risk of depression?

Q4: Would participation in mindfulness training result in a change in attention towards valenced stimuli in people at risk of depression? Would this change be associated with participants' baseline depression, anxiety or mindfulness scores?

1.6 The rationale for this thesis

The rationale for this thesis is a small number of reports regarding the effect of mindfulness interventions on the attentional and declarative depressive symptoms in groups at risk of depression, such as medical students. The confirmation of the influence of mindfulness on both declarative and attentional symptoms of depression might widen our understanding of the methods of early prevention of depression in groups at risk of developing it. Furthermore, it is vital to address those issues in students, especially of medicine, because of their high psychiatric

morbidity and lower level of well-being than in the general population (Cooke et al., 2006; Fauzi et al., 2021; Gallego et al., 2014; Pham et al., 2019; Rotenstein et al., 2016; Silva et al., 2017).

Presently, it is not clear whether the impact of mindfulness interventions on self-reported depressive symptoms in the risk groups (Alzahrani et al., 2020; De Vibe et al., 2018) is limited only to the declarative aspect or is it also reflected in the change of attentional and perceptual effects. Recently, the impact of mindfulness on reducing attentional and perceptual biases (reduction of attention towards sad faces and the increase of attention towards positive faces) has been shown in a clinical population of depressed patients (Holas et al., 2020), which strengthens our hypothesis on the effectiveness of mindfulness intervention in the aspect of depressive symptoms. According to our knowledge, the current thesis is one of the first attempts to examine the link between mindfulness trait induced by mindfulness intervention and attentional and perceptual biases, as measured with eye-tracking, in the groups at risk of developing depression.

Furthermore, in this research, we examined attentional change using more complex stimuli resembling real-life situations (i.e. natural images depicting social emotional scenes) as opposed to decontextualised emotional faces which are usually used in research on attention and mindfulness. The importance of conducting research on more complex images was already raised by Ford and colleagues (2021) who described the relation between *trait mindfulness* and visual attention to valenced complex images in a group of healthy participants. According to their team, it is crucial to use stimuli which mirror the natural environment in order to obtain more generalizable results than those assessed with human face stimuli, which are "limited in focus and generalizability". Moreover, Ford and his team (2021) pointed out that mindfulness has not yet been studied in relation with non-face valenced images with the exception to their

study in which they measured associations between visual attention and naturally occurring mindfulness trait.

On the more practical ground, this thesis will assess the effectiveness of mindfulness training in a group at risk of depression such as medical students, which – if the results are promising – may prompt the introduction of mindfulness training at Polish universities as one of the means to improve the well-being of students at risk of depression. As a result, the percentage of people suffering from depression, which is usually comorbid with anxiety (Gorman, 1996; Kessler et al., 2015; Saade et al., 2019), in the course of their higher education might decrease. This study might also support the line of scientific reports regarding the practice of mindfulness at universities and medical facilities as an effective method for increasing the care for current and future employees (Alzahrani et al., 2020; Botha et al., 2015; De Vibe et al., 2018; Galante et al., 2018).

1.7 General Methods

In the course of this project, four self-descriptive measures in Polish versions were applied. Namely, (1) the short form of the Five Facet Mindfulness Questionnaire (Bohlmeijer et al., 2011; Radoń & Rydzewska, 2018; Tran et al., 2013), (2) the Mindfulness Advancement Questionnaire (MINDSENS; Radoń, 2020; Soler et al., 2014), (3) the Beck's Depression Inventory (Beck et al., 1996; Zawadzki & Popiel, 2009) as well as (4) the State-Trait Anxiety Inventory (STAI; Sosnowski et al., 1987; Spielberger, 1983).

1.7.1 Short form of the Five Facet Mindfulness Questionnaire (FFMQ-SF)

The Five Facet Mindfulness Questionnaire was established by Baer and colleagues (2006) on the basis of the exploratory factor analysis of the items of the then-available self-descriptive mindfulness scales. Namely, the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003), the Freiburg Mindfulness Inventory (FMI; Buchheld et al., 2001), the Kentucky

Inventory of Mindfulness Skills (Baer et al., 2004), and two questionnaires unpublished at that time: the Cognitive Affective Mindfulness Scale (Feldman et al., 2007; Hayes & Feldman, 2004), and the Mindfulness Questionnaire (Chadwick et al., 2005).

The psychometric properties of the five-factor hierarchical model (five associated factors incorporated in the single superior construct) were confirmed by the exploratory factor analysis (Baer et al., 2006; Gu et al., 2016). The satisfactory validity and consistency in samples of varied advancement in meditation were presented by the authors and in many following studies (Baer et al., 2006; Bohlmeijer et al., 2011; Christopher et al., 2012; Curtiss & Klemanski, 2014b, 2014a; Dundas et al., 2013; Hou et al., 2014). Nevertheless, due to the fact that the FFMQ model was established on the sample of meditators (Baer et al., 2006), the validity of the hierarchical five-facet structure of this model in groups less advanced in meditation had been questioned. Finally, it was confirmed that the four-factor hierarchical model (without *Observing* scale) provides the best fit for the data in non-meditator samples (Baer et al., 2006; Curtiss & Klemanski, 2014a; Gu et al., 2016; Williams et al., 2014). However, to provide a shorter version of the questionnaire for applied clinical research, the shortened version of FFMQ (FFMQ-SF) was established (Bohlmeijer et al., 2011; Radoń & Rydzewska, 2018; Tran et al., 2013). According to data obtained by Baer and colleagues (Baer et al., 2006, 2008) in our study on non-meditators we decided to use 4-factor FMMQ (*Observe* scale excluded) in the short version proposed by Bohlmeijer (2011).

The FFMQ-SF (Bohlmeijer et al., 2011) consists of 24 items rated on a 5-point Likert scale ranging from 1 meaning *never or very rarely true* to 5 meaning *very often or always true* arranged, as full FFMQ, in the five scales, particularly *Observing*, *Describing*, Acting with Awareness (*Actaware*), Non-judging of Experience (*Nonjudge*), and Non-reactivity to Inner Experience (*Nonreact*). *Observing* entails noticing or attending to internal and external

sensations such as feelings, thoughts, emotions. *Describe* evaluates the ability to describe experiences with words. *Actaware* involves engaging in an activity that is being performed at the present moment, instead of operating on "autopilot" or acting automatically while attention is focused elsewhere. *Nonjudge* describes a non-judgmental attitude towards thoughts and feelings. Ultimately, *Nonreact* measures the ability to detach from thoughts and emotions, allowing them to come and go without getting involved or absorbed by them (Bohlmeijer et al., 2011; Gu et al., 2016). The scores can be computed for each of the scales or as the overall score. The highest overall or subscale scores correspond to the highest intensity of the *mindfulness trait*. In the Polish version of the test, the minimum score for *Observing* scale is 4, the maximum is 20, for the remaining scales scores range from 5 to 25 points. The minimum score for overall FFMQ-SF is 24, maximum is 120 points (Radoń & Rydzewska, 2018).

The Polish adaptation of FFMQ-SF (Radoń & Rydzewska, 2018) has acceptable psychometric proprieties (reliability of particular scales varies from $\alpha = .69$ to .74 in a group of non-meditating adults from 20 to 50 years of age) and can be used in non-clinical samples aged 16-63.

1.7.2 MINDSENS Composite Index

The MINDSENS Composite Index was established by Soler and colleagues (2014) on the bases of the exploratory factor analysis of the items of the FFMQ (Baer et al., 2006) and the Experiences Questionnaire (EQ; Fresco et al., 2007).

It consists of 19 items rated on a 5-point Likert scale ranging from 1 meaning *never or very rarely true* to 5 meaning *very often or always true* arranged in three subscales, that is *Observing* (five items from the FFMQ *Observing* scale), *Non-reactivity* (five items from FFMQ *Nonreact* scale) and *Decentering* (nine items from the EQ). The last subscale was described by Soler as "measuring the capacity to observe one's

thoughts and feelings as temporary and objective events of the mind" and as a crucial facet of mindfulness training (Soler et al., 2014). The scores should be computed as the overall score (Soler et al., 2014, 2018). The highest overall scores correspond to the greatest *advancement in mindfulness*, which is associated with the frequency of mindfulness practice and the overall length of lifetime practice. According to the authors, the MINDSENS distinguishes daily from non-experienced meditators with 82% accuracy (Soler et al., 2014).

The factors of MINDSENS, i.e. *Observing*, *Nonreactivity* and *Decentering*, have been described as the most sensitive to differences in frequency of mindfulness practice, and the most discriminative between those who practice mindfulness and those who do not, compared to other mindfulness-related abilities (Soler et al., 2014). Therefore, in our study, we used the MINDSENS index primarily to implicitly control for the level of engagement in mindfulness practice among participants in the experiments described in Chapters IV and V, rather than relying solely on participants' explicit reports of practicing mindfulness at home.

We would like to clarify the exclusion of the *Observing* scale from the FFMQ-SF and transferring it to the MINDSENS measure, as this decision may be a potential source of concern. We excluded the *Observing* scale from the FFMQ-SF questionnaire because *Observing* must be interpreted with caution in groups not advanced in meditation practice (see section 1.7.1). For example, higher scores in mindful observing, as measured by mindfulness questionnaires, may also be associated with increased depressive rumination in subjects naïve to meditation practice (Baer et al., 2008). Calculating scores for the composite *mindfulness trait* measured by the FFMQ-SF (including *Observing*) would run the risk of overestimating composite *mindfulness trait* scores (FFMQ-SF Composite) in people with depression. In our work, we were primarily interested in measuring the *mindfulness trait* (FFMQ-SF) whereas

advancement in mindfulness was to be a mainly auxiliary measure. Therefore, we decided to transfer the interpretative risk to MINDSENS scale and interpret its results with more caution.

The minimum score of MINDSENS Composite Index is 19, maximum 95 points (Radoń, 2020). The Polish version of MINDSENS was translated under the name the Mindfulness Advancement Questionnaire (Radoń, 2020). It has solid psychometric properties (e.g. reliability α = .74 - .92) and can be used in clinical and non-clinical samples aged 15-72

1.7.3 Beck's Depression Inventory (BDI-II)

The first version of the Beck's Depression Inventory (BDI), a self-descriptive screening measure of the severity of depressive symptoms, was established in 1961 on the basis of the then-developing Beck's model of depression. In 1996, due to significant changes in DSM-IV diagnostic criteria for depression (American Psychiatric Association, 1994), BDI was updated, and its second version (BDI-II) was published.

The BDI-II (Beck et al., 1996)consists of 21 positions headlined by the letters from A to U which label particular symptoms of depression; each followed by the 4-level descriptive scale depicting the intensity of symptoms exhibited by the participant in the last 2 weeks. The test differentiates depressed psychiatric patients from patients with other psychiatric diagnoses such as brain injury or Huntington's disease (Łojek & Stańczak, 2019). The overall score of BDI-II is computed by adding the scores obtained in each letter section. The results from 14 to 19 points indicate mild depression, from 20 to 28 moderate, and at least 29 points indicate severe depression. The minimum score of BDI-II is 0, maximum is 63 points.

The Polish adaptation of the BDI-II with good psychometric proprieties for the two-factor structure described by Zawadzki and Popiel (2009) can be used among a population of Polish speakers aged 20-79 (Łojek & Stańczak, 2019). The internal reliability of this measure is α =

.91 for standardisation sample and α = .93 for depressive patients. The test-retest Pearson's correlation is r = .86

1.7.4 State-Trait Anxiety Inventory (STAI)

The State-Trait Anxiety Inventory was developed by Spielberger and colleagues (Spielberger et al., 1983) in order to measure anxiety as a state (temporal, situation-oriented anxious state) and as a trait (anxiety as a stable element of personality) (Sosnowski et al., 1987).

The STAI consists of two scales, namely X1 measuring anxiety as a state and X2 measuring anxiety as a trait. Each of the scales consists of 20 items with a 4-point scale describing the intensity of anxiety in the present moment (X1) or generally throughout life (X2). The scales for X1 range from 1 meaning *not at all* to 4 meaning *very much so*, while for X2 scales range from 1 meaning *almost never* to 4 meaning *almost always* (Sosnowski et al., 1987; Spielberger et al., 1983). The minimum score for each of the scales is 20, the maximum is 80 points (Sosnowski et al., 1987; Spielberger et al., 1983). According to the Polish normalisation of STAI (Sosnowski et al., 1987), raw results can be transformed to sten scores.

The Polish adaptation of the STAI has good psychometric proprieties and can be used among a population of Polish speakers aged 15-18 and 21-79 (Sosnowski et al., 1987).

2. CORRELATION OF SELF-REPORTED SYMPTOMS OF DEPRESSION AND ANXIETY WITH MINDFULNESS PRACTICE

2.1 Introduction

The positive influence of mindfulness trait and mindfulness practice on the decrease of depressive and anxiety symptoms as well as negative correlations between those factors have been demonstrated in a multitude of studies (Ayhan & Kavak Budak, 2021; Deng et al., 2014; Hofmann & Gómez, 2017; Kabat-Zinn, 1990; Khoury et al., 2013; Vignaud et al., 2018; T. Wang et al., 2018). Therefore, mindfulness techniques have been incorporated into many psychotherapeutic approaches such as Dialectical Behavioural Therapy (DBT; Linehan, 2014), Acceptance and Commitment Therapy (ACT; Hayes et al., 2012) as well as Mindfulness-Based Cognitive Therapy (MBCT; Segal et al., 2013).

In recent years, practicing *mindfulness state* (which is associated with developing *mindfulness trait*) has been described as promising in strengthening the well-being of students who as a population are considered to be at risk of developing depression, and moreover, exhibit a lower level of well-being than the general population (Cooke et al., 2006; Gallego et al., 2014; Gockel et al., 2019; Noda et al., 2022; Rosky et al., 2022; Serrão & Alves, 2019; Sousa et al., 2021) Therefore, mindfulness interventions are recommended as means of diminishing the risk of psychiatric morbidity in students and are linked to better academic performance (Sumell et al., 2021; Vorontsova-Wenger et al., 2021; Wang et al., 2022; Worsley et al., 2022). According to our knowledge, until now, associations between depressive symptoms and *mindfulness trait* and *advancement in mindfulness* in this group have not been studied in Poland, partially due to the fact that the Polish versions of self-descriptive mindfulness measures have not been accessible. Thanks to recently created adaptations (Radoń, 2020; Radoń & Rydzewska, 2018; Radoń, forthcoming; Radoń & Górska, forthcoming), it was possible for the first time to

examine levels of self-descriptive mindfulness in the Polish population (previously it was examined only for standardisation purposes; Radoń, 2014, 2020; Radoń & Rydzewska, 2018).

The aim of the current study was twofold. Firstly, to replicate the results of similar studies (Deng et al., 2014; Soysa & Wilcomb, 2015; Vorontsova-Wenger et al., 2021) in order to confirm associations between mindfulness and depression as well as anxiety in a group of Polish students (Gaspersz et al., 2018; Goldberg & Fawcett, 2012). Secondly, to describe correlations between depression and anxiety with mindfulness in its various measures in one homogenous sample. We hypothesised that the *advancement in mindfulness* and *mindfulness as a trait* assessed with self-descriptive measures correlate negatively with symptoms of depression and anxiety (as a state and a trait) assessed with self-descriptive measures in the population at risk of depression.

2.2 Materials and methods

2.2.1 Participants

The group of 261 participants (213 women, 45 men, 3 non-binary; age: 18-29, M = 20.9, SD = 1.92, years of education: M = 14.2, SD = 1.89) was recruited via The Jagiellonian University advertisement mailing system. The majority of participants were students of social and cognitive sciences (N = 167, 105 of them were psychology students), the remaining part comprised the students of other faculties such as exact sciences, natural sciences as well as modern languages (N = 94). Forty-six participants declared being diagnosed with an affective illness, 34 of them were under psychiatric treatment, mean time since their psychiatric diagnosis was 2.8 (SD = 3) years. Moreover, affective diseases in the family were declared by 37 participants (19 were diagnosed with an affective disorder themselves).

The inclusion criteria were willingness to collaborate, being a student, and the age of at least 18 years. The participants received credit points for participation in the study. Before the beginning of the study, all participants signed informed consent.

Our study was carried out in accordance with the Declaration of the Helsinki (World Medical Association, 2001).

2.2.2 Methods

In order to measure self-descriptive symptoms of depression, Beck Depression Inventory-II (Beck et al., 1996) was applied, whereas to measure self-descriptive symptoms of anxiety, State-Trait Anxiety Inventory (Spielberger et al., 1983) was used. Moreover, to assess self-descriptive levels of mindfulness, two measures were applied. Namely, the Short form of the Five Facet Mindfulness Questionnaire (FFMQ-SF; Bohlmeijer et al., 2011) to assess *mindfulness trait*, and the MINDSENS Composite Index (Soler et al., 2014) to examine *advancement in mindfulness*. Responses were collected via Google Forms. The approximate time for filling in the questionnaires was 30 minutes. All the methods were described in detail in Chapter I, section 1.7.

2.2.3 Statistical analysis

To analyse the data, jamovi software (The jamovi project, 2021) operating in R programming language (R Core Team, 2021) was used. The dataset contained ordinal and continuous variables, therefore, Spearman's Correlation analysis was applied. The analysis consisted of correlating the results of depression and anxiety measures (BDI-II and STAI) with the results of mindfulness measures (FFMQ-SF, MINDSENS Composite Index). The significance threshold for all analyses was determined as $\alpha = .05$.

2.3 Results

2.3.1 Descriptive statistics

The highest mean score of FFMQ-SF was observed for *Describe* scale and the lowest for *Non-reactivity to Inner Experience* scale. Moreover, relatively high standard deviations (SD > 10) occurred in the overall sum of FFMQ-SF, MINDSENS Composite Index, BDI-II as well as STAI-X1 and X2.

Table 2.1

Descriptive statistics of self-descriptive measures

measure	M	SD	scale range
FFMQ-SF Describe	16.91	4.48	5 - 25
FFMQ-SF Actaware	16.08	2.74	5 - 25
FFMQ-SF Nonjudge	15.54	4.31	5 - 25
FFMQ-SF Nonreact	12.92	4.08	5 - 25
FFMQ-SF Composite	61.45	11.26	20 - 100
MINDSENS	57.29	10.39	19 - 95
BDI-II	14.5	10.4	0 - 63
STAI-X1	45.16	11.16	20 - 80
STAIX-2	48.55	10.98	20 - 80

FFMQ-SF: Five Factor Mindfulness Questionnaire short form (*Observing* excluded); *FFMQ-SF Actaware: FFMQ-SF* Acting with Awareness scale; *FFMQ-SF Nonjudge*: FFMQ-SF Non-judging of Experience scale; *FFMQ-SF Nonreact*: Non-reactivity to Inner Experience scale; *FFMQ-SF sum:* overall sum of FFMQ-SF (*Observing* excluded); *MINDSENS*: MINDSENS Composite Index; *BDI-II:* Beck's Depression Inventory-II, *STAI:* State-Trait Anxiety Inventory

2.3.2 Results of Spearman's correlation

Highly significant negative correlations were found between the measures of mindfulness and depression (BDI-II) as well as between the measures of mindfulness and anxiety (STAI) (see Fig. 2.1 - 2.6). The negative correlations between depression (BDI-II) and mindfulness measures as well as between *anxiety state* (STAI-X1) and mindfulness measures were: weak to strong correlations with *mindfulness trait* (weak to moderate for FFMQ-SF four distinct facets, strong for FFMQ-SF Composite score) and moderate correlations with the *advancement in mindfulness* (MINDSENS Composite Index). Furthermore, the negative correlations between *anxiety trait* (STAI-X2) and mindfulness measures were: moderate to strong correlations with *mindfulness trait* (moderate to strong for FFMQ-SF distinct four facets, strong for FFMQ-SF Composite score) and moderate with the a*dvancement in mindfulness* (MINDSENS Composite Index).

Table 2.2

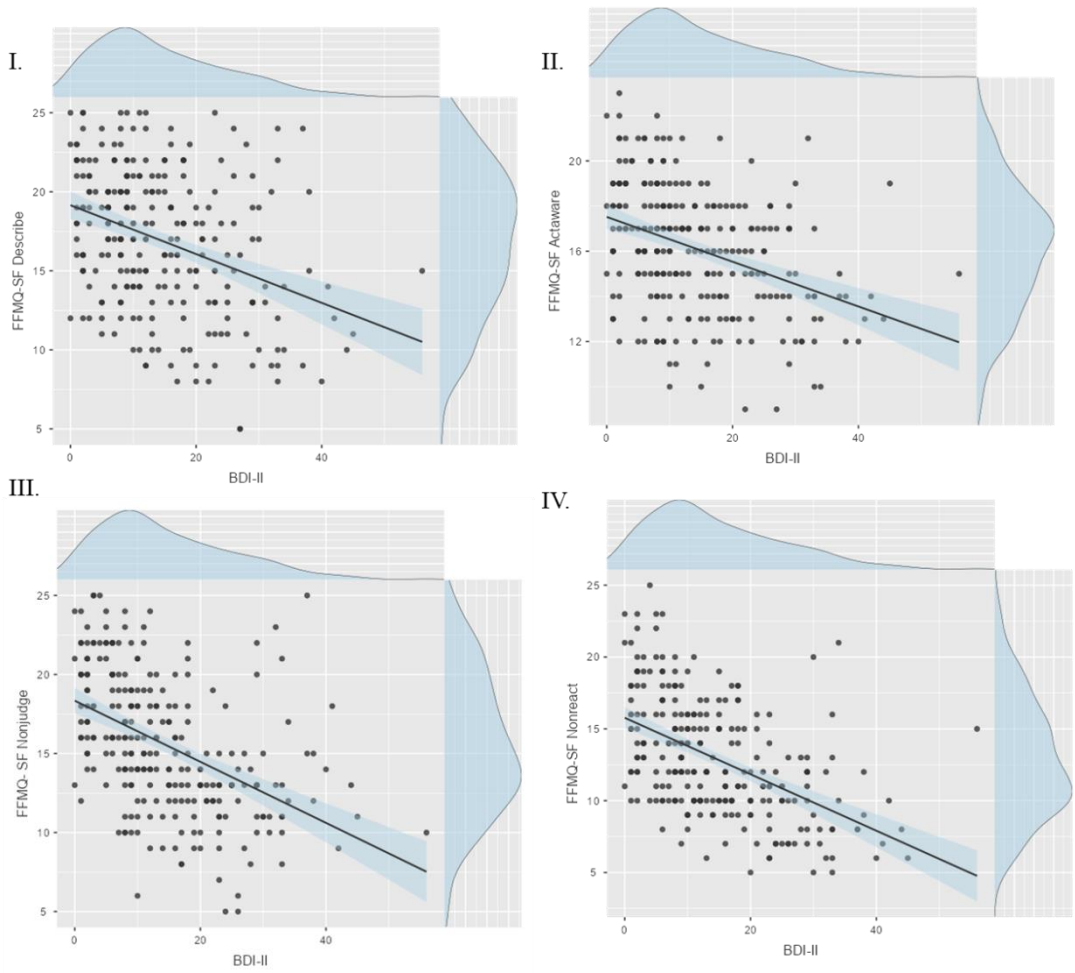
Spearman's correlations between mindfulness measures and measures of depression and anxiety

measure	BDI-II	STAI-X1	STAI-X2
FFMQ-SF Describe	-0.34 ***	-0.37 ***	-0.43 ***
FFMQ-SF Actaware	-0.38 ***	-0.34 ***	-0.41 ***
FFMQ-SF Nonjudge	-0.54 ***	-0.51 ***	-0.63 ***
FFMQ-SF Nonreact	-0.53***	-0.5 ***	-0.65***
FFMQ-SF Composite	-0.62 ***	-0.6 ***	-0.76 ***
MINDSENS	-0.45 ***	-0.41 ***	-0.58 ***

FFMQ-SF: Five Factor Mindfulness Questionnaire short form (*Observing* excluded); *FFMQ-SF Actaware: FFMQ-SF* Acting with Awareness scale; *FFMQ-SF Nonjudge*: FFMQ-SF Non-judging of Experience scale; *FFMQ-SF Nonreact*: Non-reactivity to Inner Experience scale; *FFMQ-SF sum:* overall sum of FFMQ-SF (*Observing* excluded); *MINDSENS*: MINDSENS Composite Index; *BDI-II:* Beck's Depression Inventory-II, *STAI:* State-Trait Anxiety Inventory; ***: $p < .001$; green colour: weak correlation (r = 0.2-0.39); orange colour: moderate correlation (r = 0.4-0.59), red colour: strong correlation (r = 0.6-0.79)

Fig. 2.1

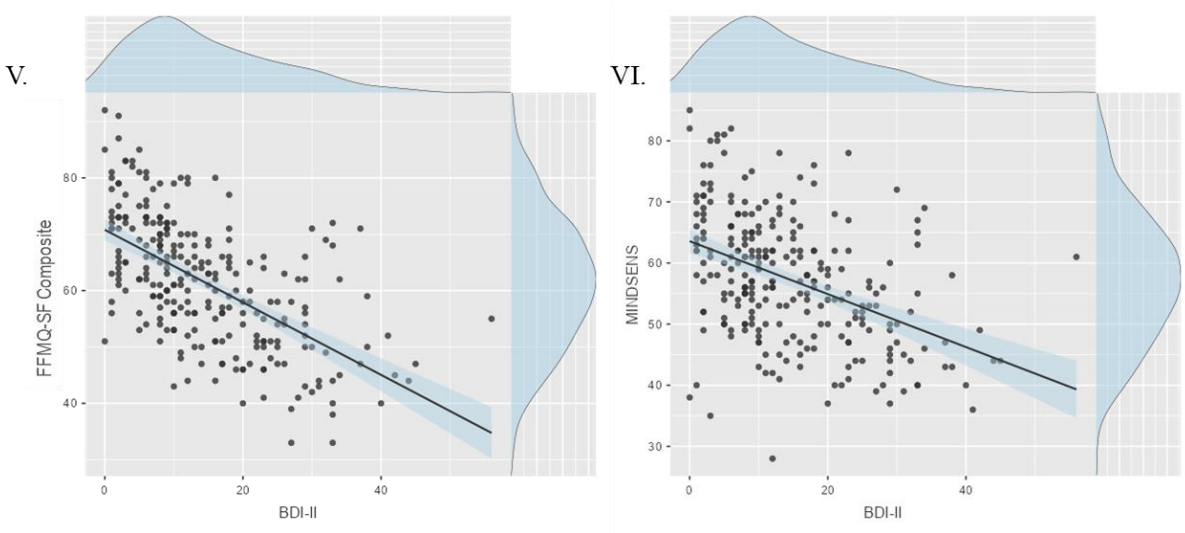
Regression lines and densities of four *mindfulness trait* scales: (1) FFMQ-SF Describing (I), (2) FFMQ-SF Acting with Awareness (II), (3) FFMQ-SF Non-judging of Experience (III), (4) FFMQ-SF Non-reactivity o Inner Experience (IV) and the measure of depression (BDI-II).



Note. Bands represent the standard error of the mean

Fig. 2.2

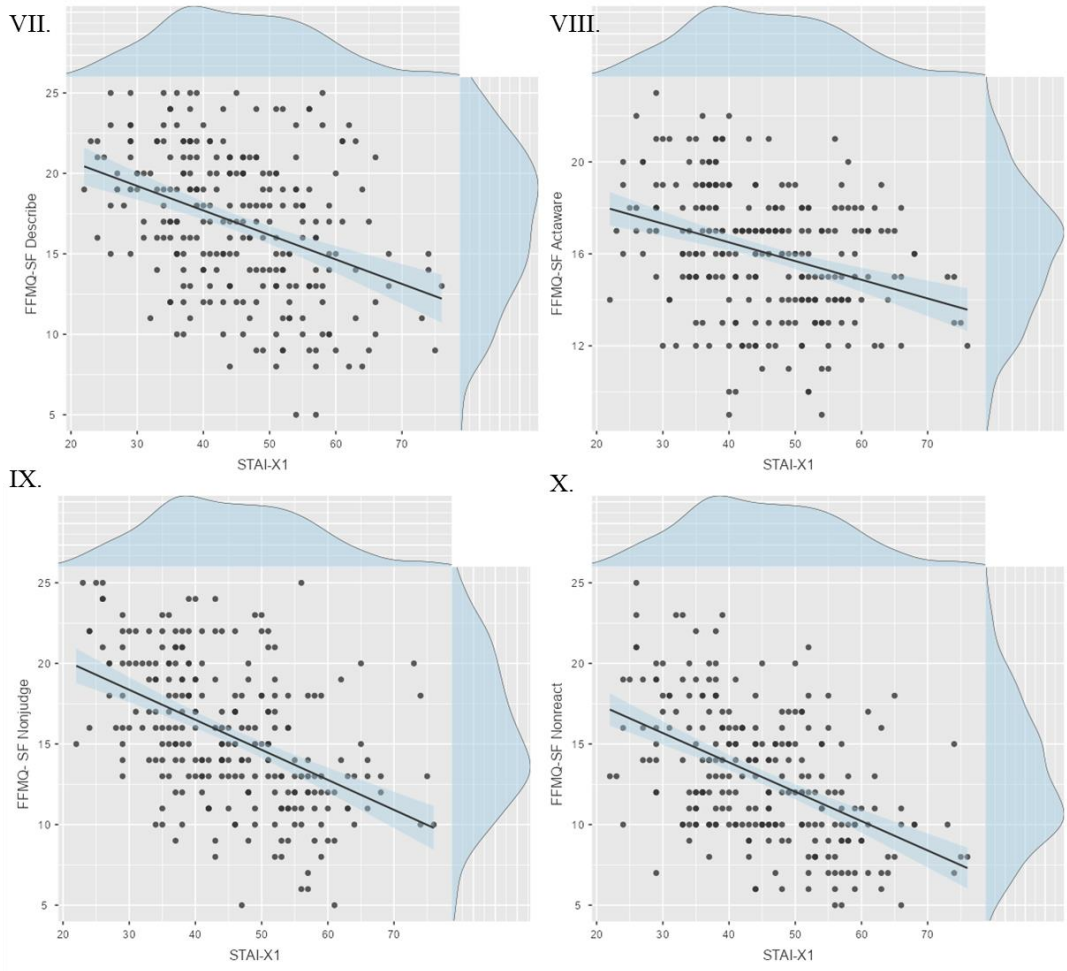
Regression lines and densities of two mindfulness scales: (1) FFMQ-SF Composite (*Observing* excluded) measuring *mindfulness as a trait* (V), (2) MINDSENS Composite Index measuring a*dvancement in mindfulness* (VI.), and the measure of depression (BDI-II).



Note. Bands represent the standard error of the mean

Fig. 2.3

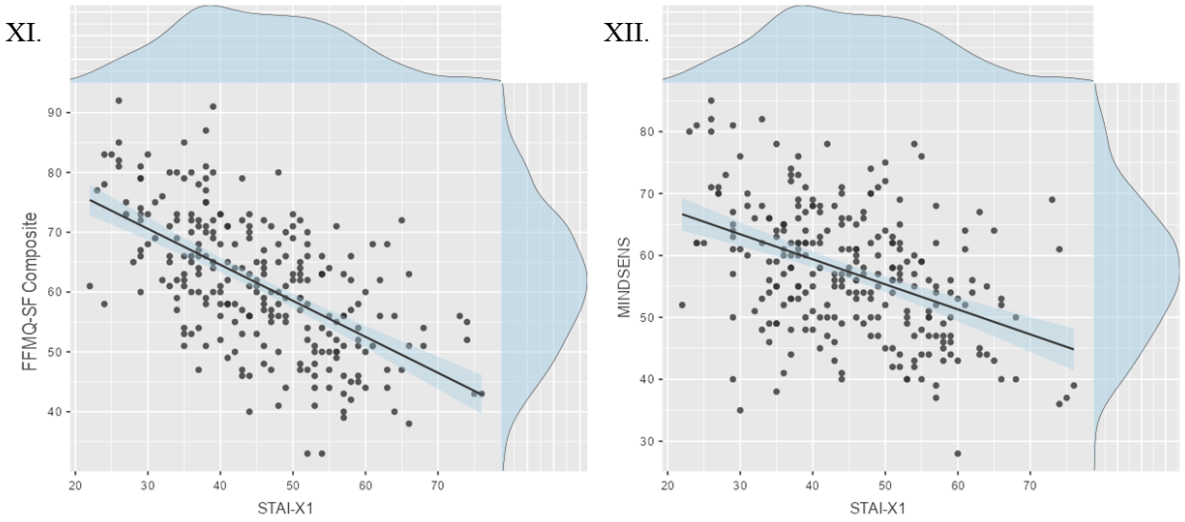
Regression lines and densities of four *mindfulness trait scales*: (1) FFMQ-SF Describing (VII*)*, (2) FFMQ-SF Acting with Awareness (VIII.), (3) FFMQ-SF Non-judging of Experience (IX), (4) FFMQ-SF Non-reactivity to Inner Experience (X) and the measure of state anxiety (STAI-X1).



Note. Bands represent the standard error of the mean

Fig. 2.4

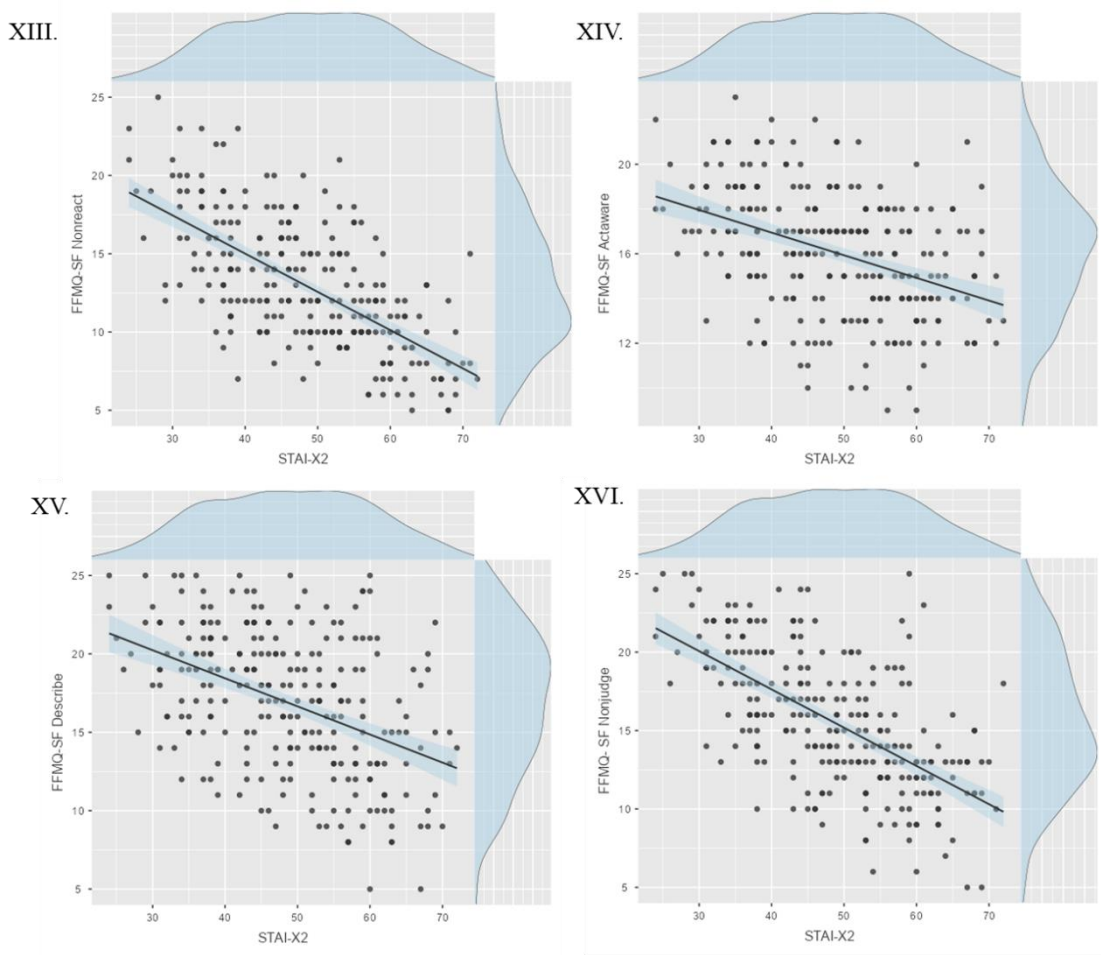
Regression lines and densities of three mindfulness scales: (1) FFMQ-SF Composite (*Observing* excluded) measuring *mindfulness as a trait* (XI.*)*, (2) MINDSENS Composite Index measuring *advancement in mindfulness* (XII), and the measure of state anxiety (STAI-X1)



Note. Bands represent the standard error of the mean

Fig. 2.5.

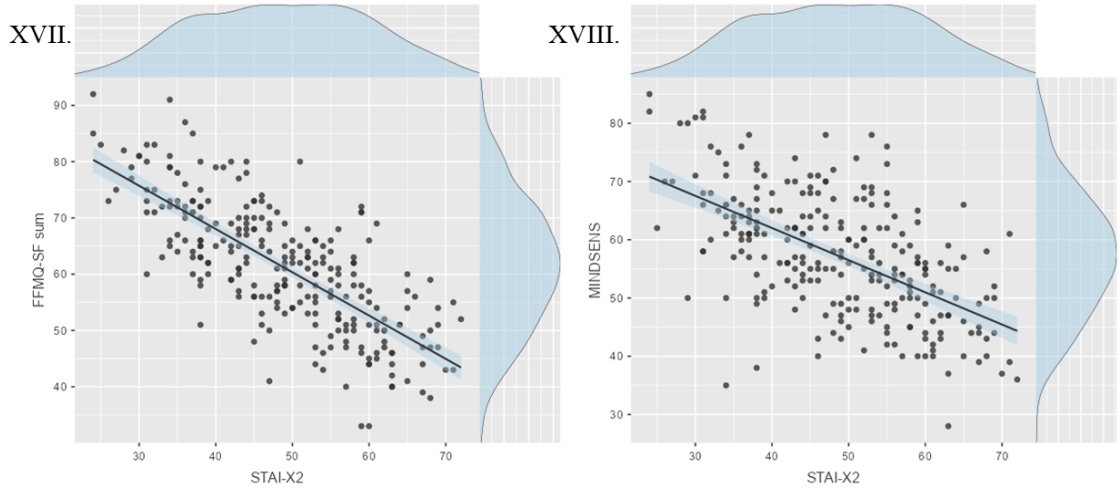
Regression lines and densities of four *mindfulness trait scales*: (1) FFMQ-SF Describing (XIII*)*, (2) FFMQ-SF Acting with Awareness (XIV), (3) FFMQ-SF Non-judging of Experience (XV), (4) FFMQ-SF Non-reactivity to Inner Experience (XVI), and the measure of trait anxiety (STAI-X2).



Note. Bands represent the standard error of the mean

Fig. 2.6.

Regression lines and densities of three mindfulness scales: (1) overall sum of FFMQ-SF (*Observing* excluded) measuring *mindfulness as a trait* (XVII*)*, (2) MINDSENS Composite Index measuring *advancement in mindfulness* (XVIII), and the measure of trait anxiety (STAI-X2).



Note. Bands represent the standard error of the mean

2.4 Discussion

Here, we examined correlations between self-descriptive measures of mindfulness and depression as well as correlations between self-descriptive measures of mindfulness and anxiety in a group of students. Firstly, the results revealed strong negative correlations of *mindfulness trait* (FFMQ-SF Composite) with depressive symptoms and state anxiety (STAI). Secondly, we found a strong negative correlation between the *mindfulness trait* and the *anxiety trait*. Similar results were obtained with regression analyses in a group of psychology students from Geneva (Vorontsova-Wenger et al., 2021). In particular, a negative correlation occurred between *mindfulness trait* (FFMQ) and depressive symptoms (BDI-II) as well as mindfulness and anxiety state (STAI). Moreover, a study by Deng and colleagues (2014) revealed that mindfulness assessed by The Mindful Attention Awareness Scale (Brown & Ryan, 2003), which is another measure of *mindfulness trait*, was strongly and negatively correlated with symptoms of depression measured by BDI in a group of students of Dalian University of Technology.

Likewise, Soysa and Wilcomb (2015) in their study in which depression and anxiety were measured by the short version of The Depression, Anxiety, and Stress Scales-21 (Lovibond & Lovibond, 1995) whereas mindfulness was assessed with four scales of the FFMQ, reported similar results. Namely, they identified *Nonjudge, Actaware,* and *Describing* along with two aspects of negative self-compassion (*Isolation, Self-judgement*) as significant negative (*Nonjudge, Actaware,* and *Describing*) and positive (*Isolation, Self-judgement*) predictors of depression. Interestingly, *Describing* and *Nonjudge* turned out to be the strongest unique negative predictors of depression. In our study, among facets of FFMQ-SF, *Nonjudge* and *Nonreact* displayed the strongest negative correlations with depressive measure (r = -0.54, r =

-0.53 respectively; moderate correlations) whereas *Describe* was only weakly negatively correlated with depressive symptoms (r = -0.34).

In the same vein, the study by Soysa and Wilcomb (2015) also revealed that *Nonjudge* and *Nonreact* were negative predictors of anxiety. Furthermore, *Nonjudge* was described as the strongest unique predictor of anxiety (with *Nonreact* being significant but weaker, and the remaining elements of hierarchical analysis nonsignificant). Correspondingly, our study indicated strong negative correlations of *Nonreact* and *Nonjudge* with *anxiety trait* and moderate negative correlations with *anxiety state*. Our results also revealed a moderate negative correlation between *advancement in mindfulness* (MINDSENS Composite Index) and depressive symptoms, and moderate correlations between *advancement in mindfulness* and anxiety (state and trait).

Those outcomes confirm the aforesaid association between being more mindful (here, advanced in cultivating mindfulness or having greater *mindfulness trait*) and being less depressed and anxious in a group of students. Effectively, the MINDSENS questionnaire consists of a number of the FFMQ Composite items, therefore the similarity of the correlation results between these scales and BDI-II as well as STAI should be also understood as resulting from the common origin of FFMQ-SF, and MINDSENS items.

2.5 Limitations

This study has some limitations which are worth noting. Firstly, the majority of our sample were women. Therefore, in order to generalize the results, it would be necessary to conduct a study in a more heterogeneous group. Secondly, the participants of the study were solely the students of Jagiellonian University. Thus, future studies should focus on expanding the sample to include people from remaining Polish universities. Moreover, the meditational experience

such as participation in mindfulness interventions were not examined. Further studies should take measuring meditational experience into account.

2.6 Conclusions

Previous research confirmed that being more mindful is associated with decreased symptoms of depression and anxiety in students, who are characterised as a group at risk of developing depression. Our study corroborated those results and confirmed the stated hypothesis. Obtained outcomes revealed that the *advancement in mindfulness*, and *mindfulness as a trait* assessed with self-descriptive measures correlate negatively with symptoms of depression and anxiety (as a state and a trait) assessed with self-descriptive measures in the population at risk of depression.

Interestingly, according to our knowledge, those outcomes were obtained for the first time using Polish adaptations of mindfulness questionnaires. Finally, our results imply that mindfulness interventions might be beneficial for decreasing the morbidity of depression among students and should be considered an element of the academic curriculum.

3. DIFFERENCES IN SELECTION OF VALENCED REGIONS OF SOCIAL IMAGES BETWEEN DEPRESSED AND HEALTHY INDIVIDUALS

3. 1 Introduction

Emotional visual content is detected by humans in a prioritised way as it usually carries the information most crucial to safety and survival (Elazary & Itti, 2008; Pilarczyk & Kuniecki, 2014). In order to examine the engagement of human attention in affectively loaded natural scenes, stimuli used in experimental studies should resemble our everyday environment. Therefore, social scientists created emotional pictures databases such as the Geneva Affective Picture Database (Dan-Glauser & Scherer, 2011) or the International Affective Picture System (Lang et al., 2008) standardised in terms of arousal as well as valence, and containing complex naturalistic images.

In order to select key meaningful regions of complex images, manual segmentation is employed, as it is not yet possible to detect those regions algorithmically (Henderson et al., 2019). On the basis of manual segmentation, meaning maps which represent the distribution of meaningful content in the image are created and can then be used to study attention engagement by visual stimuli.

Extracting the meaning of a scene requires the viewer to attend to the most semantically salient regions of an image (Henderson et al., 2019). Therefore, due to individual differences in, for example, personality traits or psychiatric diagnoses, regions of high attentional priority might vary across people and thus influence patterns of visual attention (Bendall et al., 2022). According to the theoretical model of depression by LeMoult and Gotlib (2019), depressed patients exhibit cognitive biases (in attention, interpretation, self-referential processing, and memory) which affect how they perceive the world. The biases of key interest to our study are *depressive attentional bias*es which, in the case of visual emotional stimuli, are associated with

(1) difficulties to disengage attention from negative content, (2) decreased visual attention to positive information, and (3) sustained attention to negative stimuli (less time spent on positive images and more time spent on negative ones when compared with healthy participants) (Caseras et al., 2007; Eizenman et al., 2003; Kellough et al., 2008; LeMoult & Gotlib, 2019).

We expected that our research task of selecting meaning maps in emotional images might lead to the emergence of two of the four cognitive biases described above, i.e. interpretation bias (a tendency to interpret ambiguous content as negative, LeMoult & Gotlib, 2019) and attentional bias. As our research hypotheses only addressed attentional bias, we used an experimental task that aimed to limit the impact of possible depressive interpretation bias on the results and allowed participants to focus only on the emotional content of the images. To this end, while the task involved selecting regions responsible for the emotional meaning of pictures (i.e. meaning maps), the valence of the particular image was determined and was communicated to the participants at test time.

Here, we explored attentional biases understood as differences in manual selections of regions responsible for the valence of images resembling the natural visual environment, in conditions where the influence of interpretation bias was suppressed. Moreover, since depression is associated with aberrations in social functioning described as crucial in the development of psychopathology (Kennedy & Adolphs, 2012), we decided to include in our study only pictures of social scenes. We suppose that scenes showing everyday social situations of varied valence might elicit more cognitive biases than images showing inanimate objects, for example, items of everyday use such as furniture, or elements of nature such as animals or landscapes.

To measure the differences in manual selections of meaning maps between groups exhibiting different severity of depression and anxiety (which is often comorbid with depression)

(Gorman, 1996; Kessler et al., 2015; Saade et al., 2019) we examined total area of maps, and the number of figures used to create them using meaning maps approach.

Since depressive attentional biases are associated with decreased visual attention to positive information, and sustained attention to negative stimuli (Caseras et al., 2007; Eizenman et al., 2003; Kellough et al., 2008; LeMoult & Gotlib, 2019), we expected positive relation between the depression level and the total area of meaning maps in negative pictures, and a negative relationship between the depression level and the total area of maps in positive pictures.

Depression is usually comorbid with anxiety, and anxiety symptoms influence both visual attention and clinical features of depression (Bendall et al., 2022; LeMoult & Joormann, 2012). Thus, we controlled the level of anxiety among participants and explored the association of anxiety with our results. Since anxiety is associated with a greater attention span on threatening stimuli (Armstrong & Olatunji, 2012; Gupta et al., 2019; Richards et al., 2014), we expected a positive relationship between the area size of meaning maps in negative images and the level of anxiety trait. Moreover, we hypothesised that the number of figures selected in a single image would be a differentiating factor between more and less depressed and more and less anxious individuals.

Moreover, in accordance with the literature positing that comorbidity of depression and anxiety influences the severity of symptoms exhibited by participants (LeMoult & Joormann, 2012; Rosenbaum et al., 1996), we hypothesised the occurrence of interaction between higher levels of comorbid depressive and anxiety symptoms on the occurrence of biases in creating meaning maps.

3.2 Materials and methods

3.2.1 Participants

In order to gather a group of participants varied in the severity of depressive symptoms, we recruited 49 subjects (14 men) via the author's social network (n = 15), Research Management System of the Institute of Psychology of the Jagiellonian University (n = 13), and in the Adult Psychiatry Outpatient Clinic (n = 21). The subjects aged from 19-63 (M = 35, SD = 12). Fifteen participants declared being under psychiatric treatment. Inclusion criteria were the willingness to participate in the study, having normal or corrected to normal vision, access to the computer with an internet connection and a computer mouse. Before the beginning of the study, all participants signed informed consent. The data gathered from four participants during the evaluation procedure (see section 3.2.3.) was excluded from further analysis due to them not following the study procedure.

Our study was carried out in accordance with the Declaration of the Helsinki (World Medical Association, 2001) and was approved by the local Ethics Committee of the Institute of Psychology at Jagiellonian University (no. KE/01/052019).

3.2.2 Materials

During the procedure, 245 images from standardised databases of images such as (1) EmoPics (78 images; Wessa et al., 2010), (2) the Geneva Affective Picture Database (GAPED) (21 images; Dan-Glauser & Scherer, 2011), (3) the International Affective Picture System (IAPS) (53 images; Lang et al., 2008), (4) the Nencki Affective Picture System (NAPS) (82 images; Marchewka et al., 2014) as well as (5) Erotic subset for the Nencki Affective Picture System (NAPS ERO) (Wierzba et al., 2015) were used. The valence and arousal of EmoPics, IAPS and NAPS images were rated on a 9-point scale: *very negative* (1) to *very positive* (9) for valence,

and *relaxed* (1) to *aroused* (9) for arousal. However, images from the GAPED database were rated from 0-100, therefore, for purposes of this study, they were linearly converted to a 9-point scale. Similarly to our recent work (Pilarczyk et al., 2021), all pictures were assigned to 3 valence categories: (1) *negative* including pictures rated below 4 points, (2) *neutral* including images rated from 4 to 6 points and (3) *positive* including pictures rated above 6 points. The inclusion criteria for complex images were: presenting at least 2 people, not presenting isolated objects, and not having a blurred or uniform background. Basing on these criteria, we selected 69 negative, 85 neutral, and 91 positive images (mean valence and arousal rates are presented in Table 3.1).

According to our previous research (Pilarczyk et al., 2021), the task of selecting emotional maps employed in the current study (see section 3.2.3 for a description of the task), can take up to 40 minutes for healthy people if it consists of up to 100 images. Since we prepared 245 images for the selection of meaning maps, and since our experience is that people with depressive symptoms, who were also participants in our study, perform this type of task more slowly than healthy people, we decided to divide our set into two subsets including 122 and 123 images respectively. The sets were equivalent in terms of valence, $t(238) = .019$, $p = .851$. The first set was rated by 30 subjects and the second set by 22 subjects (3 subjects decided to rate both sets of images). For each of the images, meaning maps distinguishing regions of emotional meaning were created by approximately 23 participants (SD = 4.12). There was no significant difference in the number of evaluators between the valence conditions (negative, neutral, positive), $F(2, 242) = .13$, $p = .882$; $\eta_p^2 < .001$. Positive images depicted smiling people, kissing or hugging couples, and families during pleasing activities such as bicycle trips; neutral images depicted people on their way to work or during walks, students listening to the lecture or people working; negative images depicted acts of violence or desperation as well as serious injuries.

Table 3.1

Mean valence and arousal ratings of visual stimuli used in the study

set of images	valence		arousal	
	M	SD	M	SD
negative	2.95	.75	5.98	.85
neutral	5.11	.47	3.81	.98
positive	6.91	.52	4.53	.69

Valence rates: 1 (very negative) – 9 (very positive); arousal rates: 1 (relaxed) to 9 (aroused); M: mean; SE: standard error of the mean; SD: standard deviation

3.2.3 Evaluation procedure

The task consisted of logging in to a dedicated online JavaScript-controlled tool with a given password and taking part in the approximately 45 minutes long evaluation procedure of emotional stimuli which was reported by us recently (Pilarczyk et al., 2021). Every image was described by the phrase 'Most people rate this image as negative/neutral/positive. Which regions or objects in this image are key to its meaning? Then, the participants were asked to encircle key elements of a given image with a computer mouse in order to choose the regions critical for conveying images' valence. Subjects were allowed to encircle as many figures of any size and shape as they wanted, but it was recommended that the figures were as simple as possible. Images were presented in random order, each on a separate screen with a resolution of maximally 800 in width and 600 in height. After the evaluation, participants filled in, via Google Forms, online versions of depression and anxiety measures, that is Beck Depression Inventory (BDI-II; Beck et al., 1996) and the second part of the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1983), respectively. Since this experiment was a part of a larger study

which is beyond the scope of this chapter, participants filled in also other self-descriptive measures not relevant to this work. Lastly, in order to alleviate the distress that could have arisen as a result of viewing negatively valenced photos, the subjects were redirected with a link to a webpage presenting a film clip about funny animals.

In total, the procedure (evaluation of images and completion of self-descriptive measures) lasted approximately 1hour.

3.2.3 Data reduction

Initially, we divided our participants into groups. In the case of the first division, we divided participants into low and high-depression groups according to the mean group BDI-II score. In the case of the second division, we again divided the original group of participants into two groups, yet this time according to the mean group STAI-X2 score (for data preparation scheme see Fig. 3.2).

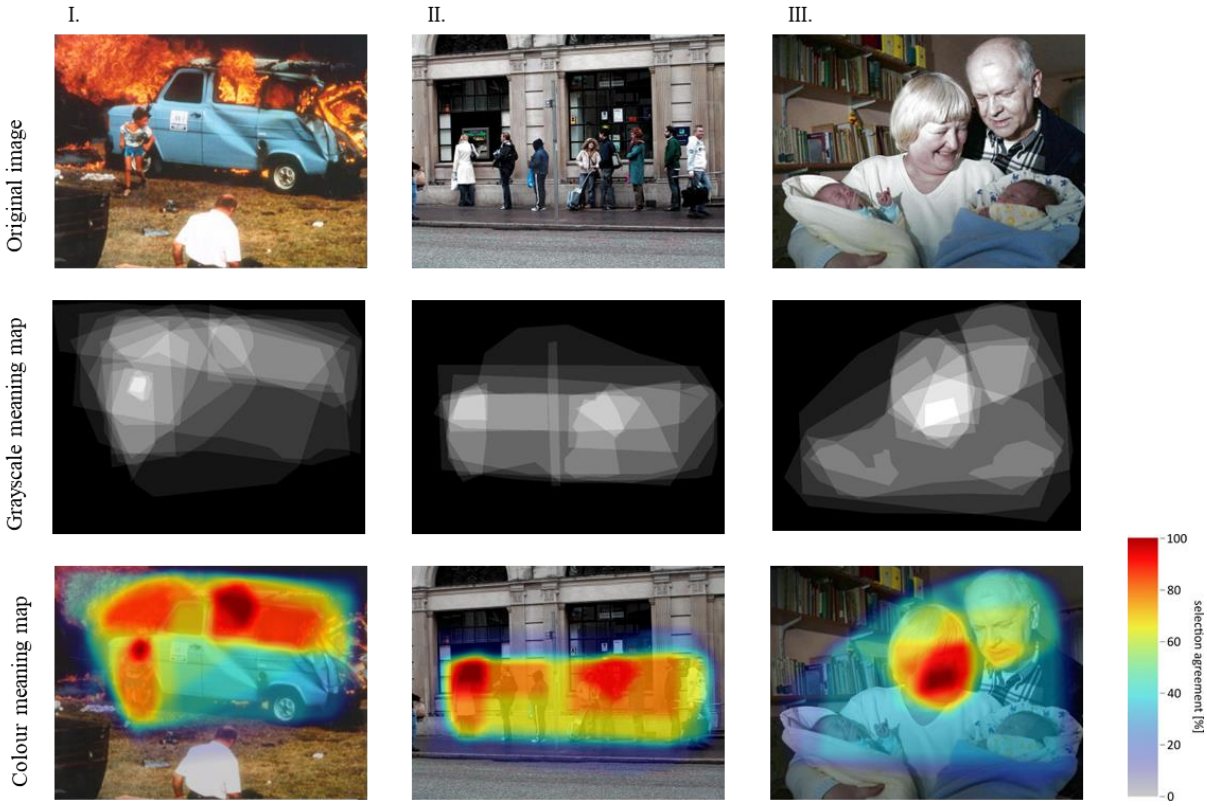
To prepare data for further analyses, all the selections were averaged following the procedure utilised in our previous studies (e.g. Pilarczyk & Kuniecki, 2014; Pilarczyk et al., 2021). Firstly, we obtained greyscale heatmaps (600 × 800 pixels) with brightness level (ranging from 0-255) representing the percent of participants from each group who selected particular regions as key emotional elements of pictures, which constituted the meaning map (Fig. 3.1).

Secondly, we computed (1) the number of figures selected in each of the images by each of the participants, and (2) the total area of selected figures (total area of the meaning map) in each picture by each of the subjects.

All computations were performed in MATLAB (The MathWorks, Inc., Natick, Massachusetts, USA, 2018).

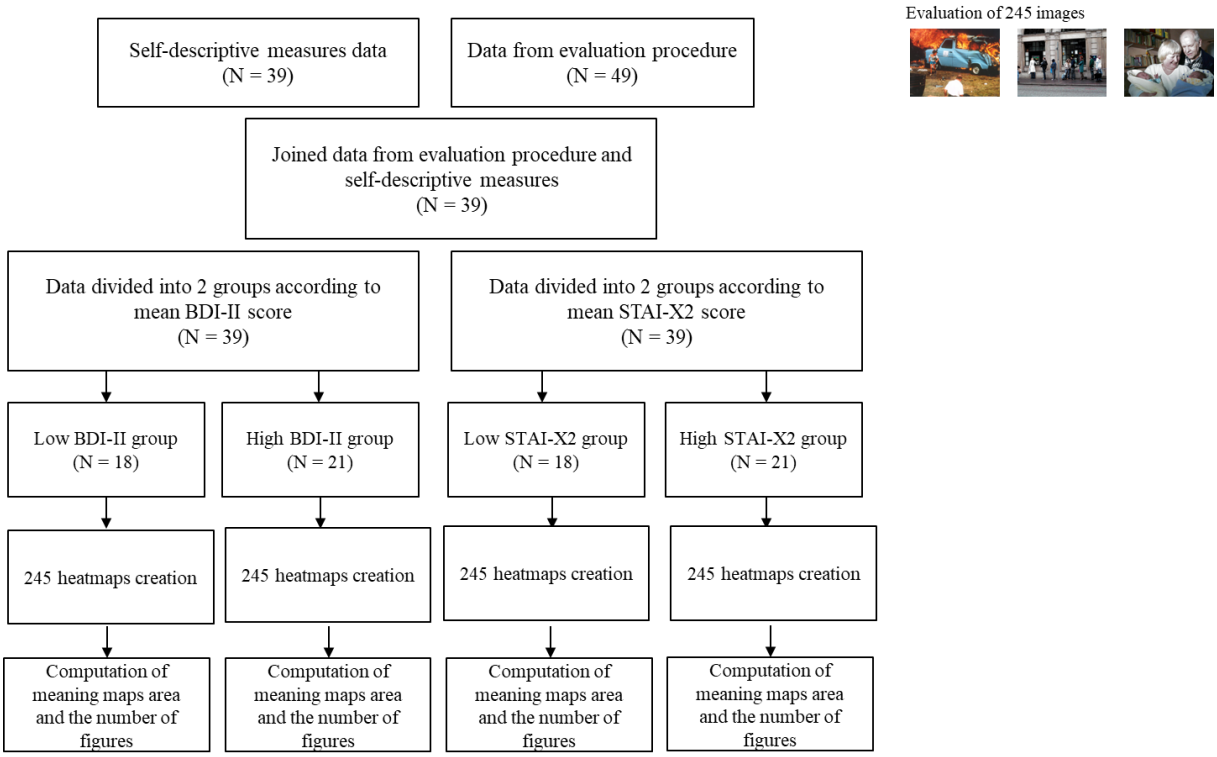
Fig. 3.1

Examples of negative (I), neutral (II), and positive (III) original valenced social images and corresponding meaning maps.



Note. Presented pictures (III) originate from NAPS (Marchewka et al., 2014) and (I, II) EmoPics (Wessa et al., 2010) databases.

Fig. 3.2 Data preparation scheme



Note. Presented pictures originate from NAPS (Marchewka et al., 2014) and EmoPics (Wessa et al., 2010) databases.

3.2.4 Statistical analyses

All analyses were performed in jamovi (The jamovi project, 2022) which operates in the R programming language (R Core Team, 2021). To perform mixed model analyses, the GAMLj package was used (Gallucci, 2019).

The significance threshold for all analyses was determined as $\alpha = .05$. We applied a linear mixed model with restricted maximum likelihood. This type of analysis enabled us to incorporate continuous and nominal predictors into one statistical model. The impact of random effects on improving the likelihood of the models was tested with the Random Effects Likelihood Ratio Test. Following Judd and colleagues (2012), stimuli and participants in the linear mixed model analyses were treated as random factors.

The model testing hypotheses regarding the total area of meaning maps included: the total area of the meaning map (*total meaning map area*, numeric value) as a continuous dependent variable; valence of images (*valence*: negative, positive, neutral; numeric value) as a fixed nominal factor; self-descriptive depression and anxiety measures (*BDI-II, STAI-X2*, numeric value) as continuous covariates, and stimuli and participant as random factors with random intercept. The interactions between (1) *valence* and *BDI-II*, (2) *valence* and *STAI-X2*, and (3) *valence*, *BDI-II*, and *STAI-X2* on the *total meaning map area* were also tested.

The model testing hypotheses regarding the number of figures marked in a single image included: the number of figures used to select the map (*number of figures*, numeric value) as a continuous dependent variable; valence of images (*valence*: negative, positive, neutral; numeric value) as fixed nominal factor; self-descriptive depression and anxiety measures (*BDI-II, STAI-X2*, numeric value) as continuous covariates, and stimuli and participant as random factors with

random intercept. The interactions between (1) *valence* and *BDI-II*, (2) *valence* and *STAI-X2*, and (3) *valence*, *BDI-II*, and *STAI-X2* on *a number of figures* were tested.

3.3 Results

3.3.1 Self-descriptive measures

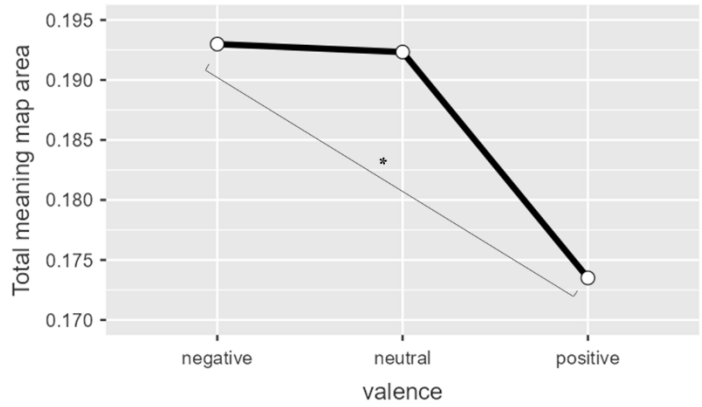
The mean BDI-II score was 13.66 (SD = 11.63) whereas the mean STAI-X2 score was 47.88 (SD = 7.32).

3.3.2 Total area of meaning maps

Results revealed a good fit of the model (R^2 conditional = .55). *Valence* had a significant effect, F(2, 302.93) = 3.77, p = .024, on the total area of meaning maps (Fig. 3.3). Participants were marking significantly larger total area of meaning maps on negative (M =.2, SD =.16) than on positive images (M = .17, SD =.15). Difference in the total area of maps between the neutral images (M = .18. SD = .15) and positive or negative was not significant.

Fig. 3.3

Plot of the mean *meaning map area* for particular valences

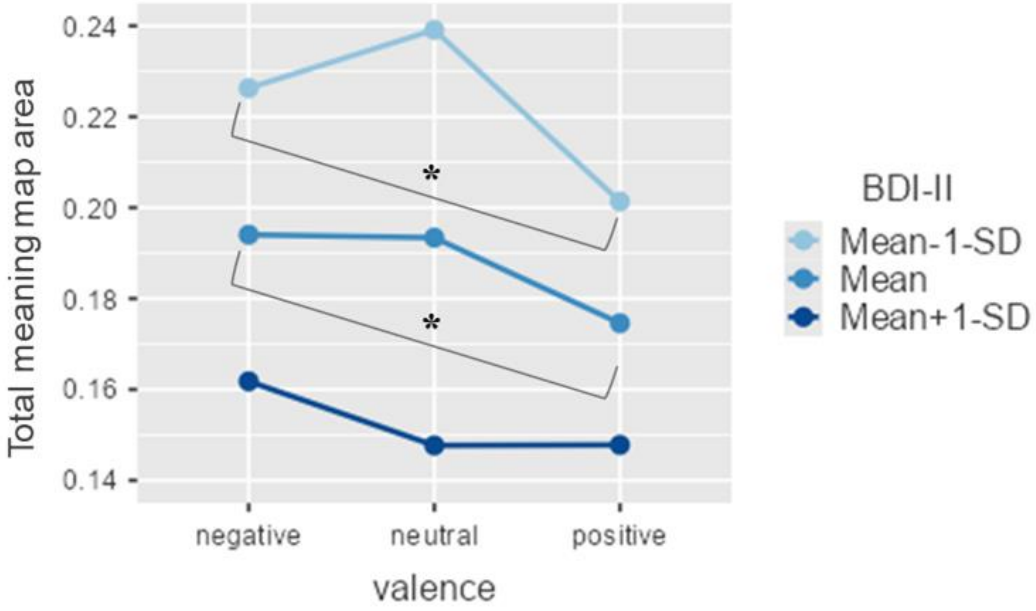


Note. Asterisks denote significant differences in pairwise comparisons; * depicts p-value of $\alpha \leq 0.05$

There was a significant interaction between the *valence* and BDI-II score, $F(2,4891.52) = 5.45$, $p = .004$. Participants with low and mean BDI-II scores, selected smaller areas of meaning maps in positive ($M = .17$, $SD = 15$) than in negative images ($M = .2$, $SD = .16$), low BDI-II scores: $t(612.4) = -2.5$, $p = .013$; mean BDI-II scores: $t(303.57) = -2.33$, $p = .02$. This effect has not been observed for participants with high BDI-II scores. (Fig. 3.4).

Fig. 3.4

Plot of the interaction between BDI-II and *valence* on *meaning map area*

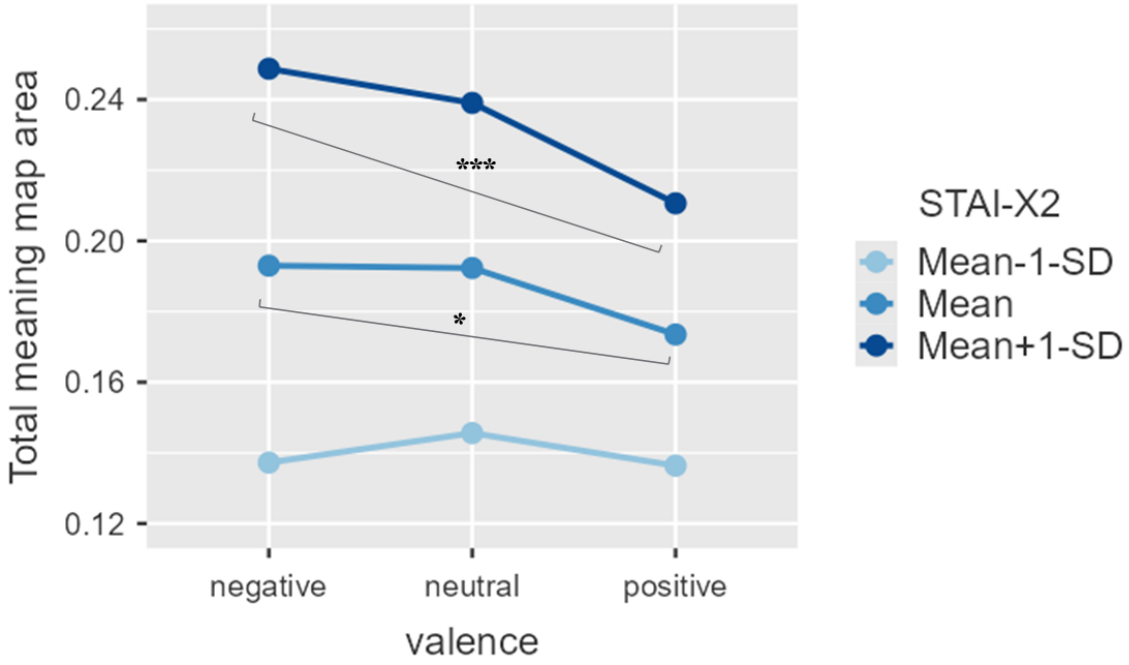


Note. Asterisks denote significant differences in pairwise comparisons; * depicts p-value of $\alpha \leq 0.05$

Moreover, we have also detected a significant interaction between the *valence* and STAI-X2 $F(2, 4884.53) = 4.92$, $p = .007$. Here the pattern of results was reversed in comparison with BDI-II. The higher the STAI-X2 scores were, the larger and more significant was the difference between the areas of key regions marked on negative images as compared to positive ones, see Fig. 3.5.

Fig. 3.5.

Plot of the interaction between *valence* and STAI-X2 on *total meaning map area*



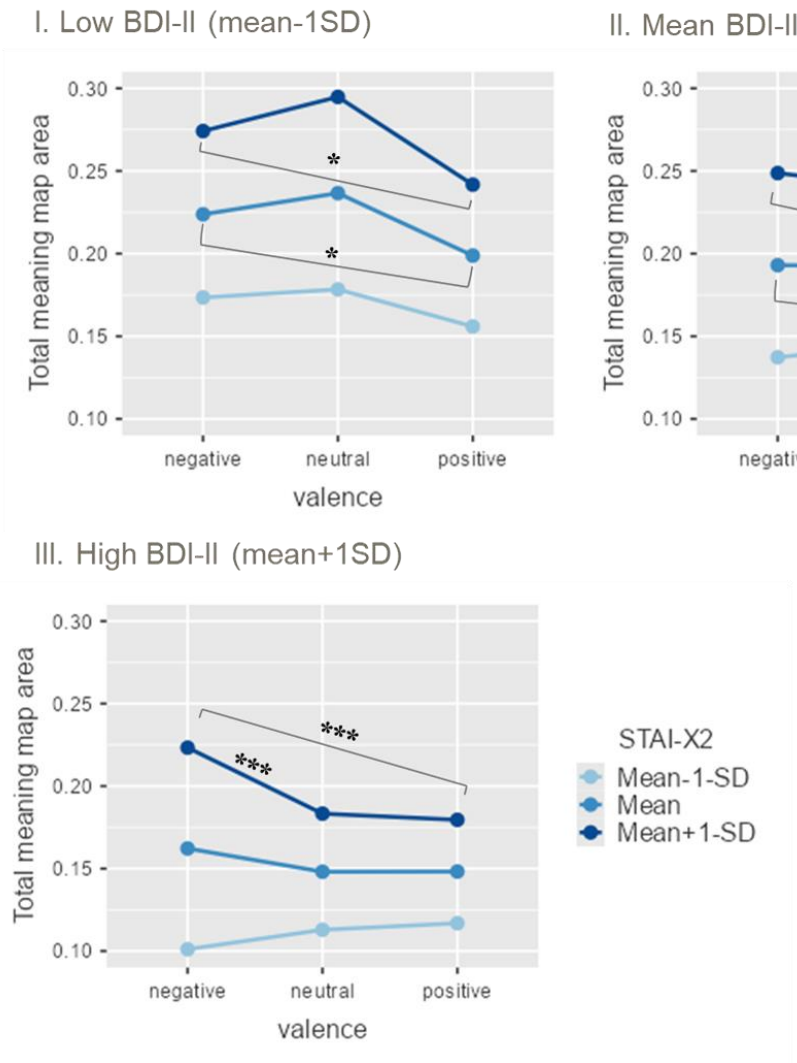
Note. Asterisks denote significant differences in pairwise comparisons; * depicts p-value $\leq$ 0.05, ** p-value $\leq$ 0.01, *** p-value $\leq$ 0.001

Importantly, there was a significant three-way interaction between the *valence*, BDI-II score, and STAI-X2 score, $F(2, 4850.64) = 11.02$, $p < .001$. Only participants with sufficiently high STAI-X2 scores selected significantly larger meaning maps on negative than on positive images, regardless of the BDI-II score (see Fig. 3.6). Crucially, subjects with high BDI-II and co-occurring high STAIX-2 scores, selected significantly larger meaning maps on negative as compared to both neutral or positive images, the effect which virtually disappeared for participants with equally high BDI-II scores but not highly anxious (see Fig. 3.6-III).

All remaining effects were non-significant.

Fig. 3.6

Plot of the interaction between BDI-II, STAI-X2 and *valence* on *total meaning map area*



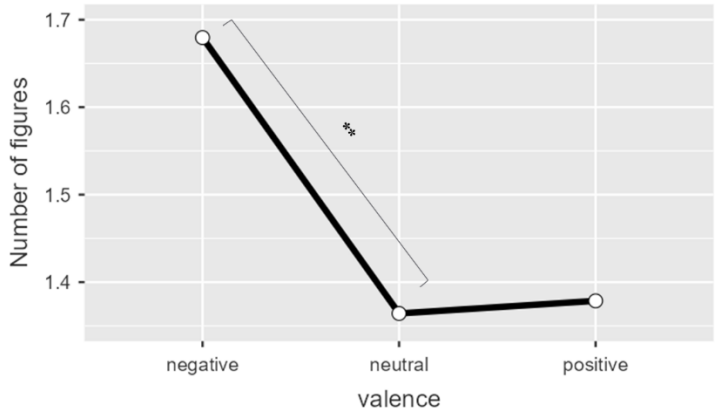
Note. Asterisks denote significant differences in pairwise comparisons; * depicts p-value $\leq$ 0.05, ** p-value ≤ 0.01, *** p-value ≤ 0.001

3.3.3 The number of figures selected in a single image

Results revealed a good fit of the model (R^2 conditional = .43). *Valence* had a significant effect, F(2, 5054.34) = 3.63, p = .027, on the number of figures (Fig. 3.7). Participants created significantly more figures on negative (M = 1.64, SD = 1.07) than on neutral images (M = 1.41, SD = .77), t(5054.39) = -2.57, p = .01.

Fig. 3.7

Plot of the mean *number of figures* for particular valences

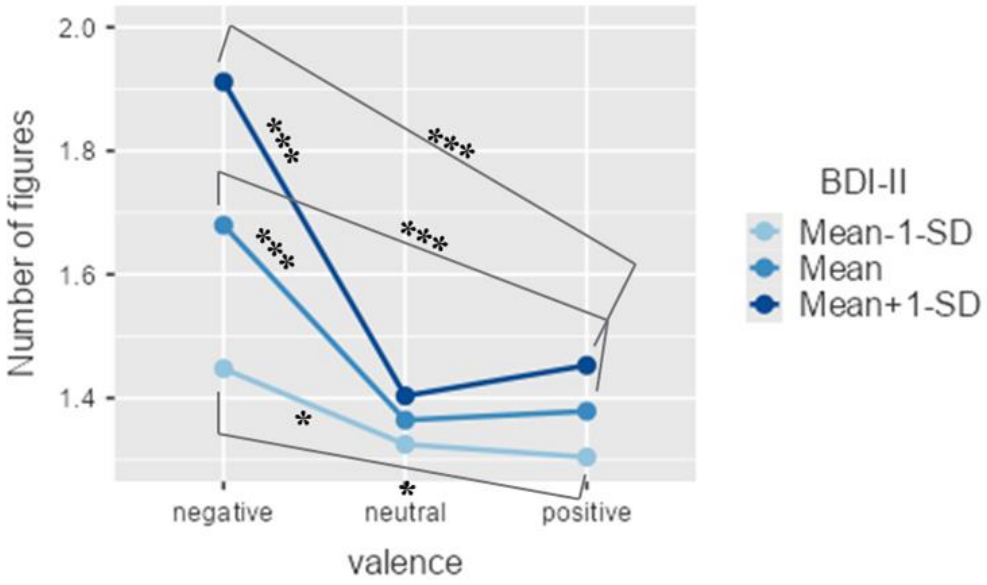


Note. Asterisks denote significant differences in pairwise comparisons; ** depicts p-value ≤ 0.01

Moreover, there was a significant interaction between the *valence* and BDI-II score, F(2,4855.74) = 10.45, p < .001. Although regardless of the BDI-II scores, the number of figures participants created on negative images was always higher than on neutral and positive ones, in terms of absolute values this difference was most pronounced and significance was highest for high BDI-II scorers (see Fig. 3.8).

Fig. 3.8

Plot of the interaction between BDI-II and the *valence* on the *number of figures*



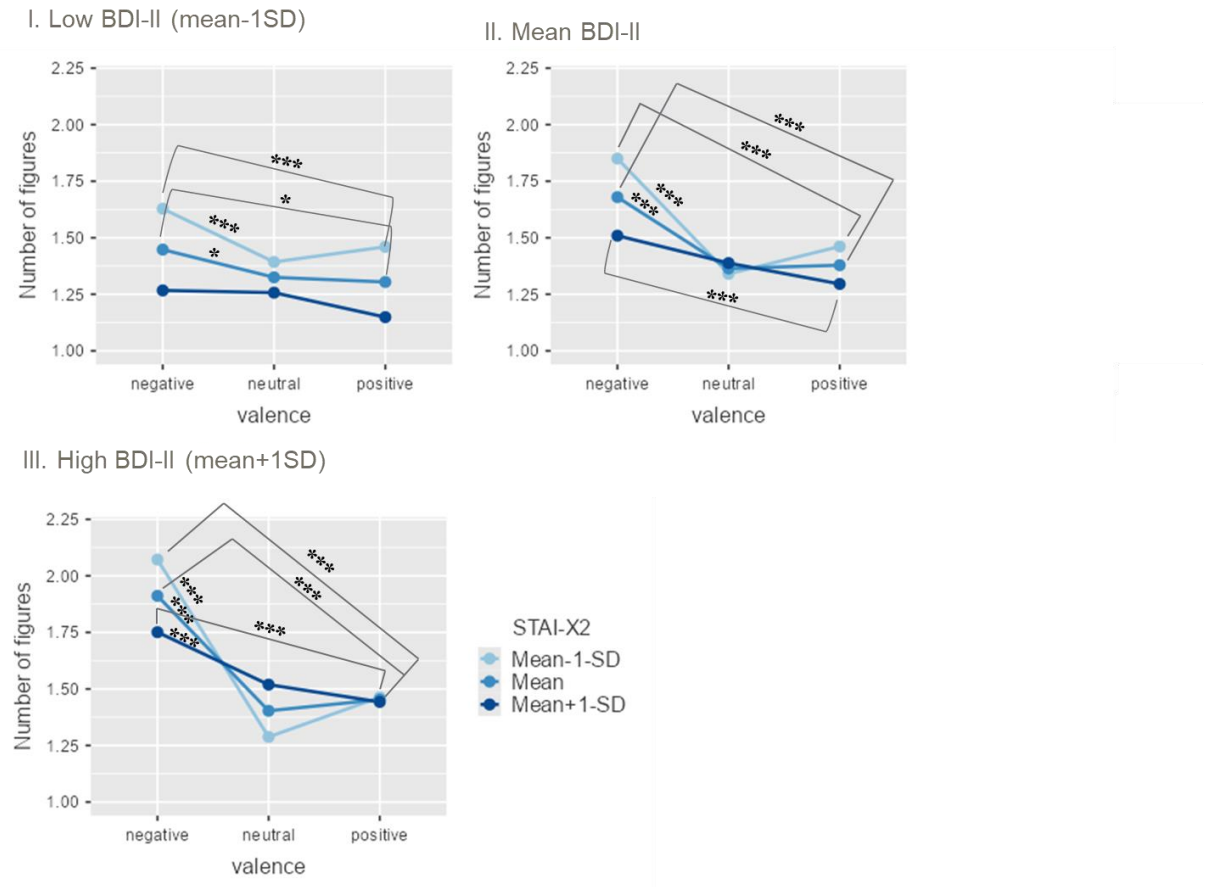
Note. Asterisks denote significant differences in pairwise comparisons; * depicts p-value $\leq$ 0.05, ** p-value ≤ 0.01, *** p-value ≤ 0.001

Furthermore, there was a significant interaction between the *valence*, BDI-II score, and STAI-X2 score, $F(2, 4855.98) = 6.5$, $p = .002$. STAI-X2 modified the interaction of valence and BDI-II insofar as the higher STAI-X2 scores lead to a less pronounced advantage of figure markings on negative over neutral and positive images, a tendency that lead, in the group with low BDI-II and high STAI-X2 scores to complete disappearance of this general tendency. Fig. 3.9-II.

All remaining effects were non-significant.

Fig 3.9

Plot of the interaction between BDI-II, STAIX-2 and *valence* on the *number of figures*



Note. Asterisks denote significant differences of simple effects analysis, * depicts p-value $\leq$ 0.05, ** p-value ≤ 0.01, *** p-value ≤ 0.001

3.4 Discussion

The present study demonstrates a complex pattern of relations between perceptual biases and the levels of often co-occurring depressive and anxiety sumptoms (Gorman, 1996; Kessler et al., 2015; Saade et al., 2019) using the meaning maps approach. Those relations were possible to capture due to the fact of simultaneous controlling self-descriptive measures of both depression and anxiety. In addition, the area of the meaning maps and the number of figures selected within each were also analysed, allowing us to gain a comprehensive insight into the particularly interesting patterns of perceptual biases in depression and anxiety.

Our work shows that taking into account the comorbidity of depression and anxiety is essential for understanding the attentional tendencies associated with these affective states. For example, analysing the influence of depressive and anxiety symptoms on the size of selections separately can lead to the misleading conclusion that as depression increases, the tendency for increased engagement with negative content (relative to neutral and positive content) decreases, whereas when the anxiety increases, the effect is reversed.

However, taking these two variables into account and considering the three-way interaction between valence, depressive symptoms and anxiety reveals the full relationship between these factors. In fact, more severely depressed individuals, when also highly anxious, show the strongest and most significant attentional tendencies of all the analysed subgroups to select larger meaning maps for negative images compared to both neutral and positive images.

Interestingly, this tendency disappears in highly depressed but relatively low anxious individuals. This may be due to the generally demotivating nature of depressive symptoms which, when anxiety is low, act as a suppressor in a tasks requiring relatively high cognitive engagement (Horne et al., 2021) such as ours, thus masking the perceptual bias. However, when depressive symptoms co-occur with high anxiety, which has been described as attentionally

motivating (e.g. to constantly search for possible threats in order to avoid them later Armstrong & Olatunji, 2012; Gupta et al., 2019; Richards et al., 2014), the attentional biases regarding sustained attention to negative stimuli described in the literature (Caseras et al., 2007; Kellough et al., 2008) are fully revealed.

This effect may also explain the long-standing ambiguity in the results of studies of negativity bias in depression, which may have been caused not only by methodological drawbacks such as the use of the dot-probe procedure or the emotional Stroop task (Chapman et al., 2019; Schmukle, 2005). We suspect that attentional bias in depression was not observed in many of the older studies (e.g. Hill & Knowles, 1991; Lichtenstein-Vidne et al., 2017; Mathews & MacLeod, 2005) because the co-occurrence of depression and anxiety, which appears to significantly affect the pattern of biases, were not taken into account. Our results indicate that failure to control for anxiety may lead to the erroneous conclusion that negativity bias does not occur in depression.

Notably, the results indicate that individuals with the lowest levels of anxiety, regardless of the severity of co-occurring depressive symptoms, do not exhibit the negativity bias shown in the main effect. This may indicate that a certain baseline (at least average) level of anxiety, in addition to depressive symptoms, is necessary for the full manifestation of the attentional preference for negative content. Otherwise, the effect is not observable, as shown in the interaction between the valence and anxiety measure (Fig. 3.5).

The analysis of the number of selections also reveals interesting relationships. Specifically, our results show that the higher the level of depression, the more the number of selected regions is dominated by negative content (as opposed to positive and neutral content). However, when anxiety is taken into account and the three-way interaction between valence, depression and anxiety is considered, another result emerges that cannot be captured without considering both

measures simultaneously. Namely, the negativity bias is not observed only in the group of simultaneously low-depressed and low-anxious individuals (Fig. 3.9-I). This may indicate that only the simultaneous attenuation of both depressive and anxious symptoms can lead to a reduction in negativity bias.

Taking into account both the size of the area and the number of figures proved to be a highly accurate analytical approach, as it allowed for a much more precise determination of attentional changes in depression and anxiety than when they were considered separately. In particular, we were able to identify a very interesting regularity. The comparison between Figures 3.6-III and 3.9-III shows that people who are particularly affected by the symptoms, i.e. people with high levels of both depression and anxiety, show a uniquely characteristic form of attentional change. In general, they select smaller key areas in the pictures (although still larger in the negative pictures than in the neutral and positive pictures), but they also seem to select more of them. This may indicate the existence of a particular kind of 'attentional sharpening', involving a narrowed field of attention and the selective and thorough detection of negative content.

Our findings add to the line of research highlighting the importance of accounting for the co-occurrence of depressive and anxiety symptoms in depression research, as it significantly alters the picture of the occurring symptoms which are, among all, attentional biases (Gaspersz et al., 2018; Hankin et al., 2010; LeMoult & Joormann, 2012). A better understanding of the impact of the comorbidity of depression and anxiety on cognitive biases should support more precise tailoring of interventions to modify cognitive biases.

3.5 Limitations

In order to fully disentangle the impact of the comorbidity of depression and anxiety on our results, more selectively chosen subgroups of participants could be recruited for future research. For example, the groups should include (1) depressed individuals with no comorbid psychiatric conditions (no comorbid anxiety and any other psychiatric illness), (2) anxious individuals (with the anxious trait or certain anxiety disorder e.g. social anxiety) with no comorbid psychiatric conditions (no comorbid depression and any other psychiatric condition), (3) people suffering from comorbid depression and anxiety with no other comorbid psychiatric conditions, and (3) healthy controls. However, it is important to notice that the complete disentanglement of symptoms of depression and anxiety in participants would be extremely difficult because anxiety occurs in 42-78% of depressed patients (Gaspersz et al., 2018; Goldberg & Fawcett, 2012).

It is important to notice that our intent was also to measure the associations between perceptual biases, depression and anxiety level as well as mindfulness trait. However, due to the fact that the first 10 depressed participants quit completing self-descriptive measures about the midpoint of the questionnaire set, we had to shorten the procedure in order not to lose respondents. For the part of the experiment which is of the scope of this chapter, we chose self-descriptive measures of depression and *anxiety trait.*

It would be also beneficial to include participants who have received a psychiatric diagnosis and rely less on less precise self-depressive measures.

3.6 Conclusions

In our study, we have shown an extremely interesting perceptual bias that occurs in highly depressed and highly anxious individuals, which was not detectable when examining the biases

for each disorder separately. This bias involves a narrowing of the field of attention and a thorough detection of the negative content of complex images.

We suspect that as depressive symptoms can significantly impair the ability to engage in complex tasks such as our evaluation task (Horne et al., 2021), this bias was therefore not present in people with high levels of depression but, importantly, low levels of anxiety. Our results suggest that only when high levels of depression co-occur with high levels of anxiety (increasing the attentional field; Armstrong & Olatunji, 2012) it leads to the appearance of 'attentional sharpening' bias.

Our research shows that to fully understand the perceptual biases in depression, it is essential to study it with the usually co-occurring anxiety.

IV. THE EFFECT OF MINDFULNESS TRAINING ON SELF-DESCRIPTIVE MINDFULNESS TRAIT, AND DEPRESSION AND ANXIETY MEASURES

4.1 Introduction

Medical students are characterised as a group at risk of depression (Rotenstein et al., 2016) due to, for example, the mentally overwhelming academic schedules, and demanding contact with critically ill patients which is also full of pressure and substantive responsibilities (Fino et al., 2021; Ungar et al., 2022). Moreover, students of this faculty are more susceptible to mental illnesses than students of other faculties (Dyrbye & Shanafelt, 2011; Heinen et al., 2017; W. Zeng et al., 2019). The demanding work regime does not end after graduation, it also persists in their professional career, hence it is very important that during their medical education students acquire the skills to cope with stress and difficulties in an adaptable way in order not to develop psychiatric conditions.

Mindfulness involves a non-judgmental and curious outlook on external and internal experiences. It employs the practicing of self-awareness in a compassionate way which enables one to respond to their everyday needs more accordingly (Daya & Hearn, 2018). *Mindfulness trait* which can be developed through mindfulness practice, can result in a decrease in depression and anxiety symptoms in medical students (e.g. Burgstahler & Stenson, 2020; Hassed et al., 2009; Shapiro et al., 1998). Thus, practicing mindfulness appears to be protective factor against depression and anxiety, which often co-occur (Gorman, 1996; Kessler et al., 2015; Saade et al., 2019).

The beneficial effects of mindfulness training on *mindfulness trait*, *depression symptoms* or *anxiety trait* have been examined in several universities, for example in Canada (Danilewitz et al., 2016; Garneau et al., 2013), the USA (Burgstahler & Stenson, 2020; Chen et al., 2016;

Rosenzweig et al., 2003; Shapiro et al., 1998), Germany (Lampe & Müller-Hilke, 2021), Malaysia (Phang et al., 2015) and Australia (Warnecke et al., 2011). All leading to the conclusion that mindfulness training is a beneficial intervention to decrease anxiety and/or depression levels in medical students being at risk of depression.

However, the effect of mindfulness training on depressive and anxiety symptoms as well as self-descriptive mindfulness has not yet been examined in Poland, not least due to the lack of Polish adaptations of mindfulness self-descriptive measures. According to our knowledge, it is the first study aiming to investigate how mindfulness training affects self-descriptive depression and anxiety symptoms, as well as the level of *mindfulness trait* and *mindfulness advancement* in a group of medical students at risk of developing depression in Poland.

In concordance with studies conducted in other countries (Burgstahler & Stenson, 2020; Chen et al., 2016; Danilewitz et al., 2016; Garneau et al., 2013; Lampe & Müller-Hilke, 2021; Phang et al., 2015; Rosenzweig et al., 2003; Shapiro et al., 1998; Warnecke et al., 2011) we expected a more dynamic decrease in depression and anxiety symptoms, as well as a more dynamic increase in *mindfulness trait* and *advancement in mindfulness* in the group which received mindfulness intervention than in the control group. Moreover, we aimed to replicate similar studies (Burgstahler & Stenson, 2020; Garneau et al., 2013; Hassed et al., 2009; Shapiro et al., 1998) examining the influence of mindfulness interventions on self-descriptive affective symptoms in groups at risk of depression.

4.2 Materials and methods

4.2.1 Experimentation design

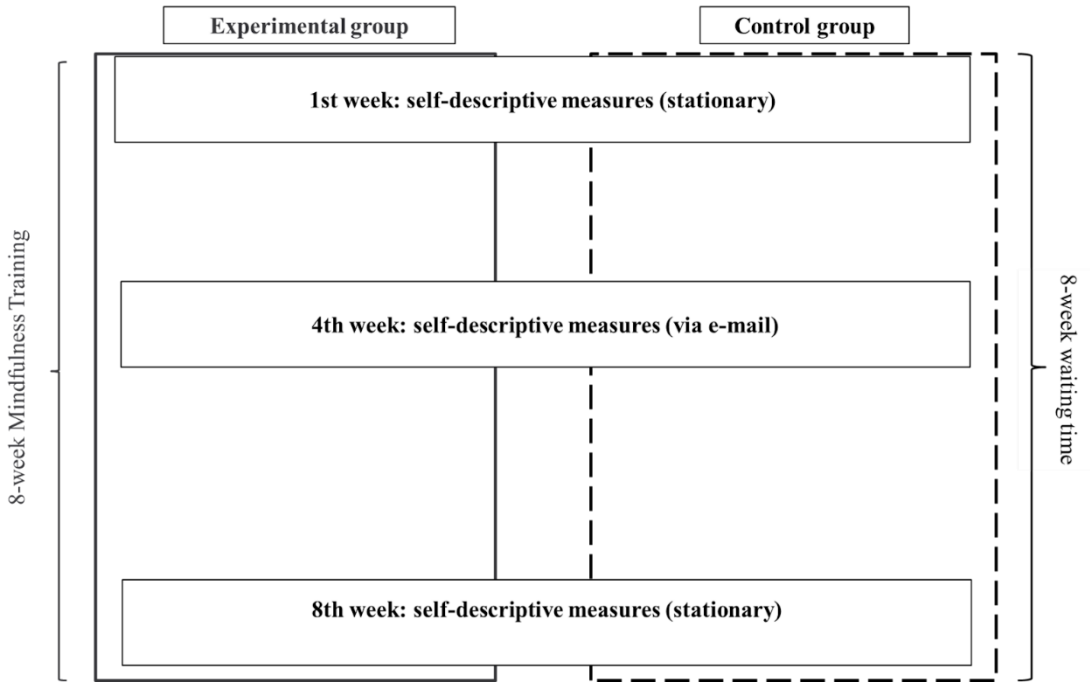
The experimental group took part in the 8-week mindfulness training, while the control group was assigned to the waitlist. We conducted 3 measurements of self-descriptive *advancement in mindfulness, mindfulness trait* as well as depression, and *anxiety trait* in the 1st, 4th and 8th

week of the mindfulness training (experimental group) or the waiting time (control group), see Fig. 4.1.

This study was part of an eye-tracking experiment with two eye-tracking measurements in 1st and 8th week of the study (described in detail in Chapter V). The first and the last self-descriptive measurements were conducted stationary immediately after the eye-tracking procedures. The second measurement took part in the 4th week of the study and the measures were taken via e-mail.

Fig. 4.1

Scheme of experimental design



4.2.2 Participants

For both eye-tracking and self-descriptive measurements, we recruited 63 participants aged 18-29 (experimental group: n = 30, 6 men; control group: n = 33, 4 men) via The Jagiellonian University advertisement mailing system (control group) and online advertisements (experimental group).

The inclusion criteria for the experimental group were: (1) being a student of medicine, (2) the willingness to participate in the study and mindfulness training, (3) having normal or corrected to normal vision. The inclusion criteria for the control group were: (1) being a student of other faculty than medicine, (2) the willingness to participate in the study, (3) having normal or corrected to normal vision. For full participation in the study, subject from the control group received credit points or money (70 PLN) whereas subjects from the experimental group received mindfulness training free of charge.

Six participants from the control group declared being diagnosed with the affective disorder (time in years from diagnosis = 2.25, SD = 1.41), four were under psychiatric treatment, and seven of them declared positive family history of affective disorders. One subject from the experimental group declared being diagnosed with affective disorder (time in years from diagnosis = 3) three were under psychiatric treatment, and two of them declared positive family history of affective illnesses.

Participants of our study did not have previous meditational experience, such as participation in a mindfulness intervention. Prior to the beginning of the study, all participants signed informed consent. Our study was carried out in accordance with the Declaration of Helsinki (World Medical Association, 2001).

In the case of the experimental group, 29 participants decided to fill in the questionnaires in the first measurement, 27 in the second, and 27 in the last one. In the case of the control group, 32 participants decided to complete the first measurement, 26 the second, and 27 the last measurement (2 participants were not present due to the COVID-19 pandemic).

4.2.3 Mindfulness training

Mindfulness Training (Williams & Penman, 2011) is a method that evolved from the Mindfulness-Based Stress Reduction (MBSR; Kabat-Zinn, 1990) and Mindfulness-Based Cognitive Therapy (MBCT; Segal et al., 2013) programmes. It was developed by one of the creators of the MBCT programme, Mark Williams, and his collaborator Danny Penman. It is designed for healthy people exposed to stress and time-pressured work who want to take care to improve life satisfaction and health. It consists of 8 weekly meetings each lasting 90 minutes oriented to the non-judgmental observation of one's own mind and body with the assumption that thoughts and feelings are not persistent. It also encourages engaging in internal and external experiences, regardless of their valence (De Raedt et al., 2012; Ford et al., 2021; Kabat-Zinn, 1990). The meetings are led by a certified mindfulness teacher and consist of group meditations as well as discussions about the main topic of the week (see Table 4.1). An essential part of the training is also a daily meditative formal (sitting meditation) and informal (during daily activities) self-practice, which lasts for about 20–30 minutes a day.

Moreover, an essential part of self-work is homework such as performing activities aiming to change habits (habit releasers) which might have elicited mood disruptions in the past, and reading particular chapters of Williams and Penman's book (2011) enabling the repetition of material from the last training session. The teacher provides the group with all reading materials and recordings of the meditations they are to perform during the week. The premise of the programme is to help to identify mental and physiological states before they result in a long-lasting change of mood, and thus create the possibility to react to them in a mindful and compassionate way (Williams & Penman, 2011).

The programme introduces meditations such as, for example, body scanning, sitting meditation and mindful movement (see Table 4.1).

Table 4.1

Summary of Mindfulness Training programme adapted from Williams and Penman's *Mindfulness: Finding Peace in a Frantic World* (2011)

Week	Aim	Individual practive	Habit releaser
1st: 'Waking up to the Autopilot'	Experimenting with conscious experiencing	Mindful awareness of a routine daily activity, Mindfulness of the Body and Breath meditation twice a day	Change of chairs on which one usually sits
2nd: 'Keeping the body in Mind'	Becoming aware of thinking and acting patterns, developing mindfulness practice during daily routines	Body Scan practice at least twice a day for 6 out of 7 days, mindful awareness of a different routine daily activity	Taking at least 15 minutes walk during a week
3rd: 'The Mouse in the Maze'	Practice of keeping attention on the body as a way of connecting with the present moment	8-minute Mindful Movement meditation followed by the 8-minute Breath and Body meditation, a Three-Minute Breathing Space meditation twice a day	Mindful media using (e.g. mindful choice of programmes watched on tv)
4th: 'Moving Beyond the Rumour Mill'	Becoming aware of patterns of interpreting reality and consequences of using them	8-minute Breath and Body meditation, 8-minute Sounds and Thoughts meditation twice a day, 3-minute Breathing Space meditation twice a day and whenever needed	Spontaneous visit to cinema to watch randomly chosen film
5th: 'Turning Towards Difficulties'	Responding to difficult emotions by gradually directing attention to their bodily symptoms	8-minute Breath and Body meditation, 8-minute Sounds and Thoughts meditation, the 10-minute Exploring Difficulty meditation, 3-minute Breathing Space meditation twice a day and whenever needed	Sowing seeds or looking after a plant
6th: 'Trapped in the Past or Living in the Present?'	Cultivating a friendly attitude towards self and each other as a way of connecting with the present moment	Befriending meditation for 6 out of 7 days, 3-minute Breathing Space meditation twice a day and whenever needed	Doing a good-natured deed for someone else
7th: 'When Did You Stop Dancing?'	Being mindful to current state as a call to take care of oneself	Practicing two meditations of choice for 6 out of 7 days, 3-minute Breathing Space meditation twice a day and whenever needed	Treating ordinary activities of choice as reminders of being mindful
8th: 'Your Wild and Precious Life'	Summary of the training, consolidating its results to cultivate mindfulness in daily life when needed the most	Starting the day with mindfulness, using Breathing Space to punctuate day, befriending feelings, maintaining meditation practice, doing mindful activities, increase level of excercise, remembering to breath minfdully	

4.2.4 Self-descriptive measures

We applied the Beck Depression Inventory-II (Beck et al., 1996) to measure self-descriptive symptoms of depression, State-Trait Anxiety Inventory *anxiety trait* subscale (Spielberger et al., 1983) to measure self-descriptive symptoms of *anxiety trait*. Moreover, to assess self-descriptive levels of mindfulness we used the Short form of the Five Facet Mindfulness Questionnaire (*Observing* excluded) (FFMQ-SF; Bohlmeijer et al., 2011) to assess *mindfulness trait,* and the MINDSENS Composite Index (Soler et al., 2014) to examine *advancement in mindfulness*. Since FFMQ-SF can be computed for each of the scales or as the overall score (see Chapter I, section 1.7), we used both approaches in order to capture possible changes not only in the FFMQ composite but also in related but separate facets of the *mindfulness trait.* Responses were collected via Google Forms. All the methods were described in detail in 1.7. General Methods.

4.2.5 Statistical analysis

To analyse the data, SPSS software (SPSS, Inc., Chicago, Illinois, USA) was used whereas for graphical purposes R programming language (R Core Team, 2021) was applied. The significance threshold for all analyses was determined as $\alpha = .05$.

In order to examine the changes in self-descriptive measures of depression, *anxiety trait, mindfulness trait* and the *advancement in mindfulness*, over time we used mixed ANOVA design with a within-group factor of *time* of self-descriptive measurement (*1st week, 4th week, 8th week*) and *group* affiliation (*group*: experimental or control) as a between-group factor. Moreover, to capture the dynamics of changes in self-descriptive measures, an analysis of linear and quadratic trends was applied. In the case of obtaining more than one significant trend, we described the one explaining the largest proportion of variance. In the case of the sphericity assumptions violation, we applied Huynh–Feldt correction. Due to the fact that our hypotheses

concern the dynamics of a change in self-descriptive measures, between-groups differences in self-descriptive measures were not interpreted. In accordance with our hypotheses, we interpreted only interactions between *group* and *time*.

4.3 Results

The mean scores of studied variables on each of the measurements are shown below (Table 4.2).

Table 4.2

Descriptive statistics of self-descriptive measures at each of the measurements

measure	group	1st measurement (1st week)		2nd measurement (4th week)		3rd measurement (8th week)		scale range
		M	SD	M	SD	M	SD	
MINDSENS	control	53.6	10.2	55.76	10.18	56.97	10.55	19 - 95
	training	58.46	10.7	67.12***	9.4	72***	12.8	
FMMQ-SF Describe	control	17.2	4.95	17.64	4.1	17.8	3.64	5 - 25
	training	17.31	3.81	18.04	3.52	19.81*	3.31	
FMMQ-SF Actaware	control	15.56	2.68	15.56	2.2	15.44	2.66	5 - 25
	training	14.12**	2.15	16.12	2.75	15.88	2.63	
FMMQ-SF Nonjudge	control	15.04	4.83	15.76	4.38	16.24	4.36	5 - 25
	training	18.35**	3.7	16.92	3.44	18.27	3.87	
FMMQ-SF Nonreact	control	11.88	2.74	11.84	2.94	12.64	2.79	5 - 25
	training	13.54	4.41	16.12***	3.2	17.38***	3.23	
FFMQ-SF Composite	control	59.69	9.36	60.8	9.13	62.12	8.45	20 - 100
	training	63.31	9.9	66.62	10	71.31**	10.3	
BDI-II	control	11.88	9.16	12.96	10.35	11.56	8.73	0 - 63
	training	8.27	7.95	4.5***	3.69	3.5***	3.45	
STAI-X2	control	49.84	9.4	50.12	9.19	49.92	9.87	20 - 80
	training	44.77	8.89	14.08***	3.25	38.42***	8.89	

MINDSENS: MINDSENS Composite Index; *FFMQ-SF:* Five Factor Mindfulness Questionnaire short form (*Observing* excluded); *FFMQ-SF Actaware: FFMQ-SF* Acting with Awareness scale; *FFMQ-SF Nonjudge*: FFMQ-SF Non-judging of Experience scale; *FFMQ-SF Nonreact*: Non-reactivity to Inner Experience scale; *FFMQ-SF sum:* overall sum of FFMQ-SF (*Observing* excluded); *BDI-II:* Beck's Depression Inventory-II, *STAI:* State-Trait Anxiety Inventory. Asterisks denote significant differences between groups in self-descriptive questionnaires at particular timepoints (1st, 2nd or 3rd measurement); * depicts p-value ≤ 0.05, ** p-value ≤ 0.01, *** p-value ≤ 0.001 in Mann-Whitney U tests.

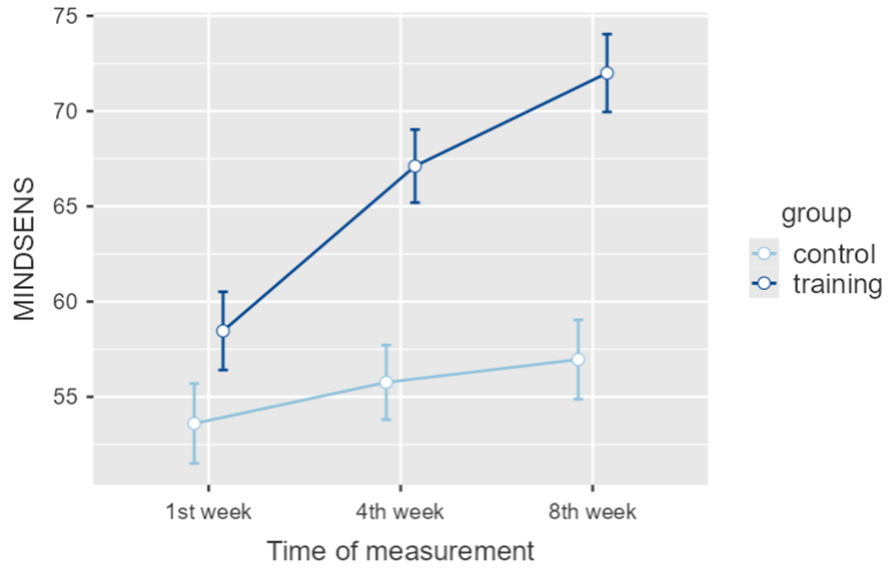
4.3.1 Advancement in mindfulness

There was a significant effect of the *time* of measurement on the MINDSENS Composite Index in omnibus ANOVA, $F(1.79, 87.62) = 33.79$, $p <. 001$, $\eta_{p^2} = .41$; and a linear trend, $F(1,49) = 55.9$, $p <. 001$, $\eta_{p^2} = .53$. Moreover, there was also a significant effect of the *group* on MINDSENS, $F(1, 49) = 16.1$, $p < .001$, $\eta_{p^2} = .25$. Furthermore, there was a significant interaction between *time* and *group* in omnibus ANOVA, $F(1.79,87.62) = 12.25$, $p < .001$, $\eta_{p^2} = .2$, and a linear trend, $F(1,49) = 20.28$, $p < .001$, $\eta_{p^2} = .53$, showing a significantly greater increase in MINDSENS in the experimental group with time than in the control group where such an effect was not present, see Fig 4.2.

All remaining effects were non-significant.

Fig. 4.2

Mean MINDSENS score at each of the measurements (1st, 4th, 8th week) in the training and control group



Note. Bars represent the standard error of the mean

4.3.2 Mindfulness trait

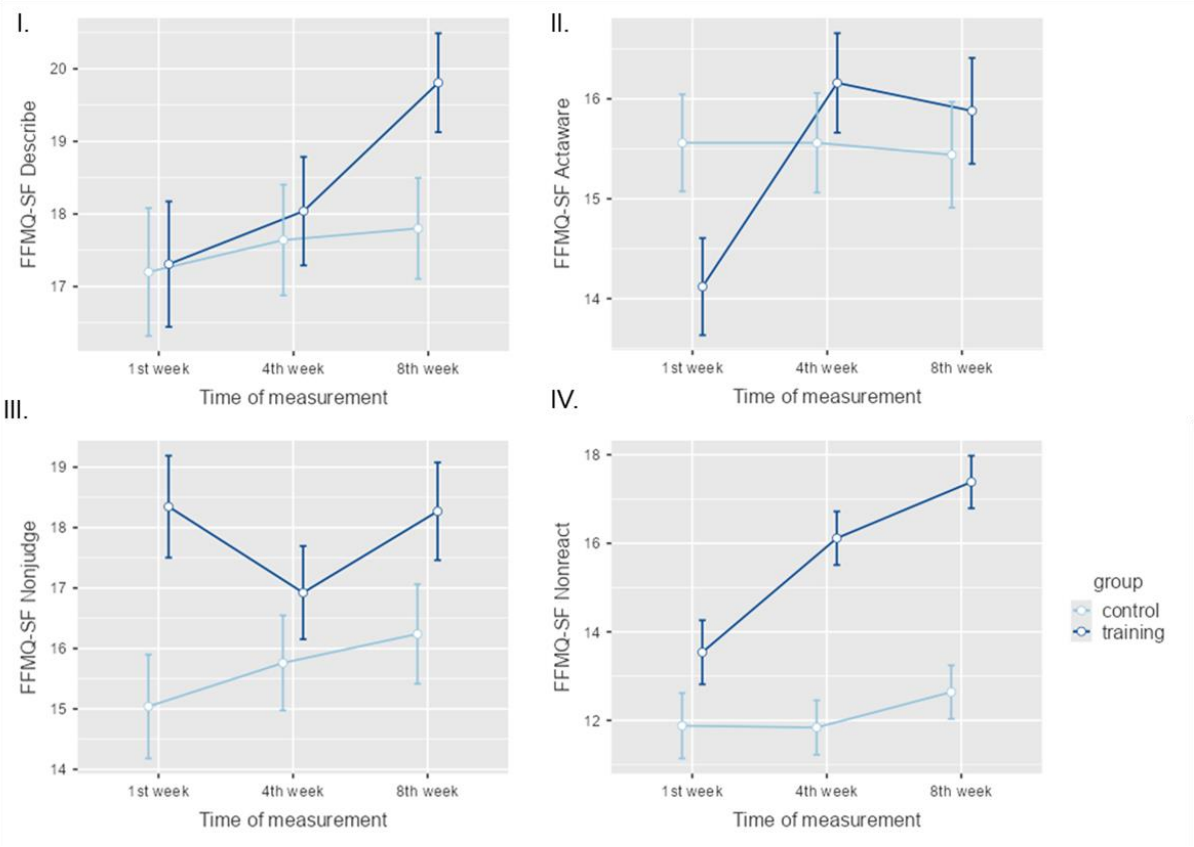
In the case of FFMQ-SF *Describe* and FFMQ-SF *Acting with Awareness* (*Actaware*) scales, there was a significant effect of *time* of measurement, *Describe:* $F(2,98) = 9.55$, $p < .002$, $\eta_{p^2} = .29$; *Actaware:* $F(2,96) = 4.55$, $p = .013$, $\eta_{p^2} = .09$, with a linear trend, *Describe:* $F(1,49) = 18.27$, $p < .001$, $\eta_{p^2} = .27$; *Actaware*: $F(1,48) = 4.68$, $p = .036$, $\eta_{p^2} = .09$. Moreover, there was a significant interaction between *time* and *group* in omnibus ANOVA, Describe: $F(2, 98) = 4.08$ $p = .02$, $\eta_{p^2} = .08$; *Actaware*: $F(2, 96) = 5.01$ $p = .008$, $\eta_{p^2} = .1$, with linear trends, *Describe*: $F(1,49) = 6.86$, $p = .012$, $\eta_{p^2} = .12$; *Actaware*: $F(1,48) = 6.14$, $p = .017$, $\eta_{p^2} = .11$, showing a significantly greater increase in the scores of both measures in the experimental group in time than in the control group where such an effect was not shown, see Fig 4.3.

Furthermore, there was a significant effect of the *group* on *F*FMQ-SF *Non-judging of experience scale* (*Nonjudge*), $F(1,49) = 4.31$, $p = .043$, $\eta_{p^2} = .08$. Moreover, there was a significant interaction between *time* and *group* in omnibus ANOVA, $F(1.81, 88.81) = 3.21$, $p = .05$, $\eta_{p^2} = .06$ and a quadratic trend, $F(1,49) = 4.48$, $p = .039$, $\eta_{p^2} = .084$), showing a significantly greater change in FFMQ-SF *Nonjudge* scores with time in the experimental group than in the control group where such a change was not shown, see Fig 4.3.

Results also have shown a significant effect of the *time* on FFMQ-SF *Non-reactivity to Inner Experience* (*Nonnreact*) in omnibus ANOVA, $F(1.58, 77.48) = 19.06$, $p < .001$, $\eta_{p^2} = .28$, and a linear trend, $F(1,49) = 28.93$, $p < .001$, $\eta_{p^2} = .38$. Moreover, there was also a significant effect of the *group* on *Nonnreact*, $F(1,49) = 19.3$, $p < .001$, $\eta_{p^2} = .28$. Furthermore, there was a significant interaction between *time* and *group* in omnibus ANOVA, $F(1.58, 77.48) = 9.9$. $p < .001$, $\eta_{p^2} = .17$, and a linear trend, $F(1, 49) = 12.99$, $p < .001$, $\eta_{p^2} = .21$, showing a significantly greater increase in *Nonnreact* in the experimental group with time than in the control group where such an effect was not present, see Fig 4.3.

Fig. 4.3

Mean scores of the four FFMQ-SF scales at each of the measurements (1st, 4th, 8th week) in the training and control group



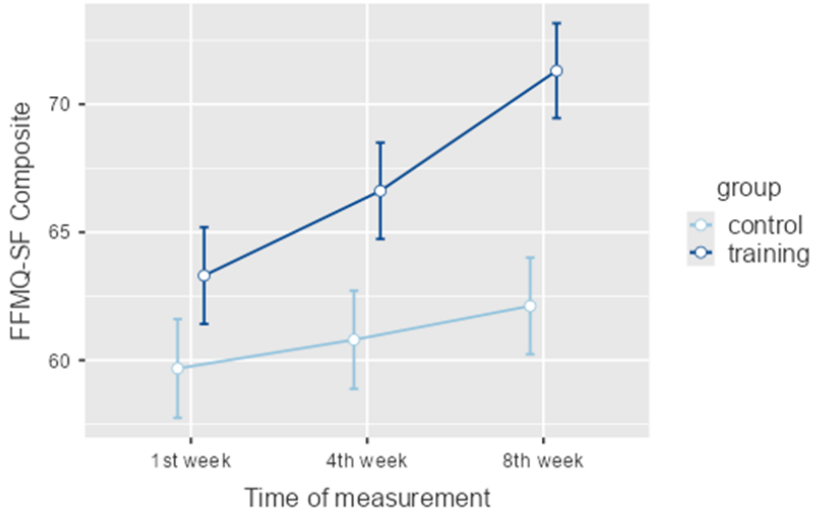
Note. Bars represent the standard error of the mean.

Furthermore, in the case of FFMQ-SF Composite, *time* of measurement proved to significantly influence the scores of this self-descriptive measure, $F(1.79, 87.89) = 15.31$, $p < .001$, $\eta_{p^2} = .24$, with a linear trend, $F(1, 49) = 29.91$ $p < .001$, $\eta_{p^2} = .38$. There was also a significant effect of the *group* on the FFMQ-SF Composite, $F(1,49) = 6.46$, $p = .014$, $\eta_{p^2} = .12$. Moreover, there was a significant interaction between *time* and *group* in omnibus ANOVA, $FF(1.79, 87.89) = 4.37$, $p = .015$, $\eta_{p^2} = .08$, with a linear trend, $F(1, 49) = 8.48$, $p = .005$, $\eta_{p^2} = .15$, showing a significantly greater increase with time in FFMQ-SF Composite score in the experimental group than in the control group, where such an effect was not present, see Fig 4.4.

All remaining effects were non-significant.

Fig. 4.4

Mean FFMQ-SF Composite score at each of the measurements (1st, 4th, 8th week) in the training and control group



Note. Bars represent the standard error of the mean

4.2.3 Depression and anxiety measures

In the case of the BDI-II score, *time* of measurement proved to significantly influence the scores of this self-descriptive measure, $F(1.64, 80.57) = 5.14$, $p = .012$, $\eta_{p^2} = .1$, with a linear trend, $F(1, 49) = 9.63$, $p = .003$), $\eta_{p^2} = .16$. There was also a significant effect of the *group* on the BDI-II score, $F(1,49) = 12$, $p < .001$, $\eta_{p^2} = .2$. Moreover, there was a significant interaction between *time* and *group* in omnibus ANOVA, $F(1.64, 80.57) = 5.75$, $p = .008$, $\eta_{p^2} = .11$, with a linear trend, $F(1, 49) = 7.37$, $p = .009$, $\eta_{p^2} = .13$, showing a significantly greater decrease in BDI-II score in the experimental group than in the control group, see Fig 4.5.

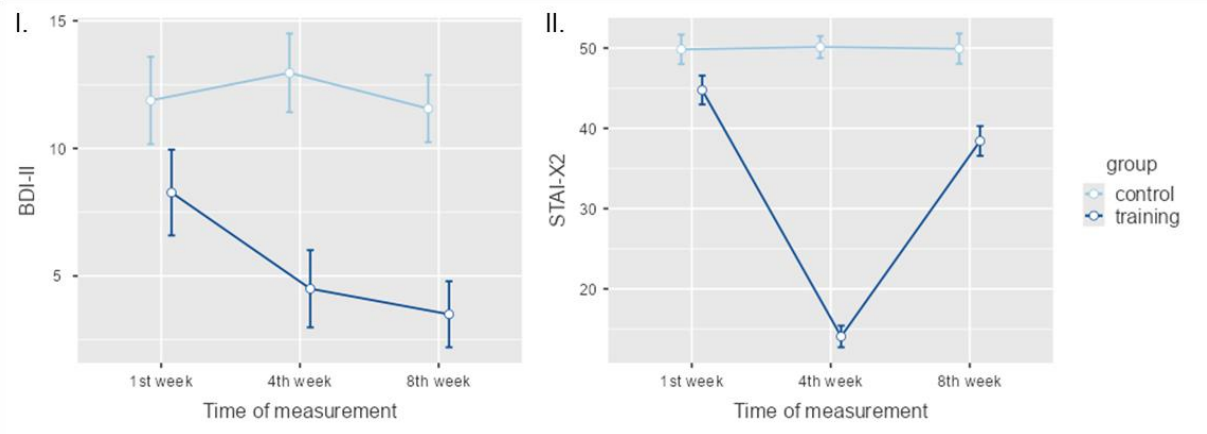
Furthermore, there was a significant effect of the *time of measurement* on the STAI-X2 score in omnibus ANOVA, $F(2, 98) = 143$, $p < .001$, $\eta_{p^2} = .75$, and a quadratic trend, $F(1, 49) = 307.71$, $p < .001$, $\eta_{p^2} = .86$. Moreover, there was also a significant effect of the *group* on STAI-X2,

$F(1,49) = 67.8$, $p < .001$, $\eta_{p^2} = .58$. There was also a significant interaction between *time* and *group* in omnibus ANOVA, $F(2, 98) = 148$, $p < .001$, $\eta_{p^2} = .75$, and a quadratic trend, $F(1,49) = 318.63$, $p < .001$ $\eta_{p^2} = .86$, showing a significantly greater increase in STAI-X2 measures in the experimental group than in the control group, see Fig 4.5.

All remaining effects were non-significant.

Fig. 4.5

Mean scores of the BDI-II and STAI-X2 measures at each of the measurements (1st, 4th, 8th week) in the training and control group



Note. Bars represent the standard error of the mean

4.4 Discussion

Here, we examined the changes in self-descriptive measures of mindfulness, depression and anxiety in a group at risk of depression following the mindfulness intervention.

First, our results have shown a more dynamic increase in the *advancement in mindfulness* (MINDSENS Composite Index) from the 1st through the 2nd, and to the 3rd measurement as a result of participating in mindfulness training. These results suggest that our mindfulness training was an effective intervention, leading to the increase in *advancement in mindfulness* in participants. According to our knowledge, it was the first study to examine the effects of a mindfulness intervention using this scale in a group at risk of depression. We assume this scale should be an integral element of mindfulness studies because it enables examining whether the participants of the intervention have progressed in the development of mindfulness during the training.

Secondly, our results have shown a more dynamic increase in *mindfulness trait* with time (FFMQ-SF scales *Describing*, *Acting with awareness*, *Non-judging of experience* and *Non-reactivity to Inner Experience* as well as composite FFMQ-SF*)* in the group which participated in mindfulness training than in the waitlist group. On these bases, it can be concluded that the training brought the hypothesised effect, i.e. the more dynamic increase in *mindfulness trait* among participants of the training than in the control group.

Most interestingly, among participants from the experimental group, *Non-judging of experience (Nonjudge)* decreased in the 4th week of training and then increased at the end of it, whereas the remaining scales of mindfulness trait were linearly increasing with time. The topic of the mindfulness training session held in the 4th week of the study was associated with responding to difficult emotions by redirecting attention to their bodily symptoms (see Fig. Table 4.1). Developing a mindful approach to such difficulties involves recalling emotionally difficult life

moments (moments judged as emotionally difficult) in order to respond to them in a new way. Therefore, we suggest that the decrease in *Non-judging of experience* in the 4th week was associated with judging emotions as difficult each time before exercising on them. According to our knowledge, our study is one of the first to collect self-descriptive measures also during the mindfulness intervention in a group at risk of depression, such as medical students. We assume it would be beneficial to include similar mid-intervention measures in future studies on similar groups so as to capture fluctuations in affective symptoms and *mindfulness trait* over the course of the intervention to be able to, e.g., respond to possibly changing moods of the participants during the training.

Surprisingly, despite the fact that the *Non-judging of experience* is described as one of the mindfulness trait facets with the strongest negative correlation with depression and anxiety (Bohlmeijer et al., 2011), depression and anxiety symptoms decreased along with *Nonjudge* in the 4th week of the training. Yet, it should be noted that this was only a transient effect, supposedly associated with the aforedescribed topic of mindfulness session held in the 4th week. Finally, after the training, *Nonjudge* facet and depression symptoms returned to the pattern described in the literature (from the 4th to the 8th week *Nonjudge* increased, whereas depression symptoms decreased).

However, unexpectedly, anxiety increased from the 4th to the 8th week in the experimental group, yet to the level below obtained in the first measurement. We suspect that the simultaneous decrease in depression and increase in anxiety may have been related to the participants' general improvement in mood after the training (decrease in depressive symptoms), but also to the anxiety (increase in anxiety symptoms) associated with returning to everyday life without the mindfulness training. It is probable that participants were anxious about whether they would be able to maintain the improvement in mood and the motivation to practice mindfulness without the possibility to meet weekly with a group of peers led by a

professional teacher. It is important to notice that despite the fact of an increase in *anxiety trait* in the 8th week, the level of depression and *anxiety trait* decreased during the mindfulness training as we hypothesised.

Our results are corroborated by other studies on medical students participating in 4 to 8-week mindfulness interventions such as Mindfulness-Based Stress Reduction, Health Enhancement Program, and Mindfulness-based medical practice course which resulted in a decrease in depression, and *anxiety trait* levels as well as an increase in mindfulness trait (Burgstahler & Stenson, 2020; Garneau et al., 2013; Hassed et al., 2009; Lampe & Müller-Hilke, 2021; Phang et al., 2015; Shapiro et al., 1998). Nevertheless, there is also a line of research positing that mindfulness interventions in medical students do not attenuate symptoms of depression (Chen et al., 2016; Danilewitz et al., 2016; Rosenzweig et al., 2003; Warnecke et al., 2011).

These differences might be due to the methodological diversity of mindfulness interventions conducted among medical students (e.g. audio-only intervention elements, peer-led meditation programmes, or usage of more classical mindfulness trainings such as MBSR). Importantly, there is a growing body of evidence (De Vibe et al., 2018; Medlicott et al., 2021; Shapiro et al., 2011) documenting positive effects of mindfulness on a more general aspect of everyday functioning, that is well-being, which itself has been described as a protective factor against depression (Bassi et al., 2017; Kim et al., 2010; Liu et al., 2009; Wood & Joseph, 2010).

Research on the long-term effects of mindfulness on the well-being of participants, including also medical students, has shown that participation in even a single mindfulness training increases well-being up to six years after participation in the intervention, even if regular mindfulness practice is not maintained after the mindfulness training (De Vibe et al., 2018; Medlicott et al., 2021; Shapiro et al., 2011).

Thus, we suggest that even if some studies did not show a significant change in depressive symptoms in the group at risk of depression, participation in a mindfulness intervention can still be expected to have a long-term antidepressive effect because mindfulness supports well-being, which is negatively associated with depression (Bassi et al., 2017; Kim et al., 2010; Liu et al., 2009; Wood & Joseph, 2010). However, longitudinal studies on mindfulness, well-being and depression are required to verify this hypothesis.

4.5 Limitations

The participants of the study were mostly women. To improve the generalisability of results, it would be beneficial to conduct future studies in more gender-diverse groups.

Moreover, the participants of the study were solely the students of Jagiellonian University. Future studies should focus on expanding the sample to include people from the general population.

4.6 Conclusions

Our study corroborates the line of research showing that mindfulness interventions bring a decrease in symptoms of depression and *anxiety trait* as well as an increase in *mindfulness trait* in groups at risk of depression such as medical students. According to our knowledge, it is the first study examining the *advancement in mindfulness* in a group at risk of depression and the first study examining the influence of mindfulness intervention on *mindfulness trait* and *the advancement in mindfulness* using Polish versions of mindfulness questionnaires.

V. THE EFFECT OF MINDFULNESS TRAINING ON VISUAL ATTENTION AND SELF-DESCRIPTIVE MEASURES OF DEPRESSION AND ANXIETY

5. 1 Introduction

Medical students are described as more susceptible to mental illnesses than students of other faculties (Dyrbye & Shanafelt, 2011; Heinen et al., 2017; W. Zeng et al., 2019). Students of this faculty are also described as being at long-term risk of depression (Rotenstein et al., 2016). According to LeMoult and Gotlib (2019), subjects at risk of depression exhibit mood-congruent cognitive biases when they are in a dysphoric mood. Moreover, as it was noted by Armstrong and Olatunji (2012) not only people with depression exhibit attentional biases to dysphoric stimuli, but also people with cut-off depression scores. The only difference between attentional biases in less and more depressed individuals is the severity of attentional biases (Armstrong & Olatunji, 2012). Since medical students are at risk of depression and even 27% of them are plagued by this illness (Rotenstein et al., 2016), they should exhibit at least a weaker form of cognitive biases characteristic of people diagnosed with depression.

Practicing mindfulness is described as reducing symptoms of stress, anxiety, depression and as increasing well-being in people such as medical students who experience chronic stress, fast-paced life and academic pressure, and are therefore at risk of high psychiatric morbidity (Fauzi et al., 2021; Rotenstein et al., 2016; Suarez et al., 2021; Ungar et al., 2022). Mindfulness practice involves intentionally noticing and observing internal and external experiences with openness, curiosity and with gentleness, but without judgement or the desire to necessarily act upon them (Kabat-Zinn, 1990; Williams & Penman, 2011). In contrast to mindfulness, depression and anxiety as internalising and often comorbid states (Gorman, 1996; Saade et al., 2019) are characterised by over-engagement (worry, rumination, overgeneralisation) or under-engagement (experiential avoidance and thought suppression) in internal experiences (Baer et

al., 2008; Feldman et al., 2007). However, it is important to notice that mindfulness trait is not simply contrary to depressive or anxiety symptoms. For example, increased self-observation occurs both in mindful and depressive states, but depressive self-observation is associated with increased negative self-attention and ruminative thinking (Baer et al., 2008), whereas mindful observation does not promote either avoiding or dwelling on emotions (Feldman et al., 2007; Kiken & Shook, 2011). Mindful observation is rather associated with non-judgmental engagement in present emotions regardless of their valence (De Raedt et al., 2012; Kabat-Zinn, 1990).

In terms of attentional processes, mindfulness has also been described as associated with greater self-regulation of attention (e.g. increased attentional inhibition and control), and an open, accepting awareness of the very experience of the present moment regardless of emotions, thoughts, and body reactions it elicits (Bishop et al., 2004; Kiken & Shook, 2011). Therefore, it might be assumed that due to a greater ability to control attention, people characterised by the *mindfulness trait* respond more adaptively to both positive and negative emotions, because they are more aware of their present experiences, and they do not feel urge to immediately react upon them (De Raedt et al., 2012; Ford et al., 2021; Goodall et al., 2012; Pavlov et al., 2015).

However, it is not yet fully understood how mindfulness interventions (during which participants practice a *mindful state* leading to the increase of the *mindfulness trait*) affect visual attention to emotional stimuli. According to our knowledge, there is only one published study employing eye-tracking in order to examine the influence of mindfulness intervention on visual attention (Holas et al., 2020). This study by Holas and colleagues (2020) has shown that an 8-week Mindfulness-Based Cognitive Therapy (MBCT) decreases depressive attentional bias in patients with a current depressive episode and, thus, leads to a decrease in depressive symptoms. The remaining studies on the effects of mindfulness training on attention to emotional stimuli (De Raedt et al., 2012; Verhoeven et al., 2014) applied reaction time measures, whose

methodological drawbacks were described in Chapter I. All of those studies (Holas et al., 2020; De Raedt et al. 2012; Verhoeven et al. 2014) examined Mindfulness-Based Cognitive Therapy (MBCT) which was designed to prevent relapses in recurrent depression in previously depressed patients.

Mindfulness is known to play a role in reducing depressive and anxious attentional and interpretative biases both in people with depression or anxiety and in those at risk of developing these conditions (Gibb et al., 2022; Holas et al., 2020). Thus, we decided to examine the effects of a mindfulness intervention on visual attention in a group of medical students at risk of depression due to university pressure and increasing occupational stress. Since generally our participants were not depressed patients, and we did not expect them to show symptoms of severe depression in self-descriptive measure, we applied 8-week Mindfulness Training by Williams and Penman (2011) designed for healthy people exhibiting fast-paced life and everyday work pressure who, thanks to the training, might avoid developing depressive episode in the future.

It is important to notice that the eye-tracking procedure by Holas and the team (2020) consisted of the simultaneous presentation of human face images showing neutral, sad, angry, or happy facial expressions. According to Aviezer and colleagues (2017), conducting research on such highly stereotypical and decontextualised facial stimuli prevents the investigation of reactions to always highly contextualised and ambiguous real-life emotional expressions. In line with Aviezer and the team (2017), it is possible to perceive such expressions accurately only in their original context (for example emotions on the decontextualised face of a winning tennis player is almost impossible to distinguish from the decontextualised face of a player who just lost a match). Therefore, in our study, we resigned from applying the classical multi-image free-viewing procedure in favour of employing more ecologically valid one-image displays of naturalistic social stimuli resembling participants' everyday experience, expected to elicit

depressive cognitive biases with higher reliability. As it was shown in Chapter III, biases in selecting key emotional regions of images are possible to capture on separately presented complex social stimuli, therefore, we assumed that similar biases in visual attention are also likely to occur in the free-viewing conditions when examined on complex social stimuli.

The key regions responsible for images' valence were determined before the study, and have been later used as regions of interest (ROIs) in eye-movements analysis. According to the line of research on meaning maps (Henderson et al., 2019; Pilarczyk et al., 2019), the meaning maps (upon which, in the case of our study, we created ROIs) serve as a good measure of attentional deployment. Therefore, we assumed this method would be sensitive enough to reveal changes in hypothesised attentional shifts for the purpose of our study. We conceptualised selective attention to stimuli of particular valence as a longer normalised first-pass duration (nFPD) towards ROIs of this valence.

Our study aimed to investigate how mindfulness training affects visual attention to complex emotional stimuli in people at risk of developing depression (students of medicine). Following the mindfulness intervention, we expected a change in the time spent on watching regions responsible for the emotional valence of natural scenes in the group at risk of depression. We assumed that participation in mindfulness training would result in an increase of attention toward positive and a decrease of attention towards negative ROIs (contrary to the mechanism of depressive attentional biases). We also suspected that, alternatively, in line with the definition of mindfulness (as promoting non-judgmental and curious experience, regardless of the type of the experience), mindfulness training might effect in a general increase in visual attention to images' ROIs regardless of the stimuli valence.

In addition, we aimed to test whether the predicted change in attention is moderated by changes in self-report measures of depressive and anxiety symptoms, *mindfulness trait*, and *mindfulness*

advancement. We predicted that this change would co-occur with a decrease in depressive and anxiety symptoms and an increase in *mindfulness trait,* as well as with *advancement in mindfulness*.

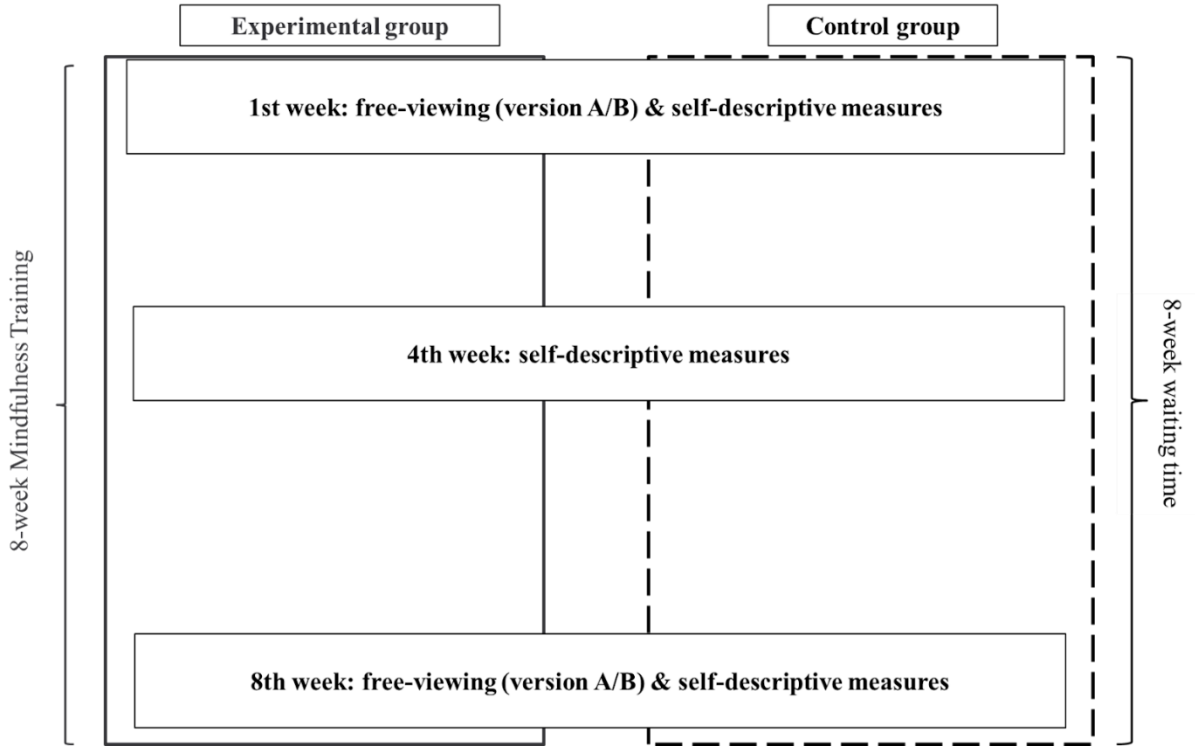
5.2 Materials and methods

5.2.1 Experimentation design

We carried out 3 measurements during the study, of which the first and the last involved eye-tracking procedure described in this chapter (for the description of self-descriptive questionnaires, see Chapter IV). The first eye-tracking measurement took place in the 1st week of the study. It consisted of a free-viewing task on previously evaluated images (in version A or B randomly chosen) and the completion of self-descriptive questionnaires after the eye-tracking procedure. After the first measurement, the experimental group started 8-week mindfulness training (Williams, Penman, 2011) while the control group waited for the following measurements. In the 4th week, participants completed self-descriptive measures again and continued the mindfulness training (experimental group) or the waiting time (control group). Finally, in the 8th week, the eye-tracking measurement was repeated. To avoid learning and habituation, the photos in the second measurement were changed to a set different from the one used in the 1st week of study, but equivalent in terms of arousal and valence. For a scheme of experimental design, see Fig. 5.1.

Fig. 5.1

Scheme of experimental design



5.2.2 Participants

For the evaluation of images used in our free-viewing study, we recruited 43 participants (8 men) aged 19-32 (M = 21.44, SE = .35, SD = 2.31). Subjects were recruited via The Jagiellonian University advertisement mailing system and received credit points for their participation. The inclusion criteria were (1) having normal or corrected to normal vision, (2) access to the computer with an internet connection, (3) access to a computer mouse, (4) not being diagnosed with affective disorder, as well as (6) negative family history of affective illnesses. Due to the positive history of affective illnesses in the family, data gathered from four participants were excluded from further analysis.

Participants of the main part of the experiment (eye tracking and completion of self-descriptive measures) were described in Chapter IV, for the description of its participants see section 4.2.2.

It should be noted that participants of our study did not have experience with meditation practices, such as participation in a mindfulness intervention.

After the study, eye-tracking data gathered from 7 subjects from the experimental group and 10 from the control group were excluded from further analysis due to large calibration errors (n = 6, n = 9, respectively) as well as COVID-19 incidence among participants (n = 2, control group) which resulted in participants withdrawal from the second measurement. Finally, from the first eye-tracking measurement we obtained 54 datasets and 46 from the second one.

Our study was carried out in accordance with the Declaration of Helsinki (World Medical Association, 2001). Prior to the beginning of the study, every participant signed informed consent.

5.2.3 Visual stimuli

We used the same set of 245 images from standardised image databases as used in the second study, described in Chapter III (section 3.2.2).

Each of the images was evaluated by approximately 30 participants (M = 30.4, SE = .04, SD = 0.55). There was no significant difference in the number of evaluators between the valence conditions (negative, neutral, positive), $F(2, 242) = .49$, $p = .615$, $\eta_{p^2} = <.001$.

5.2.4 Evaluation of visual stimuli

The evaluation procedure which concerned selecting key regions of images responsible for their meaning was identical to that conducted in the second study (see Chapter III, section 3.2.3). Conversely to the procedure conducted during the second study, no additional self-descriptive questionnaires were given. After the evaluation, in order to alleviate the possible distress, the film clip depicting funny animals was presented.

5.2.5 Regions of interest selection

After the evaluation procedure, we averaged participants' selections following the procedure described in Pilarczyk & Kuniecki (2014) to obtain greyscale 600 x 800 heatmaps representing the percent of participants who selected particular regions as key emotional elements of pictures. Later, in every image, we have algorithmically chosen regions of interest (ROIs), defined as the regions marked as key to the emotional content of images by at least 50% of participants. All computations were performed in MATLAB (The MathWorks, Inc., Natick, Massachusetts, USA, 2018).

Fig. 5.2

Examples of negative (I), neutral (II), and positive (III) original valenced social images and corresponding maps

Note. Presented pictures (III) originate from NAPS (Marchewka et al., 2014) and (I, II) EmoPics (Wessa et al., 2010) databases.

5.2.5 Eye-tracking procedure

Firstly, one of two versions of the procedure (A or B) including different images was randomly chosen by the experimenter. The other version was shown at the second experiment session, which took place after 8 weeks. (see Fig. 5.3.). Images were presented in random order.

To provide two sets (procedure A, procedure B) of emotionally valenced stimuli not significantly different in terms of valence and arousal, and to provide an equal number of images of particular valences for each of our free-viewing procedures, we have chosen 180 from previously prepared 245 images. The final set presented during the free-viewing phase of the experiment consisted of 60 negative, 60 positive, and 60 neutral images, with the mean valence and arousal of stimuli given in Table 5.1.

Table 5.1

Mean valence and arousal ratings of visual stimuli used in the study

	set A					
	valence			arousal		
set of images	M	SE	SD	M	SE	SD
negative	3.07	.13	.68	5.97	.16	.82
neutral	5.15	.09	.48	3.91	.18	.98
positive	6.91	.08	.44	4.5	.11	.57
	set B					
negative	2.99	.17	.85	5.97	.15	.76
neutral	5.08	.1	.53	3.91	.19	1.08
positive	6.91	.11	.59	4.48	.17	.86

Note. Valence rates: 1 (very negative) – 9 (very positive); arousal rates: 1 (relaxed) to 9 (aroused); M: mean; SE: standard error of the mean; SD: standard deviation

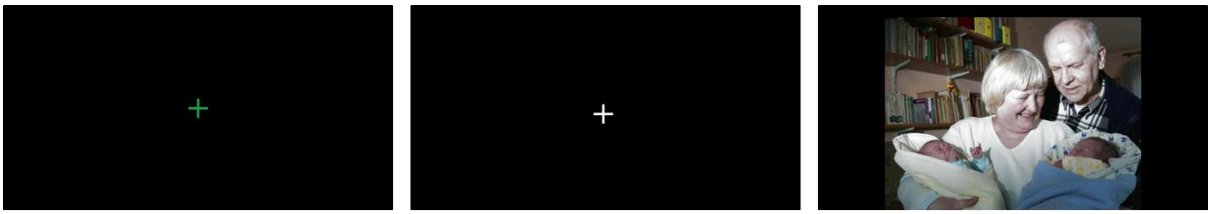
This experiment was part of a larger study which is beyond the scope of this chapter. Upon arrival, participants were informed about the time course of the study and signed informed consent. Next, they were seated in a room with constant artificial lighting set to 90 lux in an adjustable chair approximately 70 centimetres from the computer screen (24-inch TFT Benq XL2411 monitor calibrated to the white point CIE Illuminant D65 and luminance of 120 cd/m2 with The ColorMunki software (X-Rite, Michigan, USA), resolution: 1200 by 900 pixels, visual field cover: 27 deg. in width, 20.5 deg. in height). Subsequently, they were instructed to use chinrest and refrain from body moves during the procedure.

The procedure was divided into 2 blocks (45 images each) with a mid-session break to rest eyes and improve head alignment. Participants were instructed to watch images freely and not to look away from the computer screen area. They were also encouraged to limit excessive eye blinking. Each trial began with a presentation of a green fixation cross (2 sec) which was .4° × .4° of visual angle, indicating that the participant is allowed to blink, it was followed immediately by a central fixation cross (1-3.5 sec) of the same size. Next, one of the images, each of which was 12° × 17° of visual angle, was displayed (5 sec) followed by the consecutive trial.

In total, the entire procedure of one measurement (free-viewing and completing the self-descriptive measures) lasted approximately 1.5 hour. The first measurement took place before the first meeting of mindfulness training, while the last one after 8 weeks.

Fig. 5.3

Free-viewing scheme



Note. Presented picture originate from NAPS (Marchewka et al., 2014) database.

5.2.6 Recording of eye-movements

Eye-movements were recorded via an infrared remote Eyelink 1000 eye tracker (SR Research, Ontario, Canada) with 500 Hz sampling of eye position. Free-viewing procedure was programmed with Eyelink Experiment Builder 196 (SR Research, Ontario, Canada). Every block began with a nine-point calibration and validation procedure which, if necessary, was also repeated during the study. During the free-viewing procedure, the movements of both eyes were recorded, but only the data for the eye with better calibration parameters were later analysed.

5.2.7 Eye-movement analysis

Eye fixations coordinates were obtained using the in-built Eyelink 1000 (SR Research, Ontario, Canada) default algorithm, and post-processed in MATLAB environment (The MathWorks, Inc., Natick, Massachusetts, USA, 2018). Saccadic thresholds were 30°/sec for velocity, 8000°/sec^2 for acceleration, and .15 ° for saccade motion. The mean calibration error was .34° (SD = .21°, SE <.001°). Fixations were calculated as the period between the end of one saccade and the beginning of the subsequent one. We did not set a threshold to eliminate microfixations, however fixations longer than 100 ms comprised 94% of analysed data.

Our main interest was to examine the effects of mindfulness practice on visual attention patterns towards valenced stimuli in a group at risk of developing depression, i.e. with a high probability of occurrence of depressive attentional bias (Armstrong & Olatunji, 2012). To measure attention hold commonly used to assess depressive attentional biases (Caseras et al., 2007; Eizenman et al., 2003; Kellough et al., 2008; LeMoult & Gotlib, 2019), we calculated the duration of the first-pass, i.e. the summarised duration of fixations between entering and leaving the ROI for the first time. In order to normalise the first-pass duration to provide control over the influence of ROIs size, we divided the first-pass duration by a percent of the total image area covered by the ROI. Higher values of normalised first-pass duration index (nFPD) mean a longer first-pass on an object corrected for its area size.

5.2.7 Mindfulness Training

Participants from the experimental group took part in the mindfulness intervention described in detail in Chapter IV, for the description of mindfulness training see section 4.2.3.

5.2.8 Self-descriptive measures

For the description of self-descriptive methods, see section 4.2.4.

5.2.9 Statistical analysis

All analyses were performed in jamovi (The jamovi project, 2022) which operates in the R programming language (R Core Team, 2021). To perform mixed model analyses, the GAMLj package was used (Gallucci, 2019). The significance threshold for all analyses was determined as $\alpha = .05$.

We applied linear mixed models with restricted maximum likelihood. This type of analysis enabled us to incorporate continuous and nominal predictors into one statistical model, as well as explicitly assess variance associated with differences between participants and stimuli (Judd

et al., 2012). The impact of random effects on improving the likelihood of the models was tested with the Random Effects Likelihood Ratio Test.

The model consisted of normalised first-pass duration as a continuous dependent variable; valence of images (*valence*: negative, positive, neutral; numeric value), group affiliation (*group*: experimental or control), and time of measurement (*time*: 1st week or 8th week; numeric value) as fixed nominal factors; stimuli and participant as random factors with random intercept as well as self-descriptive measures of depression, anxiety, and mindfulness (*FFMQ-SF Composite, FFMQ-SF Describe, FFMQ-SF Acting with awareness scale, FFMQ-SF Non-judging of experience scale, FFMQ-SF Non-reactivity to inner experience scale; MINDSENS, BDI-II, STAI-X2*, numeric value) as continuous covariates. The interactions between *valence, group, time* and self-descriptive measures (each of the self-descriptive measures was included in a separate analysis) were all tested.

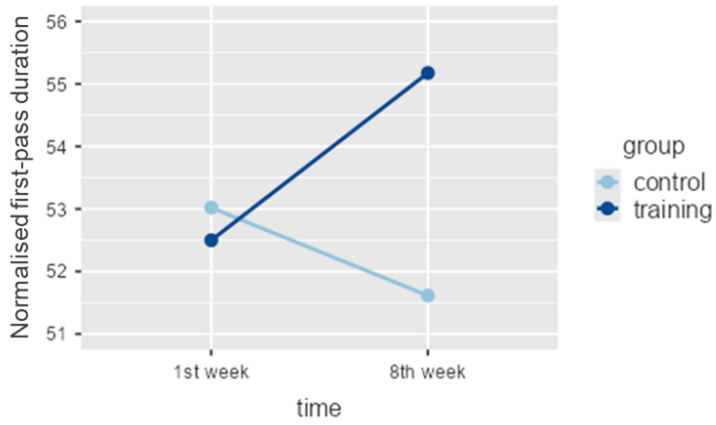
5.3 Results

Only the results in the model with MINDSENS Composite Index (*advancement in mindfulness*) as a covariate were significant. This model had a good fit (R^2 conditional = .75). There was a significant effect of *valence* on nFPD, $F(2, 161.7) = 6.9$, $p = .001$. Significantly higher nFPD was shown for neutral ($M = 55.7$, $SD = 42.91$) than for negative images ($M = 41.49$, $SD = 44.14$), $t(161.13) = 3.61$, $p < .001$, and for positive ($M = 42.57$, $SD = 32.25$) than for negative images, $t(160.96) = 2.57$, $p = .011$. Moreover, there was a marginally significant interaction between *group* and *time*, $F(1, 581.35) = 3.79$, $p = .052$, indicating an increase in nFPD from 1st to 8th week in the experimental group and a decrease in nFPD in the control group (control group: $M = 44.66$, $SD = 42.1$ in the 1st week; $M = 45.40$, $SD = 39.94$ in the 8th week; experimental group: $M = 45.59$, $SD = 40.31$ in the 1st week; $M = 48.17$, $SD = 40.16$ in the 8th week), see Fig. 5.4. Furthermore, a significant interaction between *time*, *valence* and *group* was

shown, F(2, 3954.55) = 3.78, p = .023. There was no significant difference between groups in nFPD on given valences in the first measurement. The 8-week waiting time resulted in a significant decrease in nFPD on neutral images in the control group (1st week: M = 55.89, SD = 51.25; 8th week: M = 52.74; SD = 38.34), t(3300.92) = -2.26, p = .024), see Fig. 5.5.

Fig 5.4

Plot of the marginally significant interaction between the *group* and *time* on nFPD

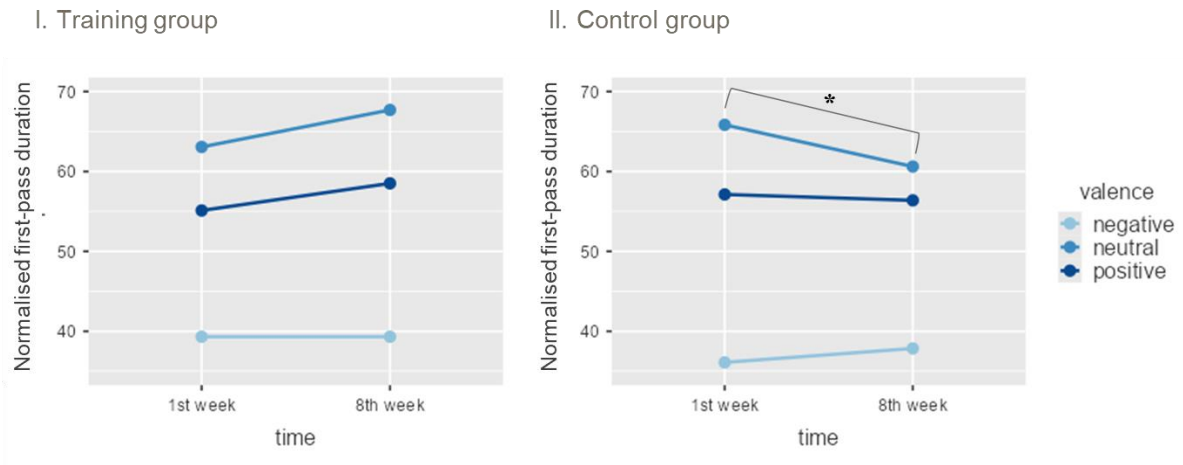


Moreover, a significant interaction between the *group*, *time*, and *advancement in mindfulness* measured in the 1st and the 8th week was shown, F(1, 1804.35) = 7.48, p = .006. For individuals more advanced in mindfulness taking part in mindfulness training was associated with a significant increase in nFPD after the training, t(676.1) = 2.37, p = .018. However, for individuals more advanced in mindfulness but not assigned to training, the waiting time was associated with a significant decrease in nFPD, t(911.44) = -2.38, p = .018, for a plot of those results, see Fig. 5.6. Finally, the interaction between *group*, *time*, *valence*, and the *advancement in mindfulness* was not significant. Importantly, there was no significant difference between groups in MINDSENS Composite Index in the 1st-week measurement, as it was shown in Table 4.2 (Chapter IV).

All remaining effects were non-significant.

Fig 5.5

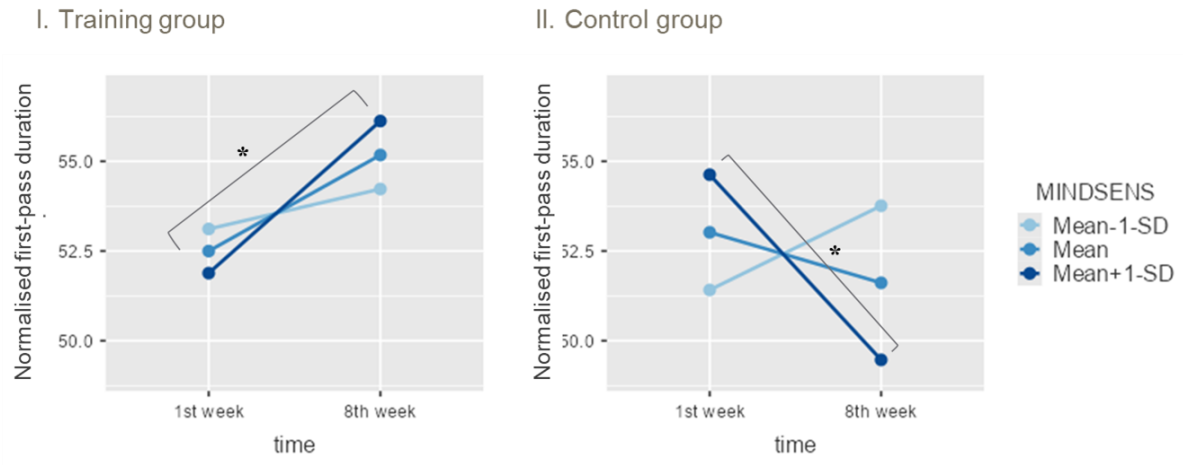
Plot of the interaction between the *time*, *valence,* and *group* on nFPD



Note. Asterisks denote significant differences in pairwise comparisons;* depicts p-value below the threshold of α = .05

Fig 5.6

Plot of the interaction between *time*, *group,* and MINDSENS on nFPD



*Note. Asterisks denote significant differences in pairwise comparisons;** depicts p-value below the threshold of α = .05

5.4 Discussion

According to our theoretical assumption, medical students as a group at risk of depression should have exhibited depressive attentional biases at the initial measurement of visual attention when compared with the control group (LeMoult & Gotlib, 2019; Rotenstein et al., 2016). However, our results did not confirm it. We suppose that it happened due to the fact that experimental and control groups did not significantly differ in terms of self-descriptive depression level (see Table 4.2, Chapter IV). An alternative possible explanation is that our methodology might not have been sensitive enough to detect subtle attentional biases which are expected in groups at risk of depression, or that those biases are difficult to detect in free-viewing of complex images presented separately. However, further research is required to determine which of these explanations is correct.

Nevertheless, mindfulness training did result in a change in the visual attention in the group undergoing mindfulness training, but not as we expected.

Participation in mindfulness training was associated with an increase, whereas waiting time with a decrease in fixation duration (nFPD) on regions responsible for the emotional valence of images (marginally significant effect). When the valence of images was taken into account, the effect was significant only for neutral stimuli in the control group. In the 8th week, after the wait time, subjects from the control group spent less time inspecting key ROIs in neutral images (nFPD) than in the 1st week. This effect might be associated with the process of habituation to mundane stimuli, which occurred in the control group but was somehow hampered in the training group. We suggest that because mindfulness practice increases non-judgmental curiosity it might decrease habituation processes (Bishop et al., 2004; Weder, 2022), usually induced by neutral repetitive stimuli (McSweeney & Murphy, 2009). As a result, the experimental group developed less habituation to neutral stimuli and maintained curiosity about its content, whereas the control group did not. Being more mindful, the experimental group was

also more resistant to habituation to the neutral (most habituating, less arousing) stimuli, and their fixation duration to the neutral stimuli did not significantly decrease in the second measurement as it did in the control group. However, in light of the studies on mindfulness and habituation measured by startle reflex response showing that intense or moderate mindfulness practice might be associated with the increase in habituation (Antonova et al., 2015; Kumari et al., 2023) those hypotheses require further investigation. Future research should address the differences between the influence of mindfulness practice on habituation processes in visual attention and on startle reflex response.

Interestingly, our results do not corroborate those obtained by Holas and his research group (2020) who conducted an 8-week Mindfulness-Based Cognitive Therapy (MBCT) in depressed participants. They observed an increase in visual attention (dwell time) towards images of positive facial expressions and a decrease in visual attention towards negative ones, accompanied by a decrease in depressive symptoms. According to Holas and colleagues (2020), self-reported depressive symptoms correlate negatively with the attentional change described above. In our study, following mindfulness intervention, there was no attentional change associated with images of positive or negative valence. We assume that was the reason we also did not observe associations of attentional measures with the change in affective symptoms (of depression and anxiety). Moreover, it is also possible that the relationship between relatively small changes in depressive and anxiety symptoms following the training might have not been sufficient for the significant relationship with attention to reveal.

We suppose that the difference between our results and those obtained by Holas's team (2020) may have also been caused by methodological differences between our studies (we used less stereotypical and more contextualised stimuli) and the subjects' diagnoses (depression vs. at risk of depression). Moreover, it is probable that MBCT used by Holas and Mindfulness Training by Williams and Penman (2012) used by us influence visual attention differently due

to, for example, differences in training programmes and session duration. However, further research on more similar groups (in terms of diagnosis and the type of mindfulness training they took part in) is required to verify this assumption.

Surprisingly, in our study, attentional change following mindfulness training was associated only with one of the examined self-descriptive measures. Our results have revealed that being naturally more advanced in mindfulness according to the self-descriptive measure (MINDSENS Composite Index) was associated with an increase in gaze duration on key emotional regions after an 8-week mindfulness intervention. Furthermore, our results have also shown that for individuals naturally more advanced in mindfulness but not participating in mindfulness training, gaze duration on regions responsible for the valence of presented images decreases after an 8-week wait time. On these bases, we suggest that the effects of naturally occurring *advancement in mindfulness* (importantly, participants had no previous meditational experience, and there were no significant differences in MINDSENS scores in the first measurements between the groups) on visual attention should be maintained by regular mindfulness practice, and if not, they might diminish with time. It is also possible that being naturally more mindful before the training is beneficial for gaining advantages (such as a change in visual attention) from an 8-week mindfulness intervention.

There were no significant associations between the changes in visual attention following the training and the measures of *mindfulness trait* (FFMQ-SF *Acting with awareness scale*, FFMQ-SF *Non-judging of experience* scale, FFMQ-SF N*on-reactivity to inner experience* scale, FFMQ-SF *Describing* scale). The most surprising effect was the co-occurrence of a non-significant association between attentional change and a composite measure of *mindfulness trait* (FFMQ-SF Composite) with a significant association between attentional change and *advancement in mindfulness* (MINDSENS Composite Index).

One of the three subscales of the *advancement in mindfulness* scale (MINDSENS) is the *Observing* which comprises items of the *mindfulness trait Observing* scale (FFMQ-SF *Observing* scale). According to Baer (2006, 2008) *Observing* scale which is an element of *mindfulness trait* questionnaire (FFMQ-SF) should not be taken into account in measuring *mindfulness trait* in non-advanced meditators (see Chapter I, section 1.7.1-1.7.2.). Therefore, in our study, we did not take this scale (FFMQ-SF *Observing* scale) into account when examining *mindfulness trait*, we measured *observing* only as an element of the composite measure of *advancement in mindfulness* (*Observing* subscale of MINDSENS).

However, our study conducted on non-advanced meditators revealed significant associations between mindfulness scales and visual attention only when a measure consisting of the *Observing* scale (MINDSENS) was taken into account. These results suggest that naturally occurring high levels of the mindful trait of observing (understood as the ability to notice or attend to internal and external sensations such as feelings, thoughts and emotions) might be crucial in eliciting the attentional change in mindfulness intervention participants. However, those assumptions need further verification, because, for example, higher scores in mindful observing as measured by mindfulness questionnaires might be also associated with increased negative self-attention and ruminative thinking (Baer et al., 2008) which were not examined in this study.

It is important to notice that in our study there was a significant effect of valence on the measure of attention. However, it was partially different from effects usually obtained in similar studies (e.g. Humphrey et al., 2012; Niu et al., 2012) where negative stimuli engaged not only more visual attention than positive stimuli (as it also happened in our study) but also negative stimuli engaged more attention than neutral, i.e. less arousing, stimuli. This difference stems from the normalisation of the first-pass duration which we used, and which has not been applied in cited studies. In our study, negative images had the largest ROIs therefore, in the effect of the

normalisation (which consisted of dividing the first-pass duration by the percent of the total image area covered by the ROI) their numerical values became smaller than the values calculated for images with smaller ROIs i.e. positive and neutral.

5.5 Limitations

The participants of the study were mostly women. To improve the generalisability of results, it would be beneficial to conduct future studies in more gender-diverse groups. Moreover, the participants of the study were solely the students of Jagiellonian University. Future studies should focus on expanding the sample to include subjects at risk of depression from the general population.

5.6 Conclusions

Although the group at risk of depression did not show attentional bias in the first measurement, at the final measurement, several important differences transpired. Our results have shown that nFPD to key semantic regions of complex visual stimuli increased following the mindfulness training and decreased in subjects who were assigned to the wait list (marginally significant effect). Moreover, only in the control group, nFPD on neutral stimuli decreased following the 8-week waiting time. We conclude it was associated with habituation to mundane stimuli in the control group, which was hampered in the experimental group due to the participation in mindfulness training, which promotes non-judgmental curiosity and decreases habituation processes.

Moreover, subjects more advanced in mindfulness (self-report measure) have shown an increase in nFPD to ROIs of valenced visual stimuli after the mindfulness training without the effect of a specific valence. Furthermore, participants from the control group have shown a significant decrease in nFPD with no effect of specific valence. This effect suggests that naturally occurring high level of *advancement in mindfulness* and especially its element which

is mindful *observation* might be important in taking advances such as the change in visual attention from an 8-week mindfulness intervention.

Our study makes a contribution to the promising line of research regarding changes in visual attention following mindfulness interventions. Most importantly, it employs more environmentally valid stimuli than other available studies and thus enables examining attention allocation in a more natural setting. Moreover, according to our knowledge, it is the first eye-tracking study to engage a group at risk of depression in a mindfulness intervention.

VI. GENERAL DISCUSSION

The aim of our work was to describe mutual relations between attention, depressive symptoms and mindfulness. We examined those relations complexly in both depressed individuals (patients of the outpatient clinic) and healthy subjects at different levels of risk of developing depression. Since anxiety is often comorbid with depression (Gorman, 1996; Kessler et al., 2015; Saade et al., 2019), in each of the conducted studies, we controlled anxiety trait measures.

Firstly, we studied the relationship between depression, anxiety and mindfulness in students of various faculties using Polish versions of mindfulness measures. Secondly, we examined perceptual biases in depression while detecting emotional content in complex social stimuli resembling natural visual scenes. We also checked the influence of comorbidity of depression and anxiety on the type of occurring biases. It was also our intent to examine associations of perceptual biases with the level of *mindfulness trait*, however, it was impossible to conduct in our group of respondents due to the large drop-out rate. Moreover, we studied the effectiveness of mindfulness training on the change of self-descriptive symptoms of depression, *anxiety trait, mindfulness trait* and *advancement in mindfulness* as well as in visual attention in a group of medical students at risk of developing depression.

It is important to notice that in our studies, we applied not only questionnaires but also more advanced computational measures such as analysis of perceptual biases in selecting meaning maps of complex visual stimuli or eye-tracking. Hence, we have significantly complemented the research on the effect of mindfulness on depressive symptoms in groups at risk of depression. Crucially, our work is one of the first in an emerging trend of combining empirical and biologically-based methods in mindfulness research, the need for which has been advocated in timely review summarising recent advances and state-of the-art in the field of mindfulness-based interventions (Zhang et al., 2021). Moreover, our results extend the line of Polish studies

on self-descriptive mindfulness measures, which up to date, were used only for standardisation purposes (Radoń, 2014, 2020; Radoń & Rydzewska, 2018).

Furthermore, contrary to other studies on mindfulness interventions and attention (De Raedt et al., 2012; Holas et al., 2020), we did not use stereotypical and decontextualised stimuli (photographs of human faces). Instead, we conducted our research using complex natural scenes differing in valence (negative, positive, neutral). It enabled us to examine participants' reactions to more contextualised and thus more environmentally valid stimuli resembling real-life situations to which they emotionally respond on a daily basis (Aviezer et al., 2017).

6.1 Mindfulness association with depression and anxiety

Our work shows that naturally occurring *mindfulness trait* and the *advancement in mindfulness* are negatively correlated with symptoms of depression and *anxiety trait* when examined with self-descriptive measures in a population of Polish students. Thereby, we corroborate similar studies (e.g Deng et al., 2014; Soysa & Wilcomb, 2015; Vorontsova-Wenger et al., 2021) showing that mindfulness can be a potential protective factor against the development of depression in students. This result answers our first scientific question regarding the relationship between mindfulness, depression and anxiety which was posed in the dissertation.

6.2 Perceptual biases associated with depression

Answering our second scientific question, we have shown that individuals who are both highly depressed and highly anxious have a very distinctive form of perceptual bias which we called ‘attentional sharpening’ that probably would not manifest had it been studied in each of the disorders separately.

Specifically, we have shown that individuals with co-occurring high levels of depression and anxiety are characterised by narrowed attentional field and selective and thorough detection of negative content. Interestingly, this bias was not present in people who also had a high level of

depression but a relatively low level of anxiety. We suppose that when co-occurring with low anxiety, depressive symptoms as rather impairing performance in complex tasks such as ours (Horne et al., 2021), mask this bias. However, when depressive symptoms co-occur with high anxiety, which motivates the constant search for threats to avoid (Gupta et al., 2019; Armstrong & Olatunji, 2012; Richards et al., 2014), 'attentional sharpening' emerges.

Our work shows that considering the comorbidity of depression and anxiety is crucial for the research on perceptual biases in depression. We believe that taking comorbidity into account would improve the efficacy of therapeutic interventions aiming to modify perceptual biases.

6.3 Influence of mindfulness intervention on self-descriptive depression, anxiety and mindfulness

Answering our third scientific question, we have also shown that mindfulness intervention leads to a significant decrease in self-descriptive depressive and anxiety symptoms and an increase in *mindfulness trait* as well as the *advancement in mindfulness* in a group of medical students at risk of developing depression.

Nevertheless, it is important to note that the consensus on the effect of mindfulness training on depressive symptoms is not shared in all studies conducted on medical students. Indeed, some studies report a lack of anti-depressive effect of mindfulness interventions conducted in such groups of students (Chen et al., 2016; Danilewitz et al., 2016; O'Connor et al., 2023; Rosenzweig et al., 2003; Warnecke et al., 2011). Importantly, however, the majority of studies conducted also in populations at risk of depression or already depressed, show a reduction in depressive symptoms following mindfulness interventions, as does our work (e.g. Barry et al., 2019; Hofmann & Gómez, 2017; Khoury et al., 2013; Serrão & Alves, 2019; Young et al., 2018; Zhang et al., 2021).

In fact, in a growing line of research, the depression-reducing effect of mindfulness practice has been demonstrated not only in medical students (e.g., Garneau et al, 2013; Hassed et al., 2009; Shapiro et al., 1998; Burgstahler et al., 2020) but also in students of other faculties (Barry et al., 2019; Rosky et al., 2022; Serrão & Alves, 2019), adolescents at risk of depression (Young et al., 2018), and individuals diagnosed with depression and anxiety (Bouvet et al., 2015; Hofmann & Gómez, 2017; Holas et al., 2020; Zhang et al., 2021). Crucially, mindfulness has also been reported to have depression- and anxiety-reducing effects, even when the impact of psychoeducation and group support (both provided during the mindfulness intervention) on mood were disentangled from the effects of mindfulness meditation (Zhang et al., 2021).

In view of our results and many of the findings described above that confirm them, we advocate the introduction of mindfulness training also into the curriculum of Polish students. In particular, we recommend it for medical students in order to provide them with antidepressive support, as their risk of developing depression is higher than that of students from other faculties (Heinen et al., 2017; S. Zeng et al., 2019) . However, it should be considered that students already suffering from depression and willing to participate in the intervention may need additional support (e.g., outpatient care, Mindfulness-Based Cognitive Therapy), which should also be provided during their studies.

6.4 Influence of mindfulness intervention on attention, mindfulness, depression and anxiety

Despite the fact that the group of medical students, who according to the literature should have been at greater risk of depression, did not manifest higher depressive symptoms than the control group, and did not show initial perceptual biases, the mindfulness training still brought a significant change in visual attention in this group.

We showed that mindfulness training results in an increase in visual attention to images regardless of their valence especially in participants with higher pre-training *advancement in*

mindfulness. Since the *advancement in mindfulness* scale was the only one of the mindfulness scales used in this study that also measured the capacity for mindful observing, we assume that mindful observing may be crucial in predicting visual change after mindfulness training.

However, when only the valence of images was taken into account in the statistical model and *advancement in mindfulness* was skipped from covariates, there was no significant effect of mindfulness training on the increase of visual attention to complex images. Nevertheless, importantly, there was a decrease in visual attention towards neutral stimuli in the waitlist group. Our results suggest that even if mindfulness training in the at-risk-of-depression group did not bring significant change in visual attention except for subjects characterised by greater *advancement in mindfulness*, it most likely, prevented participants from the decrease of visual attention towards the most mundane neutral stimuli, which might be associated with the decreased habituation processes related to practicing mindfulness.

Interestingly, despite the fact that our work does demonstrate a significant decrease in depressive and anxiety measures (see Chapter IV) as a result of mindfulness training, this change does not transpire to the changes in visual attention. We suspect that the attentional change was too weak to show an association with a decrease in depressive and anxiety symptoms. It should also be noted that our group of at-risk-of-depression participants did not actually suffer from depression (unlike the group in the experiment described in Chapter III) and hence did not show attentional biases even before training. Perhaps, therefore, the relation between their relatively small change in depressive and anxiety symptoms as a result of the training was not sufficient to reveal a significant relationship with attention. This conclusion is supported by the fact that in the second study (Chapter III) also conducted on complex stimuli, perceptual biases were related to the level of affective symptoms; however, this was reported in the older and more severely depressed subjects than the participants taking part in the study on mindfulness intervention.

Crucially, however, despite the lack of observable changes in attention, our work showed decreased depressive symptoms (Chapter IV) in individuals at-risk-group following the mindfulness intervention, which answers our fourth scientific question. Therefore, it seems safe to conclude that overall mindfulness practice may be a protective factor against the development of depression in healthy individuals, as corroborated also by other studies (Liu et al., 2021; Martínez-Rubio et al., 2021; Westphal et al., 2021) even if it does not bring the change in visual attention specifically to valenced stimuli.

6.4 Conclusions

Our work suggests the existence of a remarkably distinctive form of attentional bias in highly depressed and highly anxious patients, which cannot be captured by examining biases for each disorder separately. We describe it as 'attentional sharpening' involving a narrowing of the attentional field and selective and precise detection of negative content. Thus, our work shows that the influence of the often comorbid depression and anxiety on attention should always be examined simultaneously.

Furthermore, we demonstrated a negative relationship between depression and anxiety and naturally occurring mindfulness, as well as mindfulness developed during mindfulness training. Our work also suggests that in groups at risk of depression, *mindful observing* may be an important determinant of change in visual attention, and that mindfulness training may lead to affective improvement in groups at risk of depression, even if it does not lead to valence-specific changes in attention.

To our knowledge, our work significantly complements the line of research on mindfulness in groups at risk of depression, such as medical students, by combining self-descriptive measures with eye-tracking. Finally, it is one of the first attempts in Poland to measure the relationship

between anxiety and depression symptoms and mindfulness using Polish versions of mindfulness questionnaires.

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