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Short mindfulness-based intervention for psychological and academic outcomes among university students

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ABSTRACT
This study aimed to evaluate the effectiveness of a short mindfulness intervention on anxiety, stress and depression symptoms, as well as on inhibition of dominant responses and academic performance among university students. Fifty volunteers (M(age) = 23.8; SD = 5.3) with high levels of depression, anxiety or stress were randomly allocated to a mindfulness practice group or an active control group (listening to stories). Students who underwent the mindfulness practice had decreased levels of anxiety, stress and depression compared to the control group. The mindfulness program also had a beneficial impact on the students' academic performance. There was no change in the ability to inhibit dominant responses to neutral stimuli (letters); however, we observed a change in responses to neutral faces. Further research perspectives and the clinical implications of the study are discussed.

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The incidence of psychopathological symptoms – primarily depression and anxiety – appears to be very high worldwide, especially among students (Ediz et al., 2017; Eisenberg et al., 2007; Ibrahim et al., 2013). These symptoms have numerous negative consequences, such as cognitive functioning difficulties and impaired academic performance. According to the Swiss Federal Statistics Office, in 2018, many Swiss students were concerned about their mental health, and 18% of students had long-lasting health problems. Psychopathological symptoms were a common reason (26%) for disability in this population. Moreover, according to a recent study in a Swiss population, more than half (54.5%) of students take different kinds of substances, including sedatives, antidepressants and beta blockers, in order to feel less stressed and enhance their cognitive functioning during exams (Liakoni et al., 2015).

In general, mindfulness research over the past two decades has broadly supported the claim that mindfulness meditation, which is practiced widely to reduce stress and promote health, exerts beneficial effects on physical and mental health and cognitive performance (Tang et al., 2015). Some studies have investigated the changes in behavioral results and others in neuroscientific outcomes (Enkema et al., 2020; Fox et al., 2014). Some studies have used longitudinal designs and others cross-sectional ones (Brefczynski-Lewis et al., 2007; Tang et al., 2010; Tumminia et al., 2020). And finally,

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some studies were interested in theoretical model development and others in the clinical application of mindfulness (Davies, 2011; Dernbecher & Beck, 2017; Grabovac et al., 2011; Pickut et al., 2013). Thus, briefly summarizing the status of mindfulness research today is complicated. However the heterogeneous methodologies and the small number of published studies indicate that the field is still nascent and underscore the need for new studies to provide robust evidence of the benefits of mindfulness for students (Bondolfi et al., 2011).

Mindfulness-Based Intervention and Psychopathological Symptoms

In recent years, many studies have demonstrated the effectiveness of Mindfulness-Based Intervention (MBI) programs in reducing some psychopathological symptoms (Baer, 2003; Grossman et al., 2004; Hill & Updegraff, 2012; Kabat-Zinn, 2003). However, there is no consensus concerning the effectiveness of MBI for psychopathological symptoms in students. Numerous studies have shown that MBI can improve outcomes in several areas in healthy young adults (Khoury et al., 2015) and in young adults (18–26 years) with different disorders, especially depression (Chi et al., 2018); social anxiety disorder (Hjeltnes et al., 2016); cancer (Van der Gucht et al., 2017; Victorson et al., 2020); substance use disorder (Davis et al., 2019); and history of childhood maltreatment (Joss et al., 2020). For instance, a recent meta-analysis of the effectiveness of MBI in students that included 24 studies (N = 1348) found their methodologies to be sufficiently heterogeneous to potentially bias the conclusions (Zenner et al., 2014). Moreover, only 13 studies of the 24 selected had actually been published. According to the results of this meta-analysis, the effectiveness of MBI for stress measures was characterized by small to medium significant effect sizes; for emotional problems, including depression and anxiety symptoms, the effect sizes were small and not significant. Moreover, Prakash et al. (2015) showed that the indirect effect of trait mindfulness on emotional dysregulation by using thought avoidance was stronger in young adults than in older adults. They emphasized that mindfulness training, which particularly targets reduced avoidance of unwanted thoughts by allowing of such thoughts to be accepted, will likely help with the emotion regulation difficulties prevalent in young adults. Thus, the young adult population, and in particular university students, are of great interest for research related to mindfulness.

Mindfulness-Based Intervention and Academic Performance

As mentioned above, the high prevalence of depression and anxiety symptoms in students is often linked to changes in their academic performance. Some recent studies have tried to assess the improvement in grades, if any, after MBI programs. For instance, it has been documented that a daily 10-minute mindfulness (MF) practice enhanced elementary students' grades in reading and science (Bakoush et al., 2016). A survey of undergraduate students showed that MF practice is associated with increased engagement in the process of learning, which in turn is linked to higher academic success (Elphinstone et al., 2019). A recent randomized controlled study revealed that students who underwent a 10-week MF program obtained better grades than the control group (Sampl et al., 2017).

Mindfulness-Based Intervention and Executive Function

The benefits of MBI programs for psychopathological symptoms and for academic performance may be related to the process of inhibition, which is known to be a core executive function that plays an important role in cognitive and socio-emotional behavior (Rochat et al., 2009). One of the core processes trained during MBI is inhibitory control (Isbel et al., 2020). Sanger and Dorjee (2016) showed that MF practice improved adolescents' ability to efficiently inhibit irrelevant stimuli. They suggested that this improvement may have positive implications for academic performance and learning. It has been demonstrated that participants who engaged in MF practice improved their visual attentional processing (Hodgins & Adair, 2010) and executive processing efficiency (Zeidan et al., 2010). No beneficial effect was found, though, when inhibition was measured with the GoStop Paradigm or a continuous performance task (Cusens et al., 2010; Heeren et al., 2009). However, MF practice was found to increase backward inhibition ability and performance on the Go/No-Go task in comparison to a control group (Greenberg et al., 2013; Pozuelos et al., 2019). To address these divergent findings, we aimed to assess inhibition in a university sample with the stop-signal task (Logan, 1994; Logan & Cowan, 1984). This task has been described as well-developed theoretically (Nigg, 2000) and as a sensitive instrument (Réveillon et al., 2015; Schachar et al., 2007) for assessing the inhibition of prepotent responses. Moreover, in their study of inhibition in school students, Borella and de Ribaupierre (2014) found that resistance to distractor interference was a significant predictor of text comprehension. Another study confirmed that strong executive functioning is essential to score well in science and math (Hania et al., 2019). Thus, executive functioning, including inhibition, may play a very important role in good academic performance among university students. This topic should be investigated in future studies.

Main Aim of Current Study

Despite the growing number of studies reporting the benefits of Mindfulness-based stress reduction (MBSR), and its great potential for improving educational and psychosocial outcomes, Felver et al. (2016) point out that several methodological limitations affect these studies. For example, the majority lack an active control group, which receives some kind of training or regular activity between the pre- and post-evaluations. So, it remains unclear if the benefit observed after MF practice results from this particular type of training program or if the same effect could result from doing any regular guided practice and being continuously supported by professionals. Furthermore, we do not know whether the beneficial effects of MBSR training are related to one specific exercise or to a full set of MBSR programs (Berghmans et al., 2008). It is therefore recommended that the effects of single meditation practices be tested one at a time to better understand the mechanisms underlying their benefits (Pozuelos et al., 2019). Consequently, it would be particularly interesting to test the impact of an MF program specifically adapted for students' needs (duration, type of intervention, etc.) on psychopathological symptoms, inhibition and academic performance in a university sample. To improve on previous research and address the limits of earlier studies in the area, (1) we used an active control group in similar conditions to MBI practice; (2) we applied randomization in our study design; (3) we selected the stop-signal task, which is known to be a theoretically well-developed task to assess the inhibition process; (4) we tested the effects of single meditation practices on perceived stress, depression or anxiety symptoms, inhibition and academic performance among Swiss university students.

Building on results of previous studies of the benefits of brief meditation for stress reduction (Koerten et al., 2020; Shearer et al., 2016) and cognitive processing (Jankowski & Holas, 2020), the main aim of this study was to investigate the benefits of a short MBI for university students with high levels of perceived stress, depression or anxiety symptoms. To fit into students' busy schedules, we developed an experimental design with a short version of the MBI consisting of a self-administered 30-minute body scan meditation (BSM), without any face-to-face interaction with a therapist. Dambrun et al. (2019) described BSM as a meditation that involves shifting one's attention voluntarily to various parts of the body and then to the whole body, and noticing what happens, without judging and without reacting. Some researchers have reported that BSM can result in certain psychological changes, such as an increase in unified consciousness and a feeling of happiness (Dambrun et al., 2019). Others have reported physiological changes, such as decreased heart rate (Ditto et al., 2006); improved sleep (De Bruin et al., 2020); and reduced levels of several hormones (Schultchen et al., 2019). Therefore, it would be interesting to observe changes in inhibition activities and academic performance after BSM meditation. We also tested the dropout effect in both experimental and control groups to better understand dropout risks and find the most suitable MBI training option for students. Finally we explored whether the benefits of this kind of program could be assessed in terms of cognitive functioning – specifically inhibition – as well as academic performance. Our hypothesis was that a short MBI, represented by a 30-minute BSM daily for eight weeks of home practice, would reduce Swiss university students' perceived stress, depression or anxiety symptoms and improve their ability to inhibit dominant responses and academic performance more than another active training condition.

Method

Participants

The sample was composed of 50 students aged 18–45 years (*M*(age) = 23.8; *SD* = 5.3) who were engaged in regular full-time studies at the Faculty of Psychology and Educational Sciences at the University of Geneva. They were not currently undergoing psychotherapy, practicing meditation, or taking any medication. All participants had high scores on three measures simultaneously: a total score ≥ 20 on the Beck Depression Inventory (BDI-2; Beck et al., 1996a), a score ≥ M + 2 SD on the State-Trait Anxiety Inventory (STAI-Y; Spielberger et al., 1983), and a total score > 27 on the Perceived Stress Scale (PSS; Cohen et al., 1983). They were divided randomly into two groups (experimental and control groups) with 25 participants each. All participants were recruited by means of an advertisement presented at their courses. The Ethics Committee of the University of Geneva approved the study. Students' participation was completely voluntary and they were able to leave the study at any time.

Materials

The experimental group was given an audio CD with one MF exercise (30-minute BSM) adapted from Santorelli and Kabat-Zinn (2013). The active control group received an audio CD with one interesting neutral story to listen to (30-minute) chosen from Bertels et al. (2013). The story consisted in the biography of Nicolas Léonard Sadi Carnot, a nineteenth-century French physicist and engineer; it was qualified as neutral and not inducing any mood and therefore was comparable to the BSM exercise (for more details, see Bertels et al., 2013).

Procedure

To start, the first test session with questionnaire administration was conducted (pre-test) to all participant recruited. Then, the participants were selected by inclusion criteria (see. Participants) and randomly assigned to the experimental or control group.

The experimental group completed the training program (short MF intervention: BSM) including a maintenance training session face to face with the instructor, and then the participants were engaged in daily individual practice of the 30-minute BSM exercise, for eight weeks without any interaction with the instructor. The maintenance training in the beginning was conducted for the experimental group and the control group separately. During this session in experimental group, participants were coached by the training instructor on how to perform the exercise correctly and then practiced the BSM together.

The control group completed the training program (short intervention: Neutral story to listen) including a maintenance training session face to face with the instructor, and then the participants were engaged in daily individual practice of the 30-minute same neutral story listening, for eight weeks without any interaction with the instructor. In control group, during maintenance training participants were coached by the training instructor on how to listen the same neutral story every evening with the advice to do it in lying position and relax their body as much as possible.

Finally, the participants of the two groups completed the dropout questionnaire, and the audio CDs with exercises for daily practice were distributed. The experimental group did their BSM exercise at home and provided written feedback to the instructor weekly (see details in Supplemental Table 1). The control group was given a story to listen to at home (daily for eight weeks) and provided written feedback to the instructor weekly. The weekly written feedback to the instructor (Sunday evening) was provided by email and consisted of their everyday practice observations to check their participation and the dropout effect. After eight weeks, the second test session with questionnaire administration was conducted (post-test).

Measures

Depression

The validated French version of the Beck Depression Inventory (BDI-2) was used (Beck et al., 1996a; French translation in Beck et al., 1996b). The BDI-2 consists of 21 items developed to measure depression symptoms. The total score was calculated by summing the 21 items for a maximum of 63 points. Scores of 0–11 are considered in the normal range, 12–19 indicate mild and 20–27 moderate depression, while scores of 28–63 are considered to indicate severe depression. The reliability coefficients showed satisfactory internal consistency (.85), split-half reliability (.76) and test-retest reliability (.74).

Anxiety

The validated French "Form Y" version of the State-Trait Anxiety Inventory (STAI-Y) was used (Spielberger et al., 1983; French translation and validation in Spielberger et al., 1993). The STAI-Y consists of 40 items that measure state anxiety (SA = 20 items) and trait anxiety (TA = 20 items). Each response is scored from 1 (lowest degree of anxiety) to 4 (highest degree of anxiety). Scores lower than 35 are considered in the very low anxiety range, 36–45 in the low anxiety range, 46–55 in the mild anxiety range, 56–65 in the high anxiety range, and scores of over 65 are considered to indicate very high anxiety. The reliability coefficients showed satisfactory internal consistency (0.60 for SA and 0.86 for TA), split-half reliability (between 0.73 and 0.88) and test-retest reliability (0.75 for SA and 0.71 for TA).

Stress

The validated French version of the Perceived Stress Scale (PSS) was used (Cohen et al., 1983; French translation and validation in Bellinghausen et al., 2009). The PSS consists of 10 items and measures the perception of stress. Scores ranging from 0 to 26 are considered to indicate minimal perceived stress, while scores of 27–40 are considered to show high perceived stress. The reliability coefficients showed satisfactory internal consistency (between 0.78 and 0.87) and test-retest reliability (0.71).

Personal data and academic performance

To assess the personal and academic performance data, we used a scale developed in our laboratory. It is a 15-item self-administered questionnaire developed to collect demographic data (e.g., gender, age, housing situation, mean daily travel time to the university, financial situation, mean weekly time spent on paid work, mean weekly time spent on exam preparation, importance of achievement and academic performance). Academic performance included 3 measurements: minimum grade and maximum grade received at last exam session from different exams as well as mean grade of all session.

Mindfulness concept

To observe the five main components of MF skills, we used the validated French version of the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006; French translation and validation in Heeren et al., 2011). It is a 39-item self-administered questionnaire developed to explore five facets of MF (Observe: 8 items; Describe: 8 items; Act with awareness: 8 items; Non-judgment of inner experience: 8 items; and Non-reactivity to inner experience: 7 items). Item scores range from 1 (never or very seldom true) to 5 (very often or always true), and the total possible score ranges from 39 to 195 (higher scores indicate greater MF). For internal consistency, the reliability coefficient was .75. Test-retest reliability coefficients were as follows: Global mindfulness score, .64; Observation facet, .71; Description facet, .73; Acting with awareness facet, .72; Non-judgment of inner experience facet, .41; and Non-reactivity to inner experience facet, .64.

Dropout scale

To assess the dropout effect (the risk factors explaining why participants left the program before it was finished) and to investigate the program's appropriateness to students' needs, we used a self-developed dropout scale (see details in Supplemental Table 2). It is a 24-item self-administered questionnaire adapted from the Revised Helping Alliance Questionnaire (Luborsky et al., 1996). We also monitored abandonment of the program weekly in the two samples by means of feedback from the participants.

Stop-signal task

To assess the inhibition of prepotent responses, we selected the Stop-Signal Task (Logan, 1994; Logan & Cowan, 1984). This version was adapted from the work of Réveillon et al. (2015). Three versions of the stop signal were used, one with neutral stimuli (letters), one with neutral stimuli (faces) and one with emotional stimuli (faces). The structure, timing parameters, and numbers of "go" and "stop" trials were the same in all three versions.

The stop-signal task with neutral stimuli (letters) was a choice reaction time task in which participants had to discriminate between two stimuli (letters "X" and "O" – go stimuli) by pressing one of two response keys (C and M keys, marked with different colors). Each trial began with a fixation cross for a random period of between 500 and 1,000 ms, followed by the presentation of the stimulus, which ended either with the participant's response or after 1,500 ms. Participants were given six blocks of 48 trials, of which 12 (25%) had a stop signal. The stop signal consisted of a red square that appeared around the letters after a delay, which was continuously adjusted depending on the participant's success at inhibiting the preceding stop trials, as suggested by Logan (1994). The stop-signal delay was initially set at 250 ms and was increased by 50 ms if the participant succeeded in inhibiting his or her response to the last stop trial, or decreased by 50 ms if the participant failed to inhibit the response, in order to have a mean success rate for the stop trials of about 50%. This adjustment allows a good estimation of the stop signal reaction time (SSRT; Band et al., 2003). For go trials (execution of the response), the mean percentage of correct responses (ACC_GO execution performance) and the median go reaction time (MRT) for correct responses were computed. For each participant, anticipatory reaction times (RTs) (below 200 ms) and all RTs more than 2.5 SD from the original mean RT were excluded. For stop trials (inhibition), the mean percentage of inhibited trials (ACC_STOP inhibition performance) and SSRT were computed. On the basis of the horse-race model (Logan, 1994), the SSRT was calculated by rank-ordering RT distributions for go trials in order to find the RT (centile) corresponding to the percentage of failed response inhibitions. The mean SSRT was then subtracted from this centile RT.

The stop-signal task with neutral stimuli (faces) was constructed in the same way as the stop-signal task with neutral stimuli (letters). However, the stimuli for this neutral-face version of the task consisted of neutral facial expressions on 12 individuals (six females and six males) selected from the Macbrain Face Stimulus Set available at www.macbrain.org. Participants had to decide whether the face appearing on the screen was male or female by pressing one of two response keys (again, C and M keys, marked with different colors). The variables computed were the same as for the stop-signal task with letters.

The stop-signal task with emotional stimuli was constructed in the same way as the stop-signal tasks with neutral stimuli (letters and faces). However, the stimuli for this emotional version of the task consisted of happy, fearful, sad and angry facial expressions on 12 individuals (six females and six males) selected from the same database as the neutral facial expressions. Fearful and happy expressions were tested first, and sad and angry expressions were tested separately. In the first emotional task, participants had to decide whether the face appearing on the screen had a happy or fearful expression by pressing one of two response keys (again, C and M keys, marked with different colors). In the second, the decision concerned sad and angry emotional expressions. The variables computed were the same as for the stop-signal tasks with neutral stimuli. In addition, each variable was computed separately for happy, fearful, sad and angry facial expressions.

Data analysis

Data were analyzed using IBM-SPSS (Version 25, 2016). All variables were checked for normality. The differences between the two groups before and after MF training were analyzed using six doubly multivariate repeated-measures comparisons (MANOVAs): 2 (between-subject factor: Group) x 2 (within-subject factor: Time). For post hoc assessment, discriminant analysis (DA), described by Borgen and Seling (1978), were applied to identify the contributions of the differences noted in each general case by determining the canonical function(s) that distinguish the groups from one another on dependent variable scores (Warne, 2014). A MANOVA is used to reduce the likelihood of Type 1 errors in situations with multiple dependent variables, which increases the power compared to single, univariate analysis of variance (ANOVAs; Tabachnick & Fidell, 2013). For the first MANOVA, we combined psychopathological symptoms (depression, SA, TA, stress) because we observed several correlations between our variables: BDI-2/STAI-Y(SA) = .288; BDI-2/STAI-Y(TA) = .308; BDI-2/PSS = .238; STAI-Y(SA)/ STAI-Y(TA) = .857; STAI-Y(SA)/ PSS = .509; STAI-Y(TA) /PSS = .468. For the second MANOVA, we combined mean grade, maximum grade and minimum grade at two exam sessions to assess academic performance. The coefficients of correlation were Mean Grade/Maximum Grade = .662; Mean Grade/Minimum Grade = .573; Maximum Grade/ Minimum Grade = .036. For the third MANOVA, we combined subscores on the Observe, Describe, Act with awareness, Non-reactivity, and Non-judgment subscales to analyze mindfulness.

To assess inhibition, we carried out three MANOVAS: one for neutral letter stimuli, one for neutral face stimuli and one for emotional face stimuli. However, we did not combine the neutral letter stimuli and neutral face stimuli in a single dependent variable because the latter tend to activate more circuits that are probably involved in more elaborate cognitive processing (Carvajal et al., 2013) and so may have a different impact on inhibition. We analyzed the dropout data with a hierarchical logistic regression. Significance was accepted at $p < .05$ for all statistical analysis. To assess the size effect, we used partial eta squared value.

Results

Psychopathological symptoms

The doubly multivariate MANOVA followed by DA for the psychopathological symptoms (depression, SA, TA, stress) found no significant main effect of Group (Wilks' $\Lambda = .095$, $F_{(3,96)} = 1.232.$, $p = .303$, $\eta^2 = .05$), but there was a significant main effect of Time (Wilks' $\Lambda = .721$, $F_{(3,96)} = 15.864$, $p = .000$, $\eta^2 = .273$), and a significant Time*Group interaction (Wilks' $\Lambda = .926$, $F_{(3,96)} = 15.864$, $p = .000$, $\eta^2 = .741$). Thus, the students in the MF training experimental group experienced a reduction in psychopathological symptoms after the intervention. Likewise, the DA showed that the difference between the two groups on the combined psychological symptoms was statistically significant (Wilks' $\Lambda = .95$, $p = .002$), confirming the model's ability to correctly classify participants in two groups (experimental vs. control). The standardized canonical coefficients (SCC), which show each variable's contribution to the multivariate separation between two groups, were BDI-2 (.941), STAI-Y(SA) (–.435), STAI-Y(TA) (–.256), and PSS (1.147). Thus, stress and depression were most important for distinguishing between groups. Finally, the canonical correlation between groups and the discriminant function was .872, and the rate of correct classification between experimental and control groups was 97%.

Academic performance

The doubly multivariate MANOVA followed by DA for the combined academic performance measures (mean grade, maximum grade and minimum grade) at two exam sessions showed a significant main effect of Group (Wilks' Λ = .844, $F_{(3,96)}$ = 15.809, p = .001, η^2 = .156), a significant main effect of Time (Wilks' Λ = .815, $F_{(3,96)}$ = 17.123, p = .000, η^2 = 185.), and a significant Time*Group interaction (Wilks' Λ = .927, $F_{(3,96)}$ = 19.474, p = .000, η^2 = .731). Therefore, in the MF group, grades improved after the training session, and the effect sizes ranged from medium to large. The DA indicated a statistically significant difference between the two groups (Wilks' Λ = .855, p = .003). The SCC were Mean Grade (.755), Maximum Grade (–.153), and Minimum Grade (.434). Mean Grade and Minimum Grade were more decisive for group separation. The canonical correlation was .851, and the rate of correct classification between experimental and control groups was 96%.

Mindfulness

For the mindfulness construct (Observe subscale score, Describe subscale score, Act with awareness subscale score, Non-reactivity subscale score, Non-judgment subscale score), the doubly multivariate MANOVA followed by DA indicated a significant main effects of Group (Wilks' Λ = .643, $F_{(3,96)}$ = 6.823, p = .000, η^2 = .301), and Time (Wilks' Λ = .526, $F_{(3,96)}$ = 10.341, p = .000, η^2 = .402), and a significant Time*Group interaction (Wilks' Λ = .692, $F_{(3,96)}$ = 15.421, p = .000, η^2 = .473). To sum up, for the mindfulness construct measured by combination of subscale scores, the students in the experimental group scored better after MF training. The effect size was medium. Furthermore, the post hoc DA demonstrated a statistically significant difference between the two groups (Wilks' Λ = .947, p = .000). The SCC were Observe score (.832), Describe score (.561), Act with awareness score (.688), Non-reactivity score (.911), and Non-judgment score (–.395). Thus, Observe and Non-reactivity scores were most significant for separating groups. The canonical correlation was .864, and the rate of correct classification between the experimental and control groups was 96%. See Table 1 for a summary of results.

Inhibition of dominant responses

According to the doubly multivariate MANOVA followed by DA for neutral stimuli with letters, all main effects and interactions were non-significant. Concerning the MRT for neutral face stimuli, the two main effects and the Time*Group interaction were not significant, but ACC_STOP inhibition performance yielded significant main effects of Group (Wilks' Λ = .68, $F_{(3,96)}$ = 10.461, p = .002,

Table 1. Psychopathological symptoms, Academic performance and Mindfulness construct. *Pre- and Post-Test Results for MF and Active Control Groups*.

		MF group		Active control group		
		Pre	Post	Pre	Post	Interaction effect *p value*
BDI-2		14.16 ± 12.336	6.00 ± 12.336	10.84 ± 12.336	10.60 ± 12.336	< .001
STAI-Y	State	41.40 ± 12.336	27.10 ± 14.952	38.72 ± 12.374	39.36 ± 11.909	< .001
	Trait	44.96 ± 13.356	33.20 ± 12.097	43.84 ± 13.564	43.48 ± 13.657	< .001
PSS		33.96 ± 3.195	18.12 ± 6.064	32.08 ± 3.957	31.60 ± 4.193	< .001
AP	Mean grade	4.74 ± .396	5.28 ± .491	4.71 ± .387	4.76 ± .372	< .001
	Maximum grade	5.63 ± .740	5.82 ± .454	5.45 ± .550	5.38 ± .556	< .05
	Minimum grade	3.94 ± .870	4.55 ± .774	3.93 ± .702	3.87 ± .810	< .05
	Observe	21.12 ± 5.776	29.24 ± 4.781	21.04 ± 4.791	22.84 ± 6.039	< .001
FFMQ	AwA	20.64 ± 5.552	30.56 ± 3.927	20.92 ± 5.499	22.72 ± 5.639	< .001
	Describe	27.84 ± 7.414	30.64 ± 6.422	24.52 ± 5.917	24.00 ± 6.272	< .05
	Non-judgment	23.68 ± 7.146	28.44 ± 6.338	23.40 ± 6.683	26.00 ± 10.821	n.s.
	Non-reactivity	15.88 ± 4.295	24.32 ± 4.479	14.40 ± 4.311	15.72 ± 5.264	< .001

Note: A*P* = Academic performance; BDI-2 = Beck Depression Inventory; STAI-Y = State/Trait Anxiety Inventory; PSS = Perceived Stress Scale; FFMQ = Five Facet Mindfulness Questionnaire; AwA = Act with awareness scale; n.s. = not significant.

$\eta^2 = .198$) and of Time (Wilks' $\Lambda = .89$, $F_{(3,96)} = 16.025$, $p = .000$, $\eta^2 = .242$), and a significant Time*-Group interaction (Wilks' $\Lambda = .93$, $F_{(3,96)} = 15.743$, $p = .000$, $\eta^2 = .226$). For ACC_GO execution and SSRT inhibition, the results were not significant. The DA indicated a statistically significant difference between the two groups (Wilks' $\Lambda = .851$, $p = .004$). The SCC results were MRT (.351), ACC_STOP (.842), ACC_GO (–.058), and SSRT (–.383). Only ACC_STOP inhibition performance was important for group separation. The canonical correlation was .686 and the rate of correct classification between experimental and control groups was 84%. For emotional face stimuli (happiness, fear, anger, sadness), significant main effects of Time were observed: MRT (Wilks' $\Lambda = .516$, $F_{(3,96)} = 14.669$, $p = .000$, $\eta^2 = .314$); ACC_STOP (Wilks' $\Lambda = .516$, $F_{(3,96)} = 13.850$, $p = .000$, $\eta^2 = 302$); ACC_GO (Wilks' $\Lambda = .516$, $F_{(3,96)}$ 15.536, $p = .000$, $\eta^2 = .327$); and SSRT (Wilks' $\Lambda = .516$, $F_{(3,96)} = 19.160$, $p = .000$, $\eta^2 = .375$). However, no significant main effects of Group or significant interactions were found. In the post hoc DA, the difference between the two groups was not statistically significant (Wilks' $\Lambda = .748$, $p = .063$).

Thus, only in the neutral face condition did inhibition performance decrease in the MF group after the intervention. The effect size was quite small. With emotional faces, execution skills, execution performance, inhibition skills and inhibition performance improved after training, but in the same way in both the MF and control groups. The effect sizes ranged from small to medium. See Table 2 for a summary of results.

Dropout effect

We also tested the dropout effect in our sample to determine the risk factors for not completing the training program. To do that, we conducted a hierarchical logistic regression with our self-report questionnaire. The results showed that, if a participant was assigned to the control group, the probability of quitting the experiment was higher ($p < .05$). We also found that negative responses to the following statements were predictive of quitting the training in our Swiss sample: "The intervention method used is appropriate to my needs"; "The instructor informs me of ways to improve my well-being"; "I feel that I'm working with the instructor in a joint effort"; "The instructor and I had constructive discussions"; and "I believe that we share the same opinion of the benefits of this program" ($p < .05$). The attrition rate was 40% for the control group and 8% for the experimental group. Dropouts were observed mainly during the last two weeks of training.

Discussion

This study tested the effects of a short MBI on psychopathological symptoms, MF, academic performance, and dominant response inhibition in 50 university students with high scores for depression measured with the BDI-2, state anxiety measured with the STAI-Y, and stress measured with the PPS. Although some studies have demonstrated a change in affective reactions and metacognitive processes after a brief five- or ten-minute MF practice (Erisman & Roemer, 2010; Mahmood et al., 2016; Pozuelos et al., 2019), we were interested in studying the impact of a specific body-focused MBSR exercise (body scan meditation) on these processes. Our experimental group underwent a 30-minute BSM exercise, while the active control group listened to a story for the same length of time. Recent findings have shown divergent results concerning BSM's effects and efficiency (Dambrun et al., 2019; Schmidt et al., 2019; Upton & Renshaw, 2018), so we were interested in investigating this topic more thoroughly.

Mindfulness-Based Intervention and Psychopathological Symptoms

First, we observed that the MBI reduced psychopathological symptoms (depression, anxiety and stress) in our sample. Such results are in line with previous research that documented a reduction in different psychopathological symptoms and stress levels in various populations (individuals

Table 2. Inhibition. *Pre- and Post-Test Results for MF and Active Control Groups*.

		MF group		Active control group		
		Pre	Post	Pre	Post	Interaction effect *p value*
Stop Signal	MRT n.l.s.	642.979 ± 201.181	636.417 ± 152.861	677.838 ± 203.301	663.882 ± 185.464	n.s
	ACC_GO n.l.s.	18.582 ± 88.290	1.057 ± .530	28.382 ± 137.545	.838 ± .199	n.s.
	ACC_STOP n.l.s.	.130 ± .249	.315 ± .421	.158 ± .235	.187 ± .260	n.s.
	SSRT n.l.s.	799.134 ± 221.020	777.000 ± 226.966	834.726 ± 202.210	846.745 ± 250.852	n.s.
	MRT n.f.s.	758.274 ± 226.023	732.438 ± 182.500	755.996 ± 251.167	701.433 ± 196.386	n.s.
	ACC_GO n.f.s.	24.233 ± 112.035	1.057 ±. 530	35.153 ± 171.593	.838 ± .199	n.s.
	ACC_STOP n.f.s.	1.009 ±1.318	.315 ± .421	.203 ± .274	.187 ± .260	< .05
	SSRT n.f.s.	887.141 ± 188.204	891.829 ± 195.499	994.055 ± 195.931	953.412 ± 199.626	n.s.
	MRT h.f.	775.053 ± 169.382	372.212 ± 412.336	776.171 ± 273.520	313.599 ± 388.261	n.s.
	ACC_GO h.f.	.823 ± .209	466.774 ± 510.530	.781 ± .282	542.433 ± 537.682	n.s.
	ACC_STOP h.f.	.157 ± .239	384.491 ± 425.715	.217 ± .318	339.124 ± 367.713	n.s.
	SSRT h.f.	958.575 ± 212.861	457.892 ± 471.961	983.245 ± 195.638	390.079 ± 430.554	n.s.
	MRT f.f.	759.599 ± 238.950	387.384 ± 424.564	739.920 ± 308.517	323.368 ± 390.771	n.s.
	ACC_GO f.f.	28.099 ± 136.312	390.121 ± 430.913	36.700 ± 179.602	353.651 ± 373.617	n.s.
	ACC_STOP f.f.	.223 ± .294	.335 ± .436	.257 ± .340	.323 ± .374	n.s.
	SSRT f.f.	975.273 ± 207.751	449.939 ± 458.156	1019.071 ± 175.764	403.066 ± 444.907	n.s.
	MRT a.f.	794.701 ± 235.674	789.088 ± 225.235	749.615 ± 270.451	635.476 ± 276.652	n.s.
	ACC_GO a.f.	.782 ± .244	.954 ± .524	.720 ± .280	.661 ± .327	n.s.
	ACC_STOP a.f.	.187 ± .264	.332 ± .440	.238 ± .311	.298 ± .363	n.s.
	SSRT a.f.	1011.910 ± 208.308	968.745 ± 180.454	1036.282 ± 203.132	954.059 ± 253.768	n.s.
	MRT s.f.	760.194 ± 249.956	778.498 ± 211.405	718.883 ± 304.390	626.195 ± 226.430	n.s.
	ACC_GO s.f.	29.476 ± 143.239	1.000 ± .522	38.719 ± 189.818	.693 ± .302	n.s.
	ACC_STOP s.f.	.226±.320	.375±.460	.307±.346	.272±.354	n.s.
	SSRT s.f.	956.626± 263.833	969.517 ± 182.077	1002.694 ± 267.910	949.306 ± 248.465	n.s.

Note: MRT = median go reaction time; ACC_GO = mean percentage of correct responses in go trial (execution performance); ACC_STO*P* = mean percentage of inhibited trials (inhibition performance); SSRT = stop signal reaction time; n.l.s. = neutral letter stimulus; n.f.s. = neutral face stimulus; h.f. = happy face; f.f. = fearful face; a.f. = angry face; s.f. = sad face; n.s. = not significant.

with borderline personality disorder: Sachse et al., 2011; school students: Zenner et al., 2014; college students: Lothes et al., 2019). The MANOVA results showed a significant Time*Group interaction with large effect size. Thus, our study demonstrated that a short MBI may help university students to reduce their psychopathological symptomatology (depression, anxiety and stress).

Mindfulness-Based Intervention and Academic Performance

The results of the study also showed that the MBI had a beneficial impact on students' academic performance. Students who engaged in the MF practice improved their grades (mean, maximum and minimum grades) between two exam sessions, more significantly than the students in active control group. These results agree with previous research that documented enhanced grades in bachelor's students who participated in an MF program (Sampl et al., 2017). Our study's contribution is a more detailed measurement of improvements in university students' academic performance after MF, because three factors were measured: maximum, mean and minimum grades. The post hoc DA indicated that mean and minimum grades were more decisive in separating the experimental and control groups. It appears that even a short MBI can help to improve academic performance in student populations.

Mindfulness-Based Intervention and Executive Function

Our study tested the impact of MBI on the ability to inhibit dominant responses, which allows one to suppress a dominant response or ignore irrelevant information (Miyake et al., 2000). This is a very important process, which is critical to executive control (e.g., Aron et al., 2004) and, consequently, to executive functions and social behavior (Billieux et al., 2010). Our results showed that, after the MBI in our student sample, there was no change in the inhibition of dominant responses to neutral stimuli (letters). However, in the trial with neutral faces, the percentage of correctly inhibited stop trials was lower after the MBI than in the control group. This may be related to the choice of BSM for our MBI. In their study, Schmidt et al. (2019) showed that self-observation of the body (SoB) training had a negative impact on metacognitive efficiency; they explained that finding by hypothesizing that SoB participants developed the ability to focus their attention *away* from their own thoughts.

Many studies have shown activation in different brain areas associated with meditative practice (Hölzel et al., 2008; Tang et al., 2010; Tang et al., 2015) but, to our knowledge, no study has described an association between activation in the fusiform face area (FFA) and MBI. In our study, the detection of neutral face stimuli decreased after MBI, which may be related to activity in the FFA (Rapcsak, 2019), which is sensitive to faces. Future investigations are needed to show potential mechanisms underlying the benefits of MBI. As for emotional faces, the increase in the inhibition of dominant responses observed in both experimental and control groups may be related to the attention-focusing activities used in both groups' training.

Mindfulness-Based Intervention and Self-Perceived Mindfulness Skills

We observed an improvement in self-perceived MF skills in our experimental group after the MBI, which also corroborates previous reports (Ramler et al., 2015; Schmidt et al., 2019). According to the post hoc DA for MF skills, Observe subscale and Non-reactivity subscale were most significant for group separation. Our findings have provided some additional evidence confirming the benefits of MBI for promoting self-perceived MF skills in university students.

Dropout Effects

We tested the dropout effect in our student sample to identify risk factors for abandoning the program. According to our results, participants who did not have a positive assessment of the intervention method and the instructor's communication about how to improve well-being were at high risk of quitting the program. In addition, participants who did not feel that the instructor was working with them in a joint effort, that they were engaging in constructive discussions, and finally, that they shared the same opinion as the instructor of the benefits of the program were more likely to drop out. This finding provides useful information for the organization of future intervention programs and may help to ensure that participants' expectations with regard to these points are met, which in turn could lessen attrition during treatment.

Limitations and Future Studies

Among the limitations on our study is the lack of comparison between the effects of BSM and other types of MF practice, such as sitting breath meditation, mindful walking or movement, etc. It would be useful in future studies to test which short MBIs might be most suitable for university students. Although our control group activity (story listening) demanded a similar amount of attention ability to the BSM, the two activities may not share other MF components (Dambrun et al., 2019). Thus, future studies could offer control activities that may be closer to BSM exercise (e.g., relaxation exercise) or other types of MBI (e.g., meditation exercise).

A second limitation is the lack of long-lasting observation. A study with long-term observation of the benefits of a short MBI program in a university sample would probably lead to a better understanding and more reliable conclusions concerning improvements in well-being and academic achievement in this population. Moreover, it is possible that ceiling effects occurred when measuring maximum and minimum grades. Although we met the minimum sample size requirement for MANOVAs of 20 observations per group, we advise future researchers to use larger sample sizes to improve the power of MANOVA results.

Improvements in stress have also been documented after brief digital MF interventions (Economides et al., 2018; Huberty et al., 2019). Considering the easy availability of this type of intervention for students, we recommend that future studies assess the benefits of a brief digital MF intervention for inhibition abilities and academic performance in this population.

Relevance of Current Study

The findings of our study are very topicals as there is evidence the need to support. In 2019–2020, a campaign called "Be kind for your mind" was carried out among Swiss students to offer support for important problem related to students long-lasting health problems and mental health (Psychoscope, 6/2019). Thus, our study may suggest practical tools for organizing workshops within this kind of program.

Overall, the results of this study contribute to scientific knowledge in this domain by showing that MF interventions can be effective at helping students to handle psychopathological symptomatology including stress in a worrying context and became an alternative for the unhealthy strategies to coop with stress, for example substances taking during exams (Liakoni et al., 2015). In light of our results, and given the scarcity of similar studies, future studies should investigate the mechanisms underlying the links between MF and cognitive functions.

Conclusion

These findings highlight the effectiveness of a MF intervention for Swiss university students in improving psychopathological symptoms (depression, anxiety and stress), as well as academic performance. Considering the alarming psychological health conditions prevailing among university students in Switzerland, our results have important implications and suggest that students could benefit from adopting MF practices, which are benign, accessible techniques for regulating their psychopathological symptoms. We believe that the use of this safe, pleasant technique in young populations could represent an alternative to long-term medication. It would therefore be useful for future research to study the most effective way of offering the students MF interventions with the aim of enhancing their cognitive functioning, their health and their academic performance.

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