Mobile device-based mindfulness intervention promotes emotional regulation during anticipatory stress

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ABSTRACT

Mindfulness training applications for mobile devices are increasing in number and use, but little is known on their effectiveness. Our study (N = 107) is the first to examine the effect of a brief mobile-based mindfulness intervention on the emotional reactions to anticipatory social stress. Results show that the intervention is effective in weakening the increase of negative affect related to anticipatory stress, mostly in men. Implications and future research directions are discussed.

Keywords

Mobile-based intervention, Mindfulness, Anticipatory stress, Positive and negative affect, Trier Social Stress Test

1. INTRODUCTION

With the advent of smartphones, the recent years have seen a massive increase in the availability and use of software aimed at improving health. No less than 40,000 mobile medical and health apps existed already in 2012, and their rate of appearance increasing [3]. Initial research also demonstrates a public interest in the use mobile applications in the management of depression, anxiety and stress [30].

The healthy and the ill would benefit from effective health applications, but most apps are currently untested, and their claims for health benefits remain unwarranted by research [17].

In this paper, we discuss health improvements that can be expected from mindfulness interventions and their relation to emotional regulation. We then examine how effective a mobile device-based mindfulness intervention is in promoting emotional regulation in the face of anticipatory social stress.

1.1 Mindfulness training and health outcomes

Mindfulness Based Stress Reduction (MBSR) is a program designed to assist people with a number of health-related conditions. The program, with origins in Buddhist practices, is designed as an eight-week intervention, which includes group meetings and home assignments. The aim of the training is the development of mindfulness, defined as moment-to-moment awareness without judgment [19], entailing self-regulation of attention, and concentration on the present moment. Mindfulness is beneficial for a range of physical and mental conditions [13], for instance eating disorders [22], high blood pressure [8], depression [39], and anxiety [14].

One of the best-known benefits of mindfulness training is stress reduction. Stress is known for its pathogenic effects on a number of physical and mental conditions, with behavioral and physiological factors contributing to ill health [26, 37]. Mindfulness-based interventions are effective in stress reduction in both clinical and healthy populations [9, 34], and several theoretical frameworks explaining the effectiveness of mindfulness have been proposed [16, 36].

Yet, little is known of the relationship between mindfulness training and responsivity to acute stressors, such as social-evaluative threat [15, 31]. This research avenue is important due to the fact, that social-evaluative stress is very frequent in daily life and can lead to particularly negative health outcomes [20].

Anticipatory social-evaluative stress, notably, has not been sufficiently studied, as research on social-evaluative stress has been mostly concerned with how people deal with the stressor during the encounter, e.g., [23, 24]. But recent research shows a renewed interest on anticipatory stress, due to its importance in both the genesis and the modulation of physiological responses to stressors [12, 18, 27]. Research is notably needed on the effectiveness of mindfulness training in attenuating reactions to anticipatory social stress.

1.2 Shorter mindfulness interventions

Several studies focused on the effectiveness of brief mindfulness interventions, based on the principles of the MBSR. Shorter interventions of various lengths were successful with regards to substance addiction [4], memory improvement [1], pain tolerance [25], and other outcomes. Shorter meditation interventions are effective at reducing negative mood, depression, fatigue, confusion, and heart rate [42]. Those results provide initial evidence that shorter and brief mindfulness-based interventions are linked to positive health-related outcomes, and the magnitude of results is to some extent independent of the duration [10].

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Only few studies examined the impact of shorter mindfulness interventions on stress [21]; and among the numerous mobile applications for mindfulness training only a few had their effectiveness tested [28].

1.3 Positive and Negative Affectivity

Positive and Negative Affects represent distinct dimensions in mood measurement. Positive Affect (PA) "reflects the extent to which a person feels enthusiastic, active, and alert" [41, p. 1063], and Negative Affect (NA) assesses negative mood states (fear, hostility, anxiety) [41]. Both trait and state PA are associated with positive health outcomes, such as improved pulmonary function, decreased level of cortisol, lower mortality rates [29], while NA is linked to anxiety and depressive disorders [40].

Social evaluative stressors increase NA and decrease PA [6]. PA and NA in turn affect health outcomes through the activation of the parasympathetic or sympathetic nervous system (release of stress hormones) resulting in change in immunity as well as heart rate (HR) and blood pressure (BP) [7, 33, 38]: Prolonged activation of the cardiovascular response and deteriorated immunity mediate the relationship between negative emotions and disease [5, 38].

1.4 This study

Previous research has shown that emotional regulation plays a major role in the mindfulness-health relationship: Mindfulness is negatively related to NA and positively to PA [6, 11, 35].

While short mindfulness interventions can buffer the emotional impact of mood inductions [2], it is not known whether short mindfulness interventions are beneficial with regards to the emotional impact of anticipatory social stress.

Our aim in this study is to test whether a short mobile-based mindfulness intervention moderates the impact of anticipatory social stress on PA and NA. Our hypotheses are presented below:

Hypothesis 1a: NA will increase during anticipatory stress compared to baseline. Hypothesis 1b: Short mindfulness intervention buffers against the effect of anticipatory stress on NA.

Hypothesis 2a: PA will decrease during anticipatory stress compared to baseline. Hypothesis 2b: Short mindfulness intervention buffers against the effect of anticipatory stress on PA.

2. METHOD

2.1 Participants

Sixty-five women and 42 men were recruited by master students as a part of a seminar on stress interventions. They were 25.18 years old on average (*SD* = 6.93). The Control and Mindfulness groups were respectively composed of 53 participants and 54 participants.

2.2 Procedure and measures

Upon arrival to the lab, participants were briefly introduced to the study, and signed informed consent forms. They provided their e-mail address in order to participate in a raffle for a tablet. The experiment was composed of different phases (an adaptation of the Trier Social Stress Test [23]).

Phase 1 - Baseline: Participants were requested to wait for 5 minutes and completed the Positive and Negative Affect Schedule (PANAS; [12]) a first time among other scales (omitted for space reasons). The instrument uses Lickert scales ranging from 1 to 5. The reliability of the PA and NA scales was good throughout the experiment (all Cronbach alphas > 0.83). Participants' heart rate (HR) and blood pressure (BP) were then measured a first time using a Beuer Medical BC 58 automatic tensiometer.

Phase 2 - Experimental manipulation: Participants in the Mindfulness group listened to a female natural text-to-speech voice that guided them through different mindfulness exercises (mindfulness of breath and body scan). The audio was delivered using a smartphone (Nokia Lumia 520, OS: Windows Phone 8). Participants in the Control group were instructed to wait (non-active control group). This phase lasted for 5 minutes in both groups.

Phase 3 – Anticipation stress: Participants were informed that they would participate in a 5-minute simulated job interview with the experimenter in which they would have to convince they are the best candidates for the 'job of their dreams' (self-presentation task). They were also informed that the job interview would be filmed and that a jury would judge their performance at a later stage based on the recordings. They were given 5 minutes to prepare for the self-presentation task. Participants then filled in the PANAS again. Their HR and BP were measured a second time.

Phase 4 – Social stress (self-presentation task): Participants performed the self-presentation task for 5 minutes and their HR and BP were measured immediately after. They then filled in the PANAS a third time together with other scales and socio-demographic items.

Phase 5 – Recovery: HR and BP were measured a fourth time 5 minutes after the end of the self-presentation task.

3. RESULTS

We ran mixed-effect regression analyses to test our hypotheses, using package lmer in R. The null model for NA shows that 35.1% of variance is at the level of the participants (*ICC* = 0.351). The null model for PA shows that 71.7% of variance lies at the level of the participants (*ICC* = 0.717). The null model for heart rate shows that 63.8% is at the individual level (*ICC* = 0.638). As a manipulation check, we computed a model that included Time (0 = Baseline, 1 = Anticipatory stress) as a predictor of HR. The model was significantly different from the null model ($Chi2(1)$ = 4.28, $p < .05$) and heart rate indeed increased during anticipatory stress (*B* = 2.47, *SE* = 1.19, 95% C.I. = 0.13 – 4.81, $p < .001$). This shows the manipulation was effective at eliciting a physiological stress response from the participants. Other results regarding HR and BP are not presented here.

3.1 Negative affect

To test our hypotheses, we computed a first model with the main effects of Time (0 = Baseline; 1 = Anticipatory stress) and Condition (0 = Control; 1 = Mindfulness), and a second model containing also their interactions. Gender (0 = Men; 1 = Women) was included as a control variable in all models (main effect and interactions included). The dependent variable was NA in all models. The first model presented a significantly lower *-2likelihood* value compared to the null model, meaning that it explained the data better: $Chi2(5)$ = 42.00, $p < .001$. The second model presented a marginally significant lower *-2likelihood* value compared to the first, meaning that it fitted the data better to some extent: $Chi2(2)$ = 5.76, p = 0.056.

According to Hypothesis 1a, NA increases from the Baseline to the Anticipation phase. This is corroborated by the data: participants had a higher NA score during Anticipatory stress in both models (model 1: B_{Time} = 0.32, SE = 0.09, 95% C.I. = 0.14 – 0.50, $p < .001$; model 2 : see table). According to Hypothesis 1b, the condition moderates the effect of anticipatory stress on NA. This is corroborated by the data. As displayed in Table 1, the significant Condition by Time interaction is negative, meaning that the increase in NA was lower in the Mindfulness condition.

Our intervention buffered the effect of anticipatory stress to a lesser extent in women as revealed by the marginally significant and positive Condition x Time x Gender interaction. This is shown on the interaction below (Figure 1).

3.2 Positive affect

To test hypotheses H2a and H2b, we ran the analyses in a similar fashion as above, but with PA as a dependent variable. The first model fitted the data better than the null model based on the difference in *-2loglikelihood* value: *Chi2*(2) = 18.00, p = 0.002. The first model is displayed in Table 2. According to Hypothesis 2a, we expected PA to decrease from the Baseline to the Anticipatory stress phase. This is not supported by the data: PA was actually higher in the Anticipatory stress phase. Yet, PA didn't increase among women: The interaction of time and gender is negative and its coefficient is bigger than that of Time. The second model didn't explain the data better than the first model: *Chi2*(2) = 3.41, p = 0.18. Hypothesis 2b is therefore unsupported by the data.

4. Discussion and conclusion

Our study is the first to examine the effect of a short mindfulness intervention on the emotional reaction to anticipatory social stress.

Confirming our hypothesis, the mindfulness mobile-based intervention successfully weakened the increase in NA during social stress, in comparison to the control condition. The intervention failed to increase PA in participants, contrary to what was predicted. One explanation is that the duration of the intervention (5 minutes) was too short for significant improvements to appear in the face of stressors. Another possibility would be that performing the task frequently could be necessary: programs such as the MBSR require participants to practice daily, and the true benefits of a mindfulness intervention for PA might come from repeated practice [19]. Further research could focus on these two avenues: testing a single but longer procedure, and testing a short intervention such as ours, but over a week or a month.

Another intriguing aspect of our results was that the intervention seemed not to be so beneficial for women. It is known that women and men differ in their reactions to stressors. A review is provided in [26]. In a nutshell, this can be explained by genetic differences, differences in the social environment – women and men differ with regards to their role in society, and differences in psychological gender (femininity and masculinity). Traditionally, femininity is higher in women than in men and masculinity is higher in men than in women. Research shows that femininity is related to higher threat appraisal (resources assessed as lacking to face the stressor) and masculinity to higher challenge appraisal (resources assessed as sufficient to face the stressor) [32]. For this reason, notably, men are less affected by social-evaluative threat [23]. One explanation for the gender differences observed in our study could be that women, because of a higher dispositional appraisal of a lack of resources in the face of stressors (compared to men), might not have considered the intervention as useful in dealing with anticipatory social stress, and therefore may not have benefited from it so much. Further research might focus on these aspects as well. We have pointed out that most mobile health applications lack proper testing. As our study has demonstrated, results might vary between women and men, and potentially other characteristics of the users.

It is particularly intriguing that from tens of thousands of health apps available, the National Health Services (UK; http://apps.nhs.uk) only considers about 400 as safe to use. The effectiveness of mobile-based interventions should be adequately demonstrated before they are made available to the public.

Table 1. **Anticipatory stress and negative affect**

	B (*SE*)	95% *C.I.*
Intercept	1.31 (0.15)*	1.02 – 1.61
Gender (G)	0.17 (0.18)	-0.17 – 0.52
Condition (C)	0.11 (0.19)	-0.26 – 0.47
Time (T)	0.61 (0.15)**	0.32 – 0.91
C x G	-0.05 (0.24)	-0.52 – 0.42
T x G	-0.18 (0.18)	-0.52 – 0.17
C x T	-0.45 (0.19)*	-0.82 – -0.08
C x T x G	0.42 (0.24)#	-0.05 – 0.89

*: $p < .001$; *: $p < .05$; #: $p < .10$

Table 2. **Anticipatory stress and positive affect**

	B (*SE*)	95% *C.I.*
Intercept	3.04 (0.17)*	2.71 – 3.36
Gender (G)	-0.02 (0.19)	-0.40 – 0.36
Condition (C)	0.27 (0.20)	-0.12 – 0.66
Time (T)	0.23 (0.08)*	0.08 – 0.38
C x G	-0.00 (0.25)	-0.51 – 0.49
T x G	-0.30 (0.10)*	-0.50 – -0.10

*: $p < .05$

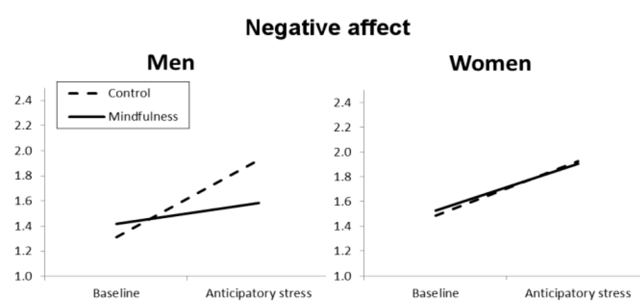

Figure 1. **Anticipatory stress and negative affect (interaction plots)**

5. References

[1] Alberts, H. J. and Thewissen, R. 2011. The effect of a brief mindfulness intervention on memory for positively and negatively valenced stimuli. *Mindfulness* 2, 2 (Feb. 2011), 73-77. DOI = 10.1007/s12671-011-0044-7.

[2] Arch, J. J. and Craske, M. G. 2006. Mechanisms of mindfulness: emotion regulation following a focused breathing induction. *Behav. Res. Ther.* 44 (Dec. 2006), 1849-1858. DOI = 10.1016/j.brat.2005.12.007.

[3] Boulos, M. N. K., Brewer, A., Karimkhani, C., Buller, D. B., and Dellavalle, R. P. 2014. Mobile medical and health apps: state of the art, concerns, regulatory control and certification. *Online J. Public Health Inform.* 5, 3 (Feb. 2014), 229. DOI = 10.5210/ojphi.v5i3.4814

[4] Bowen, S. and Marlatt, A. 2009. Surfing the urge: brief mindfulness-based intervention for college student smokers. *Psychol. Addict. Behav.* 23, 4 (Dec. 2009), 666. DOI = 10.1037/a0017127

[5] Brosschot, J. F. and Thayer, J. F. 2003. Heart rate response is longer after negative emotions than after positive emotions. *Int. J. Psychophysiol.* 50, 3 (Nov. 2003), 181-187. DOI = 10.1016/S0167-8760(03)00146-6

[6] Brown, K. W., Weinstein, N., and Creswell, J. D. 2012. Trait mindfulness modulates neuroendocrine and affective responses to social evaluative threat. *Psychoneuroendocrino* 37, 12 (Dec. 2012), 2037-2041. DOI = 10.1016/j.psyneuen.2012.04.003

[7] Buchanan, T. W., al'Absi, M., and Lovallo, W. R. 1999. Cortisol fluctuates with increases and decreases in negative affect. *Psychoneuroendocrinology* 24, 2 (Feb. 1999), 227-241. DOI = 10.1016/S0306-4530(98)00078-X

[8] Carlson, L. E., Speca, M., Faris, P., and Patel, K. D. 2007. One year pre–post intervention follow-up of psychological, immune, endocrine and blood pressure outcomes of mindfulness-based stress reduction (MBSR) in breast and prostate cancer outpatients. *Brain Behav. Immun*. 21, 8 (Nov. 2007), 1038-1049. DOI = 10.1016/j.bbi.2007.04.002

[9] Carlson, L. E., Ursuliak, Z., Goodey, E., Angen, M., and Speca, M. 2001. The effects of a mindfulness meditation-based stress reduction program on mood and symptoms of stress in cancer outpatients: 6-month follow-up. *Support Care Cancer* 9, 2 (Mar. 2001), 112-123. DOI = 10.1007/s005200000206

[10] Carmody, J. and Baer, R. A. 2008. Relationships between mindfulness practice and levels of mindfulness, medical and psychological symptoms and well-being in a mindfulness-based stress reduction program. *J. Behav. Med.* 31 (Feb. 2008), 23-33. DOI = 10.1007/s10865-007-9130-7

[11] Creswell, J. D., Way, B. M., Eisenberger, N. I., and Lieberman, M. D. 2007. Neural correlates of dispositional mindfulness during affect labeling. *Psychosom. Med*. 69, 6 (Jul./Aug. 2007), 560-565. DOI = 10.1097/PSY.0b013e3180f6171f

[12] Gaab, J., Rohleder, N., Nater, U. M., and Ehlert, U. 2005. Psychological determinants of the cortisol stress response: the role of anticipatory cognitive appraisal. *Psychoneuroendocrinology*, 30, 6 (Jul. 2005), 599-610. DOI = 10.1016/j.psyneuen.2005.02.001

[13] Grossman, P., Niemann, L., Schmidt, S., and Walach, H. 2004. Mindfulness-based stress reduction and health benefits: A meta-analysis. *J. Psychosom. Res 57*, 1 (Jul, 2004), 35-43. DOI = 10.1016/S0022-3999(03)00573-7.

[14] Hofmann, S. G., Sawyer, A. T., Witt, A. A., and Oh, D. 2010. The effect of mindfulness-based therapy on anxiety and depression: A meta-analytic review. *J. Consult. Clin. Psych.* 78, 2 (Apr. 2010), 169-183. DOI = 10.1037/a0018555

[15] Hoge, E. A., Bui, E., Marques, L., Metcalf, C. A., Morris, L. K., Robinaugh, D. J., . . . Simon, N. M. 2013. Randomized controlled trial of mindfulness meditation for generalized anxiety disorder: Effects on Anxiety and Stress Reactivity. *J. Clin. Psychiatry*, 74, 8 (Aug. 2013), 786-792. DOI = 10.4088/JCP.12m08083

[16] Hölzel, B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., and Ott, U. 2011. How does mindfulness meditation work? Proposing mechanisms of action from a conceptual and neural perspective. *Perspect. Psychol. Sci.* 6, 6 (Nov. 2011), 537-559. DOI = 10.1177/1745691611419671

[17] Husain, I., and Spence, D. 2015. Can healthy people benefit from health apps? *BMJ* 350 (Apr. 2015), h1887. DOI = 10.1136/bmj.h1887

[18] Juster, R.-P., Perna, A., Marin, M.-F., Sindi, S., and Lupien, S. J. 2012. Timing is everything: Anticipatory stress dynamics among cortisol and blood pressure reactivity and recovery in healthy adults. *Stress* 15, 6 (Nov. 2012), 569-577. DOI = 10.3109/10253890.2012.661494

[19] Kabat-Zinn, J. 1990. *Full catastrophe living: The program of the stress reduction clinic at the University of Massachusetts Medical Center*. Delta, New York. NY.

[20] Kemeny, M. E., Gruenewald, T. L., and Dickerson, S. S. 2004. Shame as the emotional response to threat to the social self: Implications for behavior, physiology, and health. *Psychol. Inq.* 15, 2 (Dec. 2004), 153-160. DOI = 10.2307/20447221

[21] Klatt, M. D., Buckworth, J., and Malarkey, W. B. 2009. Effects of low-dose mindfulness-based stress reduction (MBSR-ld) on working adults. *Health Educ. Behav.* 36, 3 (June 2009), 601-614. DOI = 10.1177/1090198108317627

[22] Kristeller, J. L. and Wolever, R. Q. 2010. Mindfulness-Based eating awareness training for treating binge eating disorder: The conceptual foundation. *Eating Disorder,* 19, 1 (Dec. 2010), 49-61. DOI =10.1080/10640266.2011.533605

[23] Kudielka, B. M., Hellhammer, D. H., Kirschbaum, C., Harmon-Jones, E., and Winkielman, P. 2007. Ten years of research with the Trier Social Stress Test—revisited. In *Social neuroscience: Integrating biological and psychological explanations of social behavior*, Harmon-Jones, E., and Winkiwlman, P., Eds. The Guilford Press, New York, NY, 56-83.

[24] Latu, I. M., Mast, M. S., Lammers, J., and Bombari, D. 2013. Successful female leaders empower women's behavior in leadership tasks. *J. Exp. Soc. Psychol.* 49, 3 (May 2013), 444-448. DOI = 10.1016/j.jesp.2013.01.003

[25] Liu, X., Wang, S., Chang, S., Chen, W., and Si, M. 2013. Effect of brief mindfulness intervention on tolerance and

distress of pain induced by cold-pressor task. *Stress Health*, 29, 3 (Aug. 2013), 199-204. DOI = 10.1002/smi.2446

[26] Mayor, E. 2015. Gender roles and traits in stress and health. *Front. Psychol.* 6 (Jun. 2015), 779. DOI = 10.3389/fpsyg.2015.00779

[27] Mayor, E. and Gamaiunova, L. 2014. Using wearable technology for psychophysiological experiments. Gender roles and cognitive appraisal impact cardiac response to socio-evaluative stress. In *Proceedings of the 4th International Conference on Wireless Mobile Communication and Healthcare* (Athens, Greece, November 3-5, 2014). IEEE, 15-18. DOI = 10.1109/MOBIHEALTH.2014.7015897

[28] Plaza, I., Demarzo, M. M. P., Herrera-Mercadal, P., and García-Campayo, J. 2013. Mindfulness-based mobile applications: Literature review and analysis of current features. *JMIR mHealth and uHealth*, 1, 2 (Jul./Dec. 2013), e24. DOI = 10.2196/mhealth.2733

[29] Pressman, S. D. and Cohen, S. 2005. Does positive affect influence health? *Psychol. Bull.* 131, 6 (Nov. 2005), 925-971. DOI = 10.1037/0033-2909.131.6.925

[30] Proudfoot, J., Parker, G., Pavlovic, D. H., Manicavascar, V., Adler, E., and Whitton, A. 2010. *J. Med Internet Res.* 12, 5 (Oct./Dec. 2010), e64. DOI = 10.2196/jmir.1475

[31] Rahl, H. 2014. *Brief Mindfulness Meditation Training and Stress Reactivity: Mechanisms and Outcomes.* Doctoral Thesis, Carnegie Mellon University

[32] Sarrasin, O., Mayor, E., and Faniko, K. 2014. Gender traits and cognitive appraisal in young adults: The mediating role of locus of control. *Sex Roles*, 70, 3-4 (Feb. 2014), 122-133. DOI = 10.1007/s11199-013-0336-6

[33] Shapiro, D., Jamner, L. D., Goldstein, I. B., and Delfino, R. J. 2001. Striking a chord: moods, blood pressure, and heart rate in everyday life. *Psychophysiology*, 38, 2 (Mar. 2001), 197-204. DOI = 10.1111/1469-8986.3820197

[34] Shapiro, S., Astin, J. A., Bishop, S. R., and Cordova, M. 2005. Mindfulness-based stress reduction for health care professionals: results from a randomized trial. *Int. J. Stress Manage.* 12, 2 (May 2005), 164. DOI = 10.1037/1072-5245.12.2.164

[35] Shapiro, S., Brown, K. W., and Biegel, G. M. 2007. Teaching self-care to caregivers: Effects of mindfulness-based stress reduction on the mental health of therapists in training. *Train. Educ. Prof. Psychol*. 1, 2 (May 2007), 105-115. DOI = 10.1037/1931-3918.1.2.105

[36] Shapiro, S., Carlson, L. E., Astin, J. A., and Freedman, B. 2006. Mechanisms of mindfulness. *J. Clin. Psychol.* 62, 3 (Mar. 2006), 373-386. DOI = 10.1002/jclp.20237

[37] Stefano, G. B., Stefano, J. M., and Esch, T. 2008. Anticipatory stress response: a significant commonality in stress, relaxation, pleasure and love responses. *Med. Sci. Monit. Basic Res.*14, 2, (Feb. 2008), RA17-RA21.

[38] Steptoe, A., Wardle, J., and Marmot, M. 2005. Positive affect and health-related neuroendocrine, cardiovascular, and inflammatory processes. In *Proceedings of the National Academy of Sciences of the United States of America* 102,18 (Apr. 2005), 6508-6512. DOI = 10.1073/pnas.0409174102

[39] Teasdale, J. D., Segal, Z. V., Williams, J. M. G., Ridgeway, V. A., Soulsby, J. M., and Lau, M. A. 2000. Prevention of relapse/recurrence in major depression by mindfulness-based cognitive therapy. *J. Consult Clin. Psych.* 68, 4 (Aug. 2000), 615-623. DOI = 10.1037/0022-006X.68.4.615

[40] Watson, D., Clark, L. A., and Carey, G. 1988. Positive and negative affectivity and their relation to anxiety and depressive disorders. *J. Abnorm. Psychol.* 97, 3 (Aug. 1988), 346-353. DOI = 10.1037/0021-843X.97.3.346

[41] Watson, D., Clark, L. A., and Tellegen, A. 1988. Development and validation of brief measures of positive and negative affect: the PANAS scales. *J. Pers. Soc. Psychol.* 54, 6 (Jun. 1988), 1063-1070. DOI = 10.1037/0022-3514.54.6.1063

[42] Zeidan, F., Johnson, S. K., Gordon, N. S., and Goolkasian, P. 2010. Effects of brief and sham mindfulness meditation on mood and cardiovascular variables. *J. Altern. Complement. Med.* 16, 8 (Aug. 2010), 867-887. DOI = 10.1089/acm.2009.0321