

Effects of Technology-Based Mindfulness Training on Wellbeing and Stress

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Abstract

More and more people practice mindfulness to reduce stress and improve their wellbeing. In this regards, technology-based interventions such as smartphone apps provide an interesting potential. Our study explores effects on users' perceived wellbeing and stress on the example of the mindfulness-based app My Blossom. Forty-four new users answered four online questionnaires in one-week intervals, containing established multi-item wellbeing and stress scales for as well as single-item direct explicit questions about perceived changes in wellbeing and stress. In combination, these two forms of assessment provided insights to what degree users are conscious of a possible change and whether these perceptions are in parallel to the more indirect measures. Paired t tests show significant improvements in positive and negative affect, mood and stress in both scales and overall ratings after three weeks of mindfulness-training with My Blossom compared to the pre-intervention baseline. These findings suggest mindfulness-training in form of an app as an interesting alternative to mindfulness-trainings under instructions of a physically present trainer and the power to increase wellbeing and decrease stress. Future research should concentrate on the specific mechanisms and possible design factors of app-based mindfulness-trainings (e.g., variety of training offers, degree of guidance, reminder functions) as well as long term effects.

Keywords: mindfulness, technology-based interventions, apps, wellbeing, stress reduction

Effects of Technology-Based Mindfulness Training on Wellbeing and Stress

When currently scrolling through the lifestyle-section of the App-Store, more and more apps refer to wellbeing and stress reduction. From sleep tracker to meditation apps, from yoga programs to fitness apps or even soothing anti stress games, the demand for technology helping to reduce stress and improve wellbeing seems to grow steadily. With smartphones being our constant companions, these apps seem to be interesting options for a lightweight way of everyday healthcare for everyone. Similarly, institutional healthcare could profit from app-based services as a complement to other approaches.

In many of these app-based wellbeing interventions, mindfulness appears as a central concept.

As described by Crane ¹, the mindfulness based programs, inter alia, focus on present moment focus, decentering and an approach orientation as well as emotional and behavioral self-regulation. Some are pure mindfulness applications (e.g. Headspace, [headspace.com](https://www.headspace.com)), some focus on yoga (e.g. Down Dog, www.downdogapp.com) or meditation (e.g. 7Mind Meditation, <https://www.7mind.de>), others use specific aspects of mindfulness in their trainings, such as focusing the mind on the present moment and sensations (e.g. Peak, [peakmindful.com](https://www.peakmindful.com)). Indeed, previous research on the effects of mindfulness and its training showed promising results and positive effects for a number of variables related to wellbeing. These include, for example, a reduction of vulnerability through dealing with stress and emotional distress in a more adaptive way ², a reduction of the perceived stress, anxiety and depression symptoms ^{3,4}, as well as reduced negative affect and increased hope ⁵. In general, it

has been found that more mindful persons are more likely to use adaptive coping strategies when stressed and therefore feel fewer negative effects of stress in their lives ^{2,3}, whereby mindfulness as a skill can be systematically trained and improved via mindfulness trainings ³.

A meta analysis of more than 200 mindfulness studies revealed medium effect sizes on reductions of stress, anxiety and depression symptoms in clinical populations ⁶. Another meta analysis of 20 mindfulness studies found medium effect sizes in clinical as well as non-clinical populations ⁷.

Regarding the psychological mechanisms behind the effects of mindfulness, Grecucci et al ⁸ especially highlight the influence of mindfulness on emotion regulation. Particularly distancing oneself of own emotions and reactions and the skill to evaluate own reactions to stimuli seem to lead to this enhanced emotional regulation.

Other authors discuss that the positive effects of mindfulness training on stress is achieved by less negative cognitive appraisals through the open and accepting way that is practiced with mindfulness. In addition, mindfulness supplements adaptive coping strategies by reducing negative ways of thinking, that are associated with avoidant-coping and by supporting approach-coping. Beyond the reduced avoidant-coping, more mindful persons also assess future events more benign and less threatening, what has a positive influence on wellbeing. They also showed that the higher level of adaptive coping in more mindful people mediates the connection between mindfulness and wellbeing (more positive and less negative indicators) ².

In sum, such findings speak for the general effectiveness of mindfulness-based interventions. However, in contrast to the number of studies on

mindfulness in general, research on digital or web-based mindfulness intervention is still rare. For example, first promising studies showed that it is possible to learn mindfulness as self-help, meaning without a physically present trainer and profit from the positive effects with small to medium effect sizes⁹. Another study of short web-based mindfulness trainings over a two-week period led to increased mindfulness skills, reduced perceived stress and less anxiety and depression symptoms. Moreover, the participants were more likely to use such a program even after the study, which underlines the potential of technology-based wellbeing interventions as a suitable form of long-term prevention, which can be easily integrated in every day life^{3,4}. At the same time, with the increasing digitalization and acceleration of life, the wish for contemplation and stress-reduction in everyday life becomes ever more central and the smartphone appears as an obvious medium. As Apple's famous commercial slogan suggests – "there's an app for that". In the present study we examined the effects of one of such app-based mindfulness programs over a three-week usage period in a sample of healthy adults.

Hypotheses and research questions

Our study set out to explore effects of an app-based mindfulness intervention on wellbeing and stress by a variety of measures. Additionally, we examined wellbeing and stress values in the course of time. Finally, we were interested in whether there is a discrepancy between more implicit measures of changes in wellbeing and stress (i.e., contrasting measures of wellbeing and stress before and after the usage period using established multi-item scales) and more explicit measurements (i.e., direct questions regarding the overall rating of wellbeing and stress as well as the

perceived change in wellbeing and stress after the usage period).

To answer this research issue, we examined the following hypotheses (H) and research questions (RQ) on the example of the mindfulness-based wellbeing app My Blossom:

H1: After three weeks of using My Blossom, the wellbeing is significantly higher than before, as indicated by the following measures:

- a. significantly higher values of positive affect (PA)
- b. significantly lower values of negative affect (NA)
- c. significantly higher mood values
- d. significantly lower reactivity values
- e. significantly higher ratings of overall wellbeing

H2: After three weeks of using My Blossom, the level of stress is significantly lower than before, as indicated by the following measures:

- a. a significantly lower stress index
- b. significantly lower values of irritation
- c. significantly lower values of overall stress

RQ1: How do values of wellbeing and stress change in the course of time? Is there a linear change?

RQ2: Do participants report subjectively perceived changes in wellbeing and stress after the three-week usage period? Is participants' subjective perception of change comparable to the calculated difference values of assessed wellbeing and stress before and after the usage period?

Methods

Study procedure

The study was conducted via online survey and announced via a social media campaign in context of the German My Blossom website. The

survey and all materials were in German language. Furthermore, My Blossom distributed the link to business partners and participants have been encouraged to share the link to the study with others. To participate in the study, one had to be 18 years or older, use the app My Blossom during the data collection and haven't been regularly using the app before. In context of the study, new users were able to use the application free of charge.

Interested individuals followed a link to a website about the study, where they could inform themselves about the procedure and were able to sign up for the free trial as well as the study. After the registration, participants saw a site with the instruction to use My Blossom in the following three weeks as they feel comfortable. Their personal access code to My Blossom and the links to the online surveys were provided by email. The first survey, assessed before the usage period, was an initial baseline questionnaire. This questionnaire consisted of questions about demographics (e.g., age, gender), previous experiences with mindfulness training and different measures of wellbeing and stress as further described below. The then following three intervention questionnaires, surveyed after one, two and three weeks of usage, were structured similar to the baseline survey. As additional measures, the intervention surveys also assessed the intensity of the My Blossom usage in the previous week as well as questions about perceived changes in wellbeing and stress since using the app. Figure 1 summarizes the study procedure from

receiving the study link and first information to the last questionnaire.

Measures

Wellbeing

Positive and Negative Affective Schedule¹⁰

This 20 item instrument measures wellbeing as positive affect (PA) and negative affect (NA, ten items each), which are considered as independent dimensions and not as opposite poles in the underlying model¹⁰. Sample items of positive affect are “enthusiastic” or “active”, sample items of negative affect are “distressed” or “irritable”. Participants rate the items on a 5-point Likert scale from 1 – not at all to 5 – very much. The reliability was good with $\alpha = .88$ for PA and $\alpha = .86$ for NA.

Mood scale¹¹

This 15 item instrument measures two dimensions of mood: overall mood (Am I normally feeling good or bad?, nine items) and reactivity (number and intensity of mood swings, six items). Mood in this context does not mean a permanently changing construct but a continuous tendency in experience and behavior¹¹. Sample items are “I consider myself a happy person.” for mood and “Sometimes my mood changes rapidly.” for reactivity. Participants rate the items on a 7-point Likert scale from 1 – very bad to 7 – very good. The reliability was good with $\alpha = .86$ (mood) and $\alpha = .72$ (reactivity).

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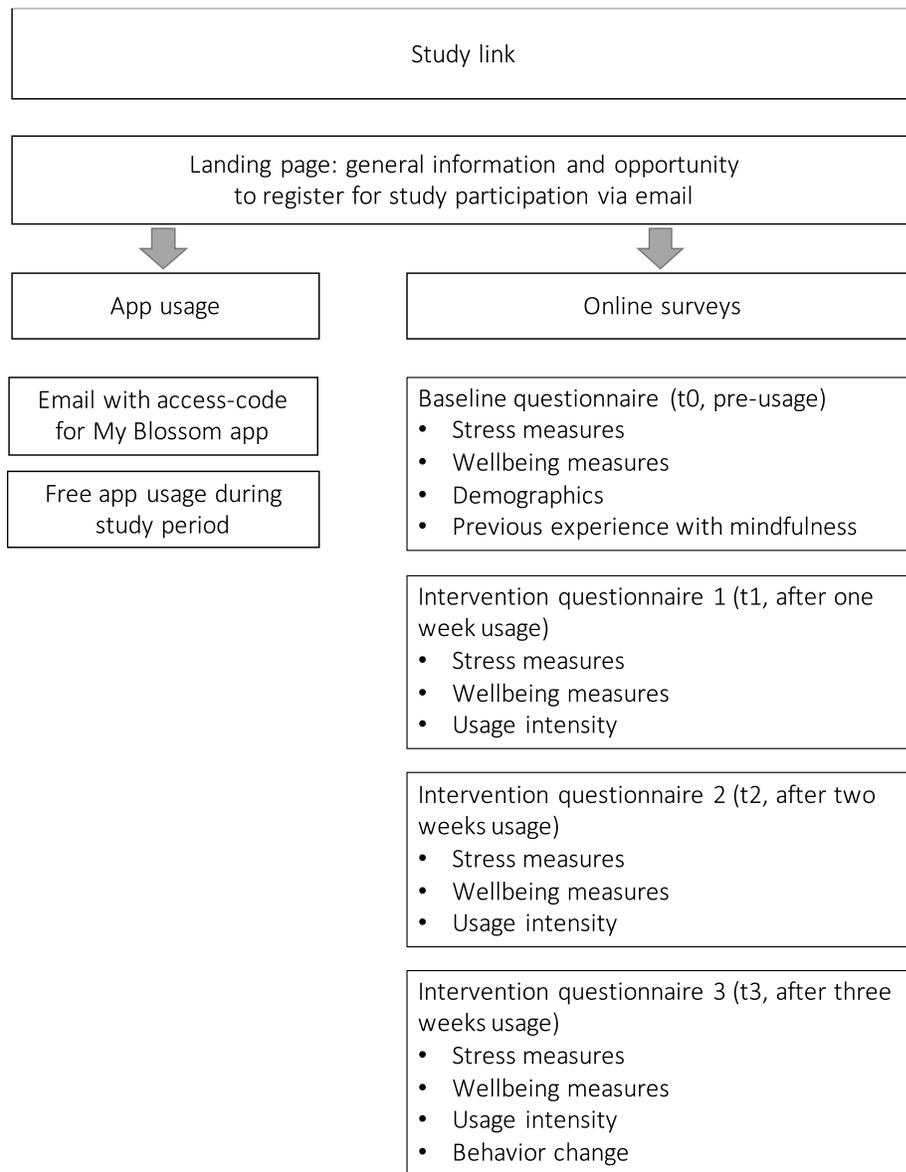


Figure 1. Procedure for the participants, from first information to the last questionnaire.

Overall wellbeing

One single item, “How well did you feel during the last week?”, assessed the participants' overall wellbeing in the last week on a Likert scale from 1 – not at all to 5 – very much.

Perceived change in wellbeing

Another single item, “Did you experience any changes in your wellbeing since using the app My Blossom?”, was used to examine to which degree participants are aware of changes in their wellbeing. Participants rated the change they felt in their wellbeing since using the app on a 5-point Likert scale from 1– none at all to 5 – very high.

Stress

The Standard Stress Scale ¹²

This 11 item instrument measures experienced stress relating to different areas such as overcommitment/workload, enjoyment of work/self-realization/empowerment, social distress/social support/social approval, recreational capacities/exhaustion and anxiety about the future/uncertainty ¹². Sample items are: “After a normal day I am exhausted.” or “I am doing meaningful tasks.” Ratings are assessed on a 5-point Likert scale from 1 – not true at all to 5 – true in every way. The reliability was acceptable ($\alpha = .66$).

Irritation scale ¹³

This 8 item instrument measures irritation as a component of stress, covering facets of cognitive and emotional irritation ¹⁴. While cognitive irritation describes a lasting goal discrepancy with reinforced efforts toward goal-achievement, emotional irritation is “a state of losing the incentive to achieve a certain goal after intense efforts toward goal-achievement have not led to diminished goal-discrepancy” ¹⁵. Sample items are “I have difficulty relaxing after work” or “From time to time I feel like a bundle of nerves.” Participants rated the items on a 7-point Likert scale from 1 – is not true at all to 7 – true in every way. The reliability was good with $\alpha = .84$.

Overall stress

One single item, “How stressed did you feel during the last week?”, assessed the participants' overall wellbeing in the last week on a Likert scale from 1 – not at all to 5 – very much.

Perceived change in stress

Another single item, “Did you experience any changes in your stress since using the app My Blossom?”, was used to examine to which degree participants are aware of changes in their stress. Participants rated the change they felt in their stress since using the app on a 5-point Likert scale from 1 – none at all to 5 – very high.

Usage intensity and behavior change

During the intervention participants were free to use the app as intensively as they wanted. The instruction was: “Use My Blossom in a way, that you feel good.” Participants stated their intensity of using My Blossom in the weekly intervention questionnaires on a 7-point scale with 1= never, 2= once, 3= two to three times, 4= every second day, 5= almost every day, 6= every day, 7= more than once a day.

After three weeks of using the My Blossom app, participants stated if they changed their behavior compared to before. Multiple of the following answers could be selected: “Yes, I did more yoga.”; “Yes, I did more pilates.”; “Yes, I meditated more”; “Yes, I adjusted my diet according to the application.”; “Yes, other: _”; “No, I did not change my behavior.”.

Intervention

The intervention consisted of a three-week usage of the smartphone application My Blossom. The app My Blossom offers a wide range of mindfulness-based practices such as yoga and meditations and is roughly divided into five sections. The section „Workouts” includes the mindfulness-based activities yoga and pilates. The duration of the 27 programs varies between five and 60 minutes. “Meditation” consists of 19 mindfulness-based meditations in an audio format,

with a duration of five to 30 minutes. In addition to these solely mindfulness-based sections, the app also offers recipes, a diary function and an emotion-tracker.

Participants

Participants were recruited in April and May 2020. Out of 286 persons starting the first questionnaire, 44 persons still filled in the fourth questionnaire after the three-week usage period and built the final sample. Of the 44 participants, 41 participants were female, three male, with an age from 18 to 59 (16 participants were 18-29 years, four 30-39 years, 14 40-49 years and ten were 50-59 years old). 37 of the 44 participants heard about the app for the first time when signing up for the study, the others had already heard about My Blossom but not tested it. Seven out of the 44 participants stated to not to have practiced mindfulness on a regular basis before the test. The

remaining 37 have been practicing at least one of the mindfulness trainings yoga, pilates or meditation regularly before.

Statistical analyses

The statistical analyses were conducted using the software R with one sided testing at a significance level of $p \leq .05$ and Bonferroni-correction against alpha error accumulation for multiple comparisons.

Results

Usage intensity

As depicted in Figure 2, the intensity of usage decreased a little over the course of the data collection. While in week 1, 37 of the 44 (84%) participants used the app at least two times a week, this number decreased to 28 (64%) in week 2 and to 22 (50%) in week 3.

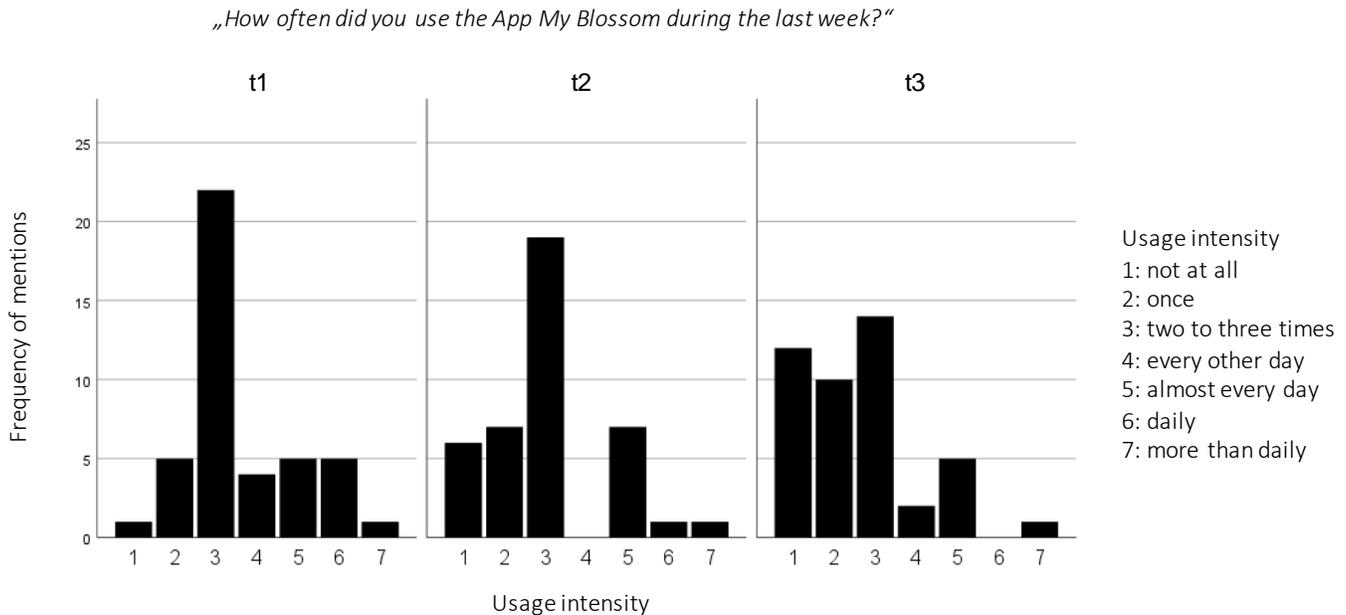


Figure 2. Bar plots of app usage intensity over the three week usage period.

Change in behavior

After three weeks of intervention, participants stated whether they changed their behavior in the last three weeks. 26 out of the 44 participants answered to have changed at least one of the following behaviors: Eleven participants stated to have been practicing more yoga, eight more pilates, 14 meditated more and one participant states to have been eating more awarely according to the recipes in the app. Three participants used the open answer format for other changes: one was outside in fresh air more often, one collected happy moments, even if they were small, and one reflected himself more.

Descriptive analysis of baseline measures

The mean value of the positive and negative affect at the baseline survey fell within the average range, one standard deviation around the mean value of the norm sample, with mean of PA= 2.83 (norm sample: M= 3.17, SD= 0.63) and NA= 1.92 (norm sample: M= 1.72, SD= 0.57)¹⁰. The sample differs neither in positive nor negative affect from the norm sample. The mean value of the scale mood (mood survey) fell, with 4,65 (norm sample: M= 3.25, SD= 0.84) one standard deviation above the average range of the norm sample, the reactiveness with a mean of 3.78 lay within the average range (M= 3.55, SD= 0.81)¹¹. Thus, the present sample of My Blossom users had a slightly more positive mood than the norm sample, the reactiveness was average. The mean value of the Standard Stress Scale was, with 0.44, also average. The norm sample is normally distributed around the value 0.4¹². The sample was averagely stressed at the beginning of the study. The irritation scale gave a mean value of 3.32 at the baseline, which is in the average range of M= 3.10,

SD= 1.21¹³. In sum, the baseline values of the present sample did not differ gravely from the norm samples any of the raised scales of wellbeing and stress.

37 participants stated to constantly have been practicing forms of mindfulness before the intervention (yoga= 26, pilates= 8, meditation= 11). Seven participants have not been practicing any mindfulness at all before participating in the study.

H1: Wellbeing

In line with H1a, a one-sided t test for paired samples showed a significant increase of PA from baseline (M= 2.83, SD= 0.58) to t3 (M= 3.25, SD= 0.65, p= 0.001, d= 0.60, 95% CI= [0.28, 0.92]). Considering NA, the t test for paired samples showed a significant decrease from a mean of 1.92 at baseline (SD= 0.53) to 1.61 at t3 (SD= 0.51, p= 0.003, d= 0.55, 95% CI= [0.23, 0.87]), what is in line with H1b. The mean of the scale mood, in line with H1c, significantly increased from baseline (M= 4.65, SD= 0.99) to t3 (M= 4.91, SD= 1.04, p= 0.042, d= 0.40, 95% CI= [0.09, 0.71]), as shown by a one-sided t test for paired samples. However, in contrast with H1d, there was no significant difference for reactivity values at baseline (M= 3.78, SD= 1.04) and t3 (M= 3.56, SD= 0.89, p= 0.339). The analyses of the overall wellbeing showed, in line with H1e, with a one-sided t test for paired samples, a significant increase from baseline (M= 3.02, SD= 0.73) to t3 (M= 3.45, SD= 0.76, p= 0.030, d= 0.42, 95% CI= [0.11, 0.73]). Thus, in sum, the results lend partial support for H1, indicating a higher wellbeing after three weeks of using My Blossom regarding all measures except for reactivity: The positive affect was significantly higher, the negative affect significantly lower than

before the usage. Also, participants' mood and overall wellbeing was significantly more positive.

H2: Stress

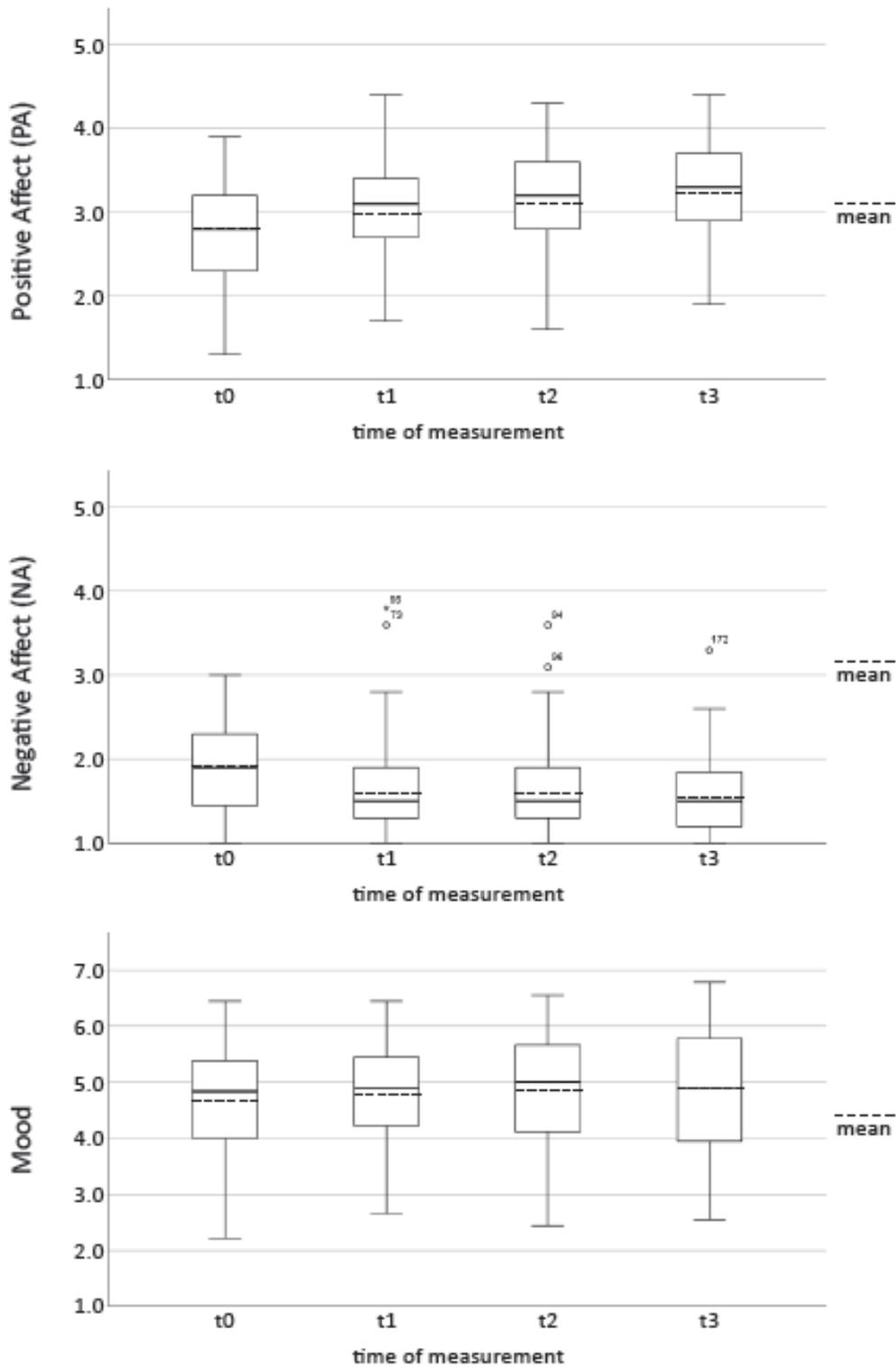
In line with H2a, the one-sided t test for paired samples of the Standard Stress Scale showed a significant decrease of the stress index from baseline (M= 0.44, SD= 0.10) to t3 (M= 0.39, SD= 0.11, $p < 0.001$, $d = 0.63$, 95% CI= [0.31, 0.95]). Considering irritation, the one-sided t test for paired samples did not, in contrast to H2b, show a significant decrease from baseline (M= 3.32, SD= 1.1) to t3 (M= 3.12, SD= 0.99, $p = 0.264$). The one-sided t test for paired samples regarding the overall stress measure showed, in line with H2c, a significant decrease of stress from baseline (M= 2.91, SD= 1.07) to t3 (M= 2.23, SD= 0.94, $p = 0.002$, $d = 0.58$, 95% CI= [0.26, 0.90]). Therefore, the data partially supports H2, pointing towards a lower level of stress after three weeks of using My Blossom, with only Irritation not

showing lower stress levels: The Standard Stress Scale was significantly lower after three weeks of mindfulness training, also participants rated their overall stress significantly lower.

RQ1: Wellbeing and stress values over the course of time

Figure 3 depicts the mean values for the wellbeing (Figure 3a) and stress measures (Figure 3b) over the course of time. As it can be seen, the most obvious difference and positive effect is typically between the baseline and week 1. After week 1, the wellbeing and stress values do not drop back to the baseline level, but also show no further improvements. In line with the visual impression, repeated measures ANOVAs with post-hoc contrasts between consecutive times of measurements showed significant differences only between baseline and t1 for NA ($p = 0.005$), Standard Stress Scale ($p = 0.017$), overall wellbeing ($p = 0.044$) and overall stress ($p = 0.003$).

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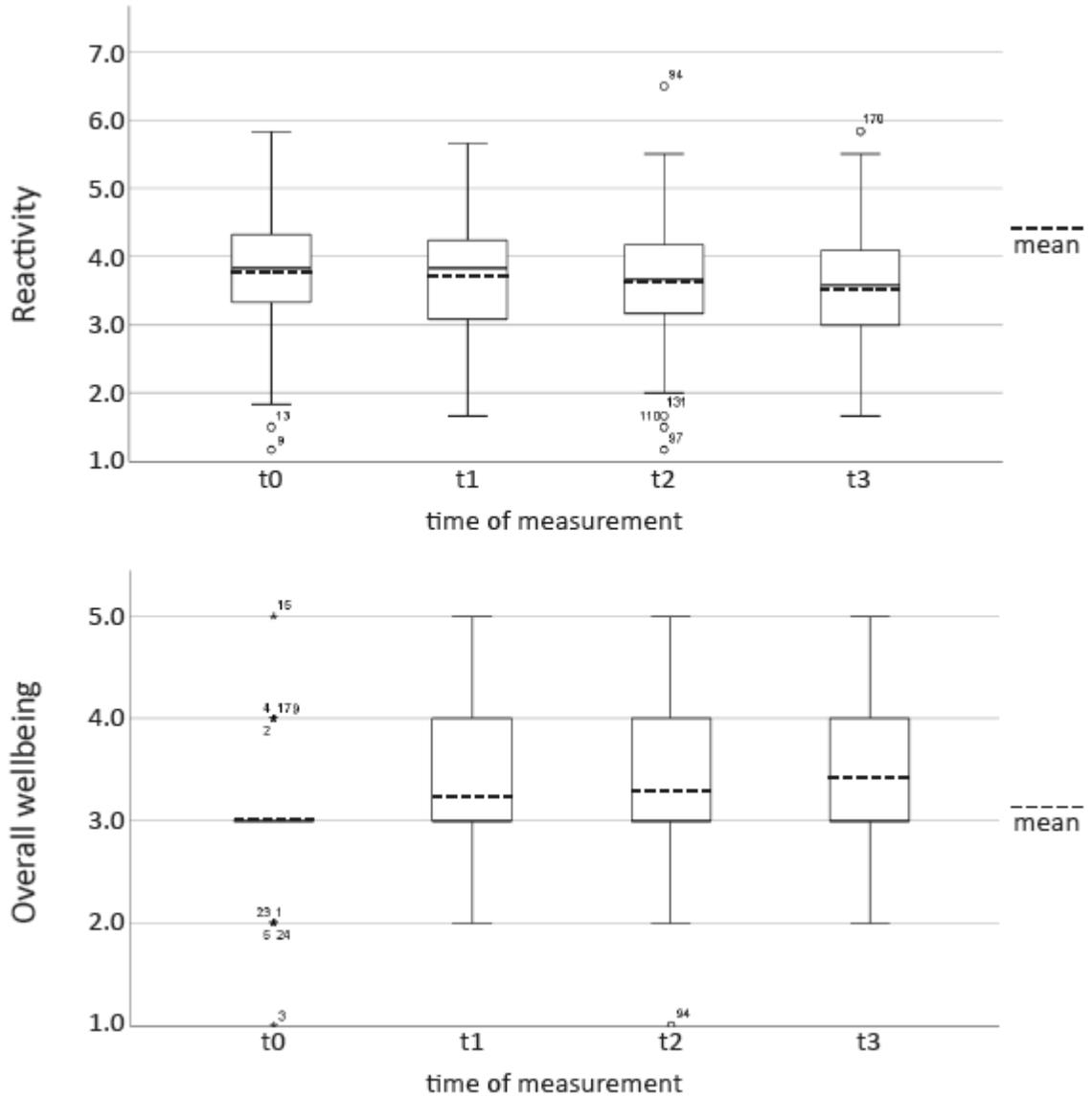


Figure 3a. Mean values and boxplots of the wellbeing measures over the course of time.

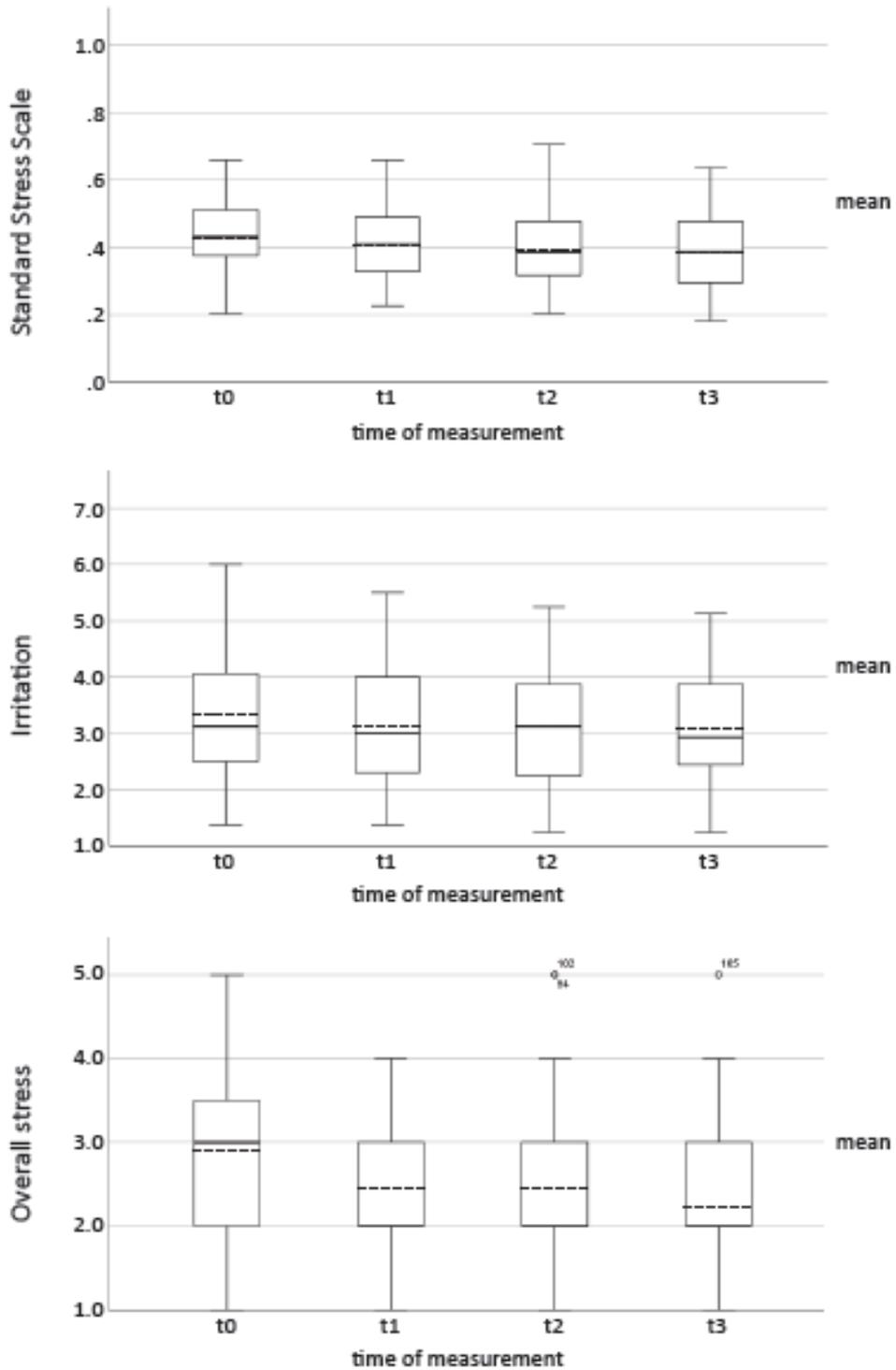


Figure 3b. Mean values and boxplots of the stress measures over the course of time.

RQ 2: Subjectively perceived changes in wellbeing and stress

Participants' reports on their subjectively perceived change in wellbeing indicated significant but moderate changes and increasing change values over the course of time. For all three weeks, the average value of perceived change in wellbeing as well as stress was below the scale midpoint of 3.0, however, significantly exceeded

the scale endpoint of 1.0 (no change at all) in all three weeks. Table 1 shows the descriptive data and significance values for one-sample t tests against 1.0. Overall, participants' subjective perception of change in wellbeing and stress is in line with the statistic differences in wellbeing across time as analyzed in H1 and H2, indicating a moderate but significant improvement of wellbeing and stress.

		N	M	SD	Test value=1.0		
					T	df	p-value (2 sided)
t1	perceived change wellbeing	43	1.93	,799	7.638	42	.000
	perceived change stress	43	1.72	,701	6.742	42	.000
t2	perceived change wellbeing	41	2.22	,962	8.116	40	.000
	perceived change stress	41	2.00	,866	7.394	40	.000
t3	perceived change wellbeing	44	2.39	,993	9.257	43	.000
	perceived change stress	44	2.14	,979	7.702	43	.000

Table 1. Descriptive data and significance values for one-sample t tests against 1.0 for overall wellbeing and stress in all three weeks.

Additional explorative analyses: Impact of prior experience with mindfulness

In order to check for potential effects of prior experience with mindfulness on the effectiveness of the intervention, we contrasted those 37 participants who reported regular engagement in mindfulness-related activities (e.g., yoga, pilates, meditation) already before using My Blossom with those seven who did not. 2 x 2 ANOVAs with previous mindfulness experience (yes, no) as between subjects factor and wellbeing/stress measures at baseline and t3 as repeated measurements factor did not reveal any interaction between mindfulness training before the study and any of the stress or wellbeing measures. At least in the present sample, mindfulness novices and those with prior

experiences in practicing mindfulness did profit from My Blossom in similar degree.

Discussion

This study shows the potential of app-based mindfulness training for improving wellbeing and reducing stress in healthy adults in Germany. The effects were visible after only three weeks of mindfulness training via the app My Blossom and did not only occur in the raised scales but also in overall ratings of wellbeing and stress as more direct, explicit measures – participants stated to feel overall better and less stressed.

Upon looking into the results more deeply, they are consistent with H1a, b, c and e. The wellbeing of the My Blossom users has increased. After using the mindfulness-based app for three

weeks, positive affect as well as mood were significantly higher, negative affect significantly lower than before. Only H1d, a reduction of reactivity, has to be discarded. According to Bohner and Schwarz ¹¹, the construct of reactivity measures the number and intensity of mood swings. Therefore, it differs from positive and negative affect as well as mood, not directly measuring the valence of wellbeing but its changes. We can assume, according to our data, that people experienced an increased positive affect and mood plus a reduced negative affect, but that the individual frequency and intensity of mood swings was not influenced by the mindfulness training in form of the app.

A little less clear are the results regarding H2, a significant reduction of stress. The values of the Standard Stress Scale (H2a) significantly decreased, therefore the data is in accordance with this hypothesis. Irritation (H2b) on the other hand did not significantly lower, what is not in accordance with H2b. A possible reason for this mismatch lies in the construction of the irritation scale, which was originally constructed for use in work context ¹³. This focus on an occupational environment could have been irrelevant for some participants, especially due to the fact that the study was conducted during the COVID-19 pandemic. As part of the governmental restrictions, many worked less or not at all and the work context shifted from being in an office to working from home. Therefore, a systematic bias cannot be ruled out. In contrast, differences were significant over the time in the Standard Stress Scale. This scale reaches wider than the Irritation scale, for not being limited to the working context and validated in different contexts and populations ¹².

Interestingly, the examination of the data in the course of time (RQ1) revealed that the most

obvious changes occurred already in week one. A long-term study expanding over more than three weeks could help modelling and quantifying the long-term changes. In addition, such a long-term study could also explore possible effects of the degree of guidance the app offers, reminder functions or of the variety of training content on users' wellbeing and usage motivation. In general, more diverse trainings should be more motivating than monotone programs ¹⁶, and it would be interesting to test to what degree this is relevant for the domain of mindfulness.

Finally, besides the general assessment of changes in the experience of wellbeing and stress by pre-post-intervention difference values, our study also explored if and how conscious participants experience this change by means of direct questions, the rating of overall wellbeing and stress as well as the perceived changes in these constructs (RQ2). Indeed, both ways of analyses showed significant changes in wellbeing and stress. Especially the conscious experience of improvements in wellbeing and stress may be relevant for the continued usage motivation. If users feel like the mindfulness training is effective, thus the promise of the product is fulfilled, they might be more likely to use the app further. If the participants couldn't have stated the improvements explicitly after direct questions these improvements would have had to be made clear in the sense of a long-term customer loyalty that in this case leads to a long term mindfulness training ¹⁷. In that way, a long-term prevention through mindfulness training in this app-form can be maintained.

Altogether, our findings are consistent with previous meta-analyses on the effects of mindfulness trainings ^{7,9} supporting the hypothesis that mindfulness training can reduce stress and

improve wellbeing. Also, the hypothesis regarding web-based mindfulness training can be supported further by our results. Like Cavanagh et al.³ and Glück & Maercker⁴ we were able to show positive effects of a short web-based mindfulness training on wellbeing and stress. In line with the meta-analyses of Cavanagh et al.⁹, our data supports the assumption that mindfulness can be learned in self-help, meaning without a physically present trainer.

Based on the present findings, we can conclude that applications giving an easy and quick access to mindfulness training do have the potential to make lives less stressful and support a higher level of wellbeing. Even though many aspects of the digital approach to mindfulness are still in need of further research, it seems like it has the potential to help people feeling better.

Limitations and future research

The present study is subject to several limitations which need to be considered for the interpretation of our findings and future research.

Due to the holistic evaluation, it remains unclear, what part of the app-based mindfulness training with My Blossom is responsible for the positive effects on wellbeing and stress. Especially with My Blossom and its variety of mindfulness-based yoga and pilates workouts, meditations, recipes and the diary function, encouraging users to write down positive incidences throughout the day, it would be very interesting to find out which parts of the app generate the positive effects. Similarly, remaining unclear and in need of more research are the specific psychological mechanisms behind the effects of app-based mindfulness training. Future studies regarding mindfulness apps should concentrate on the different usage of the various components and a more specific evaluation of the separate

components as well as their respective influences on wellbeing and stress. Also, future research could benefit from protocolling the behavior before and during the usage more precisely, as well as recording the way in which the mindfulness app is used. In this way it would be possible to link certain behavior to changes in wellbeing and stress.

Another limitation refers to the present sample of study participants, regarding several aspects. One is the unbalanced gender ratio in the present sample, consisting of three men and 41 women. There are several possible reasons for why more women than men decided to take part in the study: Firstly, the app My Blossom in its current form clearly targets women. The color schemes in pink and lilac tones as well as exclusively female trainers in pictures and videos make that obvious. It is possible that these characteristics discouraged men, especially because the targeting of women was implemented similarly into the campaign advertising the study. Secondly, the topics yoga, pilates and meditation in general seem to rather speak to women. At this time there is few evidences to that statement, but a survey of the BDY (Berufsverband der Yogalehrenden in Deutschland e.V./professionals association of yoga teachers in Germany) from the year 2018 shows that 9% of women in Germany practice yoga but only 1% of the male population¹⁸. Pursuing this study, it would be especially interesting for future research to concentrate on differences between men and women in the influence of app-based mindfulness training on wellbeing and stress with a balanced gender ratio.

Also, it must be noted that most of our participants (37 of 44) reported prior experience with mindfulness-related activities such as yoga or pilates. Though the contrast with those participants without prior experience did not reveal significant

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differences in changes regarding wellbeing and stress between the two user groups, more differentiated analyses might provide other insights. Therefore, a comparing study between mindfulness beginners and advanced mindfulness trainers could give more insight to which part of the app usage favors the positive effects for the different groups of users.

Moreover, the present findings may be skewed by the high dropout rate. Out of the 286 people completing the baseline questionnaire only 44 also completed the last one after three weeks and were therefore included in the analyses. That only makes for a 15% completion rate. It could be that only those participants completed the questionnaires over the course of the three weeks, who perceived positive effects because of using the app and therefore had an interest in participating longer.

Finally, the COVID-19 pandemic could also have skewed the results in this study. At the start of the data collection in April 2020 the pandemic had already affected the whole world. Systematic effects of the restrictions and their

gradual lifting from June on (still in the time of our data collection) cannot be ruled out.

Conflict of interest statement: This study was supported by the company My Blossom. The company My Blossom organized the social media campaign for recruiting participants and free accounts for the time of the data collection. The authors did not receive any financial or additional support from the company My Blossom. The company My Blossom was not involved in the data analysis and interpretation.

Human rights statements and informed consent: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and its later amendments. Informed consent was obtained from all patients for being included in the study.

Animal Rights: This article does not contain any studies with animal subjects performed by the any of the authors.

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