Pilot testing a mobile cognitive behavioural therapy application

Bachelor thesis

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Abstract

Many people suffer from mental health problems, and interventions can be used to enhance mental well-being. Studies have shown that web-based interventions can be successful in treating mental disorders, however, no studies were found regarding short CBT interventions delivered on an app on the smartphone of participants. In this study a two-week long mobile cognitive behavioural therapy intervention was tested. The intervention was tested in a nonclinical sample who are university students, as they are in a stressful period of time which can be a risk factor for developing mental health problems. Ten participants were recruited who filled out a questionnaire, then used the app for two weeks, and afterwards they did the questionnaire again. The pre- and post-test measured positive and negative affect (PANAS), mental health (MHC-SF), anxiety (GAD-7), and depression (PHQ-9), the post-test had an additional engagement questionnaire. The post-test was followed by a short semi-structured interview to investigate positive and negative aspects about the app and how it can be improved. The results showed no improvement in mental health and engagement was low. The interviews showed that participants had good ideas for improvements for the app. Participants in this study had no mental health problems and no problems with automatic thoughts, which could have resulted in low engagement, both could be factors leading to the low effectiveness of the intervention.

Introduction

Mental well-being can be defined as optimal functioning that allows humans to live effectively, to be satisfied in life, and to experience genuine happiness (Teh, Archer, Chang, & Chen, 2013). The World Health Organization defines mental health as "a state of well-being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community" (WHO, 2018, para.2). It is said to reduce perceived stress and improve physical health (Teh, Archer, Chang, & Chen, 2013). Therefore, mental well-being is something one should strive for or maintain.

Furthermore, improving mental well-being can protect individuals against developing mental disorders, from which around 25% of people living in Europe suffer each year. This is important, as mental disorders can display a huge burden, both to society and the individual itself. They are the main cause for disability and early retirement, can cause other mental and physical illnesses, and can lead to a shorter life expectancy (WHO, 2015). One way to prevent and avoid mental disorders is to have a good mental health.

Interventions can enhance mental health. These interventions are often four to fifteen weeks long and can be very time consuming (Carlbring, Andersson, Cuijpers, Riper, & Hedman-Lagerlöf, 2018). This is however not feasible to all individuals. Some simply do not have enough time to participate, and to raise participation, one could use a shorter intervention which can be as effective as the longer one (Carmody, & Baer, 2009). These shorter interventions are called micro-interventions which differ from "standard intervention packages in terms of the depth of treatment content, expectation of time-course of treatment outcomes, and timing of content delivery" (Fuller-Tyszkiewicza et al., 2019, p.59). They can be useful for patients with milder symptoms of mental illnesses, can also be used as an addition to more complex and longer therapy forms, or while waiting for a possibility to have actual face-to-face therapy. Studies show that these short interventions using strategies like identifying and challenging negative beliefs, increasing activity levels (with a focus on enjoyable activities), relaxation exercises, and increasing assertiveness can improve mental health symptoms such as depression, stress, negative affect, anxiety and psychotic symptoms (Fuller-Tyszkiewicza et al., 2019).

Studies revealed that online psychological interventions can be effective in comparison with regular face-to-face therapy. However, one has to keep in mind that both forms only have

a medium effect on mental health (Barak, Hen, Boniel-Nissim, & Shapira, 2008). One form of therapy that can be effective in the form of an internet-based intervention is Cognitive Behaviour Therapy (CBT). A meta-analysis of 20 studies showed that internet-delivered cognitive behaviour therapy (ICBT) and face-to-face CBT had equivalent overall results (Carlbring, Andersson, Cuijpers, Riper, & Hedman-Lagerlöf, 2018). ICBT is most effective for treating depression, social phobia, and panic disorder. However, it also has an effect in treating severe health anxiety, irritable bowel syndrome, female sexual dysfunction, eating disorders, cannabis use and pathological gambling. Moreover, it is shown that ICBT is highly cost effective, as it is as effective as face-to-face CBT but requires less therapist time (Hedman, Ljótsson, & Lindefors, 2012). Participants report that the positive sides of those interventions are that they developed awareness and insight, they learned new coping skills, saw behavioural changes and achieved more self-efficacy. On the other hand, they criticized the form of delivery, content issues and technical difficulties, which led them to be frustrated, irritated and disappointed (Richards, & Timulak, 2012). This shows the importance of ICBTs being well explained, being structured in a way that makes it intuitive to use and not being prone to technical problems.

In order to make interventions available and affordable to everyone, delivering them through the internet can be a good channel. Using the World Wide Web in comparison to face-to-face therapy makes it possible that people need no or minimal guidance from a mental health professional, that interventions are ready and available, which means there is no wait time; there is no need to organize transportation, it overcomes the stigma related to going to therapy, reduces health care-related disparities, and makes sure that the costs remain small (Herrero et al., 2019).

University students may benefit from these micro-interventions, as it is estimated that as high as 50% suffer from a psychological disorder. The most common illnesses are anxiety and mood disorders (Sass et al., 2019). Going to university can be a very stressful period in the life of a young adult. It marks the transition from adolescence into adulthood, which can be challenging itself, but by attending university many other stress factors arise. These include new social relationships and contexts without the support of parents or long-time friends, stress during exams and academic pressure. With all these big changes in their lives, the time at university represents a high-risk period to develop psychological problems. These stress

situations can influence the daily life of students and their academic performance (Herrero et al., 2019). However, individuals do not want to get treatment because of the stigma that surrounds mental health problems, meaning the fear of getting labelled or being treated differently from society (Vidourek, & Burbage, 2019). Additionally, students do not seek treatment, as they either believe that they do not need an intervention, prefer to manage symptoms by themselves, or simply have a lack of time (Sass et al., 2019). As they typically do not seek classical face-to-face therapy and are in an age group in which they use technology intuitively, they are ideal candidates for online micro-interventions.

Most research has been done about interventions that are based on a website and take multiple weeks to complete (Carlbring, Andersson, Cuijpers, Riper, & Hedman-Lagerlöf, 2018). However, an app on their own smartphone can be more practical for clients, as it is always ready and available, and an app has the possibilities to send notifications and reminders. Additionally, it is worthwhile to investigate whether shorter interventions can be effective while raising participation and engagement. Furthermore, little is known about whether ICBT is not only effective in treating mental disorders, but also in preventing these in the form of increasing well-being.

Based on these findings, the research question for this study is: What are the effects of using a smartphone application during a two-week long CBT-based intervention? Additionally, four sub-research questions have been composed:

1. What is the effect of participation in the intervention on positive and negative affect, mental well-being, anxiety, and depression?
2. To what extent are the participants engaging in the application exercises?
3. What are positive and negative aspects about using the CBT-application?
4. In what ways can the CBT-application be improved?

Methods

Participants

10 students participated in this study, 7 of those were females and 3 were males. The respondents were between 21 and 25 years old (M = 22,40, SD = 1,51). All of them were of German nationality and university students.

Convenience sampling was used to recruit the participants, who were directly approached by the researcher.

Procedure

Participants who are personally acquainted to the researcher were approached directly and everyone was then contacted via email. They got sent a registration link for the TIIM web application where they created an account, and then were directed to the website Qualtrics to fill out the first questionnaire that consists of an informed consent, of four questionnaires which are described below and three demographic questions. Then they were instructed to download the app `TIIM` in the AppStore/ PlayStore to their smartphone. Each day the app sent them a reminder to do a daily exercise and to indicate how they are feeling on that day, the completion takes participants around 5 minutes every day. After 14 days of using the app, participants were asked to fill the questionnaire out again and then they met up with the researcher to do the semi-structured interview.

Materials

A mobile cognitive behavioural therapy application was made available to the participants. This was created using `The Incredible Intervention Machine`(TIIM) which is a web application where researchers can create their own surveys with interventions and series of questions and assignments which can be scheduled to be delivered to users at specific times. Participants were asked to install the app `TIIM` on their smartphones. The intervention had a duration of two weeks and gave participants daily exercises. An example exercise would be to write down and describe a situation where problematic automatic thoughts have happened. Before and after the

intervention positive and negative affect, anxiety, depression and well-being are being measured.

In the Positive and Negative Affect Schedule (PANAS) respondents are asked on a 5-point Likert scale ranging from `very slightly or not at all` to `extremely` to what extent they felt the 20 stated emotions over the past week. To give an example, the first item states this: `Indicate the extent you have felt this way over the past week: Distressed`. The internal consistency (Cronbach's alpha) of the Positive Affect subscale is 0.88 and of the Negative Affect subscale 0.87. The Positive Affect subscale has a test-retest reliability of 0.68, and the Negative Affect subscale of 0.71 (Watson, Clark, & Tellegen, 1988). In this study the Cronbach's alpha was 0.8 for the Positive Affect subscale, and 0.82 for the Negative Affect subscale. After the intervention it was 0.81 and 0.89.

Anxiety was measured by using the Generalized Anxiety Disorder Scale (GAD-7). The questionnaire consists of seven questions. On a 4-point Likert scale participants indicate how often they have been bothered by the things indicated in the different items over the last two weeks with the answer possibilities being `not at all`, `several days`, `more than half the days`, and `nearly everyday`. The first item is: `Over the past two weeks, how often have you felt bothered by feeling nervous, anxious, or on edge? `. The internal consistency of the GAD-7 is high with a Cronbach α of 0.92. The test-retest reliability of 0.83 is also good (Spitzer, Kroenke, Williams, & Löwe, 2006). In this research Cronbach's alpha was 0.79 in the first questionnaire before the intervention, and 0.76 in the questionnaire after the intervention.

To assess well-being, participants filled out the MHC-SF (Mental Health Continuum-Short Form), which includes 14 items. Respondents chose on a 6-point Likert scale (never, once or twice a month, about once a week, two or three times a week, almost every day, every day) how often in the past month they felt a feeling stated in the items, e.g., `During the past month, how often did you feel happy?`. The internal reliability was high for the MHC-SF ($\alpha = 0.89$) and it has a moderate test-retest reliability of 0.65 (Lamers, Westerhof, Bohlmeijer, ten Klooster, & Keyes, 2011). The MHC-SF in this study had an excellent internal reliability ($\alpha = 0.91$) the first time, and also the second time ($\alpha = 0.92$).

To measure depression the Brief Patient Health Questionnaire Mood Scale (PHQ-9) was used. In this questionnaire respondents answer on a 4-point Likert scale (not at all, several days,

more than half the days, nearly every day) how often they have been bothered by a problem mentioned in each item over the past two weeks, e.g., ` Over the past 2 weeks, how often have you been bothered by little interest or pleasure in doing things?`. The internal reliability of this test is α=0.89 and the test-retest reliability of 0.84 is also excellent (Kroenke, Spitzer, & Williams, 2001). In this study Cronbach's alpha was 0.67 before the intervention, and 0.52 after the intervention. Therefore, in this study the reliability is questionable or poor, which is in contrast to other studies.

Additionally, the final questionnaire had a section to assess engagement during the intervention. This part consists of 9 items, e.g., `Looking back at using the intervention, I feel the intervention was easy to use`, to which they responded on a 5-point Likert scale ranging from `strongly disagree` to `strongly agree`. Therefore, the final score could range from 9 to 45. This questionnaire had an excellent reliability (α=0.9).

After the intervention a semi-structured interview was conducted, where participants were asked questions about their experience using the app. This interview consisted of 6 questions (see Appendix A), and took on average 2:27 minutes.

Data Analysis

The data was downloaded from Qualtrics.com, and then opened in the computer program SPSS. By adding items together, a variable for each questionnaire was created. A paired-samples *t*-test was done with the data for each questionnaire.

The recordings from the interview were transcribed and analysed to find patterns and particular useful information. A deductive thematic content analytic approach was employed through a manual coding process and a coding scheme with six codes was developed. The first code which could be derived from the interview was `Completion of the intervention`. The second code, `Sincerity of doing the exercises`, explored how much effort participants put into doing the intervention. `Effect on mental well-being` is the third code that investigates whether participants indicate noticing any positive changes in their mental well-being after doing the intervention. The fourth code `Positive aspects about the app` examined what the participants liked about using the intervention. The fifth code investigated negative aspects about the app.

Building up on code five, the sixth code `Suggestions for improvement` asked for input from the participants.

Results

Positive and negative affect, mental well-being, anxiety, and depression

To investigate whether the data was normally distributed, a Shapiro-Wilk normality test was used. All questionnaires were normally distributed (see Appendix 2), except for the PHQ-9 tests. Therefore, a non-parametric test, the Wilcoxon signed-rank test, was administerd for the PHQ-9. A paired-samples *t*-test was conducted for the other questionnaires.

A paired-samples *t*-test was conducted to compare Positive Affect (PANAS) in the pre- and post-test conditions. There was not a significant difference in the scores for the pre-test (M = 32.8, SE = 1.94) and the post-test conditions (M = 33.8, SE = 1.58); $t(9) = -1.05$, $p = 0.32$, $d = 0.16$.

A paired-samples *t*-test to compare Negative Affect (PANAS) showed no significant differences between the pre-test (M = 21.2, SE = 1.85) and post-test conditions (M = 20.2, SE = 2.21); $t(9) = 0.72$, $p = 0.49$, $d = 0.17$.

A paired-samples *t*-test comparing mental well-being (MHC-SF) in the pre-test (M = 64.3, SE = 3.36) and post-test conditions (M = 66.2, SE = 2.87) showed no significant differences, $t(9) = -1.08$, $p = 0.31$, $d = 0.18$.

A paired-samples *t*-test was conducted to compare Anxiety (GAD-7) in the pre- and post-test conditions. There was not a significant difference in the scores for the pre-test (M = 11.2, SE = 0.99) and the post-test conditions (M = 12.4, SE = 0.98); $t(9) = -1.59$, $p = 0.15$, $d = 0.38$.

Finally, the PHQ-9 showed no differences between the pre-test (M = 14.9, SE = 0.92) and the post-test (M = 14.1, SE = 0.75). A Wilcoxon signed-rank test showed that the intervention did not elicit a statistically significant change in depression ($Z = -0.997$, $p = 0.319$).

Engagement

Participants scored not statistically significantly lower than the midpoint in the engagement questionnaire (M = 21.9, SD = 7.16, $t(9)$ = -2.254, p = 0.05).

Engagement was also examined in the interview. The code, `Sincerity of doing the exercises`, showed that one participant indicated that he/she did do the exercises sincerely, the rest of the participants mentioned moderate sincerity. Some participants gave reasons for doing so, for example *"It depends on how much time I had"* (participant 2) and two participants explained that their sincerity decreased during the intervention (see participant 4 and 10).

Interview: Positive and negative aspects about using the CBT-application

Regarding the code `Completion of the intervention`, nine out of ten participants gave a positive response, that they did complete the intervention. Only one person said: *"No, [...] I am not sure if I completed all of them"* (participant 9).

The code `Effect on mental well-being` reveals that seven participants indicated that they did not see any effects on their mental well-being, two indicated that they did see changes, namely *"raising [...] self-respect"* (participant 3) and becoming *"more aware of your automatic thoughts"* (participant 1). One participant was not sure whether the intervention had effects: *"Yeah, I think I became a little bit more aware of my automatic thoughts, I don't know if it really impacts my well-being, but I think I got more aware"* (participant 6).

Analyses on the code `Positive aspects about the app` showed that participants mentioned that they liked the person that is guiding users through the app, that they get information about CBT, the simple use of the app, that the app was not annoying, and that the exercises challenged them to reflect on and change their automatic thoughts and feelings. One person said: *"It was nice to reflect about what influences my mood, what influences how I feel, and to try out how I can influence that"* (participant 9). However, one person claimed that he/she liked nothing about the app, that they *"really disliked the app"* (participant 5).

The code `Negative aspects about the app` displayed that participants mentioned that the notifications did not always work, that the app had a few spelling mistakes, the instructions were a bit too long, and that sometimes there were technical difficulties. One interviewee said

that it was *"difficult to know what you are supposed to do and to answer the questions because it wasn't specified before like what the conditions were for the automatic thoughts, so for example that you should set up an experiment, so it would be best to choose an automatic thought that is where you act instead of react to a situation"* (participant 1). Two participants mentioned similar problems: *"It was also sometimes weird to do some exercises because the app didn't know what my task was, what I wrote in the app"* (participant 2), *"I had to really think about a lot of things, and often I apparently did not understand the content appropriately, so, it was difficult, so like the experiments I received were not really appropriate, like they were just copying some things I described earlier, but they were just apparently wrong, so the app does not include the bias of some participants like if they make errors the app cannot account for it"* (participant 8). Another interviewee talked about *"the most confusing part was about like try to act like this today and then the immediate questionnaire followed afterwards so I couldn't really act on it during the day"* (participant 7). Participant 3 *"didn't like this cross thing where you have to fill in your feelings, because it was hard for me to decide in which part I was, sometimes I was a bit tired but also active in reading or something, and then I had to decide where I put myself, that was hard sometimes"*.

Interview: Possibilities of improvement for the CBT-application

Regarding the code `Suggestions for improvement` participants would have liked to have shorter and clearer instructions, working push notifications and a second reminder in the evening. They would have preferred if the app takes less time to do, that they can change things they wrote even days after, and more help with thinking by giving examples. This is in line with this comment: *"Make it more clear in the first session or something or beforehand what the process is of the app, and what you should keep in mind while selecting an automatic thought, for example, to be able to really do the exercises sincerely and to be able to get the best out of it. And I think it was also difficult sometimes because you only had like three days were you should choose automatic thoughts and it was difficult for me because those days I didn't really had a difficult situation, so that was also difficult because you don't always have a negative situation each day"* (participant 1). Additionally, interviewees want that the app saves the progress during the exercises so that one could come back later and that the participants do not have to do everything in one go. One participant explained that is does not make sense without

this saving function to directly ask again how one is feeling. In contrast to two interviewees who mentioned the men guiding one through the exercises as positive, one participant thought *"it was bit too much"* (participant 3).

Discussion

The results showed that the CBT based app-intervention did not affect participants positive and negative affect, mental well-being, anxiety and depression. Both the questionnaires and the interviews showed low engagement of participant in the intervention. The interviews, however, provided information about positive and negative aspects of the intervention and revealed important ways to improve the application.

The first sub-research question was concerned with the effect of participation in the intervention on positive and negative affect, mental well-being, anxiety and depression. When asked in the interview whether they believed if the intervention had an effect on their mental well-being, seven participants said that it did not have an effect, two participants said that it did, and one participant was unsure. The experiences shared by most participants that the intervention did not affect their mental well-being, was indeed reflected in the results of the questionnaire. Quantitative data showed no improvement in positive and negative affect, mental well-being, anxiety and depression between the questionnaires before and after the intervention. So even though two participants experienced a positive effect of the intervention, the quantitative results showed no effect. Other studies have shown that micro interventions can help with symptoms of depression, negative affect, and anxiety (Fuller-Tyszkiewicza et al., 2019), and that internet-based CBT can improve anxiety and depression (Hedman, Ljótsson, & Lindefors, 2012). However, this was not the case in this study, participants showed no significant improvements in regard to anxiety, depression, mental health and positive and negative affect. As this research was an explorative study, it had a low number of participants. This could partly explain the difference to previous studies.

The second sub-question was to investigate to what extent participants were engaged in the application exercises. The questionnaire showed low engagement, which is in line with what participants reported in the interview. They indicated that they did the exercises semi-sincerely.

Another possible explanation for the nonsignificant results may be because participants where not very engaged in the intervention. If participants lacked motivation and did the exercises only semi-sincerely, the results can be impacted in a negative way. If participants do not put effort into doing the exercises and are not sincere, one cannot expect a change in mental health. Additionally, this app is designed to challenge and improve mental health problems and automatic thoughts, but participants of this study did not have any mental health problems and mentioned that they did not have a problem with automatic thoughts. Moreover, this could have resulted in the lack of motivation that participants displayed.

The third sub-research question explored positive and negative aspects about using the CBT-application. Most of the participants had positive as well as negative things to report about using the app. The interviews showed that participants liked (1) how simple the app was structured, (2) the information about CBT that was provided, and (3) that they were prompted to pay attention to their automatic thoughts, feelings and behaviour, and (4) how they were challenged to change those. Still, most participants had more negative things to report than positive things about the app. They did not like that the app had several technical difficulties and that the instructions often were too long and not clear. One major problem was that they did not understand exactly what experiments they should set up and that then they needed to keep working with what they wrote, although it did not necessarily fit. Additionally, some did not like the cross where they indicated how they are feeling and thought it was not logical to ask directly again after filling the exercises out. It was also found that it comes down to personal preferences whether one likes the `funny guy` that is guiding the users, as some mentioned him as positive, and others as negative. Overall, one could say that participants had more negative aspects in mind than positive, this could show that they had a rather negative experience with the intervention. A study conducted by Richards and Timulak (2012) found that participants liked that they developed awareness and insight by using an ICBT, but disliked the form of delivery and the technical difficulties. This is similar to the findings from this study, therefore this seems to be a recurring scheme.

Finally, the fourth sub-question examined ways in which the CBT-app can be improved. Participants mentioned that they would want the app to give shorter and clearer instructions, for instance by giving examples. Another suggestion for improvement was that the app should save the progress when doing the exercises, so that the users can return later to finish the exercises.

This would be useful, as users get an exercise in the morning that they need to do during the day, and with this `saving` feature they could reflect on that in the evening after fulfilling the exercise. With this feature it would also make more sense to ask users twice how they are feeling, one time in the morning before doing the exercise, and one time in the evening after executing it. Additionally, technical difficulties need to be solved, the main problem was that the notification feature did not always work.

Based on this, suggestions for further research can be made. It can be recommended that this kind of intervention is tested on participants that suffer from mental health problems and/or have problems with automatic thoughts. The app is better suited for these participants than for students that do not have these troubles. Moreover, it needs to be investigated whether this form of intervention can be useful not only for treating mental health problems, but also for preventing them. Additionally, it is essential when developing these apps in the future that the suggestions for improvements made in this study are taken into account. This can make the experience of future similar interventions better, and can increase its effectiveness.

A strength of this study is the drop-out rate. No participants quit during this study, which is rare. With such a small number of participants it is especially important that participants complete all parts of the study so that enough information can be gathered. Moreover, the mixed method of getting answers to the research questions can be considered a strength of the study, as participants could state their own opinions next to the statistical testing.

This study can contribute to the ongoing investigation of online therapy possibilities. The study shows that online therapy options are not always effective and gives possible explanations for that, but also makes suggestions for how interventions can be improved, which can help future research. It is important to further investigate in this field of research, as online therapy can reach people who do not have access to face-to-face therapy, and can possibly have an impact on those people. ICBT is cheaper than classical forms of therapy, easily accessible and easy to use.

To conclude, this research showed that participation in this CBT-intervention that was delivered through a smartphone app had no significant impact on mental well-being, depression, anxiety and positive and negative affect. The conduction of short interviews showed ways in

which the intervention can be improved, which can be an important contribution to future research.

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Appendices

Appendix A

Semi-structured interview questions

1. Did you complete all 14 days in the app? → if not: why?
2. How sincerely did you do the exercises?
3. Do you think the intervention had an effect on your mental well-being?
4. What did you like about the app?
5. What didn't you like about the app?
6. What would you change or improve about the app?

Appendix B

Table 1

Descriptive statistics and the Shapiro Wilk normality test of the questionnaires

	Pre-test			Post-test		
	Shapiro Wilk significance	Mean sum score	SE	Shapiro Wilk significance	Mean sum score	SE
Positive Affect (PANAS)	.202	32.80	1.94	.638	33.80	1.58
Negative Affect (PANAS)	.698	21.20	1.85	.918	20.20	2.21
Mental well-being (MHC-SF)	.629	64.30	3.36	.602	66.20	2.87
Anxiety (GAD-7)	.164	11.20	0.99	.884	12.40	0.98

Depression (PHQ-9)	.025	14.90	0.92	.072	14.10	0.75
Engagement				0.840	21.90	2.26