How mHealth programmes can treat depression: A randomised controlled trial

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An anti-depression app named PsycApps based on intervention methods such as psychoeducation, self-assessment, journalling, self-management, and goal-setting was scripted, developed and published on the iTunes app store in 2018. We proposed that using the app over a four-week timeframe would significantly lower depression levels. A randomised control trial with 276 participants (137 in the test group, 139 in the control group) was conducted, and both groups were tested using the Beck Depression Inventory (BDI), Life Satisfaction Scale, and a one-item Likert Scale for anxiety at the pre- and post-evaluation phases within a four-week period. The test group used the app, while the control group filled out a digital survey with no further intervention. Results of repeated measures of ANOVAs showed statistically significant increases when using the app over a timeframe of four weeks. The app significantly lowered the test group's depression levels, measured by the BDI as .57. While not significant, anxiety levels were lowered by .19 and, notably, the Life Satisfaction score was also lowered by .27. Smartphones are a valuable and under-utilised platform to offer mental health interventions. Mood disorders such as depression and anxiety can be effectively treated and there are promising indications for other mental illnesses such as eating disorders and mild forms of schizophrenia, as well as prevention and remittance programmes. Future research would benefit from the implementation of gamification and a general increase of attractive intervention offers.

Keywords: anxiety; depression; mental health apps; mHealth; smartphones

Depression numbers are undeniably on the rise (Klerman & Weissman, 1989), with the World Health Organization (WHO) predicting that depression alone will be the most common global disease by 2030 (Kessler, et al., 2005). Approximately 9–12% of the population will suffer from depression over the course of a year (WHO, n.d.). Along with all the other mental disorders listed in the DSM-5, nearly 40% of the population will need treatment within their lifespan (Ferrari et al., 2013). This does not only prompt worry for the well-being of the affected population, but also has a great economic impact on society in regard to treatment costs, unemployment, broken homes, absenteeism and presenteeism, insurance costs, and more (Fendrich, Warner & Weissman, 1990; von Korf et al., 1998; Rowan, McAlpine & Blewett, 2013). Unfortunately, even though more students are training as psychologists each year (Study International, 2016), there is still a significant lack of treatment spaces in health services (Gulliver, Griffiths & Christensen, 2010) with long waiting times (Trusler, Doherty, Mullin, Grant & McBride, 2006) for patients. This and other treatment barriers such as patients being too geographically remote to access treatment (Haugen, McCrillis, Smid & Mijdam, 2017), costliness (Mohr, et al., 2010), cultural rejection of therapy, and restricted business hours results in less than 75% of the population accessing treatment even in urban areas. These statistics indicate that it is pressing to discover a way of offering interventions to a wider spectrum of patients at a lower cost so as not to simultaneously overburden therapists and neglect patients. Research shows that computer- and internet-based interventions (IBI) show similar positive results to face-to-face therapy (Cuijpers, Donker, Straten, Li & Anderson, 2010), which gives hope that it can support therapists in servicing more patients and maybe even replace some types of face-to-face therapy. Internet-delivered Cognitive Behavioural Therapy (ICBT) is currently the most common form of internet intervention (Gratzer & Khalid-Khan, 2016); most types of ICBT heavily lean on face-to-face programmes, many with a mix of therapist-guided and unguided therapies (Arnberg, Linton, Hultcrantz, Heintz & Jonsson, 2014). Other intervention methods such as psychodynamic, interpersonal, and problem-solving therapies are being explored, with promising results (Cuijpers, Donker, & van Straten, 2011). Historically, Behavioural Intervention Technologies (BIT) have been delivered via data carriers including programs that patients took home to use, email, videoconferencing, telephone, text messages, and web-based interventions. Each of the BITs eliminate one or more aspects of face-to-face therapy (video eliminates physical presence and some body language cues, telephone eliminates physical presence, facial and body language cues, and so on) (Haas, Benedict & Kobos, 1996) which could give rise to the hypothesis that the lack of therapeutic alliances might be averse to therapy outcome measures. Fortunately, this does not seem to be the case, thus furthering the imperative of developing more evidence-based BITs. These findings give cause to researching therapeutic intervention opportunities on the next big digital 'real estate' arena that has roughly 65% of the world's adult population as a customer: smartphones (Pew Research Center, 2018). Web-based internet use has been steadily declining, with the average adult using their phone for more than three hours a day and picking it up more than 55 times a day (Farrell, 2018 & Trifonova, 2018).

There is no other platform that consumes more attention than the smartphone, not even the television, making a shift to mobile mental health a logical step. Since the first iPhone was released 10 years ago, and the opening of the iTunes app store a year later, over two million apps have been published , taking up 75% of smartphone users' time (Statista, 2019). The casual use of apps on a regular basis conveys an easy and comfortable handling of the medium. Before entering a therapeutic intervention, people can also face multiple inner resistance points and thresholds originating from their beliefs regarding psychology ('I am not "crazy"', 'I should do this myself", 'Nobody can help me') (Vogt, 2011). Using a platform located well within a patient's comfort zone seems to be a good opportunity to exude a sense of security and familiarity.

While there are quite a few effective evidence-based IBIs (Mohr, Burns, Schueller, Clarke, & Klinkman, 2013), the brevity of smartphones being available for the general population has limited the number of mHealth interventions that have gone through randomised controlled trials (RCTs) (Harrison, et al.,

2011). Because an average app can cost anything between $10K and $300K, the costliness of developing an app to conduct research is also a non-negligible threshold for the scientific community (AppDrawn, 2019). Meta studies on mHealth interventions show that there is a wide array of apps claiming to assist patients without providing any scientific backing (Larsen, et al., Reda, 2019); although some were designed based on empirical data, very few have been part of a clinical trial, and those that have were still backed by web-delivered sections within the programme (Baumeister, Reichler, Munzinger & Lin, 2014).

As depression is the most widespread mental disorder (World Federation for Mental Health, 2012), it was a deliberate choice to develop an app that could service the largest group of patients first, in addition to the severe implications depression can have on individuals and their friends and family. Symptoms such as lack of joy, motivation, sadness, numbness, and cognitive impairment make it impossible for heavily affected people to partake in society and fulfil their roles within their social group, for instance their family (Endicott & Spitzer, 1979). Research links problematic parenting practices with depression, which leads to children of depressed mothers being more likely to develop depression and other mental illnesses (Motta, Lucion & Manfroll, 2005). Disorder-related financial malpractice and the inability to maintain employment causes families with a depressed parent(s) to experience a decline in social economic status, significantly raising the risk of poverty (Vericker, Macomber & Golden, 2010). Many depressed patients are also not able to cultivate personal friendships due to the debilitating symptoms accompanying the disorder, thus resulting in isolation and a reduction in social resources. All these points support the decision to address the question of whether it is possible to develop a mobile treatment that could provide relief for those affected. It is not just a single person who would benefit from it, but a whole micro cosmos.

The aim of this paper is to report the outcomes of an ethically CONSORT-compliant RCT to evaluate the effectiveness of PsycApps within participants of a non-clinical population. We predict that at least 18% of the trial population will self-report levels of depression and anxiety, and that the depression levels of participants randomly assigned to the test group, which will receive the intervention via PsycApps, will be significantly reduced. The control group or wait list group (WL) will only show fluctuations expected in a non-clinical setting.

To the best of our knowledge, this is the first trial to examine a fully automated, psycho-educational self-help mobile phone based intervention for depression and anxiety.

METHODOLOGY

Eligibility criteria

Eligible participants had German or English as their native language, and were Apple iPhone and iPad owners aged 18 years and older. The app was only developed in C++ for Apple products, with a German and an English version. Depending on the language setting on a participant's iPhone or iPad, the app would automatically offer the matching language. As to mimic the distribution of depression in the general population, there was no specific search for test subjects (TS) that were clinically depressed, rather a general group of TS who were not informed of the nature of the research.

Sample and setting

To estimate the required sample size and a priori power analyses using G*Power software for a 2 (between-subjects) by 2 (within-subjects) design with an a priori effect size estimate of f = .1 (small) and an achieved power of .80 was conducted. The analysis proposed that an overall sample size of at least 200 TS would be needed to detect an interaction effect with 80% probability if one was present. Especially, given the high amount of attrition in IBI (Eysenbach, 2005), which is on average about 85%,

we targeted 1789 TS for eligibility to participate in our study. This should make sure that for at least200 full data for the study analyses would be available. The TS were students attending Ludwig Maximilian University (via the university's distribution list and in-person in lectures), in addition to advertisements via Facebook, Instagram, Twitter, and the data-collection company MTurk and Prolific between September and November 2018. The RTC was approved by the Ethics Committee of Ludwig Maximilian University of Munich, and is registered as trial DRK S00016056.

Design

A mixed factorial 2 (between-subjects) x 2 (within-subjects) repeated measures design was used with full randomisation into the two between-subjects conditions (test group vs. control group). All TS were directed to a website where they were informed that the experiment would last for a month, and a complete test response would be requested at the beginning and the end of the trial. A month of treatment was chosen as the duration, as research suggests that a four-week programme can significantly reduce depression symptoms (Sin & Lyubomirsky, 2009). A random-number-generator directed them to either the test or control group where the test group was informed that they would be sent four pre-programed weekly notifications, inviting them to take the test and use the app again.

Interventions

PsycApps is a fully automated self-help intervention tool that is intended to be used without the input or monitoring of a professional. It is delivered solely on an iOS-based smartphone and intended to be readily available to the user 24/7.

Due to mHealth being in its infancy, the researchers decided to start scripting the app based on five evidence based intervention methods: Psychoeducation, journaling, self-monitoring, goal setting, and self-management. Psychoeducation has proven to raise patients' ability to identify the signs and symptoms of mental illnesses, enhance their knowledge of illness progression, recognise relapse factors, and become aware of psychological, physical, emotional, and social functioning impairments that often come hand-in-hand with mental illnesses (Lukens & McFarlane, 2004). Psychoeducational competence arms patients with coping strategies and gives them a sense of control that lessens their perceived suffering as it increases their understanding of what is happening to them. Journaling is a long-established therapy form embedded in systemic therapy, with evidence suggesting that writing down one's experiences helps structure one's thoughts, provides explanations of experiences, and allows the writer to track their progress and look out for dysfunctional emotional and cognitive response patterns (Baikie & Wilhelm, 2005). Self-monitoring is a useful feedback technique that adds an element of reward, given recovery is tracked, or warning in case of regression (Drake & Csipke, 2013). Goal-setting is a central CBT treatment tool that allows patients to take on manageable tasks. As a behavioural activation strategy, goal-setting can help break through phases of inactivity and offer a sense of achievement and reward when successfully executed (Sudak, 2012). It is important to limit the goal-setting to a manageable size so as not to overwhelm the patient and worsen depression symptoms. Finally, self-management can be tips and exercises offering self-guided interventions patients can choose from, depending on their personal preferences. These tips can be derived from all psychological schools such as positive psychotherapy, mindfulness, CBT, and more.

Users enter the app after downloading it and are greeted by a data protection information screen and the option to enhance device privacy by setting a password. Once a password is set, if the user chooses to do so, third parties cannot access information stored on the app. All the data is encrypted and stored on the private server owned by the study leader, psychologist Silja Litvin and based on a private property in Nuevo, California.

Measurements

The users are subsequently asked to fill out their demographic information, and options are delivered via drop down menus such as gender, birth year, ethnicity, relationship status, open relationship, separated, divorced, widowed) and income. Once they have filled out the information, they reach the Home Screen (HS) where they can choose between starting the screening, learning more about depression, viewing their stats, setting up a task list, writing their journal, and editing their profile.

By entering the test option, users can self-monitor three symptoms at any one time, going through the one-item Anxiety Likert Scale, the BDI, and the Life Satisfaction Scale. Once they had answered all of the items, during which they were able to go back and forth within the questions but unable to skip, they reached a results screen. On top of the results screen, a visualisation of their results is offered in the form of a bar going from low depression to high depression and a marker indicating their position. Beneath the bar was text presenting their BDI score, ranging from 1-6: no to low probability of depression, low probability of depression, probability of depression, probability of moderate depression, probability of high depression, and probability of severe depression. As the app is a self-screening and not administered by a trained professional, the text stresses that the result is a probability, not a diagnosis, and that the user would need to seek out a professional to confirm or dispute the existence of depression. The text also aims to reassure the user, who may be shocked and worried by the results, and states that most people suffering from depression are able to effectively manage the illness with professional help (Hedman et al., 2014).

The user then had the option to read up on psycho-educational skill building modules derived from positive psychology, problem solving therapy, and medical advice. These modules cover topics such as sleep hygiene, the effects of regular exercise, the mental health impact of self-medicating habits, meditation, and medication side effects that can affect one's moods and well-being. On the results screen, users also had the option to write in their journal so as to monitor their mood and have access to explanations of why a mood may have varied from that of the previous entries. An unlimited number of journal entries of unrestricted length are possible. Once users returned to the HS, they were able to view their screening results over time on a graph and set up personalised tasks that provide structure throughout the day. Participants randomly assigned to the Test Group (TG) were sent an email both at the beginning of the trial and on a weekly basis with a reminder through an in-app notification system to use the app. At the end of the 4-week trial, they received another email reminding them to use the app for a final time. They were advised that they could use the app *ad libitum* during the trial period but were strongly encouraged to follow the notifications and use it at least weekly. Access to the app was never withdrawn. The control group/WL participants were not given any intervention, information, or non-mental health related tasks as to replicate the natural development of depression and anxiety in the general population. At the beginning of the trial, they received the same questionnaires as the TG but presented on a SurveyMonkey form. After the four-week period, they were asked to repeat the same form, and were then offered a link to the app.

Procedure

This protocol was approved by Professor Markus Maier, Head of Emotional and Motivational Psychology at Ludwig Maximilian University of Munich.

As the TS were raised from the general population with only an expected percentage of 12–28% suffering from depression, no waiting list was established, but an email address was published at the end of the control trial offering information about the research for those interested. Roughly 35% of TS were lost

during the eligibility assessment, as they didn't own an iPhone or iPad. TS assigned to the TG were led to a link that allowed them to download the app on the iTunes store. The very first page after opening the app was a terms and conditions form stating that accepting the form would lead to them sharing their data anonymously, and that their data would be encrypted and not shared with second parties. They were also informed that, because the app was anonymous, PsycApps could not take responsibility for any self-harm tendencies, and that the app did not replace therapy with professional psychologists or counsellors. Users answering the suicidal thoughts item with an answer higher than 0 (0: I don't think about harming myself, 1: I sometimes think about harming myself, 2: I wish I could commit suicide, 3: I would commit suicide if I had the opportunity) were offered a pop-up at the end of the survey with links to suicide hotlines in Germany, US, and UK. The second page was the option to set up a password that would allow only the user to access the data, as information would be stored on the research server and their device for self-monitoring purposes. Given the instructions to use the app thoroughly and respond to the notifications, they were left alone until the end of the month. Notifications have proven to be useful for engagement and adherence in non-psychological digital health interventions, which was why they were incorporated (Haberer, et al., 2016).

Statistical analyses

Statistical analysis was completed with SPSS 24.0 software. Characteristics of the two groups at baseline were compared using dependent sample t-tests. Effects on the PsycAppsE intervention on study outcomes were evaluated using intention-to-treat analysis that included all participants who completed the assessment within a minimum of four weeks. For the simplicity of the analyses, all missing data was excluded from the study.

PsycAppsE effects were evaluated by examining the significance of the dependent sample t-test outcomes demonstrating a decline in BDI score, the Anxiety Likert score, and an increase in the Life satisfaction score. Post-intervention analysis involved a two-step process of the test and control measure groups at the beginning of the four-week trial and at the end. Significant group by time interaction effects were analysed using sets of Bonferroni adjusted interaction contrasts to compare the differences between both groups in mean changes of the outcome measure of pre-intervention to post-intervention, as appropriate. All effects were tested at the $p < .05$ level.

RESULTS

Details of the enrolment organised by following CONSORT guidelines. Of the 1,789 people who answered our adverts, 500 were randomised. Of those who went through the self-eligibility assessment, 626 (35%) were excluded due to not owning an iOS smartphone, 449 (25%) didn't complete the consent form with instructions outlining the four-week trial, and 214 (12%) never visited the website with the randomiser. A total of 500 (28%) participants completed the first assessment. The sample was primarily female, white, married and earning an annual salary of between $9K – 37K. The rate of attrition for the TG was 45% (113), and 44% (111) in the control group.

Table 1
Descriptive Statistics for Depression

Dependent variable	Group	$\bar{x}$	*SD*	*N*
Pre-test	Control	1.91	0.96	139
	Experimental	2.96	1.87	137
	Total	2.43	1.57	276
Post-test	Control	1.90	0.92	139
	Experimental	2.39	1.58	137
	Total	2.14	1.31	276

Table 2
Descriptive Statistics for Anxiety

Dependent variable	Group	$\bar{x}$	*SD*	*N*
Pre-test	Control	2.19	0.99	139
	Experimental	2.03	0.93	137
	Total	2.11	0.97	276
Post-test	Control	2.16	0.94	139
	Experimental	1.84	0.89	137
	Total	2.00	0.93	276

Table 3
Descriptive Statistics for Life Satisfaction

Dependent variable	Group	$\bar{x}$	*SD*	*N*
Pre-test	Control	4.58	1.25	139
	Experimental	3.80	1.70	137
	Total	4.19	1.54	276
Post-test	Control	4.63	1.19	139
	Experimental	3.53	1.71	137
	Total	4.08	1.57	276

Effects of treatment

To test the effect of the intervention method on self-reported depression (BDI score), anxiety (one-item score) and life satisfaction (LS score) three separate repeated measures ANOVAs with pre- and post-test measurement as within subjects' factor and experimental condition (test group vs control group) as between subjects factor was conducted. Due to multiple testing, for the three ANOVAs the alpha probability of the type I error was adjusted by using a Bonferroni correction with alpha equal .05/3 = .017.

In the first ANOVA the dependent variable was the BDI-score, measuring the TSs' depression level before and after the treatment/control period. The analysis yielded a significant main effect of the pre-post-measurement, $F(1, 274) = 27.59$, $p < .01$, ηp2 = .09. , indicating an overall decrease in depression level across time ($M_{pre} = 2.44$, $SE_{pre} = .09$ and $M_{post} = 2.15$, $SE_{post} = .08$). In addition, the main effect experimental group was significant, $F(1, 274) = 23.56$, $p < .01$, $\eta^{p2} = .08$, with the test group having an higher depression level ($M = 2.68$, SE = .11) than the controls ($M = 1.91$, $SE = .11$).The interaction effect between those two factors was also significant, $F(1, 274) = 24.90$, $p < .01$, $\eta^{p2} = .08$. Four post-hoc t-tests with Bonferroni corrected alpha = .0125 (= .05/4) were conducted to further explore this interaction. Within the control group, no significant change ($t < 1$) from pre- to post-measurement of the BDI score was found ($M_{pre} = 1.91$, $SE_{pre} = .08$ and $M_{post} = 1.90$, $SE_{post} = .08$). However, as expected within the treatment group a significant decrease of the BDI score, $t(136) = 5.85$, $p < .01$, $d_Z = .50$, was obtained ($M_{pre} = 2.96$, $SE_{pre} = .16$ and $M_{post} = 2.39$, $SE_{post} = .14$). Also, pre-measurements of BDI scores differed significantly between test and control group, $t(274) = 5.83$, $_p < .01$, $d_{cohen} = .71$, with higher levels for TS ($M = 2.96$, $SE = .16$) compared to controls ($M = 1.91$, $SD = .08$). The same was true for the post-measurement BDI score $t(274) = 3.18$, $p < .01$, $d_{cohen} = .39$, with higher levels for TS ($M = 2.39$, $SE = .14$) compared to controls ($M = 1.90$, $SE = .08$). Next, the same ANOVA was conducted with the dependent variable anxiety measured before and after the treatment period. In this analysis, neither the main effect of the pre-post-measurement, $F(1,274) = 5.24$, $p = .02$ nor of the experimental group factor (test- vs. control group), $F(1,274) = 5.61$, $p = .02$, was significant given the adjusted alpha level. Furthermore, the interaction effect between those two factors was also not significant, $F(1, 274) = 2.43$, $p = .12$.

In the final ANOVA with life satisfaction (LS score) measured before and after the treatment/control period as dependent variable the main effect of the pre-post-measurement, $F(1, 274) = 3.57$, $p = .06$ was not significant. The main effect experimental group was significant, $F(1,274) = 31.57$, $p < .01$, $\eta^{p2} = .10$, with the test group having an higher LS score ($M = 4.61$, $SE = .12$) than the controls ($M = 3.66$, $SE = .12$). In addition, the interaction between those two factors was also significant, $F(1, 274) = 7.59$, $p < .01$. , $\eta^{p2} = .03$. Additional post-hoc t-tests with Bonferroni corrected alpha = .0125 (= .05/4) were conducted to further explore this interaction. Within the control group, no significant change ($t < 1$) from pre- to post-measurement of the LS score was found ($M_{pre} = 4.63$, SEpre = .11 and Mpost = 4.58, $SE_{post} = .10$). Unexpectedly, within the treatment group a significant decrease of the LS- score, t(136) = 2.59, p < .011, $d^Z = .22$, was obtained ($M_{pre} = 3.80$, $SE_{pre} = .15$ and $M_{post} = 3.53$, $SE_{post} = .15$). Also, pre-measurements of LS scores differed significantly between test and control group, $t(274) = -4.38$, $p < .01$, $d_{cohen} = .52$, with lower levels for TS ($M = 3.80$, $SE = .15$) compared to controls ($M = 4.58$, $SD = .11$). The same was true for the post-measurement LS score, $t(274) = -6.26$, $p < .01$, $d_{cohen} = .75$, with lower levels for TS ($M = 3.53$, $SE = .15$) compared to controls ($M = 4.63$, $SE = .10$).

DISCUSSION

Evidence supporting our main hypothesis was shown. Depression levels decreased as a result of the intervention in the TS group compared to the control participants. The effect size of this was medium. Given the fact that internet/smartphone-based interventions done so far had only had a small effect size, and only on depression levels, the effectiveness of our intervention method goes over and above the so far reported data. Power was also high indicating that the effect might very well be replicable and stable. Any questions regarding the long-term effect of the intervention is yet to be researched. Future studies need to include follow ups in regular intervals to examine whether the effect is stable. The apriori difference between the TS and the CG is unusual, given that the assignment to the respective groups was completely random. However, this phenomenon can hardly serve as a full explanation for the effectiveness of our intervention, since a similar amount of quantitative change could have occurred in the control group. Because their pre-measurement of the average BDI score seemed to be high enough to allow for significant reduction across time and therefore this group seemed not to be fully infected by

a floor effect. A better apriori matching of the TS and the CG on a pre-measurement depression level would nevertheless be an improvement for future studies.

No significant effects were obtained with anxiety, which was unexpected. Although the means in the respective cells went in the right direction the failure to become significant may very well be an indicator for a lack of power for this specific variable. The PsycAppsE intervention brought about accelerated improvement in the mental health symptoms of the TG over the four-week trial. Due to the population being non-clinical, the mean BDI score of 2.96 was low from the beginning, prompting the hypothesis that the effect may be higher in a clinical population. The significantly lowered depression score demonstrates that the delivery of psycho-education, journaling, self-monitoring, goal setting, and self-management through mobile interventions is effective and acceptable in the context of combined self-help practices and therapy. Consistent with the positive findings of web-based interventions, the transfer from web to mobile does not have to leave patients behind; this result was achieved despite the sample being smaller than the a priori defined size, thus suggesting a larger therapeutic benefit for PsycAppsE than the initial study design anticipated. Although the anxiety score was not significantly lowered, there was a moderate effect that points towards the benefits of PsycAppsE in the treatment of anxiety. The reduced Life Satisfaction Score after conclusion of the trial was surprising, although it aligns with other studies illustrating a decrease in happiness after the successful treatment of depression (Strupp, Hadley & Gomez-Schwartz, 1977). This can be explained through a rise in patients' awareness of ill mental health, the change of emotional well-being that needs to be processed, and that therapeutic effects which aim to reduce a pathological pattern are often accompanied by a decrease in experienced well-being and life satisfaction. Changes in emotional patterns produce uncertainty and before clients become acquainted with this new situation, they might experience subtle distress and emotional discomfort or even rejection from a life partner who may have benefitted from disorder symptoms (Crown, 1983). Furthermore, it is also possible that partaking in a psychological trial concentrating on depression has an impact as well. Also here it would be good to do a follow up a few months later to test such an initial breakdown of LS that later turns into a positive trend.

LIMITATION

These effect sizes should be interpreted in light of several important limitations of the study concerning attrition, treatment fidelity, measurement, and generalisability. Contrary to the G-Power calculated sample size of 200 to reach a power of .80 given a small expected effect size, and indeed 276 participants finished the study. Our study had enough power to detect any effects if they were real. However, it would be advisable for future research to have larger samples with lower attrition to reach an even higher a power of .95. The inter group variability between depression scores pre-test is yet to be explained as the groups were randomly assigned. It is possible that the TG reflected more critically on their emotional state due to the app having been distributed, thus self-evaluating in favour of higher BDI scores; as such, further research is needed.

This study had low retention rates, which is not unusual for web and mobile-based interventions. Only 55% of participants completed the study, despite there being a 5€ incentive. Without the incentive, a steep decline in attrition rates could be expected; the loss of 70 – 90% of participants, as mentioned in the introduction, is likely. This highlights the question of the usefulness of stand-alone mobile intervention products and raises doubts that they are not compelling enough to engage users long enough for an effect to be measurable. The lesser attrition rates do indicate that the intervention acceptance was higher than for most trials who also offer small incentives leading to the conclusion that this type of intervention may very well be in the right path and a viable treatment opportunity given some improvements to the user experience and interface.

There are multiple variables in PsycAppsE that have been grouped together in the treatment and thus the researchers were not able to differentiate which variable has which effect. With only 7% of the participants using the journal to complete 22% of the tasks, it is safe to say that Journaling and goal-

setting had an insignificant contribution to the effect, but what about psychoeducation, self-monitoring, and self-management? Further research with those therapy forms individually would be critical not only to understanding their impact on depression and anxiety but also to further the

The high attrition despite the incentive of 5€ gives an indication of how the general population would react in a non-trial situation, a population that may even be asked to pay for psychological tools in the app stores. The app only being available on the iOS store also created a sample that may not represent the general population. Apple product users tend to be more educated, liberal, and have a higher than average income (Anroid vs iOs, 2013). A liberal population is also less likely to experience anxiety, which could have had an influence on the anxiety core (Jost, Glaser, Kruglanski, & Sulloway, 2003). Because of the short duration of the intervention, we cannot deduce how stable the effects are long term. Natural remission of depression in non-treated populations (Andrews, 2001) may have the same effect over the course of a few months, though faster treatment is desirable so as not to prolong patients' suffering.

CONCLUSION

Given the dire need for affordable and scalable interventions, this study shines a promising light on mobile interventions. The ability to utilize an internationally so widespread medium as the smartphone could very well be the way to provide mental health care to each and every person in the world, independent from their financial situation, location and access to health care providers.

The decrease in depression allows the researchers to draw the conclusion that mobile-based interventions could be a powerful defence against the mental health care crisis. There is only one caveat: apps in general have high attrition rates, health apps even more so, with mental health apps taking the lead; this is unsurprising when looking at the millions of apps in the app stores, many being backed by multi-million-dollar corporations that have had years to perfect user experience and engagement. Cognitive impairment and lack of motivation and drive, both symptoms of depression, add to the difficulties a user faces when working through a mobile intervention. Most apps are based on face-to-face therapy techniques like CBT (Spek et al., 2007), simply translated into a digital format, but when the person or the therapist is removed from the intervention, the strongest influence on the therapy effect, the therapeutic alliance (Lambert & Barley, 2001), is also removed, leaving the clients with an interactive self-help booklet.

Deducting from the success of this study, the authors of this paper believe that there must be bigger steps made towards tools that support adherence and mobile therapy compliance. Gamification of interventions has proven to be successful (Papastergiou, 2009) in the past and millions of gamers in recent decades have demonstrated that games have a powerful pull (Ukie, 2018). Playing games is associated with improved mood and decreased stress, as well as improved knowledge, attitudes, and behaviour towards health and exercise (Roepke et al, 2015). Consequently, using gamification could be the missing element in a new type of therapy: mobile game therapy.

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