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Development of a Mobile Application for People with Panic Disorder as augmentation for an Internet-based Intervention

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Abstract—Smartphone technology has recently gained attention in the field of E-Mental Health research and mobile applications for measuring health-related aspects as well as mobile mental health interventions have emerged. However, little work has been done on leveraging mobile technology in combination with internet-based interventions. We argue, that mobile applications can not only enrich mental health treatments but also foster the commercial success of E-Mental Health applications. To this end, we have developed GET.ON PAPP, a mobile application for panic disorder that integrates an internet-based treatment into daily life. In this work, we present the development and structure of GET.ON PAPP and a perspective for its evaluation.

I. INTRODUCTION

E-MENTAL Health, the use of information and communication technology to “support and improve mental health conditions and mental health care” [1], has been and still is a growing field in research and practice [2]. One of the most prominent forms of an E-Mental Health application is the internet-based intervention (IBI), the use of web-sites to deliver self- or low-guided psychological treatments over the internet. With the advent of smartphones in the past years, however, researchers recently started to explore the potential of this technology for E-Mental Health [3, 4].

The ubiquitous nature of smartphones makes them ideal for measuring data on health conditions in daily life. To this end, a number of applications have been developed and evaluated. Examples are the MONARCA self-assessment system [5, 6] and the work of Morris et al. on emotional self-awareness [7]. Furthermore, smartphone sensors have been used in order to amend or replace self-reported data with more objective measures [8, 9].

Self-contained interventions are another area where mobile technology is used in E-Mental Health [3]. Examples include mobile interventions for bipolar disorder, schizophrenia and depression [10, 8]. However, to our knowledge, little work has been done on using smartphones in combination with IBIs.

We argue that by combining mobile applications with IBIs, smartphones can be leveraged to overcome limitations of the internet-only approach, thereby integrating the treatment more closely into daily life. This is important not only from a psychological point of view but also from a commercial perspective. In Europe and in particular, in the Netherlands, UK and scandinavian countries, IBIs are currently being integrated into the routine healthcare system. In recent years, vendors

have emerged that specialize in development and distribution of E-Mental Health systems. The use of new technologies together with established approaches can make systems more attractive for both, customers who offer mental health services and end-users.

To explore the potential of a mobile application in combination with an IBI, we developed the GET.ON Panik program, a treatment for people with panic disorder with and without agoraphobia. The treatment consists of two parts, an online training that is delivered via the internet-browser and the mobile application GET.ON PAPP that amends the training. In this paper, we present GET.ON PAPP and discuss its foundation, structure, development process and perspective.

The GET.ON¹ project is an international and interdisciplinary cooperation of researchers and practitioners from the Leuphana University Lüneburg, Phillips University of Marburg, VU University Amsterdam and Minddistrict, a Dutch company specialized in the development and distribution of IBIs. The goal of the EU-founded project is to develop, evaluate and disseminate interventions for common mental disorders, including depression, insomnia and panic disorder.

This paper is structured as follows. First, a brief introduction is given into the background of panic disorder and its treatment as well as IBIs and their limitations. After that, the development process and structure of GET.ON PAPP are presented. Following this, we discuss the evaluation perspective of the mobile application and finally, a conclusion is drawn.

II. BACKGROUND

Panic disorder (PD) is a common and severe mental disorder that belongs to the category of anxiety disorders. People suffering from PD experience recurrent panic attacks, which happen in an unpredictable manner. A panic attack involves heavy body-symptoms such as palpitations, breathing difficulties and dizziness². Because of this, people often fear that they will die which further exacerbates the symptoms. Panic disorder often occurs in combination with agoraphobia, the anxiety about being in places or situations in which help might not be available or from which escape might be difficult. Examples include driving a car, shopping in a supermarket and going

¹GesundheitsTraining.Online, <http://geton-training.de>

²cp. Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) for diagnose criteria

to the cinema or theater. As a consequence, people tend to avoid such situations and over time, the fear of panic attacks often becomes a central problem because it severely limits their lives. This leads to a high level of distress as well as social and job-related disabilities [11].

Panic disorders are one of the most prevalent anxiety disorders. Goodwin et al. reported (12-month) prevalences between 0.3% and 3.1% for PD with and without agoraphobia in Europe [12]. For 2010, the total economic cost for Europe was estimated to 11,894 million EUR PPP³ for PD and to 9,634 million EUR PPP for agoraphobia [13].

A. Treatment of panic disorder

Cognitive behavior therapy (CBT) is a commonly used and effective method for treatment of panic disorder [14] that is adapted by the majority of contemporary computer-based treatment programs, not only for PD but also for other mental disorders [15]. In CBT, “patients are trained to collect information in a systematic fashion to offset the influence of maladaptive information-processing strategies and to conduct behavioral experiments to test the accuracy of their negative beliefs” [16].

CBT for panic disorder typically incorporates two central components: cognitive restructuring and exposure exercises. Cognitive restructuring teaches strategies on how to identify and change negative thoughts. Exposure is a technique where people with PD and agoraphobia expose themselves to situations where they fear to have a panic attack. For people with PD without agoraphobia, a method is used where specific exercises such as hyperventilation are carried out in order to trigger body symptoms similar to those that occur during a panic attack. In both cases, it is vital to the success of the treatment that exposures are done frequently and properly.

In addition to these core components, clients⁴ are usually encouraged to keep a self-monitoring diary. This not only helps the therapist to give feedback but also increases the client’s awareness for panic symptoms and disorder patterns. Furthermore, self-monitoring accounts for the natural human drive for self-understanding [17] and can thereby reinforce a client’s involvement with the treatment.

B. Internet-based interventions

An internet-based intervention for a mental disorder is a variant of computer-based psychotherapy [15] that is provided over the internet. In a nutshell, an IBI is similar to a self-help textbook with the content being delivered over the web-browser, usually in an interactive form and enriched with multimedia elements. Participants work through the intervention either completely independent or guided by a coach who gives feedback and motivation [18].

Compared to traditional face-to-face therapy, IBIs are a low-threshold form of intervention that offer high availability at any

time as well as anonymity and thus less stigmata. Protection of privacy is another commonly noted strength of IBIs [2, 15].

Psychological research has shown effectiveness of IBIs for several mental disorders, including PD with and without agoraphobia [18, 19]. A couple of online-programs for PD were developed and evaluated in the past years, such as, for example FearFighter⁵ in the UK and Panikprojektet⁶ in Sweden. Furthermore, IBIs are now gradually implemented in practice as part of the routine healthcare system in Europe. The leading countries in this development are the Netherlands and Sweden but others start to catch up.

C. Limitations of IBIs

IBIs commonly make use of an internet-browser that is running on a stationary computer or laptop to deliver the treatment. This approach is advantageous to serve larger blocks of information as well as for exercises or quizzes where users fill in (textual) answers. The timeframe of a single interaction between an user and an IBI is typically rather long, ranging up to several hours.

While mobile devices can be used to access an IBI on the go, screen size and unstable internet-connections often impose problems. In addition, entering text on a mobile device can be cumbersome as most of them do not have a dedicated keyboard [20]. As a result, IBIs are limited when it comes to supporting clients in their daily life.

While the above can be said for IBIs in general, we identified the following two key problems with respect to panic disorder.

1) *In-situ support*: Exposure is a notoriously difficult task to perform. Clients not only need to overcome their inner resistance but also carry out the exercises in a specific and prescribed way while at the same time experiencing high levels of anxiety. Although principles and procedures can be described in an IBI, exposure usually happens far away from the computer. As a consequence clients need to memorize and recall what they have to do. In addition, they can not easily verify that the exposure was performed correctly.

2) *Self-monitoring*: Diaries are already an inherent part of many contemporary IBIs. However, the limited accessibility of these programs requires clients to recall and sum up their panic attacks and anxiety feelings, typically on a day-to-day basis. As a result, a retrospective bias is introduced, which reduces the ecological validity of the diary data [3]. This is not only unfavorable for clients and therapists but also for the researcher who wants to analyze the data.

III. A MOBILE APPLICATION FOR PANIC DISORDER

Smartphones have become increasingly powerful and almost ubiquitously available in the past years. Consequently, they “play a vital role in the practice of medicine today” [21]. In a review on mobile technology in psychological treatments, Heron and Smyth argued that mobile technology is in particular suitable to bring interventions closer to people’s daily

³Purchasing power parity

⁴In a psychotherapeutic context, people who seek the help of a psychotherapist are commonly referred to as “clients”.

⁵<http://www.fearfighter.com/>

⁶<http://www.kbt.info/behandling/>

life [3]. To this end, we have build the mobile application “GET.ON PAPP”⁷ for people with PD (with and without agoraphobia) to overcome the limitations we identified above by providing a tool that integrates the treatment in their daily life, where panic actually happens. GET.ON PAPP is not designed to be used stand-alone but as an extension to an IBI that structures the treatment and offers information as well as instructions. In doing so, we strive to use both technologies to their potential. For the remainder of this paper, however, we will concentrate on the mobile part only.

GET.ON PAPP is structured into a diary that covers the self-monitoring aspect and an exposure-guide that supports people in performing exposure-exercises. In the following, we describe and discuss the development process, the different parts of the application and the technologies we used for its implementation.

A. Development

GET.ON PAPP was developed in an iterative process, incorporating experts from various disciplines. Each iteration started by creating a paper mockup for a specific function together with psychologists. The mockup was then refined until it represented the functionality to our satisfaction. In the next step, we created a functional prototype that could be executed on a smartphone. After that, the prototype was tested and gradually improved.

Researchers have mentioned the importance of credibility for the adoption of IBIs [22, 23]. While it is unclear if these findings can be generalized to mobile interventions, Fogg argued that credibility is crucial to facilitate behavioral change in general [24]. He defines credibility has the combination of perceived trustworthiness and perceived expertise and highlights the importance of a product’s visual appearance for the perceived first-hand and long-term experience [25, 24]. For that reason, we included visual and interaction designers in the team from the early project stages on.

While it was originally planned to also incorporate potential end-users early in the process, it turned out to be difficult to find people who were willing to talk about their experiences with the disorder. Instead, we decided to employ psychotherapists and researchers with experience in the treatment of PD. Furthermore, we conducted regular but informal tests with team members who were not directly involved with the development.

B. Documentation of panic-related events

As mentioned before, self-monitoring is an important aspect in CBT based treatment of PD. To this end, a diary has been created that enables clients to document and view their panic events. This is not only helpful to increase awareness for how, when and where panic attacks develop but also as an introduction to the treatment that encourages people to reflect on their disorder.

The frequency of panic attacks varies greatly between individuals, ranging from few attacks a week to several attacks

a day. Some clients do not even have panic attacks but live in a more or less constant fear of an attack. Therefore, we opted for an event-based design for the documentation of panic-related events [26].

We define a panic-related event as either a full-blown panic attack or the feeling of fear that a panic attack may happen in an ongoing situation. To reduce the retrospective bias, clients are encouraged to document these events immediately after their occurrence. Smartphones are ideal for this task because they are accessible most of the time.

Because panic-related events are documented “on the go”, an efficient and unobtrusive user interface is required. For this reason, we tried to reduce the information that a user has to enter to a minimum. We discussed the attributes that are required to accurately describe a panic-event with scientists from the field and psychotherapists. As a result, a set of four mandatory items has been developed, which are answered on a Likert-like scale from 1 to 10.

A goal was to make the rather boring task of entering a number more interesting and engaging yet efficient. Based on the single-dimension mood-scale presented by Morris et al. [7], we created a novel input component for entering data on a numeric scale (fig. 1). Users select a value by moving a finger up and down on the display. The number moves with the finger and the intensity of the background color changes in order to provide an additional visual feedback (high values have a high intensity and vice-versa).



Fig. 1. Entering data on a scale from 1 to 10

To facilitate learning and recognition throughout the interface, we assigned a dedicated color to each question, or more precisely to the concept that underlies a question. For example, the question “How strong was your anxiety during the panic attack?” relates to the concept of anxiety, which is represented in red color. Moreover, the use of colors is not restricted to the diary. Wherever a particular concept appears in the application, the same color is used for its representation.

We did not do any formal usability testing of the input component so far. However, we conducted a couple of informal tests with PhD-students, asking them to document a panic-event. There was no further information provided on how to

⁷A supercool acronym for GET.ON Panik App

use the component. We observed that when the interface was first presented to the students, it was not immediately clear how to operate it. However, most of them immediately realized the principle when touching the screen and reported that they liked the use of colors. To overcome the initial barrier, we added instructions to the screen which disappear when the user moves the finger. That said, formal usability testing is needed to validate if the design actually works as intended and how it compares to alternative approaches.

Finally, we wanted users to be able to give individual meaning to a panic-related event in a non-prescribed way. We anticipated that some users are more visually oriented while others tend to prefer text. Therefore, we included two additional options in the documentation of events. First, we encourage users to take a photo of either the situation where the event occurred or something that is related to the situation. Second, they may enter textual notes in order to remember feelings or specific aspects of the situation.

C. Visualization of events

To make sense of the past, the diary allows users to browse through panic-related events. For the visualization, we developed a non-technical but more casual approach that is shown in figure 2. Pousman, Stasko and Mateas have discussed the need of casual information visualization for non-work related tasks and populations that are not experts in a domain [27]. To this end, we build on the work of Ljungblad, Skog and Holmquist on ambient information displays [28, 29] and developed a Mondrian-style approach to visualize the four questions that are used to document a panic-related event.

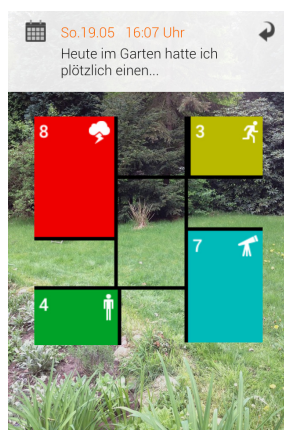


Fig. 2. Mondrian-style visualization of a panic-related event

Four colored rectangles are used to display the information. Each rectangle corresponds to a specific question which is represented by the color and an additional icon. The size of the square as well as the intensity of the color is used to visualize the value between 1 and 10. Apart from aesthetic aspects, this type of display has the additional advantage that users can see the values in relation to each other and thereby identify patterns such as the relationship between anxiety and avoidance. Furthermore, if a photo has been taken, it is

displayed as background image to facilitate fast recognition of the documented event.

In their work on informative art, Ljungblad, Skog and Holmquist reported that their Mondrian-style display created an aesthetic experience for viewers [28]. However, they also noted that, without further information, no one was able to understand how the display actually worked. Some did not even recognize the artifact as an information display at all. That said, with a brief introduction, most people quickly grasped the underlying concepts. We got similar results when presenting our display to students, although at least some candidates interpreted it correctly without any help. This might be attributed to the fact that the context of the display was clear and that the amount of visualized information is rather small in comparison to the work of Ljungblad, Skog and Holmquist. However, in order to ensure that people understand the display properly, we give them a brief introduction.

D. Daily summaries

Fogg notes that giving users ongoing information about their state and progress on a task can help to stimulate their intrinsic motivation [24]. Therefore, we wanted to give clients the ability to document their progress and to be able to track their personal development over the course of the treatment. Furthermore, the development of a client is important not only from a client's perspective but also from a researcher's as well as from a therapist's point of view.

Panic-related events are not suitable to document progress because frequency as well as severity of attacks varies over time, even for a single person. Apart from this, it may be the case that a client has more frequent and more heavy panic attacks at the beginning of the treatment. From a therapeutic point of view, however, it is important how much the PD limits a client's life. To this end, the general level of anxiety as well as the degree of avoidance⁸ are relevant variables. Building on this idea, daily summaries have been added to GET.ON PAPP in order to measure these variables not at the event but at a daily level.

A fixed-schedule diary was used to implement daily summaries [26]. Clients are asked to choose a fixed time each day, preferably in the evening, where they reflect on the past day and fill in a daily summary. In order to visualize a client's development and progress, the application can plot the daily summaries over time. Furthermore, the plot illustrates how exercising can reduce panic symptoms by depicting for each day how many exposure exercises have been performed.

E. Guiding exposures

When technology is used as a tool that leads people through a process which would otherwise be difficult or impossible to perform, it can support the change or adoption of a desired behavior [24]. As mentioned above, exposure exercises are the most difficult part of a treatment. Motivating people to confront themselves with a threatening situation or body

⁸Avoidance refers to the fact that people with PD and agoraphobia often avoid situations in which they fear to have a panic attack.

symptoms is difficult. We argue that by creating a tool that guides users and offers feedback, we can lower the barrier, thereby making it easier to persuade people to actually face exposure tasks. Therefore, we integrated an exposure guide into GET.ON PAPP.

The exposure guide supports a) in-vivo exposures, where people approach a situation in which they fear to have a panic attack and b) interoceptive exposures, where body symptoms are triggered by carrying out body-exercises. The guide is constructed as a wizard which leads the user through a sequence of steps while at the same time offering instructions and orientation. In addition, at certain points, the user is asked to answer questions in order to measure if the exposure has been performed correctly (for example the level of anxiety, the degree of avoidance and the severity of body-symptoms). For the sake of consistency, the same input component as in the diary is used to answer those questions.

Therapists noted that when they perform exposures together with clients in a face-to-face setting, people are sometimes so proud of what they achieved that they ask for a photo of the situation. Consequently, we added the ability to take a photo with the smartphone after an in-vivo exposure is completed. Users can view these photos in a gallery together with the feedback and a description of the situation. We hypothesize that taking photos and looking at them retrospectively can act as a self-rewarding mechanism and hence increase motivation for the treatment.

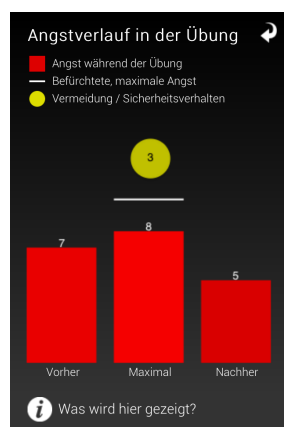


Fig. 3. Feedback for an in-vivo exposure

The feedback after an (in-vivo) exposure allows people to see if the exposure worked and to reflect on the situation (fig. 3). For example, it is important to stay in the situation until anxiety begins to drop without using any avoidance strategies. Furthermore, users can validate if their belief about how much anxiety they will feel was correct.

F. Cross platform development

A common setting for the evaluation of mobile applications in the field of e(Mental)Health is to conduct a study and hand out mobile devices with the pre-installed application to the participants. Examples for this approach are the work of

Morris et al. [7] and Cafazzo et al. [30]. On the contrary, we want to reach people who are experienced with smartphones and thus most likely already own such a device. We argue that giving them a second phone is likely to harm the adoption of GET.ON PAPP because carrying around a second smartphone for a sole application is not very convenient. As a result, the ecological validity of the evaluation could be reduced. Consequently, we decided that people will use their own smartphones to execute GET.ON PAPP. To reach a larger population, the application has been developed for the two currently most widespread mobile operating systems, Google Android and Apple iOS.

Developing a mobile application for multiple platforms is challenging because each vendor has its own, very specific, development kit and environment [31]. As a consequence, development expertise for each platform is needed and implementation time is effectively doubled. Recently, practitioners as well as researchers have advocated the use of web technology as an alternative for the development of cross-platform mobile applications [31, 32]. Frameworks such as PhoneGap⁹ carry this method even further by providing a runtime environment in which a web application is hosted inside a native app and thus pave the way for an almost native user experience.

Despite known performance issues [33], we employed the PhoneGap framework for the development of GET.ON PAPP. The use of web technologies not only enabled almost trouble free deployment on both platforms but also supported the rapid prototyping approach we used for development. That said, we experienced indeed a number of performance-related problems, for example when displaying photos that have been taken with the smartphone camera or transferring data to the server. However, we were able to solve these problems by implementing native plugins for each platform. The PhoneGap framework offers a dedicated API for this purpose and we consider the combination of a shared, web technology-based codebase with a few, specialized native plugins as ideal.

A major problem was, however, not related to performance but to the user experience. Creating a true mobile feeling with web technologies can be cumbersome, especially when it comes to gesture detection. For example, the swipe detection mechanism implemented in frameworks such as jQuery Mobile¹⁰ turned out not to be very robust. As a result, swipes were not properly detected on some devices or versions of the operating system. Another example is a delay between the user tapping on the screen and the “click”-event being fired, which resulted in a rather sluggish interface feeling. To work around these problems, we had to implement our own event handling system. Nevertheless, we would still recommend the web-based approach if the performance issues reported by Corall, Sillitti and Succi [33] are taken into account.

⁹<http://phonegap.com>

¹⁰<http://jquerymobile.com>

G. System structure

Figure 4 gives an informal overview over the system structure of the GET.ON Panik program. As mentioned above, the program is structured into an IBI and GET.ON PAPP, the mobile application which is presented in this paper. During the treatment, a client is guided by a coach who gives feedback and offers help with problems. For the feedback, the coach uses data from both, the IBI and the mobile application.

The IBI is developed and hosted inside a commercial content-management system that is provided by Minddistrict. Apart from serving the intervention content, it also offers facilities for secure conversations between coach and client.

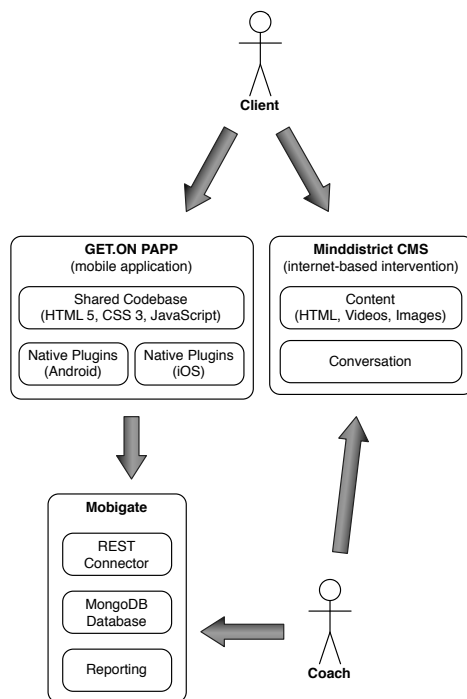


Fig. 4. Structure of the GET.ON Panik program

The mobile application periodically uploads the data entered by clients to the Mobigate backend through a REST interface which is implemented in Python using the flask micro framework¹¹. The Data is stored using MongoDB, a document-oriented database from which it is accessed by a component that generates reports for the coach.

We intentionally kept the system structure simple, especially with respect to the integration of the mobile system with the CMS. In the context of this project, it was not feasible to implement an interface between the two systems for both, organizational and security reasons. However, for the system to be used in practice, closer integration would be necessary.

IV. PERSPECTIVE EVALUATION

We currently undertake a feasibility and acceptance study (n=10) of the GET.ON Panik program that covers the IBI as

well as GET.ON PAPP. Apart from getting first insights into the clinical effectiveness, at the end of the study, we will carry out a semi-structured interview with participants about their usage of GET.ON PAPP. Our goal is to investigate how the mobile application is accepted as well as potential technical problems and opportunities for improving the application. While the study did start only recently, first comments from participants on GET.ON PAPP have been positive. However, at the time of this writing, we cannot make any substantial statement about how the application is received.

After incorporating feedback from the feasibility study, a randomized controlled trial (RCT) will be conducted (n=90). The primary outcome of this RCT is the clinical effectiveness of the GET.ON Panik program. However, in the course of the trial, we plan to perform an in-depth evaluation of the usability of GET.ON PAPP. To this end, the System Usability Scale [34] will be used as well as usability data collected from the mobile application [35]. In addition, we strive to carry out a systematic investigation of the acceptance of GET.ON PAPP using the Technology Acceptance Model in a longitudinal study [36].

Finally, we plan to conduct a formal usability test for the Likert-like scale input component, in particular, to evaluate its efficiency and engagement potential. Therefore, we will carry out an experiment to compare our input component with more traditional approaches. In addition, we want to know if and how the use of colors influences a user's input.

V. CONCLUSION

The ubiquitous nature and extended capabilities of contemporary smartphones have made them attractive for researches from the field of E-Mental Health, not only to measure health behavior but also to integrate interventions into the daily life. Furthermore, the use of mobile technology can make E-Mental Health more attractive for end-users, thereby fostering its dissemination and implementation in practice.

To combine the potential of mobile applications with the advantages of traditional internet-based interventions, we developed the GET.ON Panik program which integrates an IBI with a mobile application. The program can be used by people with panic disorder with and without agoraphobia.

In this paper, we presented the mobile application of the GET.ON Panik program, GET.ON PAPP. The application was developed in an iterative process, incorporating experts from psychology, computer scientists and visual designers. In order to target Android and iOS systems, a cross-platform approach based on web-technology was used. We outlined how the application was designed to integrate the treatment into daily life while at the same time striving to engage and motivate users.

Future research will show if GET.ON PAPP is accepted by its users and if the approach is as beneficial for the treatment as we believe. To this end, a feasibility study has been started and a randomized controlled trial will follow. We hope that systematic studies on usability and technology acceptance will contribute to our understanding on the potential of mobile technology in E-Mental Health.

¹¹<http://flask.pocoo.org>

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