Use of a Smartphone Application in the Treatment of Depression

The New Wave of Digital Tools
in Psychological Treatment

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The future is still so much bigger than the past

- Tim Berners-Lee

Abstract

Internet-delivered programs based on cognitive behavior therapy (CBT) have during the past decade shown to work in an effective way for the treatment of depression. Due to its accessibility and independence of time and location, smartphone-based CBT might represent the next generation of digital interventions. Depression is an affective disorder that affects as many as 350 million people worldwide. However, with CBT, depression can be treated, but access to this treatment is scarce due to limited health care resources and trained therapists. As a result of this, health care could highly benefit from the use of smartphones for delivering cost-effective treatment that can be made available to a large part of the population who suffer from depression. One treatment that should be especially suitable for the smartphone format is behavioral activation (BA), since it has strong empirical support as well as the benefits of being flexible and rather simple.

The overall aim of the thesis was to test and further develop a BA smartphone application, as well as to build a method for how this smartphone application could be used in a comprehensive and effective way in depression treatment. To fulfill this aim, four studies were conducted.

Study I was a pilot study of the first version of the smartphone application, investigating how 11 participants experienced an intervention on a smartphone platform. The results showed initial implications that participants receiving the smartphone application used it in contexts where it would be difficult to use a traditional internet-based program.

In Study II, the intervention was developed as a guided internet-based CBT intervention, but delivered through the smartphone application. The aim was to test the effects of this intervention compared to a smartphone-delivered mindfulness intervention. The results showed

large within-group effect sizes for both groups, but no between-group effect sizes. Subgroup analyses revealed a significant difference in favor of the BA program for participants with more severe depression at baseline. Contrary, for the participants with lower initial severity, the mindfulness program was significantly more effective than the BA program.

Study III was an extension of the second study, using a qualitative approach investigating 12 participants' experiences of the intervention. One of the main findings was that the smartphone format seemed to be a portable and flexible way of accessing the treatment – and thus could be more present in everyday life.

In Study IV, a blended treatment, using the BA smartphone application as an adjunct to four face-to-face sessions, was developed and tested against 10 face-to-face sessions. The results yielded large within-group effect sizes and no between-group effect sizes. This result is a preliminary indication that the number of face-to-face sessions can be reduced with the adjunct of a smartphone application.

In conclusion, there is reason to believe that smartphones will be integrated even further in society and therefore may serve an important role in future mental health care. Since the first indications reveal that mild-to-moderate depression can be treated by means of a supported smartphone application, it is highly possible that applications for other mental health problems will follow. Furthermore, in this thesis, the same smartphone application has been tested in three different ways and there is potential to apply smartphones in a range of other formats, such as in relapse prevention and as a way to intensify treatment during periods when needed. From a psychiatric research point of view, as my research group has been doing trials on guided internet treatment for more than 15 years, it is now time to move to the next generation of information technology – smartphones.

Empirical studies

The thesis is based on the following original research papers, which are referred to in the text by their roman numerals:

- I. Ly, K. H., Dahl, J., Carlbring, P., & Andersson, G. (2012). Development and initial evaluation of a smartphone application based on acceptance and commitment therapy. *SpringerPlus*, 1(1), 11.
- II. Ly, K. H., Trüschel, A., Jarl, L., Magnusson, S., Windahl, T., Johansson, R., Carlbring, P., & Andersson, G. (2014). Behavioural activation versus mindfulness-based guided self-help treatment administered through a smartphone application: a randomised controlled trial. *BMJ open*, 4(1), e003440.
- III. Ly, K. H., Janni, E., Wrede, R., Sedem, M., Donker, T., Carlbring, P., & Andersson, G. (2014). Experiences of a guided smartphone-based behavioral activation therapy for depression: A qualitative study. *Internet Interventions*, 2(1), 60-68.
- IV. Ly, K. H., Topooco, N., Bergström, J., Cederlund, H., Wallin, A., Molander, O., Carlbring, P., & Andersson, G. (2015). Smartphone-supported versus regular face-to-face behavioural activation treatment for depression: a randomised controlled trial. *Unpublished manuscript*.

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1 Introduction

On January 9, 2007, the late Apple CEO Steve Jobs took the stage at the Moscone Center in San Francisco to introduce the first Iphone. “*This is a day I’ve been looking forward to for two and a half years. Every once in a while, a revolutionary product comes along that changes everything*”, (Sander, 2013, p. 176) Jobs proclaimed. I believe he was right. Apple’s Iphone redefined the smartphone category – i.e., mobile phones with a third-party operating system – and has to date, together with companies such as Samsung, LG, Huawei, Sony and Nokia, put a powerful computer in the hands of more than a billion people around the world (Martínez-Pérez, de la Torre-Díez, & López-Coronado, 2013). Not only has the dissemination of smartphones been immense, it has also led to new behaviors: people have started to access all the information available on the internet on the go – through their mobile phones. Because what is really revolutionary about smartphones is that they are not a continuation of the old basic mobile phone (also known as feature phone), nor a prolongation of computers, but a fusion of the two. Behaviors that we learnt from the usage of feature phones, namely always carrying a device in our pocket, in combination with what computers with internet access can bring us, i.e. the world’s information – that is what is melting together in the smartphone. This has made it easy, fun and social not only to access information on the run, but also to provide information about ourselves in whole new contexts. Today the smartphone is often our most personal gadget, telling us more about the specific user than any other technical device – and perhaps also knowing more about that person than any other living thing, even more than the user him- or herself.

According to the report Cell Internet Use 2013 (Duggan & Smith, 2013), approximately 63% of adults in America who own a mobile phone use their devices to access internet, and approximately 34% of them use their phones as their primary means for going online. Smartphones are today

providing us with several services, such as phone calls, text and multimedia messages, internet access, camera, music player, calendar and a flora of downloadable programs, so-called applications. Health related applications have been around since the launch of smartphones. Today, there are more than 97 000 health applications and every month, 1 000 new applications are launched (Becker et al., 2014). Thus, a large percentage of the population is now carrying powerful computer-like mobile phones that provide constant access to all internet-based information. This should imply that providing effective digital mental management tools has become a real possibility, no longer representing a distant future vision. While internet-based cognitive behavioral treatment has been shown to work in an effective way, smartphone-based cognitive behavioral treatment might represent the next generation of interventions due to its accessibility and independence of time and location. This notion is supported by the fact that smartphone internet usage surpassed computer internet usage in 2014 (ComScore, 2014), making smartphones the number one tool for accessing information on the internet.

One of the most prevalent mental disorders worldwide is depression, a condition associated with high disease burden and substantial societal, economic and personal costs (Marcus, Yasamy, Van Ommeren, Chisholm, & Saxena, 2012). Depression is, however, treatable with cognitive behavior therapy (CBT) – but access to this treatment is scarce due to limited health care resources and trained therapists. Because of this, health care could highly benefit from the use of smartphones for delivering cost-effective treatment that can be made available to a large part of the population who suffer from depression.

This thesis is concerned with both testing a smartphone application aimed at depression by targeting users' everyday activities, and finding effective treatment formats delivered via smartphones. Although my work with this thesis started in 2011, the embryo to the idea began to grow already in 2008. Back then, I envisioned that the smartphone would be a tool to bring psychology beyond the therapy room, out to

people's everyday lives: with just a few taps on the mobile phone, people would be able to get reminded of important psychological strategies to apply in order to strengthen their psychological wellbeing, both short-term and long-term. This has not happened – yet. However, the revolution of mobile technology has paved the way for innovative digital services that recently have started to change our way of communicating, traveling, consuming culture and buying commodities. I believe that mental health services can also be part of this transformation. The speed at which smartphone technology is developing implies an enormous potential for health care. We are only at the starting point of the development of smartphone-supported treatments for mental illness in general and depression in specific.

2 Depression

2.1 Diagnostic features of depression

Depression, also referred to as major depressive disorders (MDD) (Kessler et al., 2003), is an affective disorder characterized by psychological, behavioral and physiological symptoms (Cassano & Fava, 2002). Depression, like other mental disorders, is diagnosed based on symptom descriptions (Watson, 2005). There are two major diagnostic systems for mental disorders: Diagnostic and Statistical Manual of Mental Disorders (DSM; (American Psychiatric Association, 2013)) and the International Classification of Diseases (ICD; (World Health Organization, 1992)). In the empirical studies in this thesis, the DSM-IV (American Psychiatric Association, 2000) has been used. In the new DSM, 5th Edition (DSM-5) the APA has not changed any of the core criteria of symptoms for major depression, nor the requisite two week time period needed before it can be diagnosed. The only major change for MDD is that the previous exclusion criterion of bereavement in DSM-IV has been removed from depressive disorders in DSM-5 (American Psychiatric Association, 2013).

According to the DSM-5, a major depressive episode is diagnosed if five or more of the following symptoms occurred during the same two week period and represented a change from previous functioning, including at least one of the cardinal symptoms for depression, namely depressed mood or diminished of interest or pleasure:

1. Depressed mood most of the day, nearly every day, as indicated by either subjective report (e.g., feels sad or empty) or observation made by others (e.g., appears tearful);
2. Markedly diminished interest or pleasure in all, or almost all activities, nearly every day;

3. Significant weight loss when not dieting or weight gain (e.g., a change of more than 5% of body weight in a month), or decrease or increase in appetite nearly every day;
4. Insomnia or hypersomnia nearly every day;
5. Psychomotor agitation or retardation nearly every day;
6. Fatigue or loss of energy nearly every day;
7. Feelings of worthlessness or excessive or inappropriate guilt nearly every day;
8. Diminished ability to think or concentrate, or indecisiveness, (either by subjective account or as observed by others), nearly every day;
9. Recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide;

There are two additional criteria for a major depressive episode: a) The symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning; b) The symptoms are not due to the direct physiological effects of a substance or a general medical condition.

The definition according to ICD-10 is similar (World Health Organization, 1992). A major depressive episode can be classified as mild, moderate, severe, or severe with psychosis, which is determined by the number of symptoms and the intensity of these (American Psychiatric Association, 2000). In the DSM-5 classification, the depressive episodes can be further subtyped into melancholic, catatonic, and atypical (American Psychiatric Association, 2013).

2.2 Prevalence

Globally, depression affects as many as 350 million people according to the World Health Organization (WHO) (Marcus et al., 2012). However,

the prevalence varies between studies since depression is defined in different ways. For example, some studies focus on major depressive episodes (MDE) whereas other target major depressive disorders (MDD) (Kessler & Bromet, 2013). The main difference between MDE and MDD is that the latter excludes bipolar depression (Kessler & Bromet, 2013). In this thesis, I will focus on the prevalence of MDD.

In a cross-national epidemiological study, based on 38 000 subjects from 10 countries, including United States, Canada, Puerto Rico, France, Germany, Italy, Lebanon, Taiwan, Korea, and New Zealand, lifetime and 12-month rates for MDD were estimated (Weissman et al., 1996). Based on these rates, a conclusion was drawn that MDD varied widely, ranging from 1.5% in Taiwan to 19% in Lebanon for lifetime prevalence and from 0.9% in Taiwan to 5.8% in New Zealand for 12-month prevalence (Weissman et al., 1996). The variation in rates can be attributed to cultural differences that might affect how depression is expressed (Weissman et al., 1996). This might be supported by the rates that Hasin and co-workers (2005) presented in a study, showing that the MDD prevalence in four European countries only ranged from 15.1% to 17.8% for lifetime rates, and 5.8% to 7.3% for annual rates.

One of the most cited prevalence studies, conducted on a large U.S. population, showed a lifetime prevalence of 16.6% and a 12-month prevalence of 6.7% (Kessler et al., 2005a). These rates are higher than the rates reported in the original study that was made 10 years earlier (Kessler et al., 1994). In this study from 1994, the lifetime prevalence was 14.9% and the annual prevalence was 8.6% (Kessler et al., 1994). In a review by Richards (2011), factors such as an increased willingness to report and a general increase in accurate reporting rather than an actual increase in MDD cases, explains the higher rates. The global point prevalence of MDD is 4.7% (Ferrari et al., 2013)

2.3 Comorbidity

Comorbidity is very common among patients suffering from MDD. Data from more than 8 000 people, obtained from the U.S. National Comorbidity Survey, showed that as many as 51% with MDD also suffered from lifetime anxiety (Kessler, Nelson, McGonagle, & Liu, 1996). Other common comorbidity diseases include eating disorders, personality disorders, chronic illness and substance abuse disorders (Kessler, Chiu, Demler, & Walters, 2005b).

According to Kessler and colleagues (2003), nearly three fourths (72.1%) of respondents with lifetime MDD also met the criteria for at least one other disorder diagnosed with the DSM. In the same article, the authors also concluded that roughly two thirds (64.0%) of people with 12-month MDD suffered from at least one other 12-month disorder (Kessler et al., 2003). In both cases, anxiety disorder was the most common comorbid disorder to MDD. Other common comorbid disorders to MDD reported by Kessler and co-workers were impulse control disorder and substance use disorder (Kessler et al., 2003).

2.4 Risk factors

Research has consistently found a number of risk factors for depression. One of the most prominent is gender, with studies showing that MDD is roughly twice as common among women than among men (Kessler et al., 2003; Kessler et al., 1994). For example, Kessler et al. (2003) found variations in prevalence of MDD between 3% and 10% for men, compared to 5% and 25% for women. In an earlier study, Kessler and co-workers (1994) showed that the lifetime prevalence of MDD was 12.7% for men and 21.3% for women.

Gender differences are attributed to genetic factors, stress hormones, and environmental factors (Young & Korszun, 2009), which might be sup-

ported by the finding that these differences start to appear in adolescence (Hyde, Mezulis, & Abramson, 2008). Socioeconomic status also plays a role; low education level and poverty increases the risk of depression and often leads the illness to become prolonged and more difficult to treat (Everson, Maty, Lynch, & Kaplan, 2002). An interesting finding by Zimmerman and Katon (2005) was that employment status and financial strain were related to MDD, but income was not. This was found when controlling for other economic variables than income.

Furthermore, risk of depression increases for those who are separated or divorced (Maciejewski, Prigerson, & Mazure, 2001). Additional mental or physical illness also means an increased risk of depression. Also, previous depressive episodes increase the likelihood of suffering from depression. The recurrence rate is high and varies in different studies between 50% and 70% within two years after completion of treatment (Richards, 2011). Each time an individual has had a depressive episode, the risk of relapse increases (Klein, Schwartz, Rose, & Leader, 2000; Richards, 2011), and for one in five with an episode, depression becomes chronic (Hölzel, Härter, Reese, & Kriston, 2011). Furthermore, genetics play a big role. A study summarizing the results from twin studies estimated genetic factors to explain 37% of MDD (Bienvenu, Davydow, & Kendler, 2011).

Most of the conducted epidemiological studies seem to look at samples from adults. Interestingly, researchers have found that depressive symptoms recalled during a period between one week and six months among children and adolescents are as high as 50%, which is considerably higher than among adults where the share is 20% (Kessler, Avenevoli, & Ries Merikangas, 2001). In fact, there seems to be a U-shaped distribution of MDD in relation to age, with the highest rates of MDD found among the youngest and oldest in the population and the lowest among the middle-aged (Kessler, Foster, Webster, & House, 1992).

2.5 Societal costs

MDD is associated with high levels of service use – and with substantial economic costs (Berto, D'Ilario, Ruffo, Virgilio, & Rizzo, 2000; Greenberg & Birnbaum, 2005; Smit et al., 2006). It has been estimated that the costs for depression are €177 million per year per 1 million inhabitants for MDD, and €147 million per year for minor depression (Smit et al., 2006). MDD is currently the fourth disorder worldwide in terms of disease burden, and is expected by WHO to be the disorder with the highest disease burden in high-income countries by the year 2030 (Mathers & Loncar, 2006). There are a few studies investigating cost-effectiveness of psychological treatments for depression in primary care (McCrone et al., 2004; Schulberg, Raue, & Rollman, 2002), and a systematic review examining 58 published papers concluded that their cost-effectiveness is yet to be established (Barrett, Byford, & Knapp, 2005). The review, studying the economic evaluations of interventions for depression, inferred that psychotherapy has proven cost-effectiveness for some patient groups. However, when compared against antidepressants, the medication-based treatments tended to be more effective and less costly than psychotherapy (Barrett et al., 2005). Also, the review concluded that psychotherapy alone has not been established to be more cost-effective compared to usual care.

In contrast, a more recent systematic review, investigating the cost-utility of CBT for depression, found evidence that individualized CBT for adults as stand-alone treatment or in combination with antidepressants is cost-effective in comparison to usual care and that it is not inferior to medication (Brettschneider et al., 2015).

2.6 Treatment alternatives

Several treatments have shown efficacy in the treatment of depression. In Sweden, the National Board of Health and Welfare (Socialstyrelsen)

(2010) recommended both pharmacotherapy with antidepressants, and psychotherapy for depression. The latter includes different approaches, such as CBT and interpersonal psychotherapy (IPT).

2.6.1 Pharmacological treatments for depression

Although both pharmacotherapy and psychotherapy are recommended as treatments for people suffering from depression, pharmacotherapy dominates the management of treatment in primary and secondary care (Cipriani et al., 2009). The Swedish National Board of Health and Welfare reported that between 80% and 95% of all depressed patients received antidepressants in 2009 (Socialstyrelsen, 2010).

Antidepressants' main function is to balance some of the natural chemicals in the brain, the neurotransmitters, which affect our mood and emotional responses (Hollon, Thase, & Markowitz, 2002). Antidepressants work on neurotransmitters such as serotonin, norepinephrine, and dopamine (Hollon et al., 2002). Over the past fifty years, these types of antidepressants have shown to be superior to placebo in a large number of controlled clinical trials (Fournier et al., 2010). Also, Hollon and co-workers (2002) have shown that as long as patients continue to take their medicine, antidepressants provide protection against relapse and recurrence.

Antidepressants can be categorized into classes, with the most common being serotonin reuptake inhibitors (SSRIs), serotonin norepinephrine reuptake inhibitors (SNRIs), tricyclic antidepressants (TCAs) and monoamine oxidase inhibitors (MAOIs) (Cipriani et al., 2009). It appears like these different classes of antidepressants are comparable in efficacy (Hollon et al., 2002). Therefore, the ease of management as well as to what extent they produce problematic side effects have been important factors in the decision of which medicine to prescribe (Hollon et al., 2002). One class of antidepressants that has gained in popularity because of this is SSRIs. However, SSRIs seem to be less effective for

some patients than dual reuptake medications such as TCAs and the more modern SNRIs. The latter have been used more widely in recent years since they seem to be both as effective as the older TCAs and come without any of the most problematic side effects (Hollon et al., 2002). The MAOIs are important in the treatment of atypical depression (Hollon et al., 2002).

In their review article about the treatment and prevention of depression, Hollon et al. (2002) summarized their findings by concluding that while medication is the most studied intervention for depression, their potential is limited by side effects and difficulties with adherence.

2.6.2 Psychological treatments for depression

Psychotherapy is a successful treatment alternative for depression. Cuijpers summarized the evidence status of psychotherapies for adult depression in a review, looking at more than 400 randomized controlled trials (RCTs) over the past 40 years (Cuijpers, 2015). Even if face-to-face individual CBT, IPT and behavioral activation (BA) often are included in most guidelines as first-line treatments for depression, numerous other delivery formats of psychotherapy have shown to be effective (e.g., group treatment). Apart from the above-mentioned therapies, problemsolving therapy (PST), non-directive counseling, and “possibly psychodynamic therapy” were also found to be effective (Cuijpers, 2015). One of the most important conclusions from the review is that all therapies are equally or about equally effective in the short term. Cuijpers (2015) also concluded that psychotherapy is comparable to pharmacotherapy, but the most effective treatment is a combination of these two.

Hollon and colleagues (2002) came to roughly the same conclusions. Also, they pointed out that while several types of interventions appear to be effective, none is universally effective and they all have advantages as well as disadvantages. In summary, although reviews have shown that

all therapies are equally effective, CBT has the strongest evidence of the psychological therapies mentioned earlier with more than 100 clinical studies. Several different treatment paradigms within CBT are relevant in the treatment of depression, including BA. The next chapter will further explore CBT – and BA specifically.

3 Cognitive behavior therapy

CBT can be said to be an umbrella term for a number of different treatments, including BA, and acceptance and commitment therapy (ACT). New treatment forms of CBT are constantly developed, such as rumination-focused CBT and Mindfulness-based cognitive therapy (MBCT) (Segal, Williams, & Teasdale, 2012; Watkins et al., 2011). The common factor between these different directions is the view that mental illness is caused by a history of learned behaviors and thoughts (Hollon et al., 2002). However, within CBT, different treatment paradigms emphasize and value different treatment components. To clarify this heterogeneity, CBT is often divided into three waves or generations (Kahl, Winter, & Schweiger, 2012; Öst, 2008).

Behavior therapy (BT) was developed in the 1950s and is considered to be the first wave of the scientifically based psychotherapy. Research on classical conditioning and operant learning constitutes the basis of BT. Charles Ferster was probably the first to apply BT on depression when he presented a functional analysis that emphasized the importance of an individual's behavioral repertoire (Ferster, 1973). Another influential behavior model for treatment of depression was developed by Rehm (1977) during the same period. He explained depression as a result of an individual's lack of ability to notice the long-term positive consequences over short-term negative consequences of a behavior. Treatment should therefore focus on enhancing an individual's capacity for self-control, so that a higher degree of long-term positive consequences thereby could be achieved (Rehm, 1977).

Peter Lewinsohn (1974) simultaneously created perhaps the most famous behavioral explanation model for depression, when he introduced the concept of response-contingent positive reinforcement. Based on this model, Lewinsohn developed a treatment that focused on scheduling and increasing the number of positive activities (Mazzucchelli, Kane, &

Rees, 2009). The models and methods of treatment for depression presented by Ferster, Rehm, Lewinsohn and other contemporary psychologists can be summarized as the first wave of CBT, and Lewinsohn's treatment is referred to as behavioral activation (BA) in its original form (Dimidjian, Barrera Jr, Martell, Muñoz, & Lewinsohn, 2011).

The second wave was developed only a few years later or simultaneously by Aaron Beck when he applied an information processing approach with his cognitive therapy (CT) (Öst, 2008). Negative and irrational thoughts, as well as pathological cognitive schemas, would be eliminated through their detection, correction, testing and disputation (Beck, Rush, Shaw, & Emery, 1979). This cognitive approach was first applied to depression, and later to anxiety disorders (Hayes, 2004). Eventually, BT and CT were merged into what we today know as CBT (Rachman, 2009). In CBT, treatment components from both approaches are combined. In the case of depression, this means that the treatment entails both identifying and challenging negative thoughts, and breaking behavioral patterns of passivity, avoidance and isolation. There is consensus in the scientific community that CBT is an effective treatment for depression (Cuijpers et al., 2013a).

The third wave, developed during the last 10-15 years, includes a number of new treatments, or extensions from previous CBT (Öst, 2008). While the techniques used in third wave methods are heterogeneous (Kahl et al., 2012), they all emphasize the context and functions of psychological phenomena, not just their form (Hayes, 2004). They also commonly integrate elements from Eastern philosophy, such as mindfulness (Hayes, Luoma, Bond, Masuda, & Lillis, 2006). The most well-known among the third wave therapy forms is probably ACT, which is characterized by a number of themes that are new to behavioral psychotherapies, such as cognitive fusion, acceptance, mindfulness and spirituality (Kahl et al., 2012). Nevertheless, Öst declared in his review of the efficacy of third wave behavioral therapy that some of the features found in ACT have long been a part of CBT, and thus it might not be

accurate to talk about these treatment paradigms as a wave in itself (Öst, 2008). Although there are several full-scale treatments based on third-wave CBT, such as ACT, MBCT, and Dialectical behavior therapy, it has also become very common to add single third-wave components to classical CBT treatment. For example, the ACT tool called values is often added to regular CBT treatment as a means to put the patient in contact with long-term consequences (Kanter et al., 2010). In a recent updated meta-analysis by Öst (2014), the conclusion was drawn that ACT is “possibly efficacious” for depression.

During the same time period, in the 1990s, a new variant of BA was developed by the late Neil Jacobson and colleagues at the University of Washington (Jacobson, Martell, & Dimidjian, 2001). A dismantling study, isolating the BA component and showing that this element alone could be as effective as the full CBT treatment package, paved the way for this new approach (Jacobson et al., 1996). Based on these results, Jacobson’s research group developed a new and more comprehensive model of BA designed as a treatment on its own and placed BA in a broader contextual framework (Martell, Addis, & Jacobson, 2001). Another research group simultaneously and independently developed a brief version of BA for depression (BATD) based on Jacobson and colleagues’ dismantling study (Lejuez, Hopko, LePage, Hopko, & McNeil, 2001a). Because these current BA approaches are firmly embedded in the contextualist tradition (Jacobson, 1997), they are considered to be closer to the recent behavior analytic ideas, and thus a part of the third generation of CBT (Jacobson et al., 2001). BA will be presented in more detail below.

3.1 Effects of CBT for depression

CBT is the number one most researched form of psychotherapy for depression with over 100 clinical trials during the past 30 years (Cuijpers et al., 2013a). In one of the most recent meta-analyses in this field, CBT

showed an effect size of $g=0.71$ when compared to control condition (Cuijpers et al., 2013a). However, the effect sizes yielded in these studies might be an overestimation of the true effect sizes (Cuijpers, van Straten, Bohlmeijer, Hollon, & Andersson, 2010b). In the later review, the effect size was found to be $g=0.53$ after adjustment for bias (Cuijpers et al., 2013a). This might also be true when CBT has been compared to antidepressants in earlier meta-analyses (Butler, Chapman, Forman, & Beck, 2006), which found a superiority of CBT over medication (Dobson, 1989). Cuijpers and colleagues found no differences in efficacy in short-term outcomes when antidepressants and CBT were compared to each other ($g=0.03$) (Cuijpers et al., 2013a). For long-term effects, in this case at 1- and 2-year follow-up, two meta-analyses have pointed out a lower relapse rate for those treated with CBT, as compared to those that received antidepressants (Cuijpers et al., 2013b; Dobson et al., 2008; Vittengl, Clark, Dunn, & Jarrett, 2007).

In their meta-analysis, Cuijpers and co-workers could compare CBT to other psychotherapies, such as BA, IPT, and psychodynamic psychotherapy, in 46 studies. The results showed an effect size in the range of $g=-0.02$ to 0.25 , which was interpreted as indicating no evidence in favor of CBT compared to the other psychotherapies (Cuijpers et al., 2013a). A conclusion from these studies is that CBT is as effective as other psychotherapies or pharmacotherapy (Cuijpers et al., 2013a). Nonetheless, a combination of CBT and antidepressants outperforms antidepressants alone with an effect size of $g=0.49$ (Cuijpers et al., 2013a). Another study, investigating the effects of antidepressants alone and in combination with CT found that the combined treatment enhanced the rates of recovery from MDD, compared to antidepressants alone (Hollon et al., 2014). This was however limited to patients with severe, non-chronic depression (Hollon et al., 2014). This is an example of a general tendency found in research, namely that depression severity is a significant moderating factor in the treatment of depression. There are also indications of a distinct difference between antidepressant medication and placebo in severe depression. Such a difference has not been verified in mild-to-moderate depression (Fournier et al., 2010). An-

other study found BA to be superior to CT in the treatment of moderately to severely depressed adults (Dimidjian et al., 2006). These results suggest that baseline depression severity may moderate the response to different variants of treatments.

There are several proposed active mechanisms of CBT explaining its effects on depression, although definitive evidence is difficult to establish. One of the most central assumed active mechanisms is behavioral activation, which will be explained in detail in later chapters (Cuijpers, van Straten, Andersson, & van Oppen, 2008; Jacobson et al., 1996). Another one is cognitive restructuring, whereby the patient learns to challenge deeply held assumptions about him- or herself that have been driving the depressive state (Cuijpers et al., 2008; Driessen & Hollon, 2010).

3.2 Availability of CBT

While CBT is a treatment that has shown to be effective for many mental health problems, the demand of CBT has for a long time been exceeding the supply (Cartreine, Ahern, & Locke, 2010). For example, Shapiro and colleagues drew the conclusion, when investigating the availability of CBT in England and Wales in the beginning of the 2000s, that only 1% of people suffering from anxiety disorders and depression had access to proper CBT (Shapiro, Cavanagh, & Lomas, 2003). Also, the results showed a large geographic inequity: among the 10% best-provided in the population, there were up to 20 times more CBT therapists per 100 000 inhabitants, as compared to the 10% worst-provided (Shapiro et al., 2003). Recently, a 10-year update was made which indicated that the availability of CBT is now more equitable throughout the population of England and Wales (Cavanagh, 2014). Nevertheless, differences in geographic availability were still found, showing that the best-provided 10% of the population had five times

more accredited CBT therapists within its postcode areas than does the worst-provided 10%.

Andrews et al. estimated (2004) that current treatment methods are only capable of reducing the burden of disease of depressive disorders with about one third. Also, in a consensus statement by Hirschfeld and colleagues (1997), it was expressed that patients with depression are “seriously undertreated”.

Several factors contribute to the lack of availability. Shapiro and colleagues (2003) highlighted the lack of properly trained therapists and high costs for the patient when buying CBT on the private market. Hirschfeld and co-workers (1997) attributed this problem to three different factors: patient, provider and health care system. Patient-based reasons include failure to recognize depression symptoms, limited access to treatment, reluctance to see a mental health care specialist due to stigma, non-compliance with prescribed medical regimens, and lack of adequate insurance reimbursement (Hirschfeld et al., 1997). Some of the reasons that rest with the physician include: limited adequate training in interpersonal skills, belief in the myth that psychiatric disorders are not "real" illnesses, inadequate time to evaluate and treat depression, unwillingness to treat patients with depression because of poor insurance coverage, poor collaboration among providers, prescribing inadequate doses of antidepressant medication for inadequate durations, and the fact that psychiatric disorders may take more time to diagnose and treat than many other medical conditions (Hirschfeld et al., 1997). Lastly, health care system factors include financial constraints, a lack of qualified providers to refer to, or a fear of offending the patient (Hirschfeld et al., 1997). Also, many managed health care systems create barriers against prescribing the best antidepressant medication, and too many patients with depression are treated for very brief periods of time and then lost to the health care system (Hirschfeld et al., 1997).

A couple of solutions have been discussed to solve the availability problems. These solutions include the up-scaling of training efforts and

redistribution of therapists to areas with higher unmet need (Cavanagh, 2014). Also, other distribution formats are discussed such as the potential of tele-therapy to extend the reach of CBT interventions beyond well-served areas, and the potential for increased volume of delivery of guided self-help interventions (Shapiro et al., 2003).

3.3 The need for CBT

Since the availability of trained CBT therapists is limited and pharmacotherapy has been shown to be effective in the treatment of depression, it is reasonable to question whether dissemination of CBT is important. One argument might be that only one third of depressed patients respond fully to pharmacotherapy (Trivedi et al., 2006). Secondly, patients generally prefer psychotherapy over medication (Angermeyer, Matschinger, & Schomerus, 2013; Tylee, 2001), and at the same time there is a shortage of trained therapists (Wagner et al., 2013). Therefore, finding cost-effective formats for CBT is crucial. BA involves fewer intervention components than both CT and CBT and is a relatively straightforward treatment. Consequently, it may be particularly well-suited for paraprofessional or self-administered implementations, which would make BA uniquely cost effective (Christensen & Jacobson, 1994).

3.4 Behavioral activation

BA has over the past three decades been developed both as an independent treatment for depression, as well as a component in the overall CBT treatment package (Kanter et al., 2010). It has a long history and started with Lewinsohn's early work on pleasant events scheduling (Lewinsohn, 1974). The more contemporary approaches by Martell and colleagues (2001), and by Lejuez and colleagues (2001b) were made possible by Jacobson and co-workers' well-known dismantling study (1996) de-

scribed earlier. From the earlier days of BA until today's prevailing approach, BA has shifted from focusing on increasing positive activities, to a functional contextual approach (Kanter et al., 2010).

In spite of these shifts, some of the core techniques remain the same. In a review of the empirical literature of BA, it was established that two techniques have followed the history of BA, from Lewinsohn's early work to Martell and co-workers', and Lejuez and co-workers' manuals (Kanter et al., 2010). These two techniques are activity monitoring and activity scheduling (Kanter et al., 2010). The main purposes of activity monitoring are basically to provide a baseline activity level, and to investigate the relation between activities and mood. This relation is normally both significant and important, and this can provide a useful education for the patient (Kanter et al., 2010). Thus, activity monitoring can be seen as an early assessment in the treatment, rather than an active treatment component. However, activity monitoring can function as an important method to explain the treatment rationale of BA for depression (Kanter et al., 2010).

With the exception of Lewinsohn's early work (1970), all 32 trials that were reviewed by Kanter and co-workers included activity scheduling (Kanter et al., 2010). Even though the form of activity scheduling has moved from pleasant activities to a more value-based approach, the core is the same, namely "to increase contact with available sources of positive reinforcement in the environment" (Kanter et al., 2010, p. 612). In addition to activity monitoring and activity scheduling, six other techniques have been used together with BA: values and goals assessment; skills training; relaxation; contingency management; procedures for targeting verbal behavior; and procedures for targeting non-verbal behavior (Kanter et al., 2010). Among the contemporary BA approaches, Martell and co-workers' manual include all of these techniques except for relaxation, whereas Lejuez and co-workers' brief manual exclude skills training and procedures for targeting avoidance and verbal behaviors as well (Lejuez et al., 2001b; Martell et al., 2001). One potential advantage with BA over CBT is that the rationale of it is simpler (Kanter et

al., 2010), which could make it more user-friendly and easier to implement than the full CBT package.

3.4.1 Effects of BA in depression

Four large meta-analyses have been published targeting the efficacy of BA among depressed. The first, conducted by Cuijpers, van Straten, and Warmerdam (2007) in 2007 included 16 studies involving BA and concluded that pleasant activity scheduling was slightly superior to other psychological treatments and equal to CT at posttest and follow-up.

A subsequent meta-analysis by Ekers, Richards, and Gilbody (2008) included 17 studies and concluded that behavior therapies were superior to controls, brief psychotherapy, supportive therapy, and equal to CBT.

The third meta-analysis, conducted by Mazzucchelli, Kane, and Rees (2009), replicated and extended the above-mentioned meta-analyses by including results from 34 studies. Also, in addition to examining the effects of BA relative to other therapeutic approaches, the study examined variants of BA and hence tried to answer the question whether more complex versions of BA add anything to more parsimonious versions of the approach. The results, including data from a total of 2 055 participants, showed clear indications that BA is an effective intervention in the treatment of depression in adults. For patients meeting the diagnostic criteria for MDD the overall effect size of 0.74 remained large and significant. Comparisons of BA with CT or CBT indicated that these treatments are equally effective. There is also evidence that BA interventions have equivalent long-term effects as both CBT and CT interventions for up to 24 months.

The most recent meta-analysis on BA, published in 2014 (Ekers et al., 2014), was conducted collaboratively by the author groups behind the first and second meta-analyses mentioned above. The study can be seen as an update of both groups' previous work, since new studies have been

conducted. However, apart from exploring the effectiveness of BA as a psychological therapy for depression compared to usual care, this new meta-analysis also explored the relationship of study level moderators such as therapist training level, delivery mode, multi-morbidity, number of sessions and severity with treatment effect. The study also added new information to the body of knowledge by exploring the effectiveness of BA compared to anti-depressant medication. In total, four studies including 283 participants were examined, and the result revealed a small but significant short-term effect size in favor of BA. However, when poor quality studies were excluded in the review, the significance of the effect disappeared (Ekers et al., 2014).

BA has been described as a well-established empirically validated treatment for depression when evaluated by APA standards (Kanter et al., 2010; Manos, Kanter, & Busch, 2010).

4 Digitally administered CBT for depression

In digitally administered psychological treatments, therapists and their patients do not need to be in the same room and see each other face-to-face. Although the typical context for psychological treatments has been the face-to-face format, the history of other methods of therapy delivery is as old as the history of psychotherapy itself (Perle, Langsam, & Nierenberg, 2011). For example, historical articles suggest that Sigmund Freud used letters as an active, indirect therapy (Perle et al., 2011). Telemedicine is often considered to be a recent innovation. However, as early as 1959, the first article using tele-treatment to provide psychiatric and health services was published in the United States (Brown, 1998). With the advent of computers, new possibilities came along. One example of that was the computer program “Eliza” in the 1960s, that used natural language to simulate therapeutic dialogue for a therapeutic interview (Weizenbaum, 1966). From Eliza, the use of computers continued to evolve into both guided and unguided internet-based, as well as self-directed adjuncts to face-to-face therapies such as psychoeducation, self-monitoring, and positive reinforcement systems (Perle et al., 2011).

This chapter will focus on digitally administered CBT for depression. First, I will present the body of knowledge from studies on internet-based CBT for depression, as this format has been subject to research during the past 15 years. The term internet-based CBT is here defined as programs based on CBT principles in the form of bibliotherapy, used when sitting in front of a computer. No other digitally distributed interventions for depression have reached the same level of empirical support. Second, I will move from the internet-based format to smartphone-based CBT programs, as this is the main focus in this thesis. Smartphone-based CBT is here defined as programs based on CBT principles, delivered via a smartphone.

4.1 Internet-based CBT for depression treatment

In the mid-1990s, when the internet started to disseminate into our homes, our workplaces, our schools and our government institutions, new opportunities started to arise also for the field of clinical psychology. When professor Tim Berners-Lee (1989) submitted his paper *Information Management: A Proposal*, this was the start for the World Wide Web. The title of the paper neatly illustrates what the internet has so far been utilized for in psychotherapy: providing and sending information. This function has been designed in more or less user-friendly ways across programs. In the best cases, it has been done in the form of written communication between a therapist and a patient, readings for patients in order for them to learn about a specific mental health disorder and questionnaires for patients to fill out so that the therapist can receive the scores instantly.

According to a meta-analysis conducted in 2006, four RCTs on internet-based CBT interventions for depression focusing on treatment were found (Spek et al., 2007). The first one was conducted by Clarke et al. in the U.S. (Clarke et al., 2002). The research group developed a web-based depression program on the notion that although bibliotherapy was effective in the treatment of depression, the information could be made more interactive via the internet. The aim of the program was to offer information as well as direct training in self-help and cognitive restructuring skills. Participants were randomized to either receive this internet-based CBT program or to a control condition. No therapist support was given and the participants were told to use the program as much as they wanted. This might have been one reason for the infrequent patient use of the program; on average only 2.6 times per patient. The researchers failed to find any effect of the internet-based program at 4, 8, 16 and 32 weeks after intake. Post-hoc analysis revealed a modest effect among persons with low levels of depression severity at intake, suggesting that this program is better suited for those with mild-to-moderate levels of depression (Clarke et al., 2002).

A few years later, a research group in Australia conducted a similar trial on a depressed population, but with three treatment arms: internet-based CBT, control condition and internet-based information about depression (Christensen, Griffiths, & Jorm, 2004). As in Clarke and co-workers' study, no feedback or support from a therapist was given, although initial guidance on how to use the program via telephone calls was given by a lay interviewer. The results showed a significant and moderate effect size of $d=0.40$ for both the internet-based CBT intervention and the internet-based information program when compared to the control condition. However, no difference was found between the two intervention groups, indicating that information about depression was effective and as good as the CBT program in reducing symptoms of depression. One reason for this was thought to be the acceptability of the information site (as well as the CBT program) with low dropout rates (15% as compared to 25% for the CBT program) (Christensen et al., 2004).

Clarke and colleagues conducted a new study based on the same internet-based CBT program as in the first study, but added postcard and telephone reminders to increase participants' usage of the intervention (Clarke et al., 2005). The background of this change was that the research group concluded that frequent use of the program was one of the most important factors for successful outcome in their intervention. The results also showed both an increase in usage of the program and a significant, yet small, difference in effect between the intervention group and the control group ($d=0.28$). No difference was found among the participants receiving postcard reminders and those receiving telephone calls. Interestingly, and in contrast to their first study, the largest effect was seen among the participants with a higher severity of depression at baseline ($d=0.54$) (Clarke et al., 2005).

The fourth study described in the meta-analysis from 2006 was conducted in Sweden by Andersson and co-workers in Sweden. The study compared an internet-based CBT program with minimal therapist contact and participation in a discussion group with the effects of participation in a discussion group only. Hence, this study not only added re-

minders but also individualized support from a therapist, albeit minimal time (2 hours in total per participant), as well as optional participation in an online discussion group. Another difference from previous interventions was that the material was divided into distinct chapters, so called modules, distributed consecutively, with each module describing one CBT technique. The results revealed a considerably larger effect size than yielded in previous studies: $d=0.94$, with maintained improvement at six months' follow-up (Andersson et al., 2005). This early trial conducted by Andersson and colleagues set the standard for what was going to be the format for guided internet-based CBT interventions, where therapist support and distinct modules are essential parts of the program, especially in European countries (Andersson et al., 2008).

In a meta-analysis a few years later, both newly conducted studies and studies that were not part of the first meta-analysis were included (Andersson & Cuijpers, 2009). From a total of 12 trials, one clear conclusion was drawn: internet interventions with therapist support generally produced larger effect sizes compared to programs without support ($d=0.61$ compared to $d=0.25$) (Andersson & Cuijpers, 2009). This was later supported by a review article, specifically investigating therapist support in internet-based CBT interventions for depression (Johansson & Andersson, 2012). In the article, the authors categorized 25 RCTs into four different categories depending on the degree of support; from no human contact at all to contact before, during and after. A correlation analysis was made, which indicated that more support produced larger effect sizes ($\rho=0.64$) (Johansson & Andersson, 2012).

A more recent meta-analysis conducted by Richards and Richardson extended the number of RCTs to 19 (as compared to 12 trials in Andersson et al. and 13 trials in Spek et al.) (Richards & Richardson, 2012). This meta-analysis added some important information to the body of knowledge regarding internet-based CBT for depression. For example, the authors concluded that these interventions on average have an effect size of $d=0.20$ at follow-up compared to control conditions (Richards & Richardson, 2012). Also, when comparing a community setting with pri-

mary and secondary care settings, pooled effect sizes were similar: $d=0.52$ compared to $d=0.46$ with no significant difference. Since the importance of therapist support has been acknowledged earlier, the authors tried to highlight the nuances in this finding. Indications that were reported included that support from a non-mental health professional works equally well as regular therapist support; that dropout rate is drastically lower in therapeutically and administratively supported studies, as compared to unsupported studies (28% and 38%, compared to 74%). Moreover, the majority (71%) of participants receiving therapist support reported that the quality of the communication was excellent or good (Richards & Richardson, 2012).

More recent reviews have concluded that internet-based CBT with therapist support for depression is as effective as face-to-face CBT (e.g. (Andersson, Cuijpers, Carlbring, Riper, & Hedman, 2014; Andrews, Cuijpers, Craske, McEvoy, & Titov, 2010; Cuijpers, Donker, van Straten, Li, & Andersson, 2010a)). In the most recent systematic review on this topic, two studies on depressive symptoms were included, showing equivalent effects between internet-based CBT and face-to-face CBT ($d=0.05$). The same outcome was found in an earlier meta-analysis, showing an effect size of $d=0.02$ for direct comparisons between guided self-help and face-to-face treatment. However, that analysis, including 21 studies, investigated both bibliotherapy and internet interventions, as well as investigating both depression and anxiety. A conclusion in the article was that it is time to start thinking of implementing internet-based CBT in routine care. This was later studied by Hedman et al (Hedman et al., 2013). They conducted a cohort study, including 1 203 patients that received internet-based CBT for depression in a routine care setting in Stockholm between 2007 and 2013. The finding from the study was that internet-based CBT for depression can work very well in a routine psychiatric setting. Large improvements from pre- to post-measurement with sustained results at six month follow-up were found, and the effect sizes were at least as high as in controlled settings (2013).

In summary, a number of studies have established both the efficacy and the effectiveness of internet-based CBT for depression, especially when supported by a person, preferably by a therapist. In those cases internet-based CBT seems to work as good as regular face-to-face CBT for depression.

4.2 Smartphone-based CBT for depression treatment

The development of, and the evidence for internet-based CBT interventions, used when sitting in front of a computer, paved the way for new formats, such as smartphone software applications based on CBT. In 2007, when the first modern smartphone was released, new opportunities arose beyond programs via computers. This was discussed in Donker and co-workers' (2013) systematic review of smartphone programs targeting mental health. Advantages with smartphone mental health applications include an increase in treatment accessibility and therefore a potential for improved adherence, participant retention, portability and flexibility, as well as the possibilities to track progress and other measurements in real-time (Donker et al., 2013). Perhaps even more importantly, according to ComScore, an internet analytics company, internet usage through smartphone surpassed desktop usage in the U.S. during 2014 (ComScore, 2014). In fact, from December 2010 to December 2013, smartphone engagement has grown from 131 billion total minutes to 442 billion, as compared to 401 billion to 429 billion total minutes for desktop internet usage (ComScore, 2014). In China, the shift from desktop to smartphone devices happened already in 2013 (Meeker & Wu, 2013). This means that smartphone is the main device by which users access information on the internet today. Therefore, not developing and providing evidence based CBT programs for smartphones, means ignoring the platform where people spend the major part of their time online – and where they will probably spend even more time in the future.

To date, the evidence for this treatment format is scarce. In the aforementioned review by Donker and colleagues (2013), only four studies describing three smartphone applications were found. One of the studies was a pilot with no control group, and one was a prolongation of another study, investigating whether self-monitoring would increase emotional self-awareness. Since the review, two more studies have been conducted and published and one of them is Study II in this thesis. The first study was conducted by an American research group, investigating a self-help smartphone application that passively recorded user data such as location, accelerometer data, and recent calls (Burns et al., 2011). Based on these data points the application generated information and tools teaching and facilitating behavioral activation. Both brief telephone calls and e-mail were used to increase adherence among the eight participants. Result revealed a significant reduction in depression case-ness (Burns et al., 2011). The unique feature of the study was that it was the first smartphone depression intervention to make use of the smartphone's ability to collect context-sensitive data. The accuracy rates were, according to the authors "promising"; from 60% to 91% (Burns et al., 2011).

The first RCT on a smartphone application for depression was conducted in 2012 (Reid et al., 2011). A total of 114 participants, aged 14 to 24 years with depressive symptoms were randomized into either the intervention group or to the control group. The intervention group received an application to self-monitor mood, stress and daily activities, whereas the control group only monitored daily activities. The trial was conducted in the context of a primary care setting with general practitioners distributing the application and later (after two to four weeks of self-monitoring) reviewed the monitoring data with their patients. Results showed no significant difference between the two groups (Reid et al., 2011). However, indications that self-monitoring increases emotional self-awareness, which in turn decreases depressive symptoms, were found (Kauer et al., 2012).

Since internet-based CBT programs for depression designed for computer-use have strong evidence, the step to developing these programs for smartphone-use should not be that great. In a pilot RCT, Watts and colleagues (2013) compared a previously validated computerized program to the same program, distributed via smartphone. Apart from the size of the font, which was adapted for the mobile version, only small revisions were made to the content of the program. The program contained six lessons and the participants received therapist support until completion of lesson two. No differences were found between the groups, and at the same time, results yielded a significant and large within-group effect from pre- to post-measurement for both interventions. In addition, the results showed that more participants using the computer than those using the phone (64% versus 54%) endorsed the program stating that they were 'very satisfied'. Despite methodological limitations, including the absence of a control group and small sample size, the study showed initial indications that the previous format of internet-based CBT might be feasible also in the smartphone context.

About the same time, Proudfoot and co-workers (2013) conducted an RCT with the same approach; a CBT program that could be accessed both via smartphone and computer. However, this program was a pure self-help program with no therapist support. A total of 720 participants with mild-to-moderate depression, anxiety and/or stress were either assigned to the self-help program, an attention control intervention or to a waitlist condition for seven weeks. Despite high dropout rates in the intervention group (43.4% were lost to follow-up), the results showed that the program produced moderate effect sizes of $d=0.36$ and $d=0.46$ on measurement of depression compared to the attention control and waitlist control respectively.

All in all, not much is known about smartphone as a depression treatment format, yet the studies that have been conducted so far on this topic show initial promising results and the possibility of delivering CBT in this new way.

Prior studies of smartphone-based CBT programs have used interventions consisting of full CBT, and in two cases BA (Burns et al., 2011; Kauer et al., 2012). It should be noted that the smartphone format in itself has certain implications for content. Boschen and Casey (2008) have stated that one challenge with using the mobile phone as a platform for psychological treatment, is that the user must be able to interact with the program in an easy way. In order to attain this simple and fast interaction, it might be easier to target specific treatment components rather than entire treatment programs in smartphone applications. This means that certain CBT interventions are probably better suited for the smartphone format than others. One treatment that should be especially suitable for the smartphone format is BA. This treatment has the benefits of being flexible and rather simple (Hopko, Magidson, & Lejuez, 2011). In addition, as described earlier, BA has strong empirical support as a treatment of adult depression (Ekers et al., 2008; Ekers et al., 2014; Mazzucchelli et al., 2009). For these reasons, BA was selected as the main treatment in the studies included in this thesis.

5 Aims of the thesis

The overall aim of the thesis was to test and further develop a smartphone application targeting activities in users' everyday lives, as well as building a method for how this smartphone application could be used in a comprehensive and effective way in depression treatment. In addition, I will also suggest a preliminary conceptual framework for classification of smartphone-based CBT programs. To fulfill these aims, four studies, three of which were trials (Study III was a qualitative extension of Study II), have been conducted. The interventions in the trials were based on BA. Although the first trial was described as an ACT intervention, it is better categorized as a BA intervention with additional assessment of values.

The main functionality of the smartphone application was to make it easy for users to remember and register important everyday behaviors in order to increase everyday activation – i.e. in line with the basic premises of BA (Jacobson et al., 2001; Kanter et al., 2010; Martell et al., 2001; Martell, Dimidjian, & Herman-Dunn, 2013). In order to provide suggestions, help, and inspiration to get started with the application, it contained a database of behaviors, divided into different areas for the user to add to their application. Users were also able to add their own areas and behaviors into the application and start performing and registering these. When a behavior was completed, for example: *Take a 15-minute walk*, the user could register this in the application and add a short reflection. In Study I, this behavior registration was the single developed function of the application.

Subsequently, new functions were added. These were scheduling, statistics, and messaging, as well as an administration system. Thus, in Study II and Study IV, users could plan ahead, noting the behaviors they intended to perform in the following days in the application and setting reminders. There was also statistics and summaries of quantitative (i.e.

behavior frequency) and qualitative data (i.e. reflections) available to the user in the application, enabling the tracking of his/her own progress. In addition, there was now an administration system where all the data from the users' smartphone application was accessible from a website. From the administration system, a therapist could send short text messages to the participants via a messaging system, similar to Short Message Service (SMS). The administration system functioned as a one-way communication, meaning that the users were not able to reply to the messages.

No sensitive data, through which the person providing data could be identified, were saved. In addition, all internet (including the administration system) and smartphone activities (including the users' smartphone application) were secured, with Secure Sockets Layer (SSL) encrypted information. Throughout the studies, all participants were using their own smartphones and no monthly service charges for the phone were paid for.

Study I

The first study was a pilot study of the first version of the smartphone application, investigating how 11 participants experienced an intervention on a smartphone platform.

Study II

In the second study, the intervention was developed as a guided internet-based CBT intervention, but delivered through the smartphone application. The aim of the second study was to test the effects of this intervention compared to a smartphone-delivered mindfulness intervention.

Study III

The third study was an extension of the second study, using a qualitative approach investigating 12 participants' experiences of the intervention.

Study IV

In the fourth and last study a new intervention was designed with a blended approach of the smartphone application and added to four face-to-face sessions. This was compared to a full face-to-face treatment without the smartphone application.

6 The empirical studies

6.1 Study I: Development and initial evaluation of a smartphone application based on acceptance and commitment therapy

6.1.1 Context and aims

The first empirical study was an exploratory investigation of a smartphone-based self-help treatment. The intervention was described as being based on ACT, but is better categorized as a BA intervention with assessment of values. At this time, there was a shortage of simple and accessible psychological interventions for individuals with minor levels of psychological distress and without a diagnosis. This intervention was designed to be flexible and useful for non-clinical populations. Therefore the intervention did not target any specific disorder. Also, when the present study was conducted in 2010, not much was known about the smartphone as a tool for delivering psychological self-help. Therefore, this was primarily a pilot study aimed at investigating a new field, providing a basis for generating hypotheses for further research.

The first aim was to examine if the smartphone-based treatment would have an effect on measures of valued actions, psychological flexibility, and global satisfaction as well as symptoms of depression, anxiety and stress. The second aim was to investigate how the participants experienced the intervention. An open-ended questionnaire was used to examine how the participants experienced the content of the intervention, as well as the intervention as a mobile-based platform. In this study, I also examined when, where and how often the participants used the application.

6.1.2 Methods

6.1.2.1 Trial design

This was a quasi-experimental pretest-posttest trial without control group.

6.1.2.2 Recruitment and participants

Participants were 11 people (four females and seven males; mean age 29.5 years, $SD=6.0$, range from 22 to 42 years old), recruited via a website. Inclusion criteria were: being at least 18 years old and having continuous access to a smartphone. Provided that the study was exploratory, major psychiatric conditions or undergoing treatment were not allowed among participants. However, one participant who showed mildly elevated levels of self-reported depression and anxiety, as measured with the short version of the Depression Anxiety Stress Scale (DASS-21; (Lovibond & Lovibond, 1995)), was still included in the study.

6.1.2.3 Outcome measures

In the study, the Bull's Eye Value Survey (BEVS; (Lundgren, Luoma, Dahl, Strosahl, & Melin, 2012)) was used to evaluate valued actions, the Acceptance and Action Questionnaire II (AAQ-II; (Hayes et al., 2004b)) was used to evaluate psychological flexibility – a term that is used to describe the ability to accept unwanted internal experiences and engage in valued actions (Hayes et al., 2004b), and the Satisfaction With Life Scale (SWLS; (Diener, Emmons, Larsen, & Griffin, 1985)) was used to measure global satisfaction. In addition to that, DASS-21 (Lovibond & Lovibond, 1995) was used to measure states of depression, anxiety and stress.

Also, a questionnaire, containing seven questions, was developed specifically for the study to evaluate the participant's experience of the intervention. The questionnaire contained four open-ended and three closed-ended questions along with follow-up questions.

6.1.2.4 Intervention

The intervention consisted of a smartphone application (described earlier) and a web-based psychoeducation. Considering that the total amount of text in an internet-based program is usually between 100 and 175 text pages (Lindfors, Hedman, & Ljótsson, 2012), the education in this treatment was rather short, consisting of eight text pages. The aim of the education was to present only the most essential content to understand the concept of the intervention and to get started with the smartphone application. Thus, the education contained information on the core processes of values and committed actions, as well as the functionality of the application. Although the psychoeducation could be viewed in a web browser (i.e. on a smartphone or a desktop), the participants were suggested to read it when sitting in front of a computer. The participants were informed that the psychoeducation would take about 45 minutes to read through. As for the smartphone application, the participants were encouraged to use it freely (i.e. as much as they wanted) during the study.

6.1.2.5 Statistical analysis

Index on dependent variables, including SWLS, AAQ-II, BEVS and DASS-21, was analyzed using dependent t-test on pre to post changes in score. In addition, Cohen's *d* effect sizes were calculated by dividing the differences in means by the pooled standard deviations.

The qualitative data contained answers from 11 participants. No analysis was done.

6.1.3 Results

6.1.3.1 Group analysis

A dependent t-test showed significant differences between pre and post intervention for the BEVS ($t(10)=-2.87$, $p<0.05$), and AAQ-II ($t(10)=-3.06$, $p<0.05$). No significant differences were found on the SWLS, or on the DASS-21. Cohen's d effect sizes, adjusted with Öst's (2006) recommended limit of value for within-group analysis (0.50 for small effect, 0.80 for medium effect, and 1.10 for large effect) showed small effect sizes between pre and post intervention for valued actions (Cohen's $d=0.77$), measured by BEVS and psychological flexibility (Cohen's $d=0.50$), measured by AAQ-II. No meaningful effect sizes were obtained for the other measures.

6.1.3.2 Individual analysis

From the questionnaire, the general indication that the participants reported, was that the intervention made them think of their values and behaviors more. A majority of the participants used the application a couple of times per week. Among those participants who used the application the most, sitting on – or waiting for the bus, metro or train, was the most common context to use it in. Noteworthy, the participant that showed mildly elevated levels of self-reported depression and anxiety at baseline reported in the qualitative questionnaire that the intervention had been a contributive factor to higher activation, which led to a reduction in depressive symptoms. This was also shown in the self-reported measurement DASS-21, where this participant went from severe to normal for the emotional state of depression, and from severe to mild for the emotional state of anxiety.

6.1.4 Discussion

Study I was an initial, exploratory study with the aim to investigate the functionality of the application, as well as to generate hypotheses for a forthcoming RCT. Thus, the purpose of the study was not to determine the effects of the intervention. The study pointed at some features that could be tested in controlled studies. For example, it may be that smartphone applications could be used to increase adherence (Boschen & Casey, 2008), which is a problem in many treatment settings including internet-delivered CBT (Andersson, 2009). Another implication from the current paper was that smartphone applications may increase awareness of being in treatment in an everyday setting. This does not necessarily have to be a good thing, but might help clients who need reminders to engage in homework and other treatment related activities outside of the therapy room.

In conclusion, the study showed that the format of using a smartphone application to target activation in participants' everyday lives, in combination with an introductory education, could be further tested in an RCT. Also, the findings from the study indicated that this treatment format should be tested with mild-to-moderately depressed participants. Since it is unlikely that clinicians will be able to serve all patients in need of traditional face-to-face interventions, finding new ways to develop accessible and cost-effective psychological interventions is important. Study I was my first pilot in this area, and my conclusion was that mobile technologies have the potential to facilitate this work. Thus, it was motivated to continue on the same path, since there were reasons to believe that digitally distributed CBT interventions in the future would be executed through smartphones or at least supported by smartphones.

6.2 Study II: Behavioural activation versus mindfulness-based guided self-help treatment administered through a smartphone application: a randomised controlled trial

6.2.1 Context and aims

In Study II, three big changes were made from Study I. First, instead of a non-clinical group, participants with mild-to-moderate depression were included. Second, the intervention was developed as a guided internet-based CBT intervention, but delivered through the smartphone platform. Third, the study was designed as an RCT.

In Study II, I wanted to test the effect of a BA treatment delivered via smartphones, for mild-to-moderate depression. The treatment consisted partly of a smartphone application, which was a further developed version of the application tested in Study I. It has previously been hypothesized that one of the challenges with using the mobile phone as a platform for psychological treatment is that the user must be able to interact with the program in an easy way (Boschen & Casey, 2008). In order to attain this simple and fast interaction, it could be easier to target specific treatment components than entire treatment programs in smartphone applications. Another important feature of mobile technology is the possibility for a therapist to reach the patient outside of the therapy room or when not sitting in front of the computer, and thus create direct incentives for behavior change in the patient's everyday life. Therefore, BA is a treatment that could benefit from the use of smartphones.

The aim of Study II was to test the effects of a smartphone-delivered treatment based on BA. The treatment was controlled against a mindfulness program, since mindfulness, just as BA, is a component in a more extensive treatment package. Thus, it might fit well in the smartphone

format. The control condition had a similar treatment setup as the BA treatment. It was hypothesized that the BA treatment delivered over smartphone would be more effective than mindfulness treatment delivered over smartphone since the effects of a full MBCT program were not tested, but rather a brief version with fewer exercises. In addition, it was hypothesized that the BA intervention would be more suitable for the more severely depressed participants. This was motivated by the notion that mindfulness may require more cognitive functioning in the initial stages of a treatment, e.g. in the form of prolonged concentration and handling of distracting thoughts (Bishop, 2002; Tang & Posner, 2009), and research has shown that depressed individuals, to a greater extent, have deficits in cognitive functioning (Clak & Beck, 1999; Gotlib & Joormann, 2010). In order to evaluate long-term effects, a six month follow-up after the start of the treatment was included.

6.2.2 Methods

6.2.2.1 Trial design

Study II was a parallel RCT. Participants were allocated using an online randomization tool, handled by an independent person who was separate from the staff, conducting the study.

6.2.2.2 Recruitment and participants

The participants were mainly recruited via mass media and advertisements in large Swedish newspapers. After the selection process, a total of 40 participants diagnosed with major depressive disorder received the BA treatment, and 41 participants received the mindfulness treatment. Nine participants were lost at the post-treatment. Among the randomized participants, there were 70.3% women ($n=57$) and 29.6% men ($n=24$). The mean age was 36.0 years ($SD=10.8$) ranging from 20 to 61 years. Inclusion criteria for the study were a) being at least 18 years

old, b) having a total point of ≥ 5 on PHQ-9, c) reported unchanged dosage of medication for depression and anxiety during the last month, d) not being in any concurrent psychological treatment, e) not suffering from a severe comorbid psychiatric condition that could interfere with the treatment (e.g. bipolar disorder or schizophrenia, assessed during a clinical interview prior to the start of the trial), f) not having other primary medical problems which would need other treatments first hand, g) not having severe alcohol problems, h) no assessed risk of being suicidal and i) suffering from major depression according to the DSM-IV, with at least an episode in partial remission, which was confirmed by administering the Mini International Neuropsychiatric Interview (MINI) (Sheehan et al., 1998).

6.2.2.3 Outcome measures

The primary outcome measures were the Beck Depression Inventory-II (BDI-II; (Beck, Steer, Ball, & Ranieri, 1996)) and the 9-item Patient Health Questionnaire Depression Scale (PHQ-9; (Kroenke, Spitzer, & Williams, 2001; Titov et al., 2011)) that were administered pre-treatment, post-treatment and also six months after the treatment had ended. The PHQ-9 was also administered on a weekly basis during the entire treatment phase (eight weeks). The secondary outcome measures were the Beck Anxiety Inventory (BAI; (Beck, Epstein, Brown, & Steer, 1988)), the Quality of Life Inventory (QOLI; (Frisch, Cornell, & Villanueva, 1992)) and the Acceptance and Action Questionnaire (AAQ-II; (Hayes, Strosahl, Bunting, Twohig, & Wilson, 2004a)). The AAQ-II was administered on a weekly basis during the entire treatment phase (eight weeks). All other outcome measures were collected at pre-treatment, post-treatment and at six month after the start of the treatment.

6.2.2.4 Treatments

The BA treatment was an eight week smartphone-based intervention with minimal therapist contact (maximum time of 20 minutes per

participant and week) and was developed in Study I but updated for Study II. The intervention consisted of a short web-based psychoeducation, and a smartphone application (described earlier). The psychoeducation aimed to introduce the participants to BA and to establish a minimum level of knowledge concerning (MDD). The participants were suggested to go through the psychoeducation via a computer.

Apart from the messages that the therapists sent via the administration system (described earlier), the participants were told to write a reflection to summarize every week for their therapist, and send it via e-mail by the end of every treatment week. The participants received personal feedback on their reflection from their therapist via e-mail.

The mindfulness intervention was similar to the BA treatment and likewise consisted of an eight week smartphone-based intervention with minimal therapist contact (maximum time of 20 minutes per participant and week). The intervention was comprised of a short web-based psychoeducation, and a step-by-step practice program, administered via a smartphone application. The psychoeducation for the mindfulness intervention was similar to the education for the behavioral activation intervention, except that the theoretical basis of mindfulness was presented instead of the theoretical basis of BA. The application consisted of a number of audio tracks with both guided and unguided exercises, as well as short (three minutes) and long (30 minutes) formats, to facilitate the practice of mindfulness.

The mindfulness application did not have an administration system where messages could be sent to the participants, as in the BA application. Therefore, the therapists used e-mails as a replacement. Because of this, the therapists could not give specific feedback on activities or exercises to the participants in the mindfulness treatment. Other than that, the communication was similar (length and type of guided content in the feedback). In addition, and equivalent to the BA treatment, the participants in the mindfulness intervention were asked to write a weekly

reflection to summarize their work and thoughts on the current treatment week, and send this reflection to their therapist via e-mail. The participants received personal feedback on their reflections from their therapist.

6.2.2.5 Therapists

The therapists were four final-semester students from a five year Master of Science (M.Sc.) clinical psychologist program. All therapists had completed their clinical training as well as 16 weeks of practice. Each therapist was responsible for 8-10 participants from the BA group and an equal number of participants from the mindfulness group – and was randomly allocated to the participants. For the entire duration of the study the therapists received continuous supervision from an experienced psychotherapist with CBT orientation.

6.2.2.6 Subgroups

A classification of high and low severity of depression was made with all randomized participants, which was based on the cut-off scores on the PHQ-9. A total number of 51 participants were considered to suffer from higher severity of depression, since they scored ≥ 10 on PHQ-9, which is the scoring level for moderate depression – as well as fulfilled the criteria for an ongoing primary diagnosis of major depression of moderate character in the clinical interview. In contrast, 30 participants were considered to suffer from lower severity of depression, since they did not fulfill these criteria.

6.2.2.5 Statistical analysis

Independent t-tests and chi-square tests were used to test for group differences in demographics, pre-treatment data and recovery rates. Mixed effects models were used to analyze the continuous outcome variables. This was to adhere to the intention-to-treat principle, since mixed

effects models are able to handle missing data (Gueorguieva & Krystal, 2004). All analyses used Maximum Likelihood estimation. Random intercept models were selected for all measures. Differences between the BA treatment and the mindfulness treatment were primarily investigated by modeling interaction effects of group and time. Additionally, independent t-tests were used to analyze the between-group differences at post-treatment. Power analysis indicated an 89% chance of detecting a between-group effect size of $d=0.60$ (α level=0.05, one tailed). Within- and between-group effect sizes (Cohen's d) were calculated by dividing the differences in means by the pooled standard deviations (Borenstein, Hedges, Higgins, & Rothstein, 2011). This was done both from pre-measurements to post-measurements, and from pre-measurements to the six month follow-up data.

6.2.3 Results

6.2.3.1 Attrition

Of the 81 participants, 57 (70.4%) succeeded to adhere to all the eight weeks. Of these, 25 (62.5%) were in the BA group and 32 (78.0%) were in the mindfulness group. No significant difference in adherence was found between the two groups ($\chi^2(n=81, df=1)=2.35, p=1.00$). In average, participants succeeded to adhere to six weeks ($M=5.8, SD=2.5$).

6.2.3.2 Primary and secondary outcome measures

No significant interaction effects of group and time on the PHQ-9 and the BDI-II were found between the groups, neither from pre-treatment to post-treatment (PHQ-9: ($F(1, 501.47)=0.28, p=0.60$); BDI-II: ($F(1, 74.11)=0.28, p=0.60$)), nor from pre-treatment to the six month follow-up (PHQ-9: ($F(1, 571.49)=0.36, p=0.55$); BDI-II: ($F(1, 147.96)=0.09, p=0.77$)). Large within-group effect sizes were found on the PHQ-9 and BDI-II, between pre-treatment and post-treatment, as well as between

pre-treatment to the six month follow-up. This was the case for both the BA treatment and the mindfulness treatment ($d=0.91$; CI $[-0.44, 2.27]$ to $d=1.83$; CI $[0.27, 3.38]$).

No significant interaction effects were found on the secondary measures between the groups, neither from pre-treatment to post-treatment (BAI: ($F(1, 74.05)=1.30, p=0.26$); AAQ-II: ($F(1, 570.00)=0.07, p=0.79$); QOLI: ($F(1, 76.43)=1.06, p=0.31$)), nor from pre-treatment to the six month follow-up (BAI: ($F(1, 147.01)=0.35, p=0.56$); AAQ-II: ($F(1, 639.00)=0.11, p=0.74$); QOLI: ($F(1, 148.61)=0.39, p=0.53$)). Medium to large within-group effect sizes were revealed on all secondary outcome measures for both treatments ($d=0.51$; CI $[-1.39, 2.40]$ to $d=0.91$; CI $[0.58, 1.25]$).

6.2.3.3 Subgroup analyses

For the participants (total $n=51$, BA $n=23$, MF $n=28$) suffering from higher severity of depression (≥ 10 on the PHQ-9 and an ongoing primary diagnosis of major depression of moderate character), a mixed effects model analysis on the PHQ-9 revealed significant interaction effects of group and time in favor for the BA group from pre-treatment to six month follow-up ($F(1, 362.1)=5.20, p<0.05$), but not on pre-treatment to post-treatment. The effect size between the groups at six month follow-up was moderate (Cohen's $d=0.47$; CI $[-1.46, 2.40]$).

For the more mildly depressed participants (total $n=30$, BA $n=17$, MF $n=13$) there was a significant effect in favor of the mindfulness group from pre-treatment to six month follow-up on both the PHQ-9 ($F(1, 69.3)=7.70, p<0.01$) and the BDI-II ($F(1, 53.60)=6.25, p<0.05$). The effect sizes were large (PHQ-9: Cohen's $d=0.98$; CI $[-0.72, 2.68]$; BDI-II: Cohen's $d=1.21$; CI $[-1.71, 4.13]$).

6.2.4 Discussion

Study II was one of the first RCTs to test a treatment for depression, administered via smartphone. The large within-group effects on the primary outcome measures for both groups are comparable to other depression treatments and indicate that this smartphone format with a small amount of text and minimal therapist support might work well for a depressed population. However, to rule out that the effects occurred due to natural recovery, a replication with a waiting list group should be conducted.

Moreover, Study II also showed that BA might work better for a more severely depressed population, whereas mindfulness might work better for people suffering from light depression. These results suggest that different treatments distributed digitally can target different subgroups of depressed patients in terms of severity. However, more studies are needed to strengthen this hypothesis before any conclusions can be drawn.

From a broader perspective, not much was known about smartphone-administered depression treatments at the time when this study was conducted, even though this and some other studies had shown implications that depression could be treated by means of a smartphone application. In addition, it was difficult to point out the active treatment components in the BA intervention. Therefore, it was concluded that a study with a qualitative approach would be important to get a deeper understanding of how this kind of treatment functioned and was experienced by participants. I believed this was important since it was likely that smartphones would be integrated even further in society, and therefore may serve an important role in health care. Study II constituted a first step in finding a depression treatment administered via a smartphone application that could be more assimilated into people's daily lives. More work would be needed to understand this treatment format better.

6.3 Study III: Experiences of a guided smartphone-based behavioural activation therapy for depression: A qualitative study

6.3.1 Context and aims

In Study II, I started to examine the efficacy of a smartphone application in the treatment of depression. At this point, a number of studies had investigated treatments administered via smartphones, showing that the format has a potential to be effective in the treatment of depression (Burns et al., 2011; Proudfoot et al., 2013; Reid et al., 2011; Watts et al., 2013), as well as for other conditions (Dagöo et al., 2014; Donker et al., 2013). However, there was still limited knowledge available about how patients experience this treatment format (Kok, Bockting, Burger, Smit, & Riper, 2014), even though patient satisfaction with smartphone applications has been measured (Burns et al., 2011; Watts et al., 2013).

Considering the rapid development of smartphone-based interventions, qualitative studies might be important for the research field of digitally administered therapy. It was hypothesized that more knowledge on participants' perceptions of this particular format could be helpful in the development of new smartphone-based treatments.

The main objective of Study III was to develop an understanding of the views and experiences of a smartphone-based BA treatment, using interviews and questionnaires. The content of the interviews were analyzed using thematic analysis. The current study was a qualitative follow-up of Study II. Study III focused on the participants' experiences from the BA treatment in order to learn how to develop the concept further and was initiated six months after the treatment had been completed in the original study.

6.3.2 Methods

6.3.2.1 Recruitment and participants

The selection was made out of the participants that had participated in Study II. A total of 90.6% of the participants in Study II had agreed in advance to also participate in this qualitative study. A strategic selection was made among these participants, in order to cover as broad an experience of the treatment as possible. Due to time limitations, the number of participants was restricted to 12 (six females and six males; mean age 37.9 years, $SD=14.0$, range from 21 to 59 years old). In accordance with the strive for maximum variation, participants with different overall experiences (positive, neutral and negative) after treatment were selected. This data was obtained in connection with post-measurement of Study II, where all participants were asked about their overall experience of the intervention.

6.3.2.2 Treatment

See the BA treatment in Study II.

6.3.2.3 Procedure

The data were gathered through semi-structured telephone interviews, which were 30 to 60 minutes long. An interview guide was prepared to allow for openness in the questions while at the same time covering the areas that prior research has shown to be central to the outcome of all psychological treatments. Examples of that included expectations, alliance and feedback. Most questions in the interview guide were open-ended with subsequent follow-up questions, in order to gain as rich information as possible. During the course of the study, as new questions arose, the interview guide was adjusted. Thus, the interview guide was used rather as an inspiration than as a mandatory instrument. The interviewers; one woman and one man – both clinical psychology stu-

dents in their last term of a five year clinical program, and specifically trained to assess qualitative interviews, conducted and transcribed six interviews each. The interviewers were familiar with the original study, and were not blinded to the participants' outcome of the treatment.

6.3.2.4 Analysis

Thematic analysis (Braun & Clarke, 2006) was used to process the interview data. The pre-understanding of the interviewers was mainly reflected in the selection of themes for the interview guide. The research process was then guided by the participants' answers to the largest possible extent. The analysis process was as follows: First, the interviews were transcribed and followed by several thorough readings in order to identify patterns in the data, reflecting common themes in the participants' experiences of the treatment. Second, the interview content was coded in such a way that material, which provided answers to the research questions, was identified. For each section that was deemed meaningful in terms of answering the research question, a code was ascribed. Third, when all interviews had been coded, these codes and their corresponding quotes were assembled in a document. Preliminary themes were then identified and the codes were grouped under these themes. This procedure is in line with how thematic analysis is described in literature (Braun & Clarke, 2006).

Up until this point, the two interviewers worked individually with six interviews each. To test whether the coding would be replicated by an additional person trained in coding of qualitative data, a senior researcher also read and coded all interviews. New themes were then generated. The last step was to find relevant and representative quotes to illustrate the results. In order to check the study for quality, the process followed the Consolidated criteria for reporting qualitative research (COREQ) checklist (Tong, Sainsbury, & Craig, 2007).

6.3.3 Results

The analysis generated three main themes with attached subthemes. The themes were ***Commitment*** with the subthemes *expectations* and *motivation*; ***Treatment*** with the subthemes *awareness*, *behavioral activation*, *tool for help*, *therapist support*, *positive experiences of treatment*, *standardization and individualization*, and *impressions of the application*; and lastly ***Lack of important components*** with the subthemes *goals* and *closure*.

In summary, the results indicated that the participants' experiences on the whole were comparable with previous findings within qualitative research of internet-based guided self-help treatment (Beattie, Shaw, Kaur, & Kessler, 2009; Bendelin et al., 2011; Khan, Bower, & Rogers, 2007; Macdonald, Mead, Bower, Richards, & Lovell, 2007). What seemed to be unique in this study was that the smartphone-based treatment felt more accessible and present in the participants' everyday lives. This is something that has been suggested earlier, for example in Study I. In general, it seemed like the smartphone-based treatment had a number of potential benefits that deserved further investigation. For example, some individuals reported that the constant proximity of the smartphone created a sense of security, whereas one participant pointed to the possibility of smartphone-based treatment being more immediately motivating because of the reminders.

Furthermore, and in line with prior research (Khan et al., 2007), the results revealed that the therapist support was perceived as crucial to a positive experience of the treatment. Thus, none of the participants thought the treatment would be motivating or effective without a therapist. Most distinctly, the therapist support seemed to contribute largely to motivation. Another function of the therapist support, that some of the participants experienced, was the possibility of individual tailoring of the treatment. Several participants described how they, together with the therapist, designed activities that suited their particular problems. A

number of participants lamented the lack of individualization of the treatment.

6.3.4 Discussion

The aim of Study III was to gain a deeper knowledge of the participants' experiences of the BA treatment in Study II. I believed that this was important for further developing the concept of the smartphone application, as well as the treatment format and the specific method. In order to develop an effective smartphone-distributed treatment, new formats must be taken into consideration.

In conclusion, Study III added important information to the body of knowledge regarding digitally distributed self-help interventions, namely that the smartphone-based treatment might be more accessible and present in users' everyday lives. Noteworthy, none of the participants thought the treatment would be motivating or effective without a therapist. This notion is supported by earlier research on internet-based CBT. It is, however, important to highlight the limited generalizability of the results, given that the data of this study were related to a single smartphone application featuring one specific treatment.

Its availability, assimilation into users' everyday lives, and possible motivational qualities speak to the smartphone as a potentially effective treatment format. However, considering that this format is still novel, it is important that new ways of applying it is being examined.

6.4 Study IV: Smartphone-supported versus full behavioural activation for depression: a randomised controlled trial

6.4.1 Context and aims

Based on the conclusions from my previous studies in this thesis, it was concluded that new ways of applying a smartphone application in the treatment of depression should be examined. In light of the research support for BA (Kanter et al., 2010), as well as of the initial promising findings of smartphone-delivered psychological treatment for depression (Proudfoot et al., 2013; Watts et al., 2013), it was assumed that a combination of these two formats might be useful to explore. Therefore, a new blended approach in which the smartphone application was used as an add-on to face-to-face therapy, was investigated in Study IV. Specifically, it was hypothesized that the number of treatment sessions could be reduced by means of the smartphone application.

The evaluation of combined treatment methods shows promising results (e.g., combining an internet treatment program with live group sessions for social phobia) (Andersson & Titov, 2014). However, these treatment programs mainly rely on self-help exercises, reading texts, and online group discussions with the support from therapist-guided sessions (Andersson & Titov, 2014). The starting point of this treatment was traditional face-to-face treatment with the addition of a smartphone tool for support. It has recently been suggested that this kind of blended approach should be further investigated in RCTs, since initial evaluation shows that both patients and therapists expect more benefits than drawbacks from this format (van der Vaart et al., 2014).

The aim of Study IV was to evaluate a *blended treatment* for mild-to-moderate depression, consisting of the smartphone application used in

my previous studies, in addition to face-to-face therapy sessions. Since it is known that BA works for mild-to-moderate depression (Kanter et al., 2010), I compared our blended treatment to a full BA treatment. Specifically, I used four face-to-face sessions plus the smartphone application and compared this outcome against a full regular ten-session program conducted without the smartphone support. It was hypothesized that the new treatment would show similar outcomes as the standard treatment and thus, overcome the drawbacks that previous studies have suggested, namely that adding digital components also increases costs and workload among professionals (Meglic et al., 2010; Meyer et al., 2009; van der Vaart et al., 2014).

6.4.2 Methods

6.4.2.1 Trial design

Study IV was an RCT, comparing a blended treatment against a full ten-session treatment for people with mild-to-moderate depression. Participants were, as in Study II, allocated using an online randomization tool, handled by an independent person who was separate from the staff conducting the study.

6.4.2.2 Recruitment and participants

A total of 93 participants (65 females and 28 males; mean age 30.6 years, $SD=11.4$, range from 18 to 73 years old) were randomized to either receive the blended smartphone-supported treatment ($n=46$) or the full BA treatment ($n=47$). The participants were recruited by self-referral via advertisements in Swedish newspapers. The study was conducted in two cities (Stockholm and Linköping) in Sweden, at three clinical settings: Stockholm University (Clinic for Psychology), Wemind Psykiatri (Clinic for Psychiatry), and Linköping University (Clinic for

Psychology). The inclusion criteria were: a) owning a smartphone; b) at least 18 years of age; c) a total score of ≥ 5 on the PHQ-9; d) in the last month, consumed none or a fixed dose of medication for depression and anxiety; e) no participation in a similar psychological treatment program, i.e. CBT; f) no severe comorbid psychiatric condition, which might interfere with the treatment (e.g., bipolar disorder or schizophrenia assessed during a clinical interview prior to the start of the trial); g) no other primary medical problems, which would require other treatments; h) no severe alcohol problems; i) no assessed risk of suicide and j) suffering from major depression according to the DSM-IV (American Psychiatric Association, 1994) with at least one episode in partial remission.

6.4.2.3 Outcome measures

The same primary and secondary outcome measures as in Study II were used in Study IV: the BDI-II (Beck et al., 1996), the PHQ-9 (Kroenke et al., 2001), the BAI (Beck et al., 1988), the QOLI (Frisch et al., 1992), and the AAQ-II (Hayes et al., 2004a). All the outcome measurements were administered shortly before (pre-treatment) and after treatment (post-treatment), as well as six months after the end of the treatment (follow-up). The PHQ-9 was also administered on a weekly basis during the entire treatment period.

MINI was administered at pre-treatment, post-treatment and at follow-up to assess psychiatric diagnoses (Sheehan et al., 1998). Borkovec and Nau's credibility/expectancy scale (C-Scale) (Borkovec & Nau, 1972) was distributed after the first week of treatment to measure participants' perceived treatment credibility. To assess the quality of the working alliance, the client version of the 12-item WAI-S (Tracey & Kokotovic, 1989) was distributed after the third week of treatment. Additionally, WAI-S was also administered at pre-treatment in order to measure the expected working alliance. Adherence to the therapy manuals was evaluated using a questionnaire that, at the end of every session, asked both the therapist and the client if different core components of a session were

completed (Sundell, 2012). This was developed specifically for Study IV and contained a short questionnaire (four or five questions) that was related to the core elements for each session. Each questionnaire was administered in paper format in the end of every session and was answered with “yes” or “no” by both the therapists and the participants. This was done for both interventions.

6.4.2.4 Treatment

The blended treatment consisted of four face-to-face sessions and the smartphone application described earlier that was used in between the sessions. The treatment period ranged over nine weeks with face-to-face sessions every second or third week. The treatment structure was documented in a treatment manual, which had its starting point in Martell and co-workers' (2001) BA treatment manual. Since the blended treatment only included four face-to-face sessions, the current treatment was refined specially for the current intervention. The treatment focused on replacing depressed behaviors with non-depressed (healthy) behaviors that was assumed to lead to sustainable positive reinforcement. Thus, it was developed to target the mechanisms of increasing exposure to positive consequences of healthy behaviors and thereby increasing the likely recurrence of such behaviors. Via the administration system (described earlier), the therapists sent personal encouraging messages every other or every third day to the participants as well as weekly general educational messages.

Following Martell et al.'s (2013) treatment manual, the full comparison treatment consisted of a 10 face-to-face session BA treatment, which ranged over 10 weeks with a face-to-face session once a week. The full BA treatment included BA components such as the identification of individualized treatment targets, monitoring and scheduling "anti-depressant" activities, as well as reducing avoidance and ruminative thinking. Between the sessions, the participants received homework as well as an activity schedule and activity plan in paper format.

6.4.2.5 Therapists

The therapists ($n=26$) were final-year students from a five year M.Sc. clinical psychologist program and had all completed their clinical training. Each therapist was responsible for the treatment of one or two participants of the blended treatment and of one or two participants of the full BA. Therapists were randomly assigned to participants with the restriction not to work with more than two participants from each group. The therapists were trained in BA, MINI, and the treatment manuals, as well as on how to use the smartphone application and the administration system before the study started to reduce gaps in knowledge and to keep the skill level as equal as possible. Training sessions were conducted by the principal investigator of the trial in collaboration with me. During the entire study, the therapists continuously received supervision from psychotherapists with CBT orientation, who were experienced working with a BA treatment manual.

6.4.2.6 Statistical analysis

Independent t-tests and chi-square tests were used to test for baseline differences between conditions. Primary and secondary continuous outcomes were analyzed according to the intention-to-treat principle using mixed effects models, given their ability to handle missing data (Gueorguieva & Krystal, 2004). Differences between the blended treatment and the full BA were primarily investigated by modeling interaction effects between group and time. Random intercept models were selected for all measures.

Recovery after treatment was investigated using the BDI-II. To define responders on the BDI-II, I used Jacobson and Truax (Jacobson & Truax, 1991) procedures for calculating reliable and clinically relevant changes of significance to quantify clinical improvement in depressive symptoms on the BDI-II, which is recommended as a standard reporting method for all published research involving psychological interventions. In calculating reliable and clinically relevant criterions for changes of

significance, I used data from the BDI-II manual for clinical means, standard deviations and reliability estimates (Cronbach's alpha), and data from Dozois et al. (1998) for the non-clinical means and standard deviations. On the basis of these data, a participant had to improve by 10 points or more from pre-treatment to post-treatment to show reliable changes and in addition had to score 17 or above pre-treatment and 16 or below post-treatment to meet criteria for clinically significant changes. Thus, only participants, who scored 17 or above at pre-treatment ($n=84$), were assessed at post- and follow-up treatment. Differences in rates between treatments were analyzed by using chi-square tests. Proportions were based on the full intention-to-treat sample: that is, participants who missed data at post- and follow-up treatment were regarded as non-responders. Effect sizes (Cohen's d) were calculated by dividing the differences in means by the pooled standard deviations (Borenstein et al., 2011), based on the intention-to-treat sample.

6.4.3 Results

6.4.3.1 Attrition

Out of the 93 randomized participants, five participants (one receiving the blended treatment and four receiving full BA) decided not to start the treatment. Nevertheless, these were included in the intention-to-treat analysis. Another three (two from the blended treatment and one from the full BA) participants (totaling 8.6%) did not submit post-treatment data. From the follow-up treatment, another 16 participants, 10 from the blended treatment group and six from the full BA group (totaling 25.8%), did not submit data on the self-report measures.

Adherence to treatment was defined as the number of completed face-to-face sessions. Out of 88 participants, who started the treatment, 81 (92.0%) succeeded to adhere to the entire treatment. Of those, 42 (93.3%) participants were in the blended treatment group and 39 (92.9%) were in the full BA treatment group.

6.4.3.2 Primary and secondary outcome measures

No significant interactions of group and time were found, neither between pre- and post-treatment nor between pre- and follow-up treatment on any of the outcome measures ($F(1, 911.85)=0.11$ to $F(1, 88.32)=0.31$, $p=0.74$ to 0.58) nor between pre-treatment to follow-up treatment ($F(1, 166.88)=0.91$ to $F(1, 165.17)=1.06$, $p=0.74$ to 0.31).

Based on estimated means, the within-group standardized effect sizes for the two treatments were substantial on both post- and follow-up treatment on the primary outcome measures ($d=1.35$; CI $[-0.82, 3.52]$ to $d=1.58$; CI $[0.51, 2.65]$). The between-group standardized mean differences were absent on both post-treatment and follow-up treatment ($d=-0.13$ CI $[-2.37, 2.09]$ to $d=0.05$ CI $[-1.18, 1.27]$).

Medium-to-large within-group effect sizes were revealed on all secondary outcome measures between pre-treatment to post-treatment for both treatment groups ($d=0.60$; CI $[-1.05, 2.26]$ to $d=0.80$; CI $[0.43, 1.18]$), with treatment effects maintained at follow-up treatment. This was the case for both groups. In addition, the between-group standardized mean differences were small to absent in favor for the blended treatment ($d=-0.07$; CI $[-1.83, 1.68]$ to $d=0.36$ CI $[-1.48, 2.20]$).

6.4.3.3 Clinically significant improvement on the BDI-II

No significant differences in recovery rates between the both treatment groups were revealed, neither at post-treatment ($\chi^2(n=84, df=1)=0.00$, $p=0.58$) nor at follow-up treatment ($\chi^2(n=84, df=1)=0.04$, $p=0.50$). At post-treatment, 22 (53.7%) of the participants that received the blended treatment were classified as responders according to the Jacobson and Truax criteria (1991) compared to 23 participants (53.5%) that received the full BA treatment. At follow-up treatment, 20 participants (48.8%) of the blended treatment group and 20 participants (46.5%) of the full BA group were recovered.

6.4.3.4 Credibility, working alliance and adherence to therapy manuals

Treatment credibility ratings (C-scale) after one week of treatment showed that participants in both groups rated their respective treatment as credible. Out of a possible total score of 50, the average scores were 33.0 ($SD=8.0$) for the blended treatment group and 33.5 ($SD=6.5$) for the full BA group. The quality of working alliance, measured with WAI-S, showed no significant differences between the two groups ($t(91)=-0.32$ to $t(77)=0.89$, $p=0.75$ to 0.37). In total, 97.1% of the questions regarding adherence to the therapy manuals were answered with “yes” by the therapists and with 97.5% by the participants. For the blended treatment, 97.4% of the questions were answered with “yes” by the therapists and 98.0% by the participants. As for the full BA treatment, the numbers were 96.9% for the therapists and 97.0% for the participants.

6.4.3.5 Therapist time

The therapist time for each face-to-face session, regardless of intervention, was 60 minutes; that is, the full BA had an average therapist time of 600 minutes and the blended treatment 240 minutes. However, with respect to the blended treatment, the time in the administration system needed to be considered as well. The total time a therapist spent in the administration system on a participant throughout the treatment varied greatly, ranging from 24 to 220 minutes ($M=80.7$, $SD=41.6$). There was no significant correlation between therapist time spent in the administration system and changes on the primary outcome measures ($r=-0.05$ to 0.31 , $p=0.07$ to 0.73), neither from pre-measurement to post-measurement nor from pre-measurement to follow-up measurement. When the time in the administration system was added, the average therapist time for the blended treatment was 321 minutes, which was 46.5% less compared to the full BA treatment.

6.4.4 Discussion

The results in Study IV showed no major differences between the blended treatment (including four face-to-face sessions and a smartphone application) and the full BA (including 10 face-to-face sessions) on any of the outcome variables, neither from pre-measurement to post-measurement nor from pre-measurement to follow-up measurement. Moreover, the results revealed significant improvements from pre- to post-treatment on all the outcome measures in both treatment conditions along with large within-group effect sizes and large recovery rates, whereas treatment effects were kept at follow-up treatment. Thus, the main findings indicated that this specific blended treatment could be as effective as a full BA treatment. The blended treatment also achieved comparable scores on the treatment credibility and working alliance as the full BA treatment, although the therapist time was reduced by an average of 46.5%. This should also be seen in the light of the findings of dose-response effects, showing that lower doses of psychotherapy are associated with poorer outcomes (Weersing & Weisz, 2002). For example, one study showed that participants suffering from depression who had more than nine CBT sessions were 2.5 times more likely to have adequate treatment response than those who had nine or fewer sessions (Kennard et al., 2009). This allows us to suggest that the blended treatment method is a promising cost-effective alternative to regular face-to-face treatment for mild-to-moderate depression.

In addition, as internet-based CBT programs have shown to be a cost-effective intervention in relapse prevention for depression (Holländare et al., 2011), smartphone applications might be a continuation of that. Furthermore, it has recently been suggested that a higher intensity in therapy for depression, might increase its effectiveness (Cuijpers, Huibers, Ebert, Koole, & Andersson, 2013c). This blended format, with a smartphone application as an add-on has the potential to increase intensity by providing a support tool in patients' everyday lives, used between face-to-face sessions, and thus be constantly available.

Despite the limitations, including no randomization to an attention-controlled placebo and small sample size, Study IV implies that therapists administering this specific blended treatment method could possibly treat nearly twice as many patients with mild-to-moderate depression by using the smartphone application as add-on. I assume that our blended treatment format, in which the number of sessions is replaced by the smartphone support application, while at the same time the therapist is still highly involved in the treatment, will have implications for the future planning of psychological services.

In conclusion, Study IV might pave the way for a broad range of trials including the blended treatment format. The results from this study were promising and the format should be further investigated. From the viewpoint of smartphone interventions, this blended format might be a way to combine the best of two worlds: face-to-face support, which patients generally prefer, and a digital tool that reaches the patients in their everyday lives, thus extending the therapy sessions. Additionally, smartphones in the context of this blended format can target even more specific purposes, such as homework adherence, and thus, could be further developed to find better functions particular to fulfill these purposes. Although this is the last empirical study in this thesis, it might be a start of a new way of how to apply smartphone applications in the treatment of depression in specific, and for mental health care in general.

7 Concluding discussion

7.1 Empirical discussion

The overall aim of this thesis was to test and further develop a smartphone application targeting activities in users' everyday lives, as well as building a method for how this smartphone application could be used in a comprehensive and effective way in depression treatment.

Study I, albeit a pilot study, gave initial implications that participants receiving a smartphone CBT program would use it in contexts where it would normally be difficult to use a traditional internet-based program.

In Study II, I moved from a non-clinical group to include participants with mild-to-moderate depression and also included minimal therapist support via e-mail. As in Study I, the program consisted of a web-based psychoeducation and a smartphone application. This was to separate two types of tasks performed through two different devices: reading when sitting in front of a computer (even though the text could be accessed from a smartphone), and tracking activities via the application when in the everyday life. Our BA program was compared with an equivalent program based on mindfulness with a commercially available smartphone application. The results showed large within-group effect sizes for both groups, but no between-group effect sizes. Subgroup analyses revealed a significant difference in favor for the BA program for participants with more severe depression at baseline. Contrary, for the participants with lower initial severity, the mindfulness program was significantly more effective than the BA program.

The qualitative approach used in Study III revealed some important implications for further development of smartphone-based CBT interventions. First, as Study I already had indicated, the smartphone for-

mat seemed to be a portable and flexible way of accessing the treatment – and thus could be more present in the everyday life. Second, as found in previous research (e.g. (Khan et al., 2007)), therapist support was perceived as the most crucial factor for an effective treatment.

In Study IV, I tested the effects of a blended treatment, using the smartphone application as an adjunct to four face-to-face sessions. I hypothesized that the add-on of a smartphone application in participants' everyday lives could reduce the number of face-to-face sessions needed. Therefore, I compared this blended treatment to a full BA treatment containing 10 face-to-face sessions. The results yielded large within-group effect sizes and no between-group effect sizes. This result is a preliminary indication that the number of face-to-face sessions can be reduced with the adjunct of a smartphone application. This might also pave the way for another strategy of disseminating digitally distributed CBT programs for depression. Providing effective tools for clinicians to be used as a complement in their traditional work and context might be an easier step compared to changing their whole workflow. This is supported by recent preliminary findings that the blended format in depression treatment is viewed as a positive innovation by both therapists and patients (van der Vaart et al., 2014).

Although a cost-effectiveness analysis of Study IV was not included in this thesis, it has been conducted (Ly, Andersson, Smit, & Anderson, Manuscript in preparation). This can be seen as a logical continuation of Study IV. The results showed that the blended treatment was associated with substantially lower costs compared to the full BA, as well as being equally effective. One of the primary sources of cost difference was that the blended treatment required less therapist time, resulting in lower treatment costs. This indicates that blended treatment is a promising treatment option to increase accessibility of CBT.

7.2 Methodological limitations

The studies included in this thesis have several limitations. First, in none of the trials was there randomization to an attention-controlled placebo. Study I lacked a control group, which made it difficult to determine whether the intervention itself was the factor that caused the improvement of the dependent variables of valued action and psychological flexibility. Also, for both Study I and Study II it is difficult to evaluate which part of the intervention that caused the observed effects. The findings could be attributable to the smartphone application itself, to the psychoeducation itself, or to the whole intervention, and in the case of Study II, therapist support. For Study IV, it would have been desirable to include a third group which only received four face-to-face sessions, in order to investigate the effect of the application on its own. However, Study I constituted an initial trial which only aimed at generating hypotheses for further trials. As for Study IV, the purpose was not to determine the effect of the smartphone application, but to examine its comparability to a full BA treatment, which previous research has established as effective for adult depression.

A second limitation refers to the sample size in the trials. In Study II, the effect of the mindfulness treatment was larger than expected, and therefore I did not power the trial enough. The trial was powered as if a moderate between-group effect would be found. A post-hoc power analysis revealed that a sample of 393 participants was required to detect small between-group effects. In Study IV, I did not have enough power for a non-inferiority trial and therefore I only conducted a mixed model analysis to look for differences in interaction between the two groups over time. Non-inferiority trials usually require large samples to detect small and clinically meaningful differences between two active treatments (Piaggio et al., 2006). A much larger sample would have been needed to detect effect differences between both treatment methods and to obtain more reliable effect estimates for both types of treatments.

A third limitation is that I recruited participants by means of advertisements and not within clinic settings. This limits the generalizability of the results, even if previous findings indicate that BA for depression is effective in regular clinical settings with similar outcomes as in studies involving public recruitments (Hopko, Lejuez, Lepage, Hopko, & McNeil, 2003).

A fourth related concern was the large number of participants that had college-level or university-level education. This might compromise the generalizability of the results. However, there are data indicating that 50% of patients seeking psychotherapy have some college education (Vessey & Howard, 1993) and that educated patients may be more inclined to seek help for mental health problems in general (Howard, Cornille, Lyons, & Vessey, 1996).

A fifth limitation concerns the therapists in Study II and Study IV, who were all trained psychologists and were in the last semester of training of a five year program. Therefore, it is possible that more senior therapists would have performed even better. However, there is research suggesting that therapist experience does not make a difference apart from the finding that experienced therapists may require less time to guide patients (Andersson, Carlbring, Furmark, & Group, 2012). Also, for the entire duration of the study, the therapists received continuous supervision from experienced psychotherapists.

The most important limitation in the qualitative study (Study III) was that the results cannot be regarded as representative for all people who receive a smartphone-based treatment for depression. The sample was limited, small and selected, which means that the findings cannot be generalized. In addition, a larger number of participants might have been preferable in order to gain a fuller description. Also, the study included fewer participants who had experienced the treatment as negative compared to positive (three participants vs. five participants), and no participants with negative effects on the BDI-II. If more participants with a negative experience or a negative BDI-II score had been included, addi-

tional themes or subthemes might have emerged. However, this study should be viewed as an exploratory study that can provide a first insight into how users may experience this type of treatment and provide a ground for further studies.

7.3 A framework for smartphone-based CBT programs

Since the field of smartphone-based CBT programs for depression is still new, and the empirical work within it is scarce, it might be interesting to look at smartphone-based CBT from a conceptual viewpoint. For instance, the area lacks a systematized classification of interventions. For further development of effective smartphone-based CBT, important differences between program types need to be clarified. In the following, I will suggest a preliminary conceptual framework for classification of smartphone-based CBT programs.

The empirical background of this work is practically solely based on the findings from internet-based CBT for depression. That is because this field has the strongest evidence on how to produce effective digitally distributed CBT interventions. Interestingly, when developing smartphone-based interventions for depression, there seem to be two clear different approaches on how to design them. The first approach, seen in the studies conducted by Watts' and Proudfoot's research groups, is to develop smartphone-based CBT interventions as a prolongation of the previous work on internet-based CBT. In this case, the smartphone can be viewed mainly as a content provider: the content is the most important asset and smartphones are just a device through which the content is distributed in a more accessible way. The second approach takes a more functional perspective and tries to develop interventions based on the smartphone's functions. This approach is used by Burns and co-workers, Reid and colleagues and more or less by me in this thesis. Programs and applications built on the first approach have

been labeled *Content applications*, while programs and applications built on the second approach have been labeled *functional applications* (see Table 1). To illustrate the difference between these two categories of applications, the digital services Facebook and Instagram can be used as examples. Facebook, the world's biggest online social network, started as a web page. There is also a Facebook smartphone application. The main functionality of the application is to be a content distributor: as a user you are able to access the content on Facebook wherever you are. The Facebook application can, just as Watts' and Proudfoot's applications, be seen as a content application. In contrast, Instagram, a smartphone application for people to take photos and record videos with their smartphones and share them with other people, can be viewed as a functional application. The technical specification of Instagram is relatively simple, and it was developed with the smartphone's technical functionality and users' behaviors in mind. For example, a category of pictures that is popular to share on Instagram is food pictures. I believe that few people, when sitting at the dinner table, would take out their computers to take a photo of their meal. However, with the mobility of smartphones and our interaction with this device, taking pictures of our food has become a natural behavior for many people.

To further differentiate these two categories of smartphone interventions, I have highlighted eight dimensions where these two approaches differ from each other. Apart from *starting point* that was explained above, the remaining dimensions are: *structure*; *change mechanism*; *role of therapist or provider*; *how the smartphone is viewed*; *advantages*; *disadvantages* and *future development*.

In content applications, the *structure* of the intervention is linear and based on modules with a clear time frame. A typical program is between six and 10 weeks long, with one module each week. A basic notion is that the patient is expected to proceed from an initial state to a defined end state where he or she has acquired a predefined set of knowledge and skills. Functional applications, on the contrary, are non-linear and used in specific contexts and situations. Therefore they can be said to be

used “when needed”. There is no start and ending in functional applications – they can either apply a life-long relationship, or only be used when in depressive episodes. For example, the application developed by Burns et al. silently tracks the patient’s depressions by analyzing their smartphone activity (Burns et al., 2011). The CBT program is activated when a depression seems to be on the rise, regardless of how much time the patient has spent on the program previously. Thus, the program never “ends” in the proper sense, but rather is activated in specific, often recurring, situations.

Change mechanisms here designates both the concrete tools for change, and the psychological drivers of change. The major tool in content applications is self-help texts, which means that information and knowledge are viewed as the mechanisms for behavior change. Also in content applications, clear deadlines and therapist support have been shown to be important factors in previous research on internet-based CBT (Richards & Richardson, 2012). In functional applications, the idea is that changed contingencies lead to behavior change. The application’s functions are hypothesized to change the functions of certain key behaviors of the patient. For example, Reid and co-workers (2011) have argued that mood tracking, a common feature of functional applications, can lead to improvement in depressive patients by means of providing new positive consequences: improved understanding and overview of one’s situation, which in turn means a better chance at breaking the vicious circle where low mood leads to passivity.

Next, these two categories can be differentiated on the basis of *how the smartphone is viewed*. Should it simply be seen as a mobile device for the distribution of content, or should it be viewed as a whole new piece of technical functionality that we should adjust our CBT programs to? In content applications, the smartphone is a mobile content provider – a prolongation of computers. This means that the content still has the leading role in these interventions – the smartphone is the medium through which it is delivered. In functional applications, since the smartphone can be seen as a new device, it is also a tool for psychological change in

its own right. When constructing a program with this approach, it is not assumed that the same content as in internet-based CBT programs should simply be transferred to the smartphone. Instead, the smartphone's functionalities are central to the design of the program. For example, Burns and co-workers (2011) used data from the smartphone's functions, such as amount of time spent on telephone and location information, to detect the onset of new depressive episodes. This example shows how functional applications make use of its view of the smartphone as a completely new and unique technical device (rather than as a prolongation of computers).

The *role of the therapist or provider* in content applications is to be a back-end support and provide feedback. In some cases the sender is also the moderator in discussion groups connected to these programs. For functional applications, the role of the therapist can remain traditional, as an application can constitute an add-on to their existing work. This is the case in my Study IV, as well as in Reid and colleagues' (2011) study. It can also be that the therapist is not present at all in these programs, since the applications have the potential to replace a therapist completely. Burns et al's. (2011) study represents this alternative.

The *advantage* of content applications is that the format is already proven to work effectively. The *disadvantage* is that content applications might miss technical opportunities, such as the use of the plentiful data the patient generates through the use of his or her smartphone. Also, internet-based CBT programs have had difficulties with the dissemination into regular health care, which could partly be due to the rather marginalized role that the therapist often has in these programs. It is difficult to see how smartphone interventions, based on the same format as internet-based CBT, could be more successful in this sense. For functional applications, tailored functional analyses are made possible by the smartphone's functionality – users' idiosyncratic behaviors are in focus, which is a clear advantage. However, the empirical support is still scarce. There is also a much larger variation between different functional applications than between different content applications, which could

make them harder to standardize. Thus, comparability between trials might be mitigated and it could take longer to establish evidence. Further, functional applications entail larger technical challenges, since they are more advanced and usually include more functions. Lastly, the market for this kind of applications is largely unknown: It is difficult to foresee potential users' willingness to use this type of tools, not least since they may demand access to more personal data. This is of course also an ethical issue that needs to be addressed by researchers.

Taking these aspects together, for the *future development*, content applications should look into how new, better and more engaging content can be developed, including new ways in which content can be distributed, e.g. video, pictures. Since therapist support is one of the most important factors for successful outcomes in these types of programs (Andersson et al., 2014; Andrews et al., 2010; Cuijpers et al., 2010a), new ways in which this kind of support can be distributed is also of importance. For functional applications, researchers should consider how to make use of new digital trends, functions and innovations, e.g. artificial intelligence and wearables. Finding new contexts, scopes and functions for functional applications is also of relevance.

Taking this together, smartphone applications can be seen both as a means for providing content through a mobile device, and as a way of enhancing a specific purpose, such as tracking everyday behaviors or collecting context-sensitive data. Either way, the device that people are spending most of their internet time on is the smartphone. Therefore, developing CBT programs for smartphones also means developing interventions for the future.

Table 1. *Content applications vs. functional applications*

	Content applications	Functional applications
<i>Examples</i>	Watts, Proudfoot	Burns, Reid, Ly
<i>Starting point</i>	Bibliotherapy, internet-based CBT	Functions in smartphone, e.g. camera. Mobility and context. Format of smartphone: fast interaction, small screen, and tapping.
<i>Structure</i>	Linear, modules, clear time frame	Non-linear, life-long relationship, “when needed”
<i>Change mechanism</i>	Time, deadlines. Therapist support. Knowledge leads to behavior change	Changed contingencies lead to behavior change
<i>The smartphone is...</i>	...a mobile content provider. ...a prolongation of computers.	...a tool for psychological change in its own right.
<i>Role of therapist /provider</i>	Back-end support, moderator, providing feedback.	Traditional role – app is just an add-on to this work OR not present at all
<i>Advantages</i>	Already proven to work.	Tailored functional analysis made possible by smartphone’s functionality. Users’ idiosyncratic behavior in focus.
<i>Disadvantages</i>	Might miss technical opportunities. Have had difficulties disseminating internet-based CBT, why would this work?	Will it work? Technical and market risk. Possibly harder to standardize.
<i>Future development</i>	New, better and more engaging content. New ways in which content can be distributed (video, pictures etc.) Therapist support in new ways.	Tap into new digital trends, functions and innovations, e.g. AI and wearables. Finding new contexts, purposes and functions for mental health programs.

7.4 Conclusions and future directions

I believe there are at least five important implications following from this thesis. First, there is reason to believe that smartphones will be integrated even further in society and therefore may serve an important role in future mental health care. Since the first indications reveal that mild-

to-moderate depression can be treated by means of a supported smartphone application, it is highly possible that applications for other mental health problems will follow.

Second, while BA has empirical support on its own as a treatment for depression, the use of a smartphone application could enhance its effect even further. The application could serve as the therapist's extended arm into the daily life of the patient. Since the theoretical understanding of the mechanisms behind BA suggests that behaviors should be immediately reinforced when they occur, my smartphone application may lead to improved compliance compared to earlier internet treatments.

Third, it should be possible to reduce the number of face-to-face sessions while still having the therapist highly involved in the treatment. This could have implications for the planning of psychological services, since it might be a means to increase the availability of CBT while still preserving the beneficial effects of therapist support. In addition, information technology may also be more accepted by clinicians if it becomes an integrated part of their treatments, as initial research has indicated. Also, the initial results of the earlier mentioned cost-effectiveness study showed that this format can be cost-effective in comparison to a full face-to-face treatment.

Fourth, from a psychiatric research point of view, as my research group has been doing trials on guided internet treatment for more than 15 years, it is now time to move to the next generation of information technology – smartphones – which is not only relevant for Swedish conditions but also for the developing countries in the world, which increasingly are empowered by mobile phones with internet connection.

Finally, in this thesis I have tested the same smartphone application in three different ways; as pure self-help, as guided self-help with therapist support and lastly as an add-on in a blended format. Other researchers have also tested smartphones in additional ways in depression treatment, such as a way to notice if a user is in a depressive episode. Furthermore,

there is potential to apply smartphones in a range of other formats, such as in relapse prevention and as a way to intensify treatment temporarily when needed. While it is difficult to determine what format works better, I believe that an open approach is important. Considering the speed at which smartphone technology is developing, opportunities to build in new and potentially effective therapeutic functions in these programs will continue to open constantly. Therefore, constantly testing different formats and always challenging previous ideas is the only way to be highly innovative – and with that approach, I believe that the smartphone can help transform mental health care.

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Started from the bottom , now we're here, sang the Toronto rapper Drake in his hit song Started From the Bottom from 2013. For me, being "here" and having gained my doctoral degree, can of course not be compared to Drake's success, which among other things includes being the rapper with the most number-one singles on Billboard's Hot Rap Songs chart of all time. Nonetheless, for me it means that I have done something that I did not believe was possible when I started my psychology studies. In fact, when I entered the introductory course in psychology in 2004, I did not even know what a doctorate was. Coming from a family with no academic traditions, it was not natural for me to even study at the university. So, even though I can not compare myself with Dizzy Drake in any way, having done this work in less than four years and being able to call myself a doctor of philosophy despite my background is kind of a journey that started from the bottom. Without tremendous help and support from so many people, this would not have been possible. From the bottom of my heart, I am so thankful to all of you.

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