

Living SMART, an Internet course for adults with ADHD

Birger Moëll

Handledare: Jan Bergström
Extern handledare: Viktor Kaldo
PSYKOLOGEXAMENSUPPSATS, 30 HP 2012



STOCKHOLMS UNIVERSITET

PSYKOLOGISKA INSTITUTIONEN

LIVING SMART, AN INTERNET COURSE FOR ADULTS WITH ADHD*

Birger Moëll

Summary

ADHD affects executive functions and pharmacological treatment is the most common intervention. Medication is ineffective for some and psychosocial interventions are scarcely available. CBT that teaches organizational skills for managing ADHD-symptoms has shown promising results. Smartphones can help individuals perform executive tasks such as planning and organization and they could be efficacious as a support tool for ADHD patients. The current study is a RCT that compares an online course (n=29) based on previously effective CBT treatments for ADHD to a wait-list control (n=29). The intervention focused on teaching the use of an online calendar and smartphone apps. The intervention brought significant improvement ($p < 0.001$) to participants regarding ADHD symptoms and 38% of participants were considered clinically significantly improved. This indicates that online treatments using IT-tools for ADHD is effective and that smartphones can be used as a tool for aiding individuals with impairments in executive functions.

ADHD, or Attention Deficit Hyperactivity Disorder is the most commonly diagnosed behavioral disorder for children and adolescents. (Schilling, Walsh, & Yun, 2011). ADHD is a condition with a heterogeneous etiology and high heritability, where approximately 60 to 90 % of the etiology is explained by genetic factors and 10-40% by environmental factors. (Waldman & Gizer, 2006). Even though there is agreement that genetic factors influence ADHD, no single gene has yet been found that highly influences ADHD. Instead molecular studies show that ADHD is polygenic with at least 50 genes affecting the disorder. (Comings et al., 2005). The polygenic nature of ADHD might explain why it is a heterogeneous disorder and the high comorbidity with other psychiatric disorders. (Schilling et al., 2011). The function of the genes associated with ADHD is to manufacture neurotransmitters used mostly in the prefrontal cortex (PFC). The role of the PFC is to integrate and supervise other brain functions and is fundamental for moral judgment, social cognition and planning. (Goldberg, 2001) (Romine & Reynolds, 2005) The PFC is the last part of the brain to mature when it becomes myelinated in mid-adolescence and early adulthood. (Sowell et al, 2004). This myelination helps explain how mainly impulsivity symptoms subside in ADHD patients when the swifter transmissions of electric messages along the coated neuronal axons allows for greater control of impulses. The PFC is involved in self-control, prosocial

* The author would like to extend many thanks to Viktor Kaldo, Linnéa Nyberg Kollberg, Jan Bergström, Berkeh Nasri and Niels Eék for their help in the work with the project, intervention and essay.

behavior, planning and execution and other important brain functions commonly referred to as executive functions. ADHD can be understood as a disorder of neurological regulation and low arousal in the PFC, which affects these functions. (Tripp & Wickens, 2009) (Beaver, Wright, Delisi 2007). Reductions in the gray matter volumes of the cortices of the PFC are the most consistent brain region deficit found when brain imaging is done on patients with ADHD according to Valera (2007). These alterations in the PFC lead to weaker PFC activation when attempts are made to regulate attention and behavior. (Arnsten, 2009).

According to diagnostic criteria of the DSM IV-TR, ADHD debuts during early childhood. (APA, 1994) For some children ADHD symptoms disappear as the nervous system matures, but for more than 80 percent of children with ADHD, symptoms will remain in some form in adulthood, often with a slight change in expression. (Biederman, Petty, Clarke, Lomedico, & Faraone, 2011). Large demographic studies in numerous countries have shown that ADHD affects approximately 2-4% of the adult population. (Simon, Czobor, Bálint, Mészáros, & Bitter, 2009).

ADHD is defined in the American Psychiatric Associations Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) as a disruptive behavior disorder classified by enduring inattention and/or hyperactivity-impulsivity occurring in several settings more frequently than what would be expected for individuals in the same stage of maturity (APA, 1994). Three different types of ADHD have been recognized: ADHD predominately inattention (ADD), which is characterized by being easily distracted, forgetful, unorganized and having trouble following instructions, ADHD predominately hyperactive-impulsive, characterized by restlessness, impulsivity, fidgeting and always being in motion. The third type is a combined type where symptoms from both clusters are evident (APA, 1994). In this study both patients with ADD and ADHD are present but the focus of the study is on alleviating symptoms of inattention. Many of the symptoms of ADHD vary in rate and gravity for both individual patient and between patients. Some symptoms manifest in most healthy children but for children with ADHD these symptoms cluster together to form a chronic disorder, which can lead to severe impairment. For a diagnosis of ADHD at least six of the nine symptoms defined in DSM-IV from each cluster is needed and the symptoms need to manifest in more than one setting (APA, 1994). According to DSM-IV, 3% to 7% of children are diagnosed with ADHD but some put the estimate as high as 10%. (Schilling et al., 2011) The core symptoms of ADHD are closely linked to executive functions in the PFC and include difficulty regulating attention, activity level as well as impulses and frequent impairments in working memory and executive ability. Adults with ADHD often have difficulties planning and organizing life, perceiving time, performing multiple tasks simultaneously, staying organized and completing activities (Faraone, Sergeant, Gillberg, & Biederman, 2003)(Bálint et al., 2009)(Barkley, 2002). This leads to uneven functioning and underperforming with negative impact on work, education, personal relationships and ability to manage finances and household chores that in turn affects the individual's quality of life (Biederman et al., 2006).

Children and adults suffering from ADHD have an increased risks of a multitude of disorders and negative life outcomes including criminality (Schilling et al., 2011) (Mannuzza & Klein, 2008), drug use and abuse (Carpentier, Van Gogh, Knapen, Buitelaar, & De Jong, 2011), cigarette smoking, (Wilens et al., 2008) anxiety disorders and mood disorders, (R. Kessler & Adler, 2006a) suicidal behavior (Impey & Heun,

2012), impairment in academic achievement and social performance (De Graaf et al., 2008), dyslexia, (Alqahtani, 2010) unsafe driving and car crashes (Fischer, Barkley, Smallish, & Fletcher, 2007) and unstable relationships and divorce (R. Kessler et al., 2007). Studies suggest that up to 90 % of patients with ADHD have at least one other comorbid psychiatric disorder (Nutt et al 2007). Furthermore many children with ADHD go through life with a sense of feeling different from their peers and they are often seen as “problem children” who are stupid, lazy and disruptive (Young, Bramham, Gray, & Rose, 2008). It is thus important to find proper treatment for both children and adults suffering from ADHD.

Follow-up studies conducted on adults with ADHD shows that few patients are offered psychological treatment following completion of neuropsychiatric assessment and diagnosis (R. Kessler & Adler, 2006). The majority of adults diagnosed with ADHD are offered pharmacological treatment (stimulants) as the only treatment option. However, this treatment is not sufficiently effective for up to 20-50% of adults, who do not experience adequate symptom reduction, or find it difficult to take the medication because of side effects (Wilens et al., 2002). Responders typically also show a reduction in only 50% or less of the core symptoms of ADHD (Wilens, Biederman, & Spencer, 1998; Wilens et al., 2002). Thus, supplementary psychotherapy and other non-pharmacological therapies for the treatment of ADHD are recommended (Kooij et al 2008) (Torgersen, Gjervan, Rasmussen, 2008) (Dulcan & Benson, 1997).

Psychological treatment for ADHD

There is as of yet limited research on psychosocial treatments for ADHD. Studies in the field of cognitive behavioral therapy (CBT) and dialectical behavior therapy (DBT) have shown preliminary promising and beneficial effects for structured short-term therapies in the reduction of ADHD symptoms and improved quality of life (Bramham et al., 2009; Emilsson et al., 2011a; Mongia & Hechtman, 2012; Ramsay & Rostain, 2011; Safren et al., 2005; Weiss et al., 2012)(Hesslinger et al., 2002). A treatment developed by Safren and colleagues focused on giving the patient tools to increase functioning and compensate for impairments in executive abilities regarding planning and organization of everyday life. (Safren et al., 2005, 2006, 2010). This type of treatment has also shown positive effects on depressive symptoms, anxiety, and other comorbid conditions (Safren et al., 2005)(Hirvikoski, et al, 2010).

CBT for ADHD

The CBT treatment for ADHD pioneered by Safren has been shown in several studies to be effective in treating symptoms of ADHD. (Safren et al., 2005) (Safren et al., 2010). The treatment consists of five modules focusing on different problem areas for adults with ADHD. The first module introduces the patient to the treatment and gives an overview of the treatment and psycho-education is delivered regarding symptoms of ADHD. The patient is also encouraged to involve a significant other in helping them cope with their ADHD. The second module teaches the fundamentals of organization and planning with the help of a calendar and a notebook used as a to do list. The patients also learn how to organize large tasks by dividing them into smaller parts and how to organize papers and problem solve. The third module focuses on lowering distractibility by measuring the attention span, removing outside stimuli and changing the environment. The fourth module focuses on adaptive thinking and gives an

overview of a cognitive model of ADHD. The fifth and final module handles additional skills helping patients stop procrastinate. The module also focuses on relapse prevention. (Safren et al., 2005)

Availability of CBT treatment for adults with ADHD

Reviews of the situation for patients diagnosed with ADHD show that adults with newly diagnosed neuropsychiatric disabilities have extensive needs for support and treatment, which today is likely to be poorly catered for (Brar & Flyckt, 2006). When patients receive their diagnosis of ADHD many report an initial sense of relief when they find an explanation for their own difficulties but many harbor resentment regarding how their life might have been different if they had been diagnosed sooner. (Young et al., 2008)

Given a prevalence of ADHD around 4 % there are around 360 000 adults with ADHD in Sweden alone. Even if the psychological interventions done to date are very promising the patient group is so large there simply aren't enough trained clinicians to deliver treatment to all adults with ADHD who desire treatment without shifting resources from treating other psychiatric disorders. Delivering treatment in a format that can handle a larger sample of patients and which require less therapy time would thus be beneficial for patients and clinicians alike.

Internet treatment

Internet-based CBT (ICBT) has received good scientific support. A meta-analysis of internet-based treatment of depression with support showed a similar effect compared to regular psychological treatment. ICBT also has the advantage of requiring less therapist time and being more accessible (Andersson, 2009). The support in Internet treatment has been shown to be important for the outcome, with treatments lacking support showing worse results. The Internet format is also structured in a way, which makes it easy for both the support person and the patient to stick to the specific techniques in the program, which makes it easier to evaluate the treatment effect. (Andersson & Cuijpers, 2009). The online treatment also has the added benefit of being always available which makes it possible for patients to login of a time of their own choosing and never forget a treatment session.

Online interventions for ADHD

Online treatments can enable the inclusion of a greater number of participants with limited treatment capacity and incorporate IT-tools shown beneficial for the treatment group. Previously no studies have been made regarding online interventions for patients with ADHD.

Smartphone applications

Smartphones can aid us in many tasks usually performed by the PFC including organizing, coordination of activities, tasks, reminders and time-management. A review found that people with ADHD need help with planning the day and week, planning of activities, to be punctual, to start and finish activities, to organize the home and to manage time and time perception. The types of aids that might be useful are timers, weekly schedule, agenda/calendar, reminders, shopping lists and schedules for cleaning,

laundry etc. (Franck & Andréasson, 2003). These are all things that are readily available or easily accessible on all smartphones. Smartphones are already used as a tool by some adults with ADHD (Hallberg, 2009) but no research has been done to evaluate the effectiveness of smartphones for the group nor if a course could help participants learn new assistive technologies. Computers have both advantages and disadvantages in comparison with smartphones but increasingly, the same service or application is accessible via both smartphones and PCs, and often the combination can be an even more powerful tool for improving the structure of everyday life (Hallberg, 2009). In this study both the calendar and the to-do-list used was accessible both by smartphones and by computer.

Mobile Phone Applications as a support tool for adults with ADHD

Smartphones have many applications that can serve as aids for adults with ADHD. Alarm functions, text-messages, calendar, “to-do lists”, GPS, music, games, calculator, voice memos, and camera are all features that are useful according to Hallberg (2009). Major advantages of the smartphone is that it is always accessible for most people and that the phone does not look like a treatment tool which can reduce any stigma of being dependent on aid. (Davies et al, 2002). Several of these tools are available in their analog form as parts of Safrens CBT treatment (2005), most notably calendar and to-do-lists. A review of which IT tools adults with ADHD desired found that tools that give support for organization, structure and scheduling and coordination of activities was the most desirable. It was also important to use already established communication media such as a mobile phone or a laptop. (Fernell, 2008). Another study made a prototype of a mobile application in consultation with adults with ADHD and found that calendars, to-do lists, reminders and time-aids were the most important tools for this group (Berner Yard, 2011). In Norway, a project was carried out in which adult students with ADHD and Aspergers syndrome learned to use an iPhone calendar synchronized with a Mac computer. After the project more than 50% said they used the phone and computer for planning and that this reduced the stress of everyday life (Michelsen, 2011). Studies have been conducted regarding smartphones as an organization tool for children with traumatic brain injuries (Depompei et al., 2008) and as learning aid for children with dyslexia (Gyllin, 2012) with promising results. An application has also been developed for reminding children with ADHD to take their medication with the use of a smartphone. (Chen, Yang, Hooks, & Lee, 2012). Apart from the study in Norway, no previous studies have been performed that examined whether mobile applications can be an effective treatment tool for adults with ADHD

Summary of previous research

ADHD is a mostly hereditary disorder that primarily inhibits functions in the PFC with children experiencing greater symptoms even though most patients continue to have symptoms into adulthood. Treatment using stimulants is by far the most common intervention but not all patients benefit from medication. Different types of psychological treatments have shown promising results for the treatment of adults with ADHD. There are indications from descriptive studies that show that IT tools and especially smartphones might be useful for the patient group but this has not previously

been evaluated. The smartphone is considered a useful tool since it can mimic several functions performed by the PFC. There has to date been no research conducted analyzing Internet delivered treatment for adults with ADHD, nor regarding self-help material for adults with ADHD nor has there been any previous RCT regarding smartphones as treatment for patients with ADHD.

Purpose of this study

The purpose of this study is to evaluate if an Internet based course with adjuvant smartphone applications can alleviate symptoms of inattention and lack of organization among adults with ADHD compared with a wait-list control condition. The online course focused on the use of an online calendar and applications on smartphones with the purpose of ameliorating structure in everyday life. The secondary purpose of the study is to examine the effects of the Internet based course and adjuvant smartphone applications on general mental health and stress and overall functioning as well as collecting quantitative and qualitative data regarding the participants views of the course during and after the course. This data will later be used to revise and improve the quality of the course and provide suggestions for the design of more customized mobile applications.

Questions to investigate

1. Will the Internet course reduce symptoms of inattention?
2. Will the Internet course reduce symptoms of hyperactivity and overall ADHD symptoms?
3. Will the course reduce symptoms of anxiety, depression, and stress and heighten overall functioning?
4. Will there be a therapist effect on outcome?
5. Will subtype of ADHD/ADD affect the treatment outcome?
6. Will time spent using different types of course content affect the treatment outcome?

Method

Design

The study was a randomized control trial comparing an Internet based course with adjuvant smartphone applications with a wait-list control group that later received treatment without support. This design was used to control for the possibility of spontaneous improvement and improvements caused by better awareness of one's problems (testing effects).

Recruitment and selection

The study's target group was adults in Sweden with ADHD and problems organizing daily life. Recruitment was conducted through posting information on a patient association website, through the website of Internetpsykiatri.se (part of Stockholm County Council where the study was conducted) and through the social media network Facebook. The advertisement took place primarily in June of 2012 although the banner on the [Internetpsykiatri](http://Internetpsykiatri.se) website stayed up throughout the treatment. People interested in participating in the study were directed to a website where they filled out account

information, email and telephone number to later be contacted when the study would take place. Most of the applicants signed up in late June early August after information about the study was featured on a patient association website with more than 100 people signing up in a single day. In October 2012 participants were informed that inclusion to the study was open and the participants were asked to fill out screening questionnaires if they wished to participate. Initially many participants contacted the course after forgetting their login information to the website, an initial sign that many participants in the group suffered from symptoms of inattention. The people who weren't excluded after the screening process were contacted by telephone for a structured clinical interview where an assessment of ADHD symptoms and organization problems was made as well as an assessment of diagnosis of ADHD, an assessment of overall mental health, other psychological treatments or medication and ability to participate in the study. The assessors were the course support persons, both with prior experience diagnosing ADHD. The questions regarding symptoms of ADHD contained both structured and open-ended questions and were made to primarily confirm symptoms of inattention. The participants in the study weren't offered any form of compensation and agreed that costs for smartphone apps might total 50 kr.

Power Calculation and participants

Power calculations were based on a desired power of 80% at alpha level 0.05. Since the intervention was compared to a control group the effect size between groups was estimated to be 0.8 (Cohen's d), which would require 26 participants in each group for 80% power i.e. 52 participants in the study. The study included 29 individuals in each group, which would make the estimated study's power somewhat higher; around 85% at Cohen's d 0.8.

Inclusion criteria

To be able to participate in the study, the participant had to meet all of the following inclusion criteria. The participants were required to have a diagnosis of ADHD to participate in the study as well as significant problems with structuring daily life.

- a) ADHD-diagnosis, self-reported in screening questionnaires and later assessed in the screening telephone interview. For participants living in Stockholm the diagnosis was confirmed by assessing journal entries for the participants.
- b) Difficulties with ADHD-symptoms shown with more than 17 points on the ASRS subscale inattention (item 1-4 and 7-11) (cut-off for probable ADHD in the self-assessment) and that these problems were confirmed in an interviewer rating (phone interview)
- c) Daily access to a smartphone with a data plan and a computer with a broadband connection.
- d) Over 18 years of age
- e) Fluent in Swedish
- f) Cannot foresee any practical obstacles for participating
- g) Does not have any somatic or psychiatric illness (including abuse or depends on drugs/alcohol) that severely limits their ability to complete the course
- h) Has not recently started, or will during the time of the course start, psychological or pharmacological treatment for ADHD

Procedure

The selection process was divided into three steps: screening, phone interviews and an assessment conference.

Screening

After the applicants had registered at Internetpsykiatri.se and after giving their consent in the initial screening form they were allowed to fill out the forms described above. All the forms were filled out through the Internetpsykiatri web platform. The purpose of the screening was to determine if participants had sufficient ADHD-symptoms and measure overall functioning to determine if participants would progress to the phone interview or if they were to be excluded. Applicants who did not fill out the forms were automatically excluded.

In screening the following questionnaires and measurements were used.

- Consent for participation (accepting the conditions of the research)
- General background questions (eg. age, gender, income, past and present somatic and psychiatric diseases, and medications)
- Practical questions (contact information, ability to participate, access to smartphone)
- Questions regarding smartphones and Internet (technical skills and system of organization)
- Diagnose of ADHD (questions regarding if/how and when the patients received their diagnosis)
- Adult ADHD Self Report Scale (ASRS) (R. C. Kessler et al., 2005) to measure ADHD-symptoms
- Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor, Fuente, & Grant, 1993) to measure alcohol problems
- Drug Use Disorders Identification Test (DUDIT; Berman, Bergman, Palmstierna, & Schlyter, 2005) to measure drug problems
- Hospital Anxiety and Depression Scale (HADS; Lisspers, Nygren, & Söderman, 1997) to measure anxiety and depression

Phone interviews and assessment conference

For participants who had not been excluded by the screening forms a 15-30 minutes telephone interview was made. In this interview, ability to participate in the course, mental health and comorbidity, other treatments or medication, problems with organization in daily life, diagnosis of ADHD and system of organization were assessed. For participants who scored high on screening-forms that measured alcohol or drug-use an additional structured interview was made, Mini-International Neuropsychiatric Interview (M.I.N.I.; Sheehan, et al., 1998), regarding drug or alcohol abuse/dependence. The author and the second support person of the course made the interviews. The interviews were based on an interviewing template and the interviewers practiced together before performing the interviews to improve inter-rater reliability. Twice during the assessment period a conference was held with the support of a licensed psychologist regarding risk of suicide, severe psychiatric problems and hazardous use of

alcohol or drugs. Further questions regarding exclusion or inclusion were also addressed during these meetings.

Randomization

Randomization to the two study groups was made with the help of the Internet service random.org that uses atmospheric noise to create random distribution. A clinical psychology student made the randomization on the 29th of October 2012. The student was not in any way affiliated to the study. At the randomization the participants were distributed to two groups with 29 participants in each group.

Measurements

All questionnaires were administered through the Internet platform where the participants signed in and filled out the questionnaires.

Pre-intervention, the following measurements were used

- ASRS
- HADS
- Perceived Stress Scale (PSS; S. Cohen, Kamarck, & Mermelstein, 1983) to measure stress
- Sheehan Disability Scale (Leon et al., 1997)
- EQ-5D (Hinz, Klaiberg, Brahler & Konig, 2006)

During the intervention the following questionnaires were used

- Weekly ASRS subscale inattention
- Questionnaire that measures organization skills and understanding of the course as well as measuring the use of different techniques and apps.

Post-intervention, the following questionnaires and assessments were used

- The same questionnaires as at the pre-intervention measurement
- Questionnaire regarding medication and other treatments
- Telephone interview by blind raters to assess organization skills and inattention
- Rating scales to evaluate the intervention (intervention group only)
- Questionnaire that measures organization skills and use and understanding of the course as well as measuring the use of different techniques and apps (intervention group only)

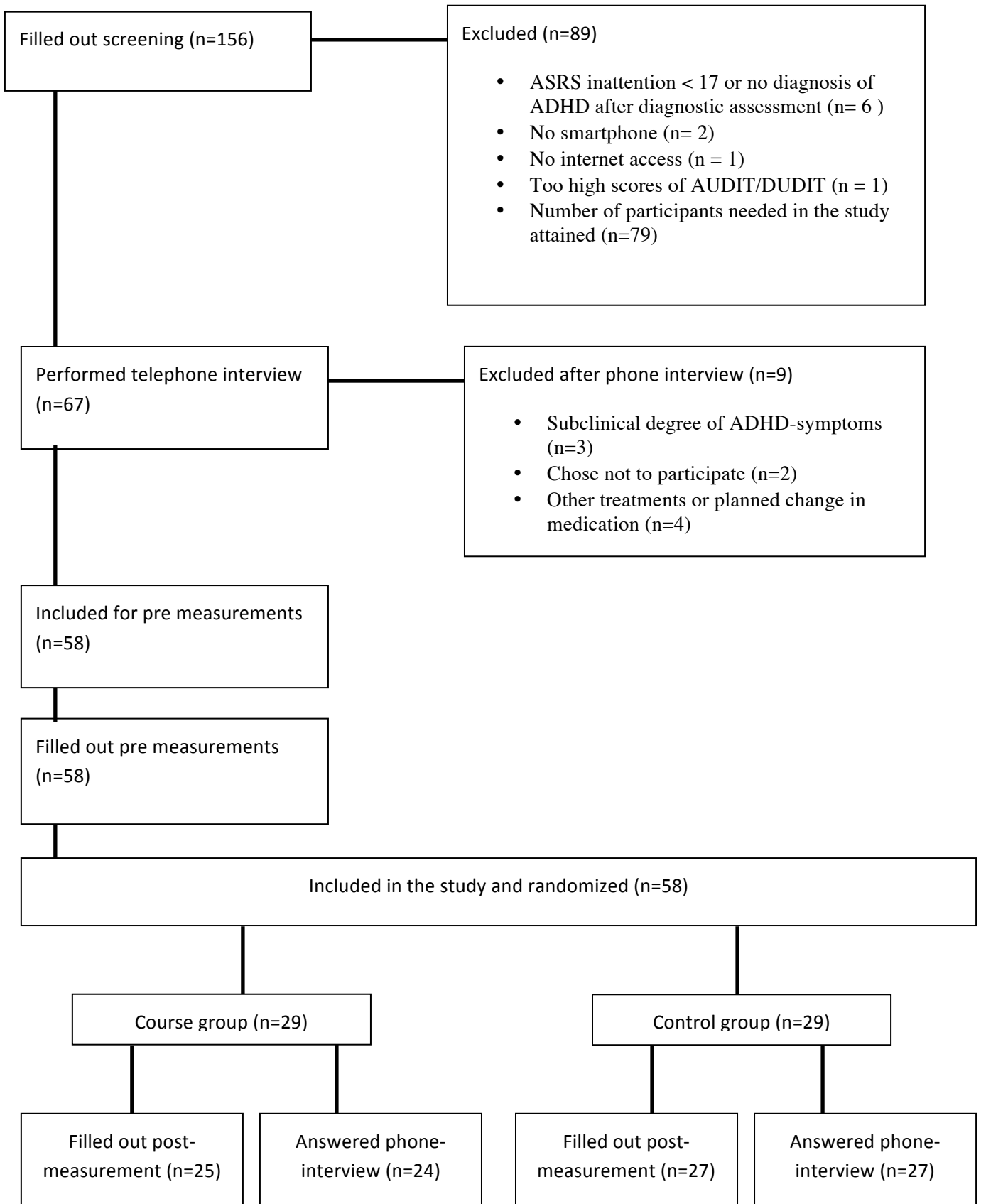


Figure 1. Flowchart regarding sample and exclusion criteria

Participants

The statistics regarding the participants' demographics are from self-assessments made by the participants in the screening process. The participants were recruited mostly from a patient association website and participants who did not report a diagnosis of ADHD in screening or were not assessed as having a diagnosis of ADHD or ADHD symptoms in the phone interviews prior to the intervention were excluded. For participants living in Stockholm the ADHD diagnosis was also confirmed from journal entries.

Table 1. Demographic table of participants.

	Intervention group (n = 29)	Control group (n = 29)	Total (n = 58)
Age, years average (SD)	36.3(11.1)	37.3 (10.7)	36.8(10.8)
<i>Gender</i>			
Women	22 (76 %)	18 (62 %)	40 (69 %)
Men	7 (24 %)	11 (38%)	18(31 %)
<i>Relationship status</i>			
Married/Registered partner	21 73%	16 (56%)	37 (64%)
Divorced/Widow/Widower	3 (10 %)	1 (3%)	4 (7 %)
Single	3 (10 %)	9 (31%)	12 (21%)
Other	2 (7%)	3 (10%)	5 (8%)
<i>Employment</i>			
Working/Self employed/Studying	23 (67%)	22 (65%)	45 (66%)
Sick leave/Disability retired	6 (21)%	4 (12%)	10 (15%)
Seeking Employment	2 (7%)	5 (15%)	7 (10%)
House wife/House husband	0 % 0%	1 (2%)	1 (1%)
Other	3 (10%)	2 (6%)	5 (7%)
<i>Highest education</i>			
Elementary school	1 (3%)	4 (14%)	5 (9%)
High school	11 (38%)	12 (41%)	31 (40%)
College/University	15 (52%)	12 (41%)	27 (47%)
Other	2 (7%)	1 (3%)	3 (4%)
<i>Somatic illness</i>			
Yes	12 (41%)	13 (45%)	25 (43%)
No	17 (59%)	16 (55%)	33 (57%)
<i>Comorbid disorders</i>			
Yes	14 (48 %)	16 (55 %)	30 (52 %)
No	15 (52 %)	13 (45 %)	28 (48 %)
Depression	1 (3 %)	4 (14 %)	5 (9%)
Anxiety disorders	5 (17 %)	4 (14 %)	9 (16 %)
Sleep disorders	2 (7%)	0 (0%)	2 (3%)
Bipolar	2 (7 %)	1 (3 %)	3 (5 %)
Asperger/Autism spectrum disorder	3 (10%)	5 (17%)	8 (14%)

ADHD subtype

ADHD	20 (69%)	22 (76%)	42 (72%)
ADD	9 (31%)	7 (24%)	16 (28%)
Current medication for ADHD	23 (79 %)	25 (86 %)	48 (83 %)

Confirmed diagnosis

ADHD	10 (34%)	14 (48%)	24 (41%)
ADD	3 (10%)	3 (10%)	6 (10%)
Not in Stockholm	12 (41%)	7 (24%)	19 (33%)
No journal access	4 (14%)	5 (17%)	9 (16%)

Chi2-tests showed no significant differences between the course group and the control group on any of the demographic variables gender, relationship status, employment, highest education, somatic illness, comorbid disorder or current medication for ADHDs. Furthermore, no difference was found with t-test comparing age between the groups.

*Material**The World Health Organization adult ADHD self-report scale (ASRS)*

ASRS is a self-report scale for diagnosing ADHD and consists of 18 items, 9 for measuring inattention and 9 for measuring hyperactivity symptoms. There are several ways in which the ASRS can be scored and it is also possible to use a shorter version of the scale using only the first 6 items, which have been shown to have good psychometric properties. (R. C. Kessler et al., 2005). Each item in the scale asks how often a certain symptom is present and the respondent can choose Never Rarely, Sometimes Often or Very Often. In the study it was decided that the scale would be used with each item given a rating of 0 (Never) to 4 (Very Often) giving the scale a total point of 72 for full-scale ASRS and 36 each on the two subscales inattention and hyperactivity. This made it possible to determine severity limits for ADHD-symptoms. For the inattention scale 17 points was used to determine cut of for ADHD symptoms after French norms which predicted that participants with scores 0-16 were unlikely to have ADHD, those with 17 to 23 were likely to have ADHD and those with 24 to 36 were highly likely to have an ADHD diagnosis. (Caci, Enfants-adolescents, Archet, Ginestière, & Cedex, 1994). The unweighted 18-question ASRS had a sensitivity of 56.3% and a specificity of 98.3% and total classification accuracy of 96.2% (R. C. Kessler et al., 2005). The ASRS was also used to determine reliable change index for participants in the group with scores lower then 17 at post measurement used to indicate reliable change. Since the test-retest value was only available for the 6 item ASRS the value for this group was used to determine reliable change for the treatment group. (R. C. Kessler et al., 2007)

Hospital Anxiety and Depression Scale, HADS

HADS is a self-report scale using 14 items and two subscales to measure depression and anxiety symptom. Each subscale consists of seven questions that scores 0-3. The scale has good internal reliability (Lisspers, Nygren, & Soderman, 1997). Eleven points can be seen as a clinical threshold on the scale (Zigmond and Snaith 1983) The HADS-A has a sensitivity of 0.66 and specificity of 0.93) and HADS-D has a sensitivity of 0.66, and a specificity of 0.97) (Bjelland et al 2002)

Sheehan Disability Scale (SDS)

Sheehan Disability Scale (SDS) is a self-report instrument designed to measure global functioning level. Each of the three test questions can be estimated from 0 to 10 and reflects how much problems the individuals impairments cause in the areas of Employment, Social Life / Leisure and Family Life / Chores. The total value ranges from 0, unmanaged function level, to 30, severely impaired level of functioning.

The psychometric properties have been tried and tested for American primary care patients and the internal reliability of the whole scale was high, with Cronbach's alpha 0.89. Recommended limit for indication of clinical illness is a total value of 5 or higher (Leon et al., 1997).

PSS

The Perceived Stress Scale (PSS) is a widely used psychological instrument for measuring stress. Items were designed to see how unpredictable and uncontrollable respondents find their lives and the scale also directly queries stress. The PSS asks about feelings and thoughts during the last month and how often the scorer felt a certain way. Higher PSS scores have been associated with greater vulnerability to stressful life-event-and more common colds (Cohen et al 1994).

EQ-5D

EuroQol (EQ-5D) is a standardized non-disease-specific instrument that measures health-related quality of life. The instrument consists of assessments of health in five dimensions: mobility, hygiene, usual activities (e.g. work, study, housework, family or leisure activities), pain / discomfort and anxiety / depression. These issues are assessed on a three-point scale: no problems, moderate problems or severe discomfort. The instrument measures health-related quality of life as both a health and an index value 0-1, where 0 = death and 1 = full health (Hinz, Klaiberg, Brahler & Konig, 2006). The instrument has shown good psychometric properties and an acceptable test-retest reliability and acceptable convergent validity (Ravens-Sieberer et al., 2010).

Blind rater assessment

Following the intervention all participants in both groups were contacted for a short telephone interview where blind assessors judged organization skills and inattention. Four different assessors were used who were trained prior to the interviews to increase inter-rater reliability.

Clinical Significance

A score of below 17 on the ASRS in-attention was chosen to determine improvement among the participants. The number was chosen since it was the cut-off criteria for the current study inclusion. During the interviews made prior to treatment the ASRS seemed like a fair assessment measurement and those who were interviewed with scores under 17 had few problems with organization. Furthermore reliable change was calculated using Jacobson and Truax's definition (1991). A third definition of reliable change will be included based on assessment of much improvement or very much improvement on symptoms of inattention assessed by the blind assessors. The study will thus have several definitions of clinically significant improvement. The most conservative of these estimates will contain both that the participant should move over a threshold of scale (under 17 for ASRS) and report a change substantial enough (at least two standard deviations) from pre-to post measurement calculated using a reliable change calculator based on Jacobson and Truax's definition (1991). This will split

participants in four groups: no reliable change ASRS above 17, reliable change ASRS above 17, ASRS below 17 and no reliable change and finally ASRS below 17 and reliable change. The participants that fill both criteria will be considered more improved and the participants who only fill one criteria will also be considered improved but with less certainty. The blind assessors' assessment will be a definition of clinical change independent of the other two measurements but will be correlated to the change of the primary outcome measurement to make sure that the assessments are reliable.

Course support person

The support persons in the study were one psychologist student (the author) and one psychologist both with experience of working with adult patients with ADHD and trained in CBT treatment.

Treatment

The course is based on central parts of Safren's manual for CBT treatment for ADHD (Safren et al., 2005) and teaching what previous studies have found to be important IT tools for adults with ADHD (Fernell, 2008; Hallberg, 2009). Furthermore, adults with ADHD have been part in assessing the applications used in the course. Parts of Safren's manual for psychological treatments of ADHD were tailored to fit in the online setting (Safren et al., 2005). The following parts of Safren's manual were used in a modified form in the course:

- Short psychoeducation regarding ADHD.
- Training in organizing and planning and maintaining of a calendar system and to-do-list.
- Learning problem-solving skills such as breaking a large or overwhelming task into smaller steps.
- Techniques for reducing distractibility and inattention.
- Techniques for handling procrastination.

Parts of Safren's manual focusing on the use of cognitive restructuring and anger management, stress reduction and communication skills were omitted. This part was omitted since it was not easily converted to the online format and was more fitting in a traditional therapeutic setting than the online course format.

In addition, the use of reminders was greatly enhanced in the course compared to the use in Safren's manual. Safren used reminders for staying on tasks. In the course the reminders were linked to the smartphone and online calendar and tasks list. The participants were trained to use reminder for remembering things in everyday life and to get started and finish tasks. (Safren et al., 2005)

The intervention was based on weekly modules that taught the use of an online calendar and smartphone applications such as calendar, reminders and to-do lists, tools that previously been proven useful for the treatment group (Fernell, 2008; Hallberg, 2009; Michelsen, 2011; Safren et al., 2005). Furthermore, additional apps were introduced that previously had been shown beneficial for adults with ADHD (Sikstro & Smart, 2007; Studer et al., 2009). Participants were also encouraged to use the help of a friend or

relative if they experienced technical difficulties. This technique was similar to the one found in Safren's manual where participants were encouraged to obtain assistance from a friend or relative. (Safren et al., 2005)

The course began with the participants gaining access to the Internet platform that included course materials and a messaging system where participants and support persons communicated during treatment. At the beginning of the course, participants created a Google account and a Google calendar that was used during treatment and synchronized with the participant's smartphone. Participants also shared their calendar with the support person. The shared calendar allowed the course support persons to keep track of the participant's progress and level of organization. Throughout the course the participants also had contact with the support persons through telephone calls to ensure progress and help participants. Text messages were also used to remind the patients of measurements and working with the course. When the participants were finished with a module they filled out questions and the support person allowed them to access new material after giving feedback regarding their work. The course consisted of 7 text modules spanning 6 weeks teaching organization and techniques for improving attention. Every week one or more apps were also introduced that was either related to organization or previously proven beneficial for adults with ADHD.

Table 2. Overview of course material

Part of course	Techniques and material
Module 1	Introduction, psychoeducation and determining intervention goals,
Module 2	Instructions on how to share and use the online Google calendar, N- back working memory app.
Module 3	Instructions on how to use a smartphone calendar, dividing difficult tasks, Evernote app
Module 4	Instructions on how to use to-do-list in Google calendar and using the to-do-list app Gtasks, dividing difficult tasks, Simplynoise app
Module 5	Improving attention and tips for lessening procrastination, programs for preventing distractions
Module 6	Problem solving, how to organize important documents, Dropbox app, Banking- apps, Mindfulness app and Commuting-apps
Module 7	Maintaining improvements

The course balanced learning different techniques that has been indicated to be effective for this patient group (Sikstro & Smart, 2007; Studer et al., 2009) with learning how to use an online calendar and smartphone apps. The most important skills were:

Plan every day (module 1-7)

Throughout the course the participants were urged to find a short period every day and use it for organization. The participants learned how to plan every day using their online calendar and plan during the day with the help of their smartphone. Planning both helps the participants remember important activities and reduces stress and increases mastery over tasks. (Hallberg, 2009)

Use reminders to remember and get started with tasks (module 2-7)

Throughout the course the participants trained how to find a working system of reminders using Google calendar online and on their smartphones. According to Hallberg (2009) reminders can help make up for deficits for patients with ADHD and can be used to compensate for a lack of perception of time, problems starting or finishing tasks and to provide structure.(Hallberg, 2009)

Dividing difficult tasks into smaller parts (module 3-7)

Dividing difficult tasks can help the patient get unstuck. The participants were asked to divide a task into smaller tasks until they felt that the tasks was small enough to be easily accomplished. This technique was applied from Safren's manual. (Safren et al., 2005)

Using to-do-lists (module 4)

The participants learned to use to-do-lists to organize different tasks and get started and complete tasks. They learned how to assign an appropriate number (10-20) of tasks to a task list and make tasks reasonably small.

Techniques for improved attention (module 5)

Several techniques were used for improving attention including a distraction list used in Safren's manual (2005) and measuring the attention span. Furthermore the participants learned to control their environment by using a white noise app or music to limit stimuli or block distracting websites with the help of a program.

Stopping procrastination and getting started (module 5)

The participants learned how to stop procrastinating and get started on tasks with the help of their calendar where they every week scheduled time to perform difficult tasks or tasks that they often procrastinated for a short period of time.

Problem solving and important documents (module 6)

The participants learned a technique found in Safren's manual (2005) for solving problems as well as a technique for organizing documents.

Finding a new routine

The participants used the course as a training surface to learn a functioning routine for organization by first learning a functioning routine for working with the course. Positive reinforcement was believed to be important for achieving this change and participants were encouraged to balance what must be done and what they wanted to do while working with the calendar so that working with the calendar would become a gratifying task. All technological aspects of the course were also explained step by step, to ensure that anyone had the possibility to participate. Furthermore, "normal" apps, meaning apps that could be easily downloaded from the app stores for iPhone or android market, were used.

Applications

The course used a multitude of apps which are all found in appendix a. The apps were chosen in collaboration with adults with ADHD and were chosen to be helpful to adults with ADHD. At module 2 an app that trained working memory using N-back was

introduced. N-back has previously been shown to improve working memory functioning and fluid intelligence even though later studies have put these earlier findings into questioning. (Studer et al., 2009) (Redick et al., 2012). At module 3, Evernote was introduced, an app for remembering thoughts and ideas. At module 4 an app for using “white noise” was introduced. White noise has been shown to be beneficial in improving concentration among adults with ADHD. (Sikstro & Smart, 2007). At module 5 two online browser extensions Stayfocusd and Leechblock were introduced for blocking distracting sites. At module 6, Dropbox, banking apps, a mindfulness app as well as apps for commuting was presented. It was voluntary for the participants to use the apps presented in the course with the exception of apps for calendar and to-do-list. The course instead focused primarily on teaching organizing skills with the help of an online calendar and smartphone and how to handle problems with inattention.

Smartphone types

The study included participants who had either an iPhone or an android Smartphone. The technical lessons differed somewhat for android and iPhone users and the android users sometimes had less step-by-step instruction since there are far too many android models for it to be feasible to make step-by-step instruction for all possible models.

Technical support persons

In the phone interviews prior to the course and in the early course material the participants were asked to find a person who could be used for technical support. Using a support person was voluntary but the participants were encouraged to use a friend or family member for technical support.

Ethical considerations

This study is performed as a part of the project VardagsSMART; a randomized controlled trial that was approved by the local research ethics review board (identifier number 2012334314) and that was registered at ClinicalTrials.gov with the Identifier: [NCT01663610](https://clinicaltrials.gov/ct2/show/study/NCT01663610). Participation in the study was voluntary and the participants left consent to be included in a research project. Prior to the consent the participants were informed that a randomization would take place where participants would either receive the course with support or be a control group who later received the course without support. The participants were also informed that they were allowed to cancel their participation at any point.

All information was protected according to the personal data act (PUL). At screening the participants received a participation code to ensure that the confidentiality requirement was fulfilled when communication was made between course supervisors, researchers and other staff. Communication during the treatment as well as collection of sensitive data, i.e. self-assessments was performed through the Internetpsykiatri web platform.

A Google account was made prior to the course and used for emailing participants about inclusion/exclusion and to answer technical questions concerning loss of passwords, problems filling out questionnaires etc. The Google accounts calendar was also used for

sharing calendars during the course. The calendar sharing was removed at the end of the course.

There were no expected reverse side effects to the course. The techniques used in the course had previously been proven effective for the treatment group and applications were chosen in consideration with previous research and consultation with adults with ADHD.

The high amount of participants who were excluded because the treatment was full (79) might be problematic since they spent time filling out questionnaires and received no treatment. The fact that the control group received the course without support is also somewhat problematic. The problems are however inherent in the RCT format and there is no simple way to guard against these types of problems without changing the study design.

Statistical analyses

All the participants including those who chose to finish the course early were asked to fill out the post-measurement. For the participants who did not finish their post-measurements last observation carried forward was used. The data missing was from 4 individuals who had not completed the treatment in the treatment group and 2 individuals in the control group. For the course group this meant that the data for ASRS-inattention for the last week with values was used. Since all other measurements only had a pre and a post-measurement, the pre-measurement was used as post on other measurement. To achieve full-scale scores of ASRS the last full score was used, meaning that pre-measurement was used when there was no post-score. Statistically, this would mean that it would be harder to find an effect on the scores of full-scale ASRS and hyperactivity. Intention-to-treat-analysis was used for all participants.

To determine if there was any difference between the groups at onset regarding age a t-test was used. To determine effect of gender, education level, current employment, smartphone type, ADHD or ADD, medication or no medication, somatic illness and comorbid disorders, chi-2 tests were used. Chi-2 tests were also used to compare the results of the blind assessments, the significant change calculations and ASRS-cut-offs at post treatment between the groups.

To determine the effect of the treatment between the groups, a Mixed ANOVA was used with time (pre and post measurement) as within subject variable and group as between subject factor. Using this measurement the ASRS full-scale, hyperactivity and inattention as well as PSS, HADS and Sheehan Disability Scale and EQ-5D was measured. Mixed ANOVAS were also used to measure the effect of support person and ADHD/ADD on the primary outcome variable. Dependent T-tests were also used to compare within group effects.

Correlations were used to determine the reliability of the blind assessment on the primary outcome measurement as well as determine how calendar use, modules completed, sent and received messages, age, use of intervention techniques and use of applications compared to the change in the primary outcome variable (ASRS-inattention

pre/post). T-test were used to determine the effect of gender, somatic illness, comorbid disorders and smartphone type on the same measurement.

Results

Summary of results

The study found that

1. The participants had significantly lower scores of ASRS both regarding full-scale, inattention and hyperactivity compared to the control group. The difference was largest for scores of inattention and smallest for hyperactivity but all differences were significant. The results show that the intervention was successful in alleviating symptoms of ADHD for the treatment group.
2. The between group effect size calculated with Cohen's d showed a large effect for ASRS-inattention, a medium effect for ASRS-full-scale and a small effect size for ASRS hyperactivity.
3. The participants showed an improvement in functioning regarding organization and inattention and fewer problems compared to the control group when interviewed by blind assessors after the intervention.
4. Reliable change was shown for 38% (11 patients) and 24 % (7 patients) scored ASRS inattention below 17, and 21% (6 patients) scored inattention below 17 and reported reliable change.
5. The interventions effect was significantly affected by smartphone type with participants using iPhones showing a significantly larger change on the primary outcome measurement.

Drop out and Attrition

Attrition was defined as not responding to the post measurements and dropout was defined as the individual stating that they aborted the intervention early. The attrition rate was 10% with four participants who did not fill out the post- measurement in the course group and two participants who did not fill out the post- measurement in the control group. In the course group one participant started the course but never filled out any forms after week one and did not answer any phone calls, another filled out measurements for week 1 and then dropped out with no contact, a third non-responder filled out measurement for week 3 and the fourth non responder filled out measurements for week 5. The two participants who did not fill out the post-measurement in the control group also did not answer the phone interview. The drop out rate for the intervention was 10% with 3 individuals reporting that they had quit the treatment early at the post-measurement. Intention-to-treat-analysis was used and the participant data was analyzed regardless if they finished the entire course or not. Last item carried forward was used for all attrition.

The interventions effect on ADHD symptoms of inattention

The result for ASRS inattention is shown below. Table 3 shows means and standard deviation and within-group and between group effect, expressed using Cohen's d. (Cohen, 1988).

Table 3. Observed mean values, standard deviations and effect sizes for ASRS-inattention

	Pre	Post	Within-group effect size <i>d</i>
IG (n=29)	28.14 (4.45)	22.17 (6.51)	1.07 ***
CG (n=29)	28.10 (4.30)	28.07 (4.20)	0.01
Between group effect size <i>d</i>		-1.08***	

IG= Intervention group CG= Control group *** Large effect size

The results on ASRS inattention for the two groups were analyzed with a 2x2 mixed ANOVA that showed a main effect of measurement point ($F(1.58) = 27.842$; $p < 0.001$) and an interaction effect between measurement point and treatment group ($F(1.58) = 27.205$; $p < 0.001$). A dependent T-test showed a significant improvement between pre and post measurement for the intervention group (IG) ($t(29) = 5.478$ $p < 0.001$) but no significant difference for the control group (CG) ($t(29) = 0.105$ $p = 0.917$ n.s.)

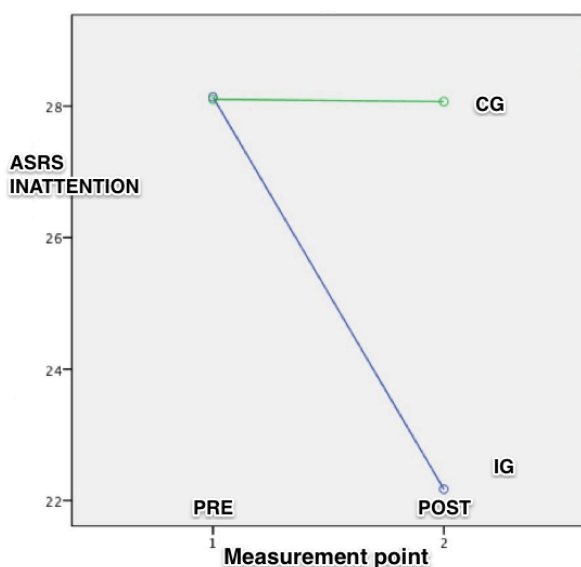


Figure 2. Results of ASRS Inattention at pre and post measurement for intervention group (IG) and control group (CG). A significant difference was shown

The interventions effect on ADHD symptoms of hyperactivity

The result for ASRS hyperactivity is shown below. Table 4 shows means, standard deviation and within-group and between group effect, expressed using Cohen's *d*. (Cohen, 1988).

Table 4. Observed mean values, standard deviations and effect sizes for ASRS-hyperactivity

	Pre	Post	Within-group effect size <i>d</i>
IG (n=29)	23.00 (5.77)	19.98 (6.56)	0.49 **
CG (n=29)	21.83 (6.36)	21.31 (6.50)	0.08
Between group effect size <i>d</i>		-0.20 *	

IG= Intervention group CG= Control group ** Medium effect size * Small effect size

The ANOVA for the ASRS hyperactivity showed a main effect of measurement point ($F(1.58) = 12.368$; $p = 0.001$) and an interaction effect between measurement point and treatment group ($F(1.58) = 6.213$; $p < 0.016$). A dependent T-test showed a significant improvement between pre and post measurement for the IG ($t(29) = 3.481$ $p = 0.002$) but no significant difference for the CG ($t(29) = 1.014$ $p = 0.319$ n.s.)

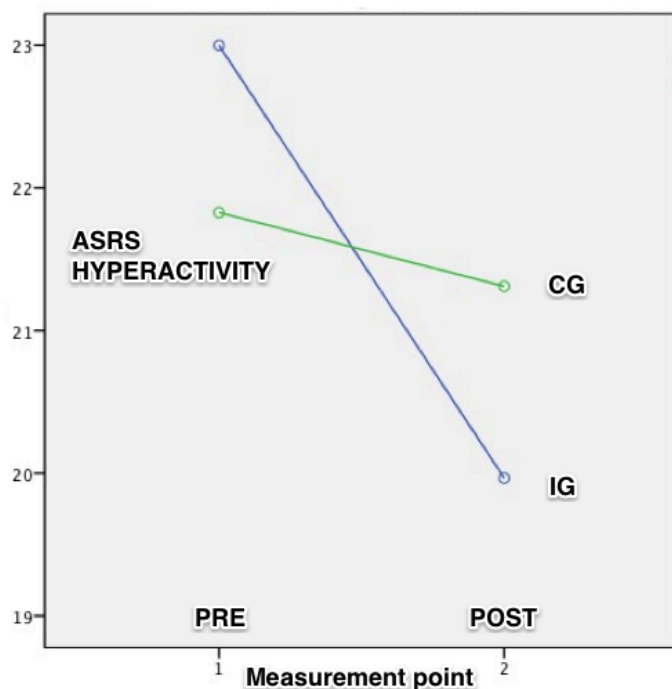


Figure 3. Results of ASRS Hyperactivity at pre and post measurement for intervention group (IG) and control group (CG). A significant difference was shown

The interventions effect on ADHD full-scale symptoms

The result for ASRS full-scale is shown below. Table 3 shows means and standard deviation and within-group and between group effect, expressed using Cohen's d . (Cohen, 1988).

Table 5. Observed mean values, standard deviations and effect sizes for ASRS-full-scale

	Pre	Post	Within-group effect size d
IG (n=29)	51.1 (8.69)	43.6 (12.13)	0.7 **
CG (n=29)	49.9 (9.62)	49.4 (9.34)	0.05
Between group effect size d		-0.54 **	

IG= Intervention group CG= Control group ** Medium effect size

The ANOVA for the ASRS full-scale showed a main effect of measurement point ($F(1.58) = 21.858$; $p < 0.001$) and an interaction effect between measurement point and treatment group ($F(1.58) = 16.332$; $p < 0.001$). A dependent T-test showed a significant

improvement between pre and post measurement for the IG ($t(29) = 4.806$ $p < 0.001$) but no significant difference for the CG ($t(29) = 0.752$ $p = 0.458$ n.s.)

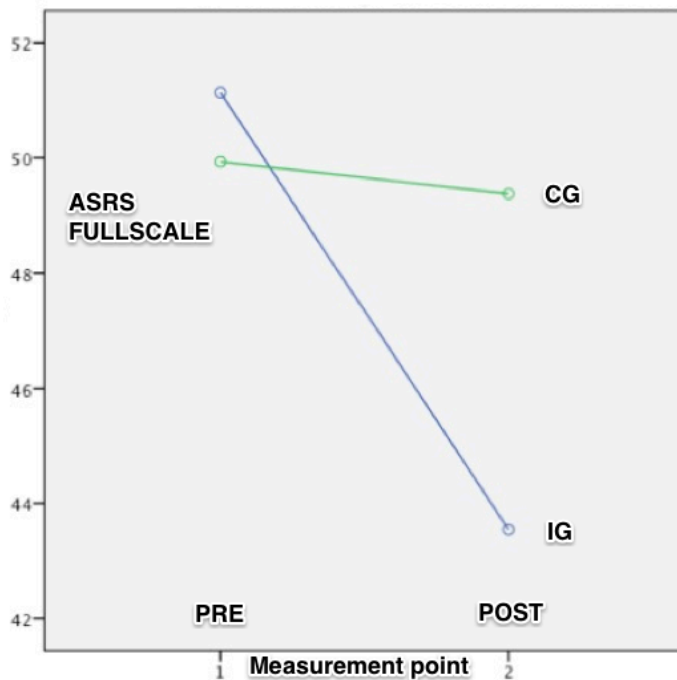


Figure 4. Results of ASRS full-scale at pre and post measurement for intervention group (IG) and control group (CG). A significant difference was shown

Clinical significant improvement of inattention

Clinical significant improvement is often defined as the number of individuals who no longer experience great problem and/or the number of people who experience a positive change. (Jacobson & Truax, 1991). In this study no longer experiencing great problems is defined as having an ASRS score below 17. This is the same threshold used as the inclusion criteria for the study. Reliable change is defined using a reliable change calculator based on Jacobson & Truax's definition (1991).

Table 6. Clinical significant improvement ASRS inattention

	IG (n=29)	CG (n=29)
Number of individuals with reliable change	38% 11	0% 0
Number of individuals with ASRS inattention <17	24 % 7	0% 0
Number of individuals with both reliable change and ASRS inattention<17	21 % 6	0% 0

IG = Intervention group CG = Control group

Table 6 shows that 11 of 29 people who received the intervention and 0 of 29 people in the control group had a reliable change. 7 people in the intervention group and 0 people in the control group scored below 17 on ASRS at post-measurement. 6 people in the intervention group and 0 people in the control group met both criteria of clinical change. Chi 2-test showed a significant difference between the groups: reliable change ($\chi^2 =$

13.574, $p < 0.001$), ASRS inattention < 17 ($\chi^2 = 7.961$, $p = 0.005$), ASRS inattention < 17 and reliable change ($\chi^2 = 6.692$, $p = 0.01$).

The interventions effect on blind rater assessment of organization skills and inattention
Following the intervention, four blind assessors telephoned all the participants and interviewed 51 of 58 participants. 24 participants in the intervention group and 27 participants in the control group were interviewed. The interviewer asked questions regarding organization and inattention and regarding medication and other treatments but most importantly made an assessment of change regarding difficulties with organization and inattention. The following table shows the results of this blind assessment.

Table 7. Blind assessors rating of change in organization and inattention

	Very much degraded	Much degraded	Minimal deterioration	No change	Minimally improved	Much improved	Very much
IG (n=24)	0% 0	4 % 1	0% 0	25 % 6	38 % 9	25 % 6	8 % 2
CG(n=27)	0% 0	15 % 4	11 % 3	59	15 % 4	0 % 0	0 % 0

IG = Intervention group CG = Control group

The blind assessors had a complaint that the scale was somewhat problematic and that a measurement point between minimally improved and much improved was needed.

Table 7 shows that 8 out of 24 (33%) of people who received the intervention and 0 out of 27 in the control group were assessed as much or very much improved. 9 (38%) in the intervention group and 4 (15%) in the control group were assessed as minimally improved. No change or deterioration was assessed for 7 (29%) in the intervention group and 23 (85%) in the control group.

The groups much or very much improved, minimally improved and no change or deterioration were compared using Chi-2 tests that showed: a significant difference between the groups very great or great improvement ($\chi^2 = 9.280$, $p = 0.002$), no significant difference between the groups minimally improved ($\chi^2 = 2.479$, $p = 0.115$), and a significant difference between the groups for no change or deterioration ($\chi^2 = 17.676$, $p < 0.001$).

The blind assessors ratings were also correlated to the change in ASRS score between pre and post. The result showed a significant correlation between assessment scores change of ASRS-inattention ($r=0.377$, $n=51$, $p=0.006$).

Measurements of anxiety and depression, stress and overall functioning

The participants filled out questionnaires measuring anxiety and depression (HADS), stress (PSS) and overall functioning (SDS, EQ-5D) at pre and post measurement.

The result for these questionnaires is shown below. Table 7 shows means and standard deviation and within group and between group effect, expressed using Cohen's d. (Cohen, 1988).

Table 8. Additional measurements, observed mean values, standard deviations and effect sizes for HADS, PSS, SDS and EQ-5D at pre and post

HADS A	Pre	Post	Within-group effect size <i>d</i>
IG (n=29)	9.07 (4.28)	8.38 (4.37)	0.16
CG (n=29)	8.52 (2.96)	8.72 (3.29)	-0.06
Between group effect size <i>d</i>		-0.09	
HADS D			
IG (n=29)	6.90 (4.06)	6.62 (4.29)	0.07
CG (n=29)	6.79 (4.53)	7.82 (5.09)	-0.21*
Between group effect size <i>d</i>		-0.25	
PSS			
IG (n=29)	21.83 (6.32)	21.79 (7.89)	0.006
CG (n=29)	21.72 (6.72)	23.34 (7.41)	-0.23
Between group effect size <i>d</i>		-0.20	
SDS			
IG (n=29)	19.90 (5.85)	17.31 (7.99)	0.37*
CG (n=29)	20.28 (3.98)	18.76 (6.13)	0.29
Between group effect size <i>d</i>		-0.20	
EQ-5D			
IG (n=29)	5.34 (3.42)	5.72 (3.42)	-0.11
CG (n=29)	6.47 (2.56)	6.09 (3.37)	0.13
Between group effect size <i>d</i>		-0.11	

*Significant at the 0.05 level

The results of the measurements for the two groups were analyzed with a 2x2 mixed ANOVA and dependent T-tests.

HADS A showed no effect of measurement point ($F(1.58) = 0.527$; $p = 0.471$ n.s.) and no interaction effect between measurement point and treatment group ($F(1.58) = 1.818$; $p = 0.183$ n.s.). A dependent T-test showed no significant difference between pre and post measurement for the IG ($t(29) = 1.382$ $p = 0.178$ n.s.) and no significant difference for the CG ($t(29) = -0.471$ $p = 0.641$ n.s.)

HADS D showed no effect of measurement point ($F(1.58) = 1.166$; $p = 0.285$ n.s.) and no interaction effect between measurement point and treatment group ($F(1.58) = 3.479$; $p = 0.067$ n.s.). A dependent T-test showed no significant difference between pre and post measurement for the IG ($t(29) = 0.516$ $p = 0.610$ n.s.) but a significant deterioration for the CG ($t(29) = -2.268$ $p = 0.031$)

PSS showed no effect of measurement point ($F(1.58) = 1.667$; $p = 0.418$ n.s.) and no interaction effect between measurement point and treatment group ($F(1.58) = 0.726$; $p = 0.398$ n.s.). A dependent T-test showed no significant difference between pre and post measurement for the IG ($t(29) = 0.023$ $p = 0.982$) and no significant difference for the CG ($t(29) = -1.333$ $p = 0.193$ n.s.)

SDS showed an effect of measurement point ($F(1.58) = 8.089$; $p = 0.006$) but no interaction effect between measurement point and treatment group ($F(1.58) = 0.549$; $p = 0.462$ n.s.). A dependent T-test showed a significant improvement between pre and post measurement for the IG ($t(29) = 2.343$ $p = 0.026$) but no significant difference for the CG ($t(29) = 1.633$ $p = 0.114$ n.s.)

EQ-5D showed no effect of measurement point ($F(1.58) = < 0.001$; $p = 1$) and no interaction effect between measurement point and treatment group ($F(1.58) = 0.982$; $p = 0.326$ n.s.). A dependent T-test showed no significant improvement between pre and post measurement for the IG ($t(29) = -.812$ $p = 0.424$) and no significant difference for the CG ($t(29) = 0.626$ $p = 0.527$ n.s.)

Summary of additional measurements

No measurements showed a significant difference based on the interaction effect of measurement point and group. SDS showed a significant effect based on measurement point and a significant improvement between PRE and POST for the intervention group. A significant deterioration was measured between PRE and POST measurements for HADS D for the control group. All other measurements were not significant.

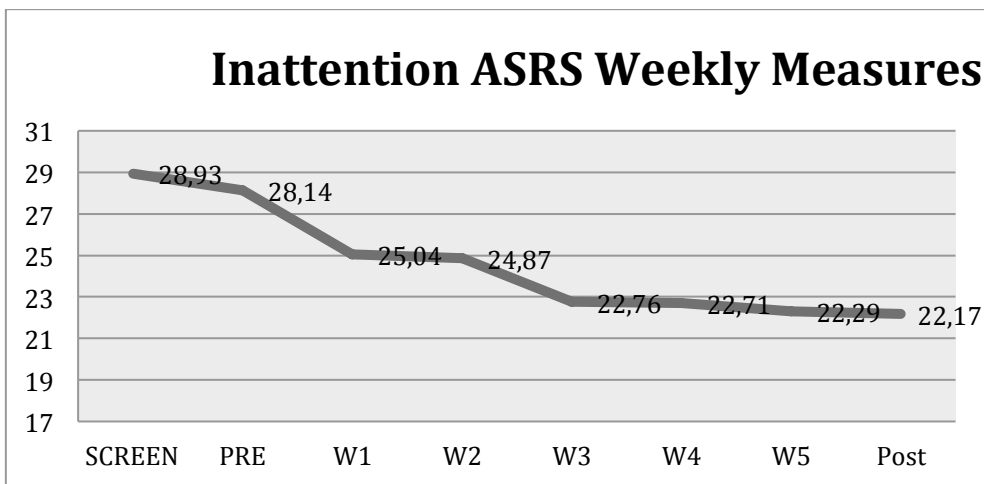


Figure 5. Weekly results of ASRS inattention for the intervention group

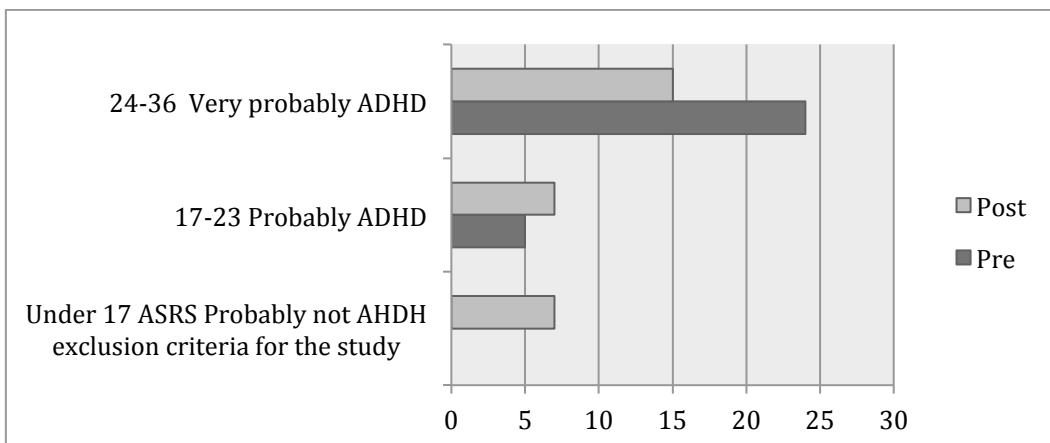


Figure 6. Results of ASRS for the individuals in the intervention group divided by cut-off limits of ASRS at pre and post measurement

Factors influencing the intervention outcome

The intervention group measured significantly lower on measurements of ASRS-inattention at post measurement compared to pre-measurements and the control group. One way ANOVAS, t-tests and correlations were used to determine which treatment variables significantly influenced this outcome.

Measurements of calendar use

Before the shared calendar was removed, all the entries were measured for the patient group. 24 individuals shared calendar entries during the intervention; participants who did not share their calendar were not counted. The intervention group shared an average of 129 entries and in total the group shared 3091 calendar entries. A correlation measurement showed no significant correlation between number of shared calendar entries and change in scores of ASRS-inattention between pre and post measurement. ($r=0.045$. $n=24$. $p=0.836$ n.s)

Communication in the platform

The participants and the support persons mainly communicated through messages in the Internet platform. Correlation measurements showed no significant correlation between number of received messages from the support person and change in scores of ASRS-inattention. ($r=-0.006$, $n=29$, $p=0.974$ n.s) nor number of sent messages and change in scores of ASRS-inattention ($r=-0.07$, $n=29$, $p=0.718$ n.s). Supervisor 1 sent significantly more messages per participant (mean 13.84 std 7.27) than supervisor 2 (mean 7.4 std 4.00) $F(1,29) = 6.705$ $p = 0.015$ and also received more messages (mean 12.11 std 9.06) than support person 2 (mean 8.3 std 6.38) but the difference in received messages was not significant $F(1,29) = 1.389$ $p = 0.249$ n.s.

Support person

The course had two support persons: support person 1 (the author) who coached 19 participants and support person 2 who coached 10 participants. The result for post ASRS inattention for the different support persons is shown below. Table 8 shows means and standard deviation and within-group and between group effect, expressed using Cohen's d. (Cohen, 1988).

Table 9. Median values, standard deviation and effect size for ASRS-inattention between support persons

	Pre	Post	Within-group effect size d
SP1 (n=19)	27.42 (4.44)	20.79 (6.14)	1.24***
SP2 (n=10)	29.5 (4.38)	24.9 (6.61)	0.82***
Between group effect size d		-0.64**	

SP 1 = Support person 1 SP 2 = Support person 2 ** Medium effect *** Large effect

The results on ASRS-inattention for the two support persons was analyzed with a 2x2 mixed ANOVA that showed a main effect of measurement point ($F(1,29) = 23.974$; $p < 0.001$) but no interaction effect between measurement point and support person ($F(1,29)$

= 7.84; $p = 0.384$ n.s). However the observed power was only 0.137, which means that there might be an effect but the power is too low to detect it. A dependent T-test showed a significant improvement between pre and post measurement for SP1 ($t(20) = 4.459$ $p < 0.001$) and a significant improvement for SP2 ($t(10) = 3.305$ $p = 0.009$)

Treatment modules and results

The participants received access to new treatment modules after filling out homework in the platform. An analysis was made comparing how many modules the participants unlocked and treatment outcome. The result showed no significant correlation between treatment modules opened and change in ASRS-inattention ($r=0.055$, $n=29$, $p=0.776$ n.s.)

ADHD/ADD

In the intervention group individuals with both ADHD and ADD participated. Measurements were made to determine if there was any differences between the outcome measurements of ASRS inattention for the different groups.

The result for ASRS inattention differentiated for ADHD/ADD group is shown below. Table 8 shows means and standard deviation and within group and between group effects, expressed using Cohen's d . (Cohen, 1988).

Table 10. Median values, standard deviation and effect size for post ASRS-inattention between ADHD/ADD group

	Pre	Post	Within-group effect size d
ADHD (n=20)	27.9 (4.56)	21.75 (7.43)	1 ***
ADD (n=9)	28.67 (4.66)	23.22 (3.87)	1.27***
Between group effect size d		-0.25*	

SP 1 = Support person 1 SP 2 = Support person 2 * Small effect *** Large effect

The results on ASRS-inattention for the ADHD/ADD groups was analyzed with a 2x2 mixed ANOVA that showed a main effect of measurement point ($F(1,29) = 23.596$; $p < 0.001$) but no interaction effect between measurement point and support person ($F(1,29) = 0.087$; $p = 0.770$ n.s). A dependent T-test showed a significant improvement between pre and post measurement for ADHD ($t(20) = 4.206$ $p < 0.001$) and a significant improvement for ADD ($t(9) = 3.874$ $p = 0.005$)

Additional factors

Additional variables were measured in relation to the difference between pre and post ASRS-inattention. T-tests, correlations and one-way ANOVAS were used.

Table 11. Demographic and treatment variables compared to the difference in ASRS-inattention.

<i>Demographic variables</i>	Type of measurement	T and r values	P	Significant
Gender	T-test	T.29 = 1.273	0.214	
Age	Correlation	N=29. $r=0.045$	0.671	
Somatic illness	T-test	T.29 = -0.911	0.370	

Comorbid psychiatric disorders	T-test	T.29 = -0.845	0.405
<i>Treatment variables</i>			
Gtasks + to do list usage	Correlation	N=29. r=-0.038p	0.844
Inattention techniques usage	Correlation	N=29. r=0.111p	0.567
Smartphone type	T-test	T.29 = -2.166	0.039 *
N-back working memory training app	Correlation	N=29. r=0.283p	0.137
Evernote remembrance app	Correlation	N=29. r=0.159p	0.409
Simplynoise whitenoise app	Correlation	N=29. r=0.083p	0.668
Dropbox organization app	Correlation	N=29. r=0.130p	0.500
All app usage	Correlation	N=29. r=0.273p	0.153

*Significant at the 0.05 level

Summary of additional factors

Smartphone type (iPhone/Android) showed a significant correlation to treatment outcome with participants in the iPhone group showing better results (avg difference - 8.38 std 6.37) compared to the android group (avg difference -3.94 std 4.68). No other factors showed a significant correlation to the primary outcome measurement.

Discussion

The purpose of this study was to evaluate the efficacy and feasibility of a new type of intervention for adults with ADHD. Overall it is fair to say that the intervention was successful and helped the participants cope with their symptoms of ADHD both regarding inattention but also symptoms of hyperactivity.

Comparing the intervention to other treatments

In a search for articles using ASRS as outcome measurement no studies were found measuring psychological treatment; however a study was found that used ASRS for measuring change for medication treated adults with ADHD versus placebo (Arnold, Feifel, Earl, Yang, & Adler, 2012). The study found no significant results between medication and placebo but had some significant within-groups effects and had change scores of average -11.75 (std 14.22) for the groups who received medication. The average change of full scale ASRS in this study was -7.5 (std 10.41). However comparing the full scale ASRS might be problematic since the study designs are dissimilar. In this study last item carried forward was used which lowered the difference scores of ASRS when there was missing data points. The other study had a dropout percent of almost 50 percent and it is somewhat unclear how dropouts were analyzed in the study. This study also primarily focused on inattention symptoms not symptoms of hyperactivity. To compare the studies a double ASRS-inattention score could be used instead of full-scale ASRS. If the double score of ASRS-inattention change is used instead the change scores from this study (-11.94 std 10.96) is similar to the one found in the medication study (-11.75 std 14.22). This type of calculation might however unfairly increase the results of the current study.

Comparing the effect of the treatment using Cohen's d to other psychological interventions showed that the treatment had a similar effect. A 2011 study assessing a 14 week skills training using DBT for adults with ADHD had a mean in-group effect

size of Cohen's d 0.57 and no between group effect (Hirvikoski et al., 2011). Another 2012 study assessing a 20 week intervention comparing CBT with medication versus CBT and placebo had a mean in-group effect size of Cohen's d 1.1 pooled between the groups and no between group effect (Weiss et al., 2012). This study had a mean in-group effect size of Cohen's d 1.07 and a between group effect size of Cohen's d 1.08 for the primary outcome measurement (ASRS-inattention) and a mean in-group effect size of full-scale ASRS of Cohen's d 0.7 and a mean between group effect size of Cohen's d 0.54.

CBT and DBT are the two most prevalent types of psychological interventions for ADHD available (Hirvikoski et al., 2011; Weiss et al., 2012). The results of this intervention are promising considering the fact that the intervention presented in this study had similar results and was 60-70% shorter than the previous interventions.

The difference between scores of hyperactivity between pre and post was smaller (mean in-group effect size Cohen's d 0.49, between group effect size Cohen's d 0.2) than the difference of inattention. Seeing as the intervention focused on improving symptoms of inattention this was not surprising. The difference was however significant and it seems reasonable to assume that the difference in scores was a result of the intervention since the intervention was based on a CBT manual for ADHD that previously been shown to alleviate symptoms of hyperactivity (Safren et al., 2010). However since the difference was small it might also be explained as a placebo effect caused by the intervention.

Online treatment for adults with ADHD

Since there are no previous studies conducted regarding online treatment of ADHD this study will bring new data to the field. The online format did not seem as a limitation and instead was a prerequisite for the course and the logical format for this type of intervention. The course material was also specialized for the online format and the ADHD group. A few different things stood out as important in this work.

1. Having precise step by step instructions
2. Relying on examples that would be familiar to the treatment group while explaining topics and exercises
3. Using visual aids and visual tools in the course
4. Repeating important treatment examples several times during the course

Online interventions might be a logical next step for treating many different types of disorders where additional resources can be found only a second away by the click of a button. There are seemingly small differences with the levels of dropout between this treatment and other online interventions for other treatment groups (Emilsson et al., 2011b). This might be in part to the fact that the participants were highly motivated and that the intervention was novel to participants.

Smartphones as self-aid for executive functions

The premise of this study was based on the idea that ADHD is a neuropsychiatric disorder that primarily targets executive functions in the PFC and that smartphones and other IT tools can be viable for helping individuals perform these executive tasks. The study results shows that this is a promising premise. There are two main reasons why smartphones are an obvious tool for helping adults with ADHD, customization and

accessibility. There are approximately 700 000 apps available for iPhone and 675 000 apps available for android (Google Android store reaches 25 billion downloads, 2012) which makes it easy to customize material for the treatment group. Smartphones are also commonly available and it is estimated that around 50% of people living in Sweden have access to a smartphone (Smartphoneanvändande i Sverige, 2012). Using smartphones as tools might also save money for the disability services. The price of a Handifon, a smartphone especially built for people with cognitive disabilities is 15867 Swedish crowns (Handifon, 2012). Assuming a prevalence of ADHD of 4% among the adult population and that 25% of individuals with ADHD would benefit from this type of aid, and assuming a smartphone price of 5867 Swedish crowns, the disability services would save 900 million Swedish crowns by prescribing smartphones as aid instead of Handifon. The number of individuals being prescribed handifon is probably much lower but the basic math is still similar.

To present already available IT tools might also be a promising premise for other disorders. Instead of using apps primarily focused on organization, apps could be chosen that are beneficial for behavioral activation for patients suffering from depression or to encourage social interactions for patients with social phobia. These types of interventions might also be beneficial for sub-clinical populations who would otherwise not seek psychological treatment but would venture to try a smartphone course.

Developing apps versus finding existing apps

In the beginning of the work with this intervention it was planned that a new application should be developed for the treatment and a partnership was sought with master students at KTH. Since no one at KTH was interested this partnership was later abandoned. However this might have been beneficial in the end. Building and maintaining an application comes with additional costs and these costs has to be taken from somewhere. Using existing tools removes these costs and leaves the care of the applications and maintenance in the qualified hands of app developers and multinational corporations like Google and Apple. As long as the tools presented are fairly standard as a calendar and to-do-list, using existing apps is preferable. Using existing apps also makes it easier to replicate the study design and bring the intervention to new patients.

Clinical significant improvement

The study had three different measurements to determine clinical significant improvement for the groups. A clinical difference based on Jacobson and Thruax (1991), a blind clinical assessment of much improved or very much improved concerning symptoms of inattention and ASRS below 17. For these different measurements the significant improvement is 38%, 32% and 24% respectively. Another study used improvement of 21% of ADHD symptoms as a cut-off for significant improved and found that 70% of participants met this criteria (Rostain & Ramsay, 2006). The same number for this study would be 48% on the primary outcome measurement (ASRS-inattention) but the other study did not carry forward their dropout data. If no data is carried forward for this study the new percentage of improvement will be 56%. The treatment in the other study was also much longer, and was a combination of pharmacotherapy and CBT that lasted 6 months for the patient group. (Rostain & Ramsay, 2006). In light of the relatively large difference in intervention time and

relatively small difference in percentage of change scores it is safe to conclude that this intervention is similar to other interventions in terms of number of participants having a significant reduction in symptoms of ADHD.

Measurements

ASRS

ASRS proved to be a robust measurement of both change and overall symptoms. During the post-measurements the participants filled out two questions regarding overall organization and change in level of organization during the last six weeks. These measurements correlated significantly with the ASRS post measurement of inattention ($r=-0.445$, $n=53$, $p=0.001$ n.s) and ASRS change score, ($r=-0.513$, $n=53$, $p <0.001$) which could be seen as an indicator that ASRS is a good measurement of inattention and problems with organization.

Other outcome measurements

Intervention group

Measurements of anxiety, depression, stress and overall functioning found few differences between the pre and post measurement for the intervention group. There was a difference in SDS that measures disability caused by the disorder. This might be a sign that the intervention was successful in alleviating symptoms of ADHD. However it might have been reasonable to expect a reduction in scores on measurements of stress (PSS) after the intervention as the participants better learned to cope with their disability.

Control group

The control group showed a significant deterioration of HADS-D between pre and post measurement. This is a troublesome finding since it might be possible that not receiving the intervention with support directly might have had a negative impact on the participants in the control group. However it has been shown that HADS-D have unclear psychometric properties and thus is not considered a suitable instrument for measuring depression symptoms (Swedish Council on Health Technology Assessment, 2012). It is still problematic that the control group deteriorated on measurement even though the deterioration in this case was fairly small.

Factors influencing the intervention outcome

Many correlations were performed to try to measure which factors influenced the outcome of the intervention but only one significant correlation was found between use of iPhone and the treatment outcome. The significant difference for use of iPhone (mean difference of inattention change -8.4 , std 6.4) compared to android (mean -3.9 std 4.7) might relate to the fact that the technical lessons for iPhone were made in a more step-by-step fashion, another factor might be that the N-back games were different between the groups. Several iPhone users reported that they liked the N-back game while several android users reported that they did not understand or like the N-back game for android. The result that no other factors related to treatment outcome was first puzzling but the following chart showing which parts of the course the participants found most useful at the post measurement might help explain the results.

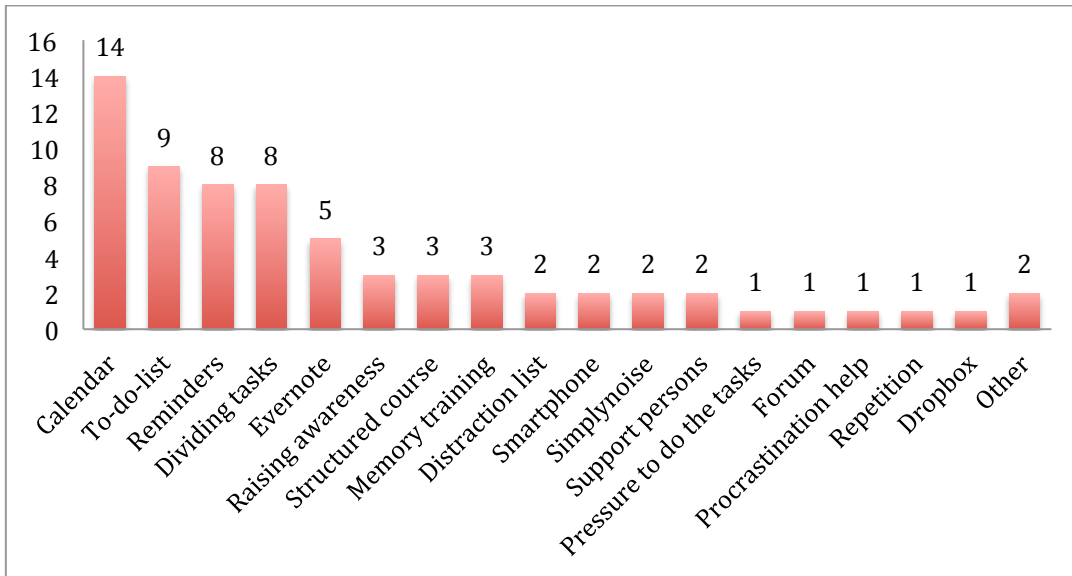


Figure 7. Which methods the participants found the most useful during the course.

Different participants rated different parts of the course as useful and this might help explain why no single variable correlated with the outcome measurement. Some factors might have been very beneficial for some participants while others hardly used the same techniques but found other interventions valuable.

Support persons

There was a difference at the primary outcome measurement between support person 1 (this study's author) and support person 2 but the difference was not significant. Even though the difference was not significant it might be reasonable to try to speculate at what might have caused this discrepancy. There are several factors that might explain the difference. Support person 1 had on average double the amount of interactions with the participants and also had a 10% higher time spent working with participants. The fact that support person 1 wrote most of the material might also have made it easier to convey and troubleshoot the material.

Another factor might be that the patients were assigned supervisor based on a participants numbers were earlier participants were assigned a lower number. This meant that the people who signed up earliest for the intervention who might be more motivated were assigned to supervisor 1. Several of the patients assigned to supervisor 2 also never answered their telephones during the course. For supervisor 1 there were only 2 patients who never responded to telephone during the intervention. There was a non-significant difference in the scores of ASRS between support persons at onset that might be related to the early and late responder group. There are thus both factors on the treatment and the patient level that might coincide to make this effect and it is hard to draw any one conclusion about this finding.

Difference between the ADHD and ADD group

Participants in the study with ADHD and ADD had somewhat similar problems but there were also obvious differences. It might be beneficial to make a program that more specializes to one of these groups, especially when considering online treatment were

material is highly formalized. The treatment proved efficient for both these groups even though there were differences at post-measurement. The ADD group had more symptoms at pre measurement and showed a larger change based on Cohen's d (1.27) and a respectable r of 0.54 (large effect size) even though the raw change in score was somewhat smaller for the group. The result for the ADD group is promising especially since these are the primary symptoms for the group and most individuals do not experience similar problems with hyperactivity and impulsivity. The ADHD group had somewhat lower symptoms at pre measurement but showed a larger change in raw score but still had a somewhat smaller change based on Cohen's d (1) and r 0.45. This was caused by a larger standard deviation in the group since there were both individuals with a very large significant improvement and participants who scored similar to onset. The larger difference in the standard deviation might also be a symptom of a more impulsive response style that might be present in the ADHD group. Overall it is fair to say that the intervention was effective for reducing symptoms for both groups.

Weaknesses in the study

A possible weakness in the study is that the study focuses on inattention symptoms and has a measurement of inattention as primary outcome measurement that might make it hard to compare the results to other studies. Since ASRS-inattention was also used as a weekly measurement it might have made a test-retest effect that could possibly have influenced the intervention outcome. The fact that the control group remained untreated might also be problematic since it makes it hard to judge if a part of the intervention's effect is caused by placebo. Originally the study was supposed to compare the group with support with a group that simultaneously received the intervention without support but the layout did not receive approval from the ethics board. Another weakness in the study is that the participants ADHD-diagnosis are only confirmed for 30 (51%) of the individuals in the study. A diagnostic interview was made for all participants in the telephone interview prior to inclusion where symptoms of inattention were assessed as well as probability of diagnosis but a confirmed diagnosis of ADHD would be preferable. The blind assessment might not have been fully blind for all participants. An email went out to all participants before the blind assessment telling the participants of the importance of not disclosing which group they belonged to and the assessors also reminded the participants of this in the beginning of the interview. However, at least at one occasion the blinding was removed when a participant provided information that removed the blinding. EQ-5D was not significant for any measurements and the assessment tool probably assessed too basic functions to be applicable to the treatment group. Other measurements to evaluate symptoms including an additional ADHD scale and a measurement of quality of life for the participant group might have been more useful for the study.

Feedback regarding the intervention

The participants filled out questionnaires at the post measurement regarding how they felt regarding the course. The participants were overall happy with the course and reported that it had been a good intervention. One participant even reported that taking part of the course had been one of the best changes they had made in their life. Some individuals reported that they wanted more guidance and one participant suggested that

scheduling the phone interviews at a special time would be helpful. Others said that the format would have worked better in a traditional therapy session with face-to-face contact. Several reported that the course gave them a better understanding of their own shortcomings, which they found helpful. Others were interested in learning about the results of the study. Several participants had things happen in their private life that made it hard for them to work on the course and several also reported that problems with lack of energy made it hard to start working on the course. One participant said that they were sad they did not take the time to properly learn things now that they had the chance but later wrote that they realized that the course had indeed helped them make a positive change in their life.

Amount of time for the course

One of the chief complaints from the participants was that the course was too short and that they needed more time to complete it. 19 individuals (76%) of the participants reported they had not enough time to complete the course. Only 3 individuals (12%) reported they fulfilled the course with or without some problems. 3 individuals (12%) reported they aborted the course on their own initiative. One participant said that 12 weeks would be a better intervention time. The decision to make a 6-week course was made to try to see if a limited intervention might have a positive effect. There might be reason to evaluate if the course time should be longer if a similar intervention is done in the future.

Technical skill

In the study there was no formal inclusion based on skills using smartphones and computers. There was one dropout that was clearly caused by problems regarding understanding the technical lessons and the participant who dropped out because of technical problems reported that they had a negative outcome of the course but did not specify in what way. Notwithstanding this unfortunate incident the technical parts of the course functioned fairly well.

Representativity of the sample

There is a selection bias in the study design since only participants who were interested in online treatment and interventions using smartphones sought to participate. It is difficult to draw a conclusion if this in some way affected the treatment outcome. Of the participants included in the study many had comorbid problems and somatic illnesses, demographic variables that are similar to those found in the ADHD population. However the education level of the participants was fairly high which might be different from the ADHD population. Furthermore, three quarters of the participants were women and even though there was no significant gender effect on outcome measurements this difference might be a sign that women are more likely to seek aid for their disability compared to men.

Suggestions for future research

An intervention could be made specific to the group of patients with ADHD or ADD. The treatment for the ADD group could focus more on activation and reminders and the treatment for the ADHD could bring in other techniques for handling hyperactivity and impulsivity. This type of intervention could also be made in combination with face-to-face therapy where a calendar could be shared and the treatment at the same time could be more tailored to the individual. Using an online intervention with adjuvant

smartphone applications could also be tried for other disorders where depression and social phobia would be prime candidates.

Conclusions

The study results shows that it is possible to administer treatment for adults with ADHD through an Internet format. The study also shows that the treatment is effective at treating symptoms of ADHD. This is a new finding and there is no previous research to relate this finding to. Online interventions for this treatment group is beneficial since the participants can read the material at their own pace and at a time and place of their own choosing and the online format also reduces the amount of time needed for the therapist to treat each patient. The online platform additionally makes it possible to remind the patients through text messages, which can be more helpful than telephone calls when dealing with this sometimes-forgetful patient group.

Even though the study has limitations it should be stated that this is the first study made analyzing online treatment for ADHD patients as well as the first RCT assessing smartphones in treatment for patients with ADHD.

Using smartphones as an aid in executive functioning is something that many do without thinking consciously about it. We store important information in our phones memory instead of our own memory, we let the phone remind us of appointments instead of reminding our self and we plan our life by quickly glancing at our smartphone calendar. ADHD patients with deficit in executive functioning are most likely the individuals who would benefit the most from these aids but paradoxically their disorder impedes them from learning these organizational skills on their own. Yet, now that these skills have been learned and a new routine has been established the participants will likely continue to use these tools to compensate for deficits in executive functioning and thus be less inhibited by their disorder and live a more organized and more fulfilling life.

References

- Alqahtani, M. M. (2010). The comorbidity of ADHD in the general population of Saudi Arabian school-age children. *Journal of attention disorders, 14*(1), 25–30. doi:10.1177/1087054709347195
- American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental Disorders DSM-IV-TR Fourth Edition*. Washington, DC: Author.
- Arnsten, A. (2009). The emerging neurobiology of attention deficit hyperactivity disorder: The key role of the prefrontal cortex. *The Journal of Pediatrics, 154*, S22–S28.
- Andersson G (2009). Using the Internet to provide cognitive behaviour therapy. *Behavior Research and Therapy 47*, 175–180.
- Andersson, G., & Cuijpers, P. (2009). Internet-based and other computerized psychological treatments for adult depression: a meta-analysis. *Cognitive behaviour therapy, 38*(4), 196–205. doi:10.1080/16506070903318960
- Arnold, V. K., Feifel, D., Earl, C. Q., Yang, R., & Adler, L. a. (2012). A 9-Week, Randomized, Double-Blind, Placebo-Controlled, Parallel-Group, Dose-Finding Study to Evaluate the Efficacy and Safety of Modafinil as Treatment for Adults With ADHD. *Journal of attention disorders*. doi:10.1177/1087054712441969
- The Swedish Council on Health Technology Assessment. (2012). Diagnostik och uppföljning av förstämningssyndrom SBU : s sammanfattning och slutsatser.
- Barkley, R.A., 2002 Major life activity and health outcomes associated with attention-deficit/hyperactivity disorder. *J Clin Psychiatry, 63* Suppl 12: p. 10-5.
- Beaver, K. M., Wright, J. P., & DeLisi, M. (2007). Self-control as an executive function: Reformulating Gottfredson and Hirschi's parental socialization thesis. *Criminal Justice and Behavior, 34*, 1345–1361.
- Berk, M., Ng, F., Dodd, S., Callaly, T., Campbell, S., Bernardo, M., & Trauer, T. (2008). The validity of the CGI severity and improvement scales as measures of clinical effectiveness suitable for routine clinical use. *Journal of Evaluation in Clinical Practice, 14*(6), 979-983.
- Biederman, J., Faraone, S. V, Ph, D., Spencer, T. J., Mick, E., Sc, D., Monuteaux, M. C., et al. (2006). Functional Impairments in Adults With Self-Reports of Diagnosed ADHD : *Psychiatry: Interpersonal and Biological Processes*, (April).
- Biederman, J., Petty, C. R., Clarke, A., Lomedico, A., & Faraone, S. V. (2011). Predictors of persistent ADHD: an 11-year follow-up study. *Journal of psychiatric research, 45*(2), 150–5. doi:10.1016/j.jpsychires.2010.06.009
- Bjelland, I., Dahl, A. A., Haug, T. T., & Neckelmann, D. (2002). The validity of the Hospital Anxiety and Depression Scale-An updated literature review. *Journal of psychosomatic research, 52*(2), 69-78.
- Bramham, J., Young, S., Bickerdike, A., Spain, D., McCartan, D., & Xenitidis, K. (2009). Evaluation of group cognitive behavioral therapy for adults with ADHD. *Journal of attention disorders, 12*(5), 434–41. doi:10.1177/1087054708314596
- Brar, A. and L. Flyckt, (2006) Adults with neuropsychiatric diagnosis are not receiving sufficient help. A survey shows extensive needs of treatment and support. *Lakartidningen, 103*(19): p. 1516-8, 1520-2.
- Bálint, S., Czobor, P., Komlósi, S., Mészáros, a, Simon, V., & Bitter, I. (2009). Attention deficit hyperactivity disorder (ADHD): gender- and age-related differences in neurocognition. *Psychological medicine, 39*(8), 1337–45. doi:10.1017/S0033291708004236

- Caci, H., Enfants-adolescents, P., Archet, H., Ginestière, D. S. De, & Cedex, N. (1994). Adult ADHD : translation and factor analyses of the ASRS-1 . 1 Symptom Checklist, 92220.
- Carpentier, P. J., Van Gogh, M. T., Knapen, L. J. M., Buitelaar, J. K., & De Jong, C. a J. (2011). Influence of attention deficit hyperactivity disorder and conduct disorder on opioid dependence severity and psychiatric comorbidity in chronic methadone-maintained patients. *European addiction research*, 17(1), 10–20. doi:10.1159/000321259
- Chen, H., Yang, H., Hooks, H., & Lee, J. (2012). Medbuddy: A Mobile Medicinal Management System for Children with ADD/ADHD. *Impact Analysis of Solutions for Chronic Disease Prevention and Management Lecture Notes in Computer Science*, 7251, 2012, 286–290. doi:10.1007/978-3-642-30779-9_46
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale NJ: Erlbaum Associates.
- Cohen, S., Kessler, R. C., & Underwood Gordon, L. (1994). Perceived stress scale. *Measuring Stress: A Guide for Health and Social Scientists*.
- Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, 24(4), 385-396.
- Comings, D., Chen, T., Blum, K., Mengucci, J., Blum, S., & Meshkin, B. (2005). Neurogenic interactions and aberrant behavioral co-morbidity of attention deficit hyperactivity disorder (ADHD): Dispelling myths. *Theoretical Biology & Medical Modeling*, 2, 50:65.
- Davies D. K., Stock S. E. & Wehmeyer M. L. (2002), Enhancing Independent Time- management Skills of Individuals with Mental Retardation Using a Palmtop Personal Computer, *Mental Retardation* 40(5) pp. 358-365
- De Graaf, R., Kessler, R. C., Fayyad, J., Ten Have, M., Alonso, J., Angermeyer, M., Borges, G., et al. (2008). The prevalence and effects of adult attention-deficit/hyperactivity disorder (ADHD) on the performance of workers: results from the WHO World Mental Health Survey Initiative. *Occupational and environmental medicine*, 65(12), 835–42. doi:10.1136/oem.2007.038448
- Depompei, R., Gillette, Y., Goetz, E., Xenopoulos-Oddsson, A., Bryen, D., & Dowds, M. (2008). Practical applications for use of PDAs and smartphones with children and adolescents who have traumatic brain injury. *NeuroRehabilitation*, 23(6), 487–99. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/19127002>
- Dulcan, M. K., & Benson, R. S. (1997). AACAP Official Action. Summary of the practice parameters for the assessment and treatment of children, adolescents, and adults with ADHD. *Journal of the American Academy of Child and Adolescent Psychiatry*, 36, 1311–1317.
- Ebert, D., J. Krause, and C. Roth-Sackenheim, (2003) ADHD in adulthood--guidelines based on expert consensus with DGPPN support. *Nervenarzt*, 74(10): p. 939-46.
- Emilsson, B., Gudjonsson, G., Sigurdsson, J. F., Baldursson, G., Einarsson, E., Olafsdottir, H., & Young, S. (2011a). Cognitive behaviour therapy in medication-treated adults with ADHD and persistent symptoms: a randomized controlled trial. *BMC psychiatry*, 11, 116. doi:10.1186/1471-244X-11-116
- Emilsson, B., Gudjonsson, G., Sigurdsson, J. F., Baldursson, G., Einarsson, E., Olafsdottir, H., & Young, S. (2011b). Cognitive behaviour therapy in medication-treated adults with ADHD and persistent symptoms: a randomized controlled trial. *BMC psychiatry*, 11(1), 116. doi:10.1186/1471-244X-11-116

- Faraone, S. V, Sergeant, J., Gillberg, C., & Biederman, J. (2003). The worldwide prevalence of ADHD: is it an American condition? *World psychiatry: official journal of the World Psychiatric Association (WPA)*, 2(2), 104–13. Retrieved from <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1525089&tool=pmcentrez&rendertype=abstract>
- Fernell, E. (2008). IT-hjälpmedel för vuxna med ADHD En behovsutredning. *Kungliga tekniska högskolan, Examensarbete*.
- Fischer, M., Barkley, R. a, Smallish, L., & Fletcher, K. (2007). Hyperactive children as young adults: driving abilities, safe driving behavior, and adverse driving outcomes. *Accident; analysis and prevention*, 39(1), 94–105. doi:10.1016/j.aap.2006.06.008
- Franck, J., & Andréasson, S. (2003). Regionalt vårdprogram. *Stockholm läns landsting*. Retrieved from <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Regionalt+vårdprogram#4>
- Goldberg, E. (2001). *The executive brain: Frontal lobes and the civilized mind*. New York: Oxford University Press.
- Google Android store reaches 25 billion downloads, 675,000 apps (2012). 05-01-2012
<http://appleinsider.com/articles/12/09/26/google-android-reaches-25-billion-downloads-675000-apps>
- Gyllin, E. (2012). Smartphone som ett alternativt verktyg för elever med läs-och skrivsvårigheter (Doctoral dissertation, LNU).
- Hallberg, P. (2009). Mobiltelefonen som hjälpmedel för vuxna med ADHD. Retrieved from <http://liu.diva-portal.org/smash/record.jsf?pid=diva2:208107>
- Handifon (2012). 05-01-2012
<http://www.abilia.se/produkter/produkt.aspx?productgroup=261848&product=265247>
- Hesslinger, B., Tebartz van Elst, L., Nyberg, E., Dykieriek, P., Richter, H., Berner, M., & Ebert, D. (2002). Psychotherapy of attention deficit hyperactivity disorder in adults--a pilot study using a structured skills training program. *European archives of psychiatry and clinical neuroscience*, 252(4), 177–84. doi:10.1007/s00406-002-0379-0
- Hinz, A., Klaiberg, A., Brahler, E., & Konig, H. (2006). The Quality of life Questionnaire EQ-5D: Modeling and norm values for the general population. *Psychotherapie, Psychosomatik, Medizinische Psychologie*, 56, 42-48.
- Hirvikoski, T., et al., (2010) Psychotherapy--a complement to drugs in adult ADHD. *Lakartidningen*, 107(11): p. 756-9.
- Impey, M., & Heun, R. (2012). Completed suicide, ideation and attempt in attention deficit hyperactivity disorder. *Acta psychiatrica Scandinavica*, 125(2), 93–102. doi:10.1111/j.1600-0447.2011.01798.x
- Jacobson, N., & Truax, P. (1991). Clinical significance: A statistical approach to defining meaningful change in psychotherapy research. *Journal of Consulting and Clinical Psychology*, 59(1), 12-19.
- Kessler, R., & Adler, L. (2006a). The prevalence and correlates of adult ADHD in the United States: Results from the National Comorbidity Survey Replication. *The American journal ...*, 163(4), 716–723. doi:10.1176/appi.ajp.163.4.716.The
- Kessler, R., & Adler, L. (2006b). The prevalence and correlates of adult ADHD in the United States: Results from the National Comorbidity Survey Replication. *The American journal ...*, 163(4), 716–723. doi:10.1176/appi.ajp.163.4.716.The
- Kessler, R. C., Adler, L. A., Gruber, M. J., Sarawate, C. A., Spencer, T., & Van Brunt, D. L. (2007). Validity of the World Health Organization Adult ADHD Self-Report Scale (ASRS) Screener in a

representative sample of health plan members. *International journal of methods in psychiatric research*, 16(2), 52-65.

Kessler, R. C., Adler, L., Ames, M., Demler, O., Faraone, S., Hiripi, E., Howes, M. J., et al. (2005). The World Health Organization Adult ADHD Self-Report Scale (ASRS): a short screening scale for use in the general population. *Psychological medicine*, 35(2), 245–56. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/15841682>

Kooij, S.J., et al., (2010) European consensus statement on diagnosis and treatment of adult ADHD: The European Network Adult ADHD. *BMC Psychiatry*, 10: p. 67.

Leon, A. C., Olfson, M., Portera, L., Farber, L., & Sheehan, D. V. (1997). Assessing psychiatric impairment in primary care with the Sheehan Disability Scale. *International Journal of Psychiatry in Medicine*, 27, 93–105.

Lisspers, J., Nygren, A., & Söderman, E. (1997). Hospital Anxiety and Depression Scale (HAD): some psychometric data for a Swedish sample. *Acta psychiatrica Scandinavica*, 96(4), 281-6.

Mannuzza, S., & Klein, R. (2008). Lifetime criminality among boys with ADHD: a prospective follow-up study into adulthood using official arrest records. *Psychiatry research*, 160(3), 237–246. doi:10.1016/j.psychres.2007.11.003.Lifetime

Michelsen, G. (2011). Prosjektrapport Mobiltelefon som kognitiv støtte for studenter med Asperger syndrom eller AD / HD,. *NAV NONITE*, 1–19. Retrieved from <http://www.autismeenheten.no/publikasjoner/mobiltelefon-som-kognitiv-stotte>

Mongia, M., & Hechtman, L. (2012). Cognitive behavior therapy for adults with attention-deficit/hyperactivity disorder: a review of recent randomized controlled trials. *Current psychiatry reports*, 14(5), 561–7. doi:10.1007/s11920-012-0303-x

Nutt, D. J., Fone, K., Asherson, P., Bramble, D., Hill, P., Matthews, K., . . . Young, S. (2007). Evidence-based guide- lines for management of attention-deficit/hyperactivity disorder in adolescents in transition to adult services and in adults: Recommendations from the British Association for Psycho- pharmacology. *Journal of Psychopharmacology*, 21, 10-41.

Rabin, R., & de Charro, F. (2001). EQ-5D: a measure of health status from the EuroQol Group. *Annals of Medicine* 33, 337-43.

Ramsay, J. R., & Rostain, A. L. (2011). CBT Without Medications for Adult. *Review Literature And Arts Of The Americas*, 25(4), 277–287.

Ravens-Sieberer, U., Wille, N., Badia, X., Bonsel, G., Burström, K., Cavrini, G., Devlin, N., Egmar, A-C., Gusi, N., Herdman, M., Jelsma, J., Kind, P., Olivares, P., Scalone, L., & 396 Greiner, W. (2010). Feasibility, reliability, and validity of the EQ-5-D-Y: results from a multinational study. *Quality of Life Research*, 19 (6), 887-897.

Redick, T. S., Shipstead, Z., Harrison, T. L., Hicks, K. L., Fried, D. E., Hambrick, D. Z., Kane, M. J., et al. (2012). No Evidence of Intelligence Improvement After Working Memory Training: A Randomized, Placebo-Controlled Study. *Journal of experimental psychology. General*. doi:10.1037/a0029082

Romine, C. B., & Reynolds, C. R. (2005). A model of the development of frontal lobe functioning: findings from a meta-analysis. *Applied neuropsychology*, 12(4), 190–201. doi:10.1207/s15324826an1204_2

Rostain, A. L., & Ramsay, J. R. (2006). A combined treatment approach for adults with ADHD--results of an open study of 43 patients. *Journal of attention disorders*, 10(2), 150–9. doi:10.1177/1087054706288110

- Safren, S.A., (2006) Cognitive-behavioral approaches to ADHD treatment in adulthood. *J Clin Psychiatry*, 2006. 67 Suppl 8: p. 46-50.
- Safren, S. a, Otto, M. W., Sprich, S., Winett, C. L., Wilens, T. E., & Biederman, J. (2005). Cognitive-behavioral therapy for ADHD in medication-treated adults with continued symptoms. *Behaviour research and therapy*, 43(7), 831–42. doi:10.1016/j.brat.2004.07.001
- Safren, S. A., Perlman, C. A., Sprich, S., & Otto, M. W. (2005). *Mastering Your Adult ADHD: A Cognitive-Behavioral Treatment Program Therapist Guide*(Vol. 2). Oxford University Press, USA.
- Safren, S. A., Sprich, S., Mimiaga, M. J., Surman, C., Knouse, L., Groves, M., & Otto, M. W. (2010). Cognitive behavioral therapy vs relaxation with educational support for medication-treated adults with ADHD and persistent symptoms. *JAMA: The Journal of the American Medical Association*, 304(8), 875-880.
- Saunders, J.B., et al. (1993), Development of the Alcohol Use Disorders Identification Test (AUDIT): *WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption--II. Addiction*,. 88(6): p. 791-804.
- Schilling, C. M., Walsh, A., & Yun, I. (2011). ADHD and criminality: A primer on the genetic, neurobiological, evolutionary, and treatment literature for criminologists. *Journal of Criminal Justice*, 39(1), 3–11. doi:10.1016/j.jcrimjus.2010.11.001
- Sheehan, D. V., Lecrubier, Y., Sheehan, K. H., Amorim, P., Janavs, J., Weiller, E., Hergueta, T., Baker, R., & Dunbar, G. C. (1998). The Mini-International Neuropsychiatric Interview (M.I.N.I.): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *Journal of Clinical Psychiatry*, 59 Suppl. 20: p. 22-33;quiz 34-57
- Söderlund, G., Sikström, S., & Smart, A. (2007). Listen to the noise: Noise is beneficial for cognitive performance in ADHD. *Journal of Child Psychology and Psychiatry*, 48(8), 840-847.
- Simon, V., Czobor, P., Bálint, S., Mészáros, A., & Bitter, I. (2009). Prevalence and correlates of adult attention-deficit hyperactivity disorder: meta-analysis. *The British journal of psychiatry : the journal of mental science*, 194(3), 204–11. doi:10.1192/bjp.bp.107.048827
- Smartphoneanvändande i Sverige* (2012). 05-01-2012
<http://frapps.se/2012/05/22/smartphoneanvandande-i-sverige/>
- Sowell, E., Thompson, P., & Toga, A. (2004). Mapping changes in the human cortex throughout the span of life. *Neuroscientist*, 10, 372–392.
- Studer, B. E., Jaeggi, S. M., Buschkuhl, M., Su, Y., Jonides, J., & Perrig, W. J. (2009). Improving Fluid Intelligence – Single N-back Is As Effective As Dual N-back, 117473.
- Torgersen, T., B. Gjervan, and K. Rasmussen, (2008) Treatment of adult ADHD: is current knowledge useful to clinicians? *Neuropsychiatr Dis Treat.*, 4(1): p. 177-86.
- Tripp, G., & Wickens, J. (2009). Neurobiology of ADHD. *Neuropharmacology*, 57, 579–589.
- Valera, E., Faraone, S., Murray, K., & Seidman, L. (2007). Meta-analysis of structural imaging findings in attention-deficit/hyperactivity disorder. *Biological Psychiatry*, 61, 1361–1369.
- Waldman, I. D., & Gizer, I. R. (2006). The genetics of attention deficit hyperactivity disorder. *Clinical psychology review*, 26(4), 396–432. doi:10.1016/j.cpr.2006.01.007
- Weiss, M., Safren, S. A., Solanto, M. V., Hechtman, L., Rostain, A. L., Ramsay, J. R., & Murray, C. (2008). Research forum on psychological treatment of adults with ADHD. *Journal of attention disorders*, 11(6), 642-651.

Weiss, M., Murray, C., Wasdell, M., Greenfield, B., Giles, L., & Hechtman, L. (2012). A randomized controlled trial of CBT therapy for adults with ADHD with and without medication. *BMC psychiatry*, *12*(1), 30. doi:10.1186/1471-244X-12-30

Wilens, T. E., Biederman, J., & Spencer, T. J. (1998). Pharmacotherapy of attention deficit hyperactivity disorder in adults. *CNS Drugs*, *9*, 347–356.

Wilens, T. E., Spencer, T. J., Biederman, J., Brown, S., Tanguay, S., Monuteaux, M. C., & Blake, C. (2002). A review of the pharmacotherapy of adults with attention-deficit/hyperactivity disorder. *Journal of Attentional Disorders*, *5*, 189–202.

Wilens, T. E., Vitulano, M., Upadhyaya, H., Adamson, J., Sawtelle, R., Utzinger, L., & Biederman, J. (2008). Cigarette smoking associated with attention deficit hyperactivity disorder. *The Journal of pediatrics*, *153*(3), 414–9. doi:10.1016/j.jpeds.2008.04.030

Young, S., Bramham, J., Gray, K., & Rose, E. (2008). The experience of receiving a diagnosis and treatment of ADHD in adulthood: a qualitative study of clinically referred patients using interpretative phenomenological analysis. *Journal of attention disorders*, *11*(4), 493–503. doi:10.1177/1087054707305172

Zigmond, A. S., & Snaith, R. P. (1983). The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavica*, *67*, 361–370.

Appendix a.

Table 12. Applications used in the course

	iPhone	Android
G-task	https://itunes.apple.com/us/app/gtasks-hd-google-tasks-	https://play.google.com/store/apps/details?id=org.dayup.gtask&hl=en
N-back	https://itunes.apple.com/us/app/nback-lite/id386244134?mt=8	https://play.google.com/store/apps/details?id=phuc.entertainment.dualnback&hl=en
Evernote	https://itunes.apple.com/se/app/evernote/id281796108?mt=8	https://play.google.com/store/apps/details?id=com.evernote
Simply noise	https://itunes.apple.com/us/app/simply-noise-lite/id380654783?mt=8	https://play.google.com/store/apps/details?id=reactor.SimplyNoise&hl=en
Dropbox	https://itunes.apple.com/us/app/dropbox/id327630330?mt=8	https://play.google.com/store/apps/details?id=com.dropbox.android&hl=sv
Mindfulness	https://itunes.apple.com/se/app/mindfulness-appen/id413867281?mt=8	http://www.appszoom.com/android_applications/health_and_fitness/mindfulness-
Banking apps	Banking apps for the Swedish banks, Nordea, Handelsbanken and	Banking apps for the Swedish banks, Nordea, Handelsbanken and Swedbank
Astrid-to-do-	https://itunes.apple.com/se/app/astrid-att-gora-listan/id453396855?mt=8	https://play.google.com/store/apps/details?id=com.timsu.astrid&hl=sv
Res i STHM	https://itunes.apple.com/us/app/res-i-sthlm-sl/id296171628?mt=8	https://play.google.com/store/apps/details?id=com.markupartist.sthlmtraveling&hl=sv
Google Maps	Installed (except ios 6)	Installed

The browser extensions Stayfocud and Leechblock were also introduced in the course. These extensions for the web browsers Google chrome and Firefox helped block unproductive and distractive sites.