

# TOWARDS FULLY AUTOMATED PSYCHOTHERAPY FOR ADULTS

## *BAS - Behavioral Activation Scheduling Via Web and Mobile Phone*

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Abstract: Behavioural activation treatment has been found to be an effective psychological treatment for depression, also if delivered as self-administered psychotherapy via the internet. However, the role of supporting professionals remains important for successful application of the therapy. In this paper a system is presented that delivers automated behavioural activation therapy via both a mobile phone and a personal website. The system motivates the client to continue with the treatment and helps him/her through the different procedures of the treatment. The architecture of the system follows a generic ambient agent architecture. A first pilot study of the system indicates that it is technically feasible and perceived as useful.

## 1 INTRODUCTION

Dozens of well-designed studies and meta-analyses have shown that psychological interventions are effective in the treatment of depressive disorders in adults (Cuijpers et al., 2007; Churchill et al., 2001; Leichsenring, 2001; Gloaguen et al., 1998). There is also a growing number of studies showing that self-administered psychotherapies are effective in the treatment of depression. In such a therapy, a patient can read in a book or on a website step-by-step what he can do to apply a generally accepted psychological treatment to himself.

Although self-administered treatments are mainly conducted by clients themselves, the role of supporting professionals remains important for successful application of the therapy (Spek et al., 2007a). In general it is assumed, that professional support is needed to motivate the client to continue with the treatment and to help him/her through the different procedures of the treatment.

It would be attractive to develop a psychological treatment that does not need a professional therapist, but still has some automated actor involved to interact frequently with the client. The current project addresses the development of an automated interactive psychotherapy for depression: BAS (behavioural activation scheduling). The core is a systematic internet intervention in which the patient

plans her daily activity (based on the principles of behavioural activation therapy, see below). The patients use a mobile phone which will help them during the day to work through the behavioural activation treatment. This daily support (through the mobile phone) is fully automated.

In this paper, the design of the BAS automated psychotherapeutic system as instantiation of intelligent ambient agent system is presented (Section 3) and first experiences within a pilot study are reported (Section 4). First the psychological intervention *activity scheduling* that is the basis of the current project is described in Section 2. Finally, the paper is concluded with a discussion.

## 2 ACTIVITY SCHEDULING

Activity scheduling (AS, also called behavioural activation) is an intervention for clinical depression based on a theory by Lewinsohn, Youngren & Grosscop (1979) who say that a low rate of behaviour (often caused by inadequate social skills) is the essence of a depression and the cause of all other symptoms. Part of his theory is the hypothesis that there is a causal relationship between lack of positive reinforcement from the environment and the depression. A depression can be treated by increasing the positive reinforcement through

increasing the quantity and quality of (social) activities. Many studies have shown that this type of intervention works just as well as or even better than other popular treatments (Dimidjian et al, 2006; Jacobson et al, 1996). Recently, it is shown that interventions of this type offered via the internet are very effective (Christensen et al, 2004; Andersson et al, 2005, Spek et al, 2007b).

There are two stages in AS treatment: the first stage is observing that pleasant activities and a good mood come together by writing down all pleasant activities and mood level. The second stage is changing the activity schedule so that the patient participates in more pleasant activities with the goal of increasing the mood level. The mood increases on a short term, and by learning that pleasant activities influence mood level positively, patients are more capable of dealing with future situations.

For the BAS intervention, this intervention as been implemented in a five-step plan: 1) rating the mood via a mobile phone or via a website; 2) registering their current pleasant activities and rate them; 3) actively planning more pleasant activities and setting a goal for the desired mood level at the end of the intervention; 4) encouraging to keep doing more pleasant by giving automated weekly feedback; 5) continue scheduling pleasant activities. In addition, a plan for the future can be made to help prevent relapse and reoccurrence of depression.

### 3 AGENT MODEL

Automated psychotherapy via website and mobile phone can be seen as an instance of Ambient Intelligence applications, where software has knowledge about human behaviours and states, and (re)acts on these accordingly (Aarts *et al.*, 2003). For this class of applications an agent-based generic model has been developed (Bosse *et al.*, 2009). This model can be instantiated by case-specific knowledge to obtain a specific model in the form of executable specifications that can be used for simulation and analysis. In this section, the automated psychotherapeutic intervention will be described using this generic framework.

#### 3.1 Generic Framework for Human Ambience applications

For the global structure of the generic model for human ambient applications, first a distinction is made between those components that are the *subject* of the system (e.g., a patient to be taken care of), and

those that are *ambient*, supporting components. Moreover, from an agent-based perspective, a distinction is made between active, *agent* components (human or artificial), and passive, *world* components (e.g., part of the physical world or a database).

Second, interactions between model elements are defined. An interaction between two agents may be *communication* or *bodily interaction*, for example, fighting. An interaction between an agent and a world component can be either *observation* or *action* performance. An action is generated by an agent, and transfers to a world component to have its effect there. An observation results in transfer of knowledge from the world component to the agent. Combinations of interactions are possible, such as performing an action and observing the effect of the action afterwards.

Finally, ambient agents are assumed to maintain knowledge about certain aspects of human functioning in the form of internally represented dynamic models, and information about the current state and history of the world and other agents. Based on this knowledge they are able to have a more in-depth understanding of the human processes, and can behave accordingly.

#### 3.2 Agent System Overview

Figure 1 gives an overview of the different components in the ambient agent model. In the remainder of this section, the components and their specific interactions are described. In Section 3.3, the internal knowledge of the specific agents is given.

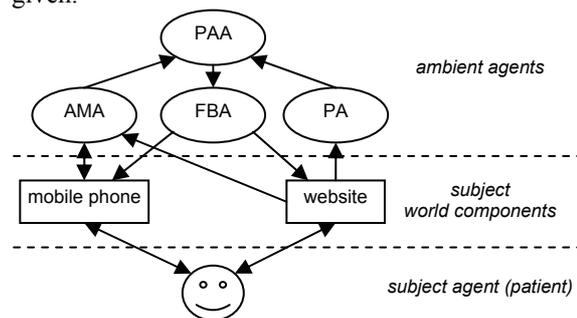


Figure 1: Components in the ambient agent model.

The *subject components* are the following:

**Subject agents:** participant suffering from a depression.

**Subject world components:** mobile phone of the participant, computer of the participant with a dedicated website.

The subject interactions:

### Observations and actions by subject agents:

Participant inputs information requested for therapy into either the mobile phone or the website via a computer. This includes:

#### Mobile phone actions by participant:

- Mood rating (number between 1 and 10)
- Activity rating (number between 1 and 10)
- Request advice

#### Mobile phone observations by participant:

- Activity schedule
- Tips

#### Web site actions:

- Planning activities
- Planning rewards
- Adding possible activities to a list
- Setting goals for the week

#### Web site observations

- Information about therapy, explanation
- Outcome of all actions performed (see above)

The *ambient components* are the following:

**Ambient agents:** activity monitoring agent (AMA), patient assessment agent (PAA), feedback agent (FBA), activity planning agent (APA)

The following ambient interactions are distinguished:

**Communication between ambient agents:** the AMA sends the information about the monitoring and rating of activities to the PAA, APA sends schedule and information to the PAA, PAA sends feedback to the FBA.

And finally, the following interactions between subjects and the ambient components:

#### Reminders

- Planned activities (AMA – mobile phone)
- Rating of mood (AMA – mobile phone)
- Rating of performed activities (AMA – mobile phone)

#### Reporting about ratings and activities

- Rating of mood (website / mobile phone – AMA)
- Rating of performed activities (website / mobile phone – AMA)
- Planned activities (website – APA)

#### Feedback

- Motivational remarks (FBA – website / mobile phone)
- Weekly feedback (FBA – website / mobile phone)
  - Plots of mood versus number of activities and rating of activities
  - Remarks about mood during week
  - Remarks about activities during week
  - Remarks about combination of mood and activities
  - Feedback on targets set for week

## 3.3 Individual Agents

### AMA: Activity Monitoring Agent

This agent is responsible for monitoring which activities have been performed by the patient and what the mood of the patient was at different moments (specifically after doing activities).

**Maintenance of Agent Information.** Maintain the ratings of the mood and the list of performed activities. Maintain preferences concerning how frequent reminders should be sent and the reminders that have already been sent.

**Agent Specific Task.** Based upon the information present: derive reminders. There are two types of reminders, namely (1) reminding the participant of the planned activities, and (2) reminding the participant to rate the activity and the mood.

#### Reminders for planned activities

The agent sends out such a reminder in case:

1. The participant requested a reminder (by indicated it in the activity schedule).
2. In case of a pattern of missed activities:
  - a. If the participant has missed a specific activity 2 times in a row, or 2 out of 3 times. The reminder is then sent half an hour before the activity is planned.
  - b. If the participant has missed two activities in general on a particular part of the day (e.g. never performs activities in the morning). Again the reminder is sent half an hour before the activity has been planned.

#### Reminders for mood and activity rating

Next to the monitoring of activities being followed, reminders of the rating of these activities are also sent. This is done when during the past three days less than 50% of the planned activities have been rated. Reminders for mood rating are sent based on the following mood rating frequency settings.

**World Interaction Management.** Process the information about performed activities, ratings and mood inserted into the mobile phone or via the website. Send reminders to the mobile phone (i.e. the patient).

**Agent Interaction Management.** Communicate the fact that ratings have been given to the PAA.

### APA: Activity Planning Agent

The APA keeps track of the planned activities and reports this to the PAA.

**Maintenance of Agent Information.** Maintain information about the activities that are planned by the patient.

**Agent Specific Task.** Based upon the information provided by the user and the options in the phase of

Table 1: Reminder frequency for mood rating.

Mood rating setting	First reminder	Second reminder (email)	Contact care taker
3 times per day	After four misses, afternoon of day 2	After a full day without response upon first reminder	After a full day without response on the second reminder
1 time per day	After one miss, evening of day 2	After a full day without response upon first reminder	After a full day without response on the second reminder
1 time per 2 days	After one miss, end of day 3	After a full day without response upon first reminder	After a full day without response on the second reminder

the therapy: maintain a schedule of activities.

**World Interaction Management.** Process the information inserted into the website.

**Agent Interaction Management.** Communicate the schedule on request to the PAA.

#### **FBA: Feedback Agent**

The role of this agent is to communicate information via either the mobile phone or the website based on the analyses of the PAA. This can be *weekly feedback*, *daily motivational remarks* or general conclusions about the progress of the therapy derived by the PAA.

**Maintenance of Agent Information.** Maintain preferences with respect to the media that is preferred (and suited) for specific type of feedback, and keep track of the feedback that has been sent.

**Agent Specific Task.** Triggered by the PAA: generate weekly feedback, select motivational messages, or forward analysis from PAA to the patient.

#### *Weekly feedback*

The weekly feedback is meant to create awareness of the participant that there is a relationship between mood and the activities being performed. First of all, in week one and two of the therapy overviews are given of the number of activities in relation with the mood (see Figure 2) as well as a similar figure showing the relation between the rating of the activities and mood.

#### *Motivational remarks*

Furthermore, also motivational remarks are sent; this is triggered by the PAA when it receives information from the AMA that the patient has rated either his/her mood or activities. Maximum of one message per day:

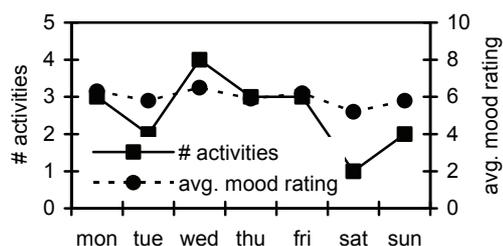


Figure 2: Number of activities and mood rating per day.

1. Communicate the highest mood of the past three days if this is higher than '6', also communicate the activities during that particular day: "Your highest mood during the last three days was on X: a Y! That day you performed the following activities: [list of activities and rating]."
2. Communicate an encouraging message in case the rating for mood just inputted was '6': "You rated your mood at X now, how nice!". In case it was '7': "You rated your mood at X now, that's really nice!". Or in case of an '8' or higher: "You rated your mood X, that's excellent!".
3. Communicate the percentage of tasks that have been performed, given that during the last 3 days at least 2 activities have been performed. In case more than 70% of the activities have been performed: "The last three days your adherence to the planning was very good, you performed X activities, which is Y% of the scheduled activities". In case less than 50% has been performed: "You did not adhere that well to the planning during the last 3 days, you performed X% of the activities, which totals to Y activities. Try to adhere to your agenda somewhat better". In all other cases: "During the last 3 days you performed X% of your planned activities".
4. If the average mood of day 4 of the week is at most 0.5 of the goal mood (in case applicable in the stage the participant is in): "Your average mood this week is X, you've almost achieved your goal. Keep this up till the end of the week! Thereafter you can reward yourself with Y". Note that the last part of the remark is only communicated in case specific rewards have been specified.

In case none of the above hold or are sent on the current day a tip is sent (from a list of expert tips).

**World Interaction Management.** Sends messages to the website or the mobile phone.

#### **PAA: Patient Assessment Agent**

The task of the PAA is to assess the status of the patient and to guide which feedback is given at what moment to the patient via the FBA.

**Maintenance of Agent Information.** Maintain information about the history of the patient, in terms of prior mood ratings, activities performed, and ratings for the activities. Maintain information

about the phase of the therapy.

**Maintenance of World Information.** Keep track of the time.

**Agent Specific Task.** Based upon the information present: derive conclusions about the performed activities and ratings in the past week. When considering the reported mood of the patient and the performed activities, the following abstracted remarks can be generated and sent to the FBA:

- Mood: “Your average mood during this week was A, on day C your mood was lowest, namely B”.
- Activities: “You performed E fun activities this week, on average this is D fun activities per day”.
- Mood in combination with activities: “Your low mood on day C corresponds with few pleasant activities, namely F. This shows that doing less fun activities can decrease your mood level”.

After the two week period more elaborate conclusion are generated. For the sake of brevity, these rules are not shown.

**Agent Interaction Management.** Send messages to be communicated to the patient to the FBA.

## 4 PILOT STUDY

### 4.1 Participants and Method

A total of nine participants joined the pilot study for the system, all students at the VU University Amsterdam, age ranging between 18 and 24 (average 21.2). They followed the intervention during three weeks after a start-up meeting. During that meeting, they received a Sony Ericsson M600i mobile phone, a link to the website and a brief explanation of the intervention. All participants were instructed to follow all assignments and to test the system. In addition, they were asked to describe any technical errors in detail. After every week the participants provided feedback about the intervention. These interviews were semi-structured. The questions were structured in five groups: look and feel, technical, textual, reminders and weekly feedback. In the end, the participants handed over their phones and received €100 participation fee and an online questionnaire was filled in.

## 4.2 Results

### 4.2.1 Weekly Feedback Sessions

**Look and Feel.** Most comments on the look and feel of both the website and the application on the phone were made after the first week. Negative comments

were about broken and illogically placed links, the layout of the menu and the font size of some of the forms. Four of the nine participants complained about the simple agenda feature: they would have liked to see more functionality such as a week overview, setting an end time for activities and a warning message when two activities are planned at the same time. Remarks about the mobile phone application were about functionalities people missed, such as changing the comments about a mood rating after saving the rating and adding or changing agenda activities. Some participants had difficulties interacting with the mobile phone itself.

**Technical.** The participants did not find many technical problems with both applications. Some complaints: the option ‘I did not do this activity’ was missing, and it was possible to give a mood rating of days in the future. Two participants received an error message on their phone after saving a mood or activity rating; this had to do with the motivational remark that was shown afterwards.

**Textual.** Apart from some spelling and grammar mistakes, the texts on the website were found very clear. However, more explanation about the mobile phone application and about when reminders could be expected was required according to most participants. In addition, no information about the transition between steps was provided and some participants were surprised when they automatically started with the next step.

**Reminders.** The reminders for rating mood and activities were judged as useful but the frequency (see Table 1) could be improved. Some participants found that the first reminder came too soon; others found that it came not soon enough.

Reminders before a planned activity also showed a pattern, although none of the participants noticed it. They all said these reminders seemed random, but were useful despite the randomness.

**Weekly Feedback.** Eight out of nine participants said that they enjoyed reading the weekly feedback and that the content matched their own experience during that week. A few of the automatically generated sentences needed more explanation, and the percentages should be rounded.

### 4.2.2 Evaluation Questionnaire

The results of the final evaluation questionnaire about how much the course was enjoyed are shown in Table 2. To the question ‘how useful was the course for you’ only one participant answered *no*, six answered *a little* and two answered *a lot*. A surprising result since none of the participants was diagnosed with depression. Apart from the

complaints about the frequency, the reminders that the participants received on their phone were judged as very useful. In general, the participants found using the mobile phone for mood rating a nice functionality, mostly because a mobile phone made it easier to rate mood several times a day compared with using a computer. The participants were also asked to score the overall intervention on a scale of 1 to 10: the mean score was 7.1.

Table 2: Results of the evaluation, the scale is from 1 (totally disagree) to 5 (totally agree).

Question	Mean answer
the information was new	2.7
I enjoyed viewing the website	3.8
I enjoyed working with the phone	3.8
the course was interesting	4.3

## 5 DISCUSSION

Based on the results of the pilot study, some changes have been made in a new version of the BAS system. The few technical issues are solved and some texts were revised. Based upon the critic of the participants on the weekly feedback and the unexpected evolving to the next step, three new general messages have been added. Furthermore, the agenda functionality on the website is extended. The rating system on the mobile phone is changed slightly, so that people can edit the comment field after saving the rating. The final adjustment is made in the reminder system: besides the mood rating setting (see Table 1), there is also a reminder frequency setting with the options low, medium and high. A combination of the two settings determines when a reminder is sent. When the reminder frequency is set to high, the participant receives a reminder after missing two rating moments, when set to medium, a reminder is sent after three missed rating moments and when set to low after four missed rating moments.

The pilot study indicates that advanced support via a website and mobile phone during activity scheduling intervention is technically feasible and perceived as useful. In the near future, a second pilot study will be conducted with between five and ten participants who suffer from a depression. The participants will be questioned in the same manner as described in this paper. After processing the results, an efficacy study will be performed with around 100 participants with a depression to determine whether their depression is lessened by

the BAS intervention system.

## REFERENCES

- Aarts, E.; Collier, R.; van Loenen, E.; Ruyter, B. de (eds.) (2003). *Ambient Intelligence. Proc. of the First European Symposium, EUSAI 2003*. LNCS, vol. 2875. Springer Verlag, 2003, pp. 432.
- Andersson, G., J. Bergstrom, F. Hollandare, P. Carlbring, V. Kalso & L. Ekselius (2005). Internet-based self-help for depression: randomised controlled trial. *British Journal of Psychiatry*, 187, 456-461.
- Bosse, T., Hoogendoorn, M., Klein, M.C.A., and Treur, J., *A Generic Architecture for Human-Aware Ambient Computing*. In: Mangina, E., Carbo, J., and Molina, J.M. (eds.), *Agent-Based Ubiquitous Comp. Amb. and Perv. Int. book series.*, pp. 35-62, Atlantis Press, 2009.
- Churchill R, Hunot V, Corney R, Knapp M, McGuire H, Tylee A, Wessely S. (2001) A systematic review of controlled trials of the effectiveness and cost-effectiveness of brief psychological treatments for depression. *Health Technol Assess*, 2001; 5: 35.
- Cuijpers P, van Straten A & Warmerdam L. (2007) Behavioral treatment of depression: A meta-analysis of activity scheduling. *Clin Psychol Rev*; 27: 318-326.
- Dimidjian, S. et al., Randomized trial of behavioral activation, cognitive therapy, and antidepressant medication in the acute treatment of adults with major depression, *J. Consult. Clin. Psychol.* 74 (2006), pp. 658-670.
- Gloaguen V, Cottraux J, Cucherata M & Blackburn IM. (1998) A meta-analysis of the effects of cognitive therapy in depressed patients. *J Affect Dis*; 49: 59-72.
- Jacobson, N.S., Dobson, K.S., Truax, P.A., Addis, M.E., Koerner, K., Gollan, J.K., Gortner, E., & Prince, S.E. (1996). A component analysis of cognitive-behavioral treatment for depression. *Journal of Consulting and Clinical Psychology*, 62, 295-304.
- Lewinsohn, P.M., Youngren, M.A., & Grosscup, S.J. (1979). Reinforcement and depression. In R. A. Dupue (Ed.), *The psychobiology of depressive disorders: Implications for the effects of stress* (pp. 291-316). New York: Academic Press.
- Leichsenring F. (2001) Comparative effects of short-term psychodynamic psychotherapy and cognitive-behavioral therapy in depression: A meta-analytic approach. *Clin Psychol Rev* 2001; 21: 401-419.
- Spek, V.R.M., Nyklicek, I., Smits, N., Cuijpers, P., Riper, H., Keyzer, J.J., & Pop, V.J.M. (2007a). Internet-based cognitive behavioural therapy for subthreshold depression in people over 50 years old: A randomized controlled clinical trial. *Psy. Med.*, 37(12), 1797-1806.
- Spek V, Cuijpers P, Nyklicek I, Riper H, Keyzer J & Pop V. (2007b) Internet-based cognitive Behavioral Therapy for mood and anxiety disorders, a meta-analysis. *Psy. Med.* 2007; 37: 319-328.