Ubiquitous Psychotherapy

Handheld-based tools let therapists customize psychotherapy for individual patients. Patients can accomplish their tasks using mobile devices, getting assistance from their tool whenever needed.

Marco de Sá, Luís Carriço, and Pedro Antunes,
University of Lisbon

Therapists commonly use *cognitive behavioral therapy* to treat anxiety, depression, and associated disorders. Based on a constructivist model, CBT relies on the therapists' ability to understand patients and induce them to gain awareness of their problems and distorted cognitions.[1] To achieve this, patients must engage in a pervasive therapy process, undertaking a series of activities both during sessions with the therapist and between sessions on their own. These activities include completing questionnaires; scheduling tasks; and registering thoughts, emotions, and situations without delay, whenever they occur. The process is inherently ubiquitous and often takes considerable time.

Currently, CBT depends on paper artifacts (for example, questionnaires, schedules, and forms for writing down thoughts) for task completion, which obstructs the process in various ways. For therapists, customizing the therapeutic materials and in-session gathering and analyzing of patient data are messy and demanding. For patients, registering situations and thoughts immediately after they occur is frequently difficult or even impossible. This often leads to patients performing these tasks either later or not at all, which can distort their perception of events and their reactions. Moreover, these paper artifacts can't directly provide guidance or incentives, which are crucial for the completion of patients' tasks. This shortcoming often results in low percentages of completed homework, which decreases the therapy's efficiency.

Recently, some researchers have proposed introducing technology to alleviate these problems (see the "Related Work in Computer-Supported Psychology" sidebar). However, these approaches tend to be for particular disorders, without therapist control or patient specificity. Furthermore, most of them rely on platforms that prevent patients from completing their tasks ubiquitously and lack support for collaborative work.

As part of the Scope (Supporting Cognition Outlines on Psychological Evaluation) project, we've developed a set of ubiquitous tools to support the entire CBT process. They support most in-session work, covering data exchange, rapid annotation and analysis, collaborative form filling, and customizing patients' homework. For between-session tasks, the tools cope with the therapy process's pervasiveness, covering therapists' and patients' daily activities, from those requiring more assistance (the initial phases) to those that are more autonomous (the final phases). Therapists can define and adjust specific therapeutic artifacts, choosing their structure, selecting and creating content, and defining proactiveness and even presentation modes. The artifacts proactively assist patients, providing help, guidance, and incentives as defined by the therapist. Overall, the tools provide a uniform common ground for both participants, which facilitates therapy. All the components are available in multiple devices and platforms, although handheld devices play a central role in our solution.

In particular, we feel that our tools

- let therapists create and refine effective mobile applications that actively respond to the patients' behavior and needs,
- extend the therapist's presence outside the office,

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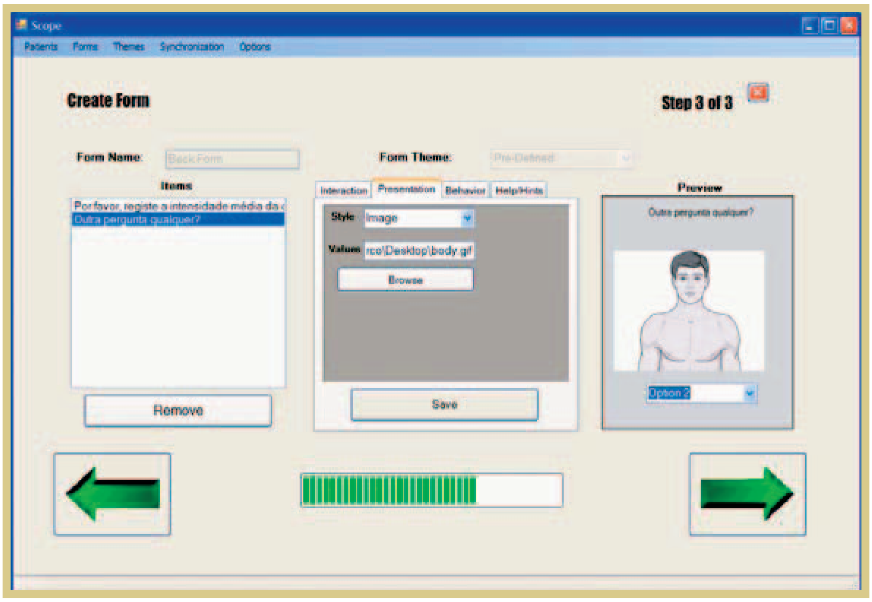


Figure 1. The ScoForms tool for defining and adjusting cognitive behavioral therapy: (a) the tablet PC version and (b) the PalmOS version.

- provide analysis and monitoring of multiple activities, and
- help patients accomplish their tasks and activities ubiquitously.

Computer-supported CBT

SCOPE features three types of tools:

- analysis, diagnosis, and prescription tools that only the therapist uses,
- a homework-registering tool that only the patient uses, and
- collaborative versions of the previous tools, which the therapist and patient use together for the previously mentioned activities and for data gathering and exchange. We developed these versions to ensure that the tools don't interfere with the collaborative process.

Our project has two main facets: between-session work and in-session collaborative work.

Between-session activities

Between sessions, therapists collect data from previous records and completed artifacts, review patient history, and define an effective therapy. This last task consists of selecting the necessary artifacts and organizing future sessions. Patients perform the therapist-prescribed tasks in their daily lives.

Defining and adjusting therapy. The ScoForms tool lets therapists define and adjust every CBT artifact. It's available in a complete version for tablet and desktop PCs (see figure 1a) and in a simpler version for mobile devices (see figure 1b). It provides means to create forms that patients can use on normal PDAs equipped with the ScoTherapy tool, which we describe later. We developed the desktop and tablet PC version using C# and .NET technologies and implemented the mobile version, aimed at PalmOS devices, using Java Micro Edition and the MIDP (Mobile Information Device Profile) API.

ScoForms lets therapists retrieve, change, or create questions and build effective questionnaires for specific patients and pathologies. A pool of standard questions is always available, as well as questions that the therapist created previously. To facilitate question selection, the tool supports different navigation arrangements (for example, by theme, such as questions for adults or questions for children, or by severity of the problem) and keyword search. The therapist decides the sequence of questions and their repetition when constructing the questionnaire. Templates and stereotyped questionnaires are available for reuse.

Each question has an associated answer type (for example, a keyword or a short text) and a default interaction element (for example, a gauge or text box). For each question on a particular questionnaire, the therapist can change the interaction element or combine it with others from a set of compatible options. For example, a common choice is a drop-down list instead of free-text entry or in conjunction with it, to provide a hint for the patient. Also, the therapist can add or delete help topics and can determine the total number of hints and help topics in the questionnaire.

Questionnaires can also include photos or images containing schematic representations of procedures or drawings (see figure 1a). This feature is particularly useful for younger patients. In addition, therapists can add sentences and several styles of text to each question or item. These capabilities let therapists define the application's presentation.

Because mobility is extremely important to CBT and all the applications are designed for mobile devices, therapists can customize the questionnaires to make them easier to use in specific situations. For instance, if the patient needs to frequently register thoughts at school, the therapist might create an application containing predefined and selectable situations and reactions. This reduces interaction with the device to simply choosing an option. On the other hand, if the patient is supposed to complete a similar form at home at the end of the day, the questionnaire might require the patient to write out the situations and his or her reactions.

Providing assistance. Because patients must complete their assigned tasks throughout the day, therapists can't always be around to help them. This lack of help is a primary cause of unsuccessful therapy and of a patient's comparatively

Related Work in Computer-Supported Psychology

The introduction of new technology to overcome difficulties that patients and therapists face with psychotherapy, and particularly with cognitive behavioral therapy (CBT), has recently gained momentum. As in many other healthcare areas, these technologies often focus on data gathering, visualization, and analysis, and on organizational tasks.[1] Software tools specifically for psychiatric and psychological use help patients follow a particular therapy,[2–4] demonstrating its effectiveness, for instance, in the treatment of anxiety and depression.[5,6]

However, most of these systems provide isolated, rigid solutions, failing to consider therapy's collaborative nature and therapists' and patients' individuality. Moreover, some of them rely on desktop approaches, which are incompatible with most real-life scenarios (for example, work, school, or office consultations).[7]

Web sites and Web-based applications for self-help are also emerging. One example is Internet-based therapy for depression and anxiety due to tinnitus (the presence of sound in the absence of auditory stimulation), in which patients reproduce the face-to-face therapy.[8] Although these techniques have advantages, such as remote assistance, they have strong disadvantages:[9]

- Patient disengagement is frequent.
- Patients frequently misinterpret the sites' objectives.
- The sites require constant management and monitoring.
- Users often require email and telephone assistance.

More recently, therapy-related applications that run on handheld devices such as PDAs have appeared.[3,6,10] However, they support only part of the therapy and don't allow customization of the patients' tasks or artifacts. Some only allow simple measurements of the severity of pathologies, indicating drug dosage or providing therapists with reference information about diseases or drugs.[5,11]

For patients, some self-control or relaxation procedures are available on handheld devices. In one case, patients engaged in group therapy using palmtop computers.[10] Each patient received a palmtop and carried it at all times. Alarms sounded several times during the day, and questionnaires regarding the patient's anxiety levels popped up. The tools consisted of modules for relaxation, cognitive restructuring, and so on. Palmtop use was intense during the therapy's initial stages but diminished throughout the rest of therapy, which indicated that the patients used the palmtops mainly to learn and understand the therapeutic procedures. Even so, patients improved in less than 6 months, and the researchers considered the treatment to be highly effective.

PDAs have also been successfully used to gather information in other mobile scenarios. For example, researchers have employed them for the Experience Sampling Method, which is very similar to some of the between-session methods used in CBT. Sunny Consolvo and Miriam Walker applied ESM to evaluate mobile devices' usability, using questionnaire-based tools on PDAs.[12] Jon Froehlich and his colleagues used a similar approach to study the relations between visited places and travelers' behaviors and preferences.[13] Although these studies had different objectives, they both illus-

slow improvement while away from the therapist. To alleviate this problem, the SCOPE tools simulate the therapist's presence.

This simulation involves two components. The first one is part of ScoForms and lets therapists customize triggers and behavior rules to attach to the patients' applications (see figure 2). The second is part of ScoTherapy and consists of a small monitoring module that actively analyzes the patient's behavior as he or she completes each artifact, triggering events according to what the therapist has defined. Events consist of notifications containing, for example, incentive sentences, congratulations, or warnings. The patient's application will display these notifications according to time, input, and interaction criteria that the therapist defined with the first tool. Therapists can also configure how these stimuli are presented and combined with the patient responses. For example, after the patient completes a task, an incentive could appear as a sentence or a graphic depicting the patient's progress through the task.

Therapists can also configure the application to act according to the patients' choices, detecting whether the patient is concentrating on the task or just answering the questions automatically. Examples of detection criteria include the number of words in an answer and the time spent answering. The application will issue a warning in an anomalous situation (for example, if the patient chooses the same answer five times or spends 10 minutes selecting an option from a list).

Deferred monitoring. Because patients must accomplish diverse and numerous assignments while away from the therapist, it's extremely difficult for therapists to follow the problems that the patients are facing. To remedy this problem, we developed a patient emulator that reenacts the patient's actions while he or she completes the assignments.

The emulator uses a repository and data produced by the monitoring module we mentioned earlier. For each action the patient takes (for example, pressing a button, selecting an option, or answering a question), the emulator adds a new entry to the repository.

trate the effectiveness of PDAs and handheld devices for gathering information pervasively and ubiquitously.

Nevertheless, to properly support CBT, we must consider both in-session and between-session activities. Support for therapists and collaborative therapist-patient scenarios is as important as the patients' individual work. Furthermore, any computer-based tools must provide therapy that's effective for specific disorders, therapy phases, and patients. These tools should offer different materials, such as questionnaires, videos, and text, that promote learning and provide reinforcement and reassurance. They should also incorporate variable interaction styles to facilitate or hinder the expression of emotions, depending on the therapy phase.

REFERENCES

1. C.S. Garrard, "Human-Computer Interactions: Can Computers Improve the Way Doctors Work?" *Schweizerische Medizinische Wochenschrift* (*Swiss Medical Weekly*), vol. 130, no. 42, 2000, pp. 1557–1563.
2. A.K. Das, "Computers in Psychiatry: A Review of Past Programs and an Analysis of Historical Trends," *Psychiatry Quarterly*, vol. 79, no. 4, 2002, pp. 351–365.
3. S. Herman and L. Koran, "In Vivo Measurement of Obsessive-Compulsive Disorder Symptoms Using Palmtop Computers," *Computers in Human Behavior*, vol. 14, no. 3, 1998, pp. 449–462.
4. M.G. Newman, "Technology in Psychotherapy: An Introduction," *J. Clinical Psychology*, vol. 60, no. 2, 2004, pp. 141–145.
5. L. Gega, I. Marks, and D. Mataix-Cols, "Computer-Aided CBT Self-Help for Anxiety and Depressive Disorders: Experience of a London Clinic and Future Directions," *J. Clinical Psychology*, vol. 60, no. 2, 2004, pp. 147–157.
6. J. Proudfoot, "Computer-Based Treatment for Anxiety and Depression: Is It Feasible? Is It Effective?" *Neuroscience and Biobehavioral Reviews*, vol. 28, no. 3, 2004, pp. 353–363.
7. P. Luff and C. Heath, "Mobility in Collaboration," *Proc. 1998 ACM Conf. Computer Supported Cooperative Work* (CSCW 98), ACM Press, 1998, pp. 305–314.
8. G. Andersson and V. Kaldo, "Internet-Based Cognitive Behavioral Therapy for Tinnitus," *J. Clinical Psychology*, vol. 60, no. 2, 2004, pp. 171–178.
9. D. Tate and M. Zabinski, "Computer and Internet Applications for Psychological Treatment: Update for Clinicians," *J. Clinical Psychology*, vol. 60, no. 2, 2004, pp. 209–220.
10. A. Przeworski and M.G. Newman, "Palmtop Computer-Assisted Group Therapy for Social Phobia," *J. Clinical Psychology*, vol. 60, no. 2, 2004, pp. 179–188.
11. M.A. Grasso, "Clinical Applications of Handheld Computers," *Proc. 17th IEEE Symp. Computer-Based Medical Systems* (CBMS 04), IEEE Press, 2004, pp. 141–146.
12. S. Consolvo and M. Walker, "Using the Experience Sampling Method to Evaluate Ubicomp Applications," *IEEE Pervasive Computing*, vol. 2, no. 2, 2003, pp. 24–31.
13. J. Froehlich et al., "Voting with Your Feet: An Investigative Study of the Relationship between Place Visit Behavior and Preference," *Proc. 8th Int'l Conf. Ubiquitous Computing* (UbiComp 06), LNCS 4206, Springer, 2006, pp. 333–350.

The therapist can configure the logged events' granularity. For example, at low granularity, the emulator could log each time the user taps the screen or clicks the mouse button and then store the taps' or clicks' coordinates. At high granularity, the emulator could log when the user moves back or forward from one item to another in a form. This flexibility is particularly important for mobile devices, which don't have much memory.

The data is stored in an XML-like format; the therapist can review and analyze it either manually or with a player application. Typically, the player presents a view of the application that the patient used and replays all the patient's actions. The therapist can also configure the number of actions and events that the player displays.

The emulator and player are part of the ScopAlysis tool, which we discuss later.

Patient homework. The ScoTherapy tool generates the application that the patient uses. Its primary goal is to let patients accomplish their homework by quickly answering questionnaires, registering thoughts and activities, or planning activities. It has a simple, easy-to-use interface, modeled according to what the therapist has defined and providing access to aids such as hints, lists of choices, reports, and rewards. The therapist can disable these aids during face-to-face therapy sessions, letting the therapist actively intervene to help the patient complete a task.

For between-sessions therapy, the therapist defines the aids and when and where they're available. For example, after the patient registers three positive thoughts, ScoTherapy might present the patient with a congratulation message. Or, at a later therapy stage, ScoTherapy might present the patient with only a list of choices for five of the most complex tasks. Another common aid is for a hint to pop up when a patient takes too long to answer a question.

ScoTherapy stores every item that the patient creates. So, if the therapist allows, in future activity planning the patient may access data that he or she entered for a previous task (see figure 3). For example,

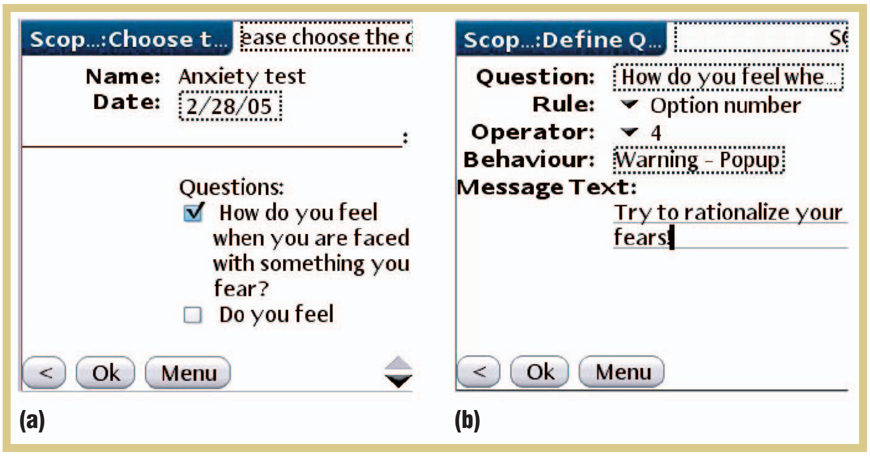


Figure 2. Defining rules and warnings on the PalmOS version of ScoForms: (a) Using the item selection menu, therapists select items for the forms and define the items' sequence. (b) Using the rule creation menu, therapists create rules and attach them to each item, defining that item's behavior.

consider a patient who plans the new activity "Go out to lunch," writing it in a text box. The therapist has allowed that patient to access a drop-down list of possible activities. So, on the next activity-planning task, the patient finds "Go out to lunch" in that list. This, naturally, reduces the time and effort spent on this task.

The therapist can transfer the applications that ScoTherapy handles between the therapist's and patient's devices when necessary. Therapists usually export the specifications for therapy assignments, which eventually contain data from a previous therapy session. They import the data that the patients have filled in, which eventually contain new items (such as recurring activities) in the choice lists.

Specifications, rules, warnings, and incentives data are defined with XML. ScoTherapy has two versions: one in Java for PalmOS devices and mobile phones and one in C# for PocketPC handhelds.

In-session work

This work consists mainly of conversations between the therapist and the patient, supplemented by data gathering and analysis. Occasionally, this work also requires adjusting artifacts "on the fly." In this modality, simple profiles of all the tools are available, capitalizing on shortcuts and predefined templates and schemas. Also, during therapy's initial stages, activities frequently require both participants.

Data gathering and annotation. During sessions, the therapist gathers patient information primarily by listening to him or her, annotating attitudes, behaviors, gestures, and other potentially relevant details. The therapist also collects completed artifacts and homework. However, the therapist must do these things without distracting or causing discomfort to the patient. This requires solutions other than fixed platforms that might obstruct face-to-face conversation and cause constant interruptions.

To meet such requirements, our ScoNotes tool lets therapists easily create structured annotations on their handhelds. Using ScoNotes, the therapist both gathers information and comments on previously gathered data. From the patient's record, the therapist selects ScoNotes and simply inputs text. The resulting annotations are registered with the creation dates and become automatically accessible from the patient's record.

Between sessions, ScoNotes lets the therapist organize annotations and create more detailed and structured annotations. These annotations could be a source of meta-information for every sort of data or artifact in the therapy process. The annotations can include keywords, and themes are reinforced (that is, annotations created over a form or a result that already has a theme will be stored under the same theme). Text entry fields are preferably character-based. New annotations are associated with patients and can be further correlated with every other artifact, including other annotations.

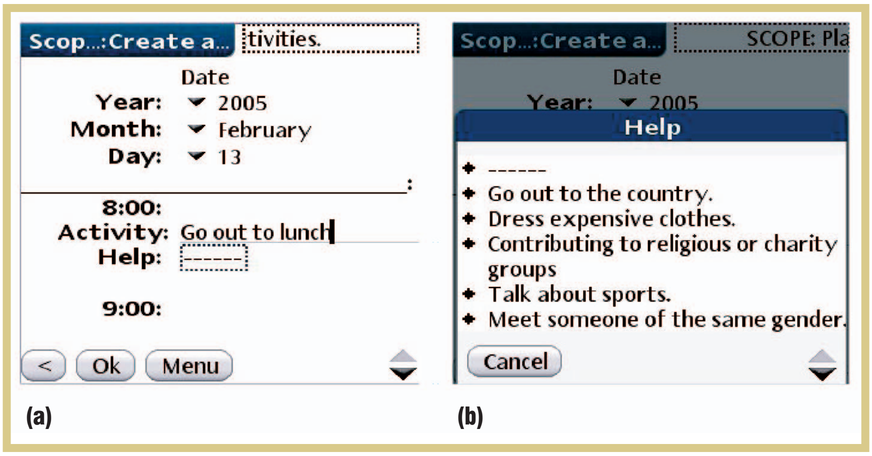
Analyzing patient information. The ScopAlysis tool provides a set of components for analyzing patient data. Its capabilities range from simple scoring of a questionnaire, usually during a session, to more complex analyses that are more appropriate for between sessions. Common types of analysis include rearranging the scoring criteria (for example, according to relevance) or determining score evolution over multiple questionnaires. Regarding thought and activity records, ScopAlysis can find recurring themes and keywords or determine word frequency. Its corpus (the body of data that it has collected) can also be extended to annotations, thus building on meta-information that the therapist introduces.

The therapist can visualize results through tables or simple graphics. On larger platforms, diagrammatic (graph based) presentations are also available. Results filtering is also possible.

Collaborative work. During the initial sessions, therapists spend much time explaining procedures and introducing the underlying methodology and correspondent artifacts. Because patients are just learning the CBT processes, they require frequent interventions and assistance from the therapist even while they're completing artifacts.

All our tools include a collaborative mode where the therapist and patient use the same device (for example, PDA or TabletPC) cooperatively, completing artifacts or reviewing results. Because the tools are context aware, help and hints are disabled as soon as the patient logs into the session, to prevent undesirable interruptions while the participants work together.

Figure 3. Activity scheduling on a Palm OS PDA: (a) registering an activity; (b) a drop-down list of possible activities.



Communication mechanisms let therapists and patients exchange information and collaborate. Because participants might be using different handheld and mobile devices, we've considered different capabilities and communication protocols. Currently, applications and other information are transferred using either Bluetooth and Java and PalmOS synchronization tools or Wi-Fi for the PocketPC version.

To facilitate data exchange, we developed an XML Schema that includes the underlying information that's transferred between applications and users. The schema provides sufficient detail to represent all the artifacts used in CBT and all the user interface specifications.

User interface design and evaluation

This project followed a user-centered design methodology developed to cope with the challenges of designing user interfaces for small devices.[2] During the early design stages, we held interviews and meetings with psychologists and assessed processes, artifacts, and generic therapies. We thoroughly studied documentation and videos describing the therapy and showing real therapy examples.[3] We identified information flows, activities, artifacts, physical settings, and cultural issues, along with major breakdowns (complaints and so on).

This process led to the construction of two low-fidelity prototypes made of paper cards. We based the PDA prototype on the Tungsten T3. To provide a realistic user experience, we emulated details such as weight, size, and interaction as closely as possible. The tablet PC prototype simulated a 12-inch standard model. We built the frames using a rigid material that let users carry the prototypes with them.

Early evaluation

We evaluated the prototypes' usability on site, simulating actual therapy or homework sessions. The evaluation took the Wizard-of-Oz approach. Three psychologists (two with clinical know-how) and 10 "patients" with different educational backgrounds assessed the prototypes. The psychologists provided a more thorough, domain-oriented evaluation. The patients focused on screen arrangement, the sequence of screens and navigation between them, and the use of artifacts during interviews. We also provided the original paper forms and explained the procedures.

Early results were quite encouraging. The psychologists welcomed the ability to exchange forms with patients digitally while being able collaborate on the filling-in process. They particularly liked the customization of forms and the elimination of such interruptions as getting printed forms, fetching previous session results, and editing during collaborative filling-in. They considered this workflow an improvement over the classic workflow.

The patients clearly preferred the prototypes, particularly the PDA, to the original paper versions. In simulated therapy sessions, they found the prototypes to be no more intrusive than paper.

Software prototype evaluation

We then developed high-fidelity software prototypes and tested them with the same group of psychologists plus two therapists who were new to the tools. Twelve computer science students, some inexperienced with handheld devices, participated as patients.

The psychologists used their tools thoroughly and tried to replicate their usual working methods. They used ScoForms to create three different artifacts consisting of different types of questions and items and targeting different subjects and disorders. They also transferred information between devices, used ScoTherapy to fill in the created artifacts, and used ScoNotes to take annotations. To assess the tools' advantages during sessions, we had them accomplish the same tasks in the traditional way. Each psychologist used the desktop and handheld versions for two sessions each.

The psychologists took approximately one minute to create each item, choosing its hints, behavior, interaction element, and content. Creating a 10-item questionnaire (after creating the items) took approximately two minutes. Creating the artifacts with ScoForms took 50 to 80 percent less time than with traditional methods.

The patients focused mainly on interaction, use, and design. They used ScoTherapy for two days to perform specific form filling-in tasks. We took measurements, administered usability questionnaires, and filmed every session for later analysis. Again, the mobile devices proved effective for the different settings that we tested (for example, individual or collaborative use). To complete the created artifacts, the patients took two to four minutes, depending on the number of free-text questions.

By using the SCOPE tools, both the

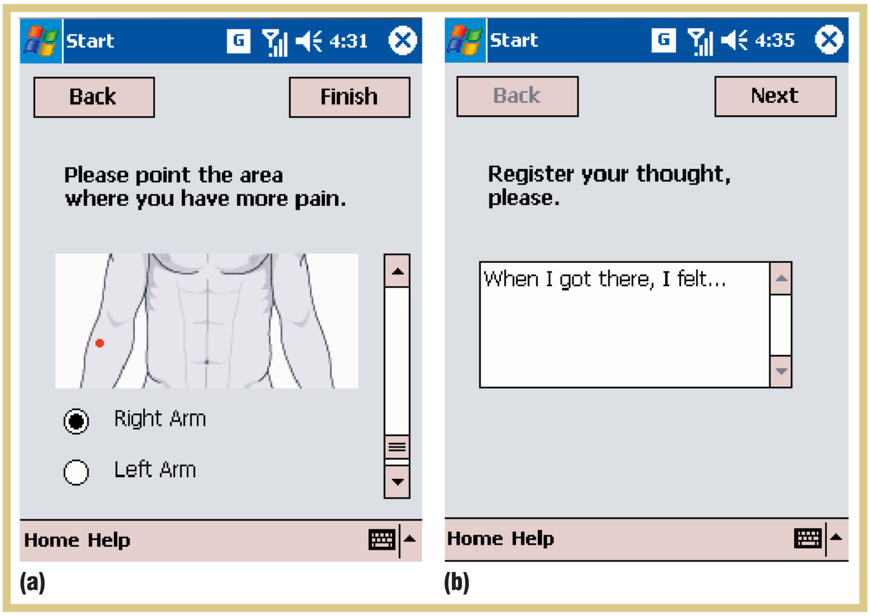


Figure 4. PocketPC-based therapy for pain- and weight-associated disorders: Patients can (a) indicate where they hurt or (b) register their thoughts related to weight-associated problems.

therapists and patients performed their tasks in less time. Our results demonstrate that therapists can effectively use ScoForms to create artifacts and organize content. Therapists welcomed the ability to configure the interaction elements and choose the question and answer types. They particularly liked that they could provide help and hints to their patients for specific therapies.

The patients appreciated using the handheld devices to complete the questionnaires, particularly because they could browse through the already-answered questions and update them if necessary. Another major benefit was the immediate feedback that ScoTherapy can provide.

Prototype validation

To validate our expectations of the tools' customization capabilities, we had five practicing therapists use them to replicate and enhance successful psychotherapy applications for specific problems. Two had experience with similar software; however, with our tools, they could now also manage the applications and adjust them to their specific needs.

Accommodating all the emulated applications required some rearrangements, such as including new interaction options. However, we successfully accomplished this, and we've integrated these applications into the software's current version.

Anxiety

Most applications that address anxiety rely on relaxation tutorials or anxiety assessment inventories.[4] With the Scope tools, therapists could adjust tutorials for similar procedures, including images illustrating relaxation techniques, hints on how to execute the movements, and a field for classifying the results' effectiveness. The therapists either already owned the images or quickly downloaded them from the Web. For the anxiety inventories (for example, the Beck Anxiety Inventory or the Max Hamilton Test), the therapists selected a simple arrangement of a few items and their corresponding intensity levels. The patients who tested the therapy application particularly appreciated these computerized inventories. The main reasons were the simplicity, quick response time, and the ability to update each item at any time, especially when compared with the traditional paper form.

Depression

Pleasant-activity scheduling is a common practice during depression therapy. Using ScoForms, the therapists composed a simple scheduling form that integrated classification fields for each scheduled task (see figure 3). The therapists added hints mainly as lists of common activities that the patient could select for a time slot during a day (see figure 3b). They also defined alarms to alert the patient when he or she needed to schedule an activity. This process resulted in different types of scheduling forms. For instance, one therapist composed a form where a patient could browse each hour of the day sequentially. Another form let patients input the date and hour and choose an activity for that slot.

Pain and weight

To treat pain-associated disorders, the therapists created pictorial-based forms. In one, users point and click on the location of their pain on displayed images of the human body (see figure 4a). Each image has an associated set of questions related to pain intensity, medication used, or associated symptoms.

Some therapists created forms addressing weight-associated problems. These forms were mainly questionnaires, but some also let patients register their thoughts (see figure 4b). The therapists could easily design this latter feature by arranging a few items (for example, a situation description, the consequent thoughts, a description of the patient's behavior, and an appropriate substitute thought).

A psychotherapy research group is using the Scope tools to treat patients recovering from cancer who have pain-associated disorders.[5]

We plan to incorporate new functionalities in the Scope tools. Examples include voice interaction with the mobile device, using different media such as video or audio to explain procedures, and alarms alerting patients or even their therapists of specific situations.

We're working on a group version of these tools. These include a managing tool that lets therapists engage in group therapy sessions with patients in the same room or at different locations. We're also developing a special version for in-exposure therapy sessions, which will let therapist and patients engage in group sessions outside the office.

We plan to adapt our tools to applications other than CBT. Some patients might need to monitor physical symptoms from day to day. So, we plan to incorporate devices that automatically monitor heart rate, temperature, and so on. These devices will communicate directly with the mobile device and trigger alerts when necessary.

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REFERENCES

1. M. Mahoney, *Constructive Psychotherapy*, Guilford Press, 2003.
2. M. Sá and L. Carriço, "Low-Fi Prototyping for Mobile Devices," *Proc. 2006 SIGCHI Conf. Human Factors in Computing Systems* (CHI 06), ACM Press, 2006, pp. 694–699.
3. J. Davidson, J.B. Persons, and M.A. Tompkins, *Cognitive-Behavior Therapy for Depression*, Psychotherapy Video Series, Am. Psychological Assoc., 2000.
4. S. Herman and L. Koran, "In Vivo Measurement of Obsessive-Compulsive Disorder Symptoms Using Palmtop Computers," *Computers in Human Behavior*, vol. 14, no. 3, 1998, pp. 449–462.
5. J. Reis et al., "Cognitive-Behavioral Therapy with an Oncological Patient via Handheld Computing," to be published in *Proc. 8th World Congress of Psycho-Oncology* (Psycho-Oncology 06), John Wiley & Sons, 2006, pp. 905–906.

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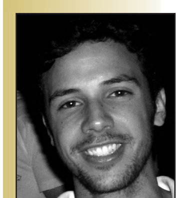
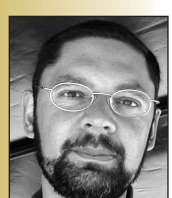


Marco de Sá is a PhD student at the University of Lisbon. His main research interests are ubiquitous computing, pervasive computing, user interface design, user-centered design, design methodologies, ambient intelligence, and context awareness. He received his MSc in computer science from the University of Lisbon. Contact him at LaSIGE, Departamento de Informática, Sala 6.3.30, Edifício C6, 1749 - 016 Campo Grande, Lisboa, Portugal; marcosa@di.fc.ul.pt.

Luís Carriço is an assistant professor at the University of Lisbon's Department of Informatics. His main research interests are accessibility, e-health, human-computer interaction, user-centered design, mobile-interface design, pervasive computing, and ubiquitous computing. He received his PhD in electrical and computer engineering from the Technical University of Lisbon. Contact him at LaSIGE, Departamento de Informática, Sala 6.3.23, Edifício C6, 1749 - 016 Campo Grande, Lisboa, Portugal; lmc@di.fc.ul.pt.



Pedro Antunes is an associate professor at the University of Lisbon's Department of Informatics. His main research interests are the design, development, and assessment of collaborative technologies; complex sociotechnical interactions; electronic meetings; and group decision and negotiation. He received his PhD in electrical and computer engineering from the Technical University of Lisbon. Contact him at LaSIGE, Departamento de Informática, Edifício C6, 1749 - 016 Campo Grande, Lisboa, Portugal; paa@di.fc.ul.pt.