Mobile Support for Personalized Therapies

OminSCOPE: Richer Artefacts and Data Collection

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***Abstract* — this paper presents OmniSCOPE, an environment for the development of mobile pervasive therapy artefacts. OmniSCOPE builds on SCOPE, a tool for the support of mobile psychotherapy. Given the positive results that emerged through the development and utilisation of SCOPE, extensions were developed in order to enhance the artefacts, the data collection by patients and its consequent analysis by therapists. These extend the usage possibilities to new situations and therapies also targeting a wider range of users. We detail the extensions and how they support new activities and therapies illustrated by three case studies in which they are being currently evaluated. We describe initial results and discuss future trends and directions.**

Keywords-mobile devices; paper-based artefacts; personalized therapy.

I. INTRODUCTION

The introduction of mobile technology within therapeutic practices, in support of several activities, has proved to provide beneficial results for both therapists and patients. For patients, the ability to carry therapeutic artefacts (e.g., tutorials, questionnaires, procedures) without location restrictions and directly on their personal devices brings a set of advantages that range from the easiness to use several artefacts on a single device up to the possibility of obtaining information and pervasive therapy support [14]. On the other hand, for therapists, it offers the opportunity to extend their presence outside therapies, means to enhance the traditional paper-based artefacts and, more importantly, the ability to collect patient data through seamless and comprehensive methods.

These advantages are, however, restrained by the usual lack of personalization, richness of interactivity and broadness of content, which can be found in other, more powerful, platforms. In general, mobile therapy tools are highly specific and focused on singular activities (e.g., register number of cigarettes smoked during a day; register thoughts; self-assessment tests) or disorders (e.g., anxiety, depression, obesity, pain related issues) [14][12][7]. Contrastingly, desktop and web-oriented tools offer richer experiences [3][12], configurable access and support to a wider set of problems, especially given the use of multimedia content. On the other hand, they fail to provide the pervasive therapy means that characterise mobile tool's efficiency and the degree of individuality and personalization that is often required for some types of therapy. Clearly, this gap between mobility and richness of interactivity, personalization and scope of existing tools open opportunities for new systems that combine the advantages of both desktop and mobile tools and urge for new approaches.

SCOPE [14] is a software framework that offers some of the abovementioned features, including tools that support 1) the construction and adjustment of specific therapeutic artefacts for psychotherapy (e.g., questionnaires and registries for cognitive behavioural therapy - CBT); 2) their utilization by patients on mobile devices; and 3) the collection of questionnaire and form completion and usage data. Through the experiences of its application to CBT, it has provided very positive results. The added benefits that it has introduced were clearly demonstrated by user preference when compared with the paper-based counterparts and by the detection of issues that were previously unnoticed when using the traditional approach.

Nevertheless, SCOPE still fails to provide a generic approach that can be applied to different disorders. It covers only psychotherapy artefacts and CBT procedures, neglecting every other health care domain that can benefit from this type of pervasive therapy support. Moreover, the absence of rich visual and multimedia content retracts from its ability to be used for more interactive, complex and demanding therapy approaches that require content other than textual and pictorial based. Accordingly, and building on the initial results and both therapist and patient opinions, new extensions and features were envisioned and have been added to the framework. These focus, in particular, the extension of SCOPE's broadness in terms of patient support, offering new and richer artefacts that cover different issues, targeting new domains and new users. Additionally, new means to support data collection and deeper analysis techniques have also been included. As a collateral result, besides extending it to new domains, it now also supports its utilisation by users with disabilities, which are, frequently, those more prone to require therapy.

This paper presents OmniSCOPE, a framework that extends SCOPE, addressing these issues and offering enhancements to the entire process. As its greatest contribution over existing and previous work it presents the data collection additions and the richness of the new created artefacts. Furthermore, it explains how it SCOPE's effectiveness and positive impact were extended into other therapies that require ubiquitous and pervasive data collection by patients and extensive therapy outside the office, as well as its access to disabled users.

II. RELATED WORK

The quick evolution of technology has promoted its inclusion within a wide set of our society's activities and domains. In

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particular, the recent burst of mobile and personal devices has allowed for the development of assistive technologies and software that provide pervasive support for patients on the go. More recently, this support has been evolving to personalized levels, matching therapies, artefacts and technology to each individual user to a level that was unavailable before. Examples of existing applications/artefacts range from simple questionnaires; digital books, diet control forms, relaxation tutorials, tests, etc., but are generally restricted to a particular type of artefact and domain. Some tools that allow the customization of digital artefacts have also started to emerge and have showed high success within their domains [16][15][16].

Following these advances, studies on how computers can improve clinicians' work [6][12] and the development of applications directed to support this kind of activities has been naturally gaining some momentum. In general, excluding expedite diagnosis solutions that have revealed strong human rejection [5], studies have demonstrated the effectiveness of the computer role in the process of therapy [18][8].

However, most of the existing systems provide either isolated therapist solutions or isolated patient solutions with no therapist control. Moreover, they only cover partial steps of the therapy process and do not allow the customization of the patients' tasks or artefacts. The majority is rather simple and allows simple measurements of the severity of pathologies, indicates drug dosage or provides therapists with reference information about diseases or drugs [7].

Applications developed for the treatment of specific pathologies, such as bulimia nervosa, had positive outcomes [11]. On a mobile strand, making use of handheld such as PDAs or TabletPCs, some self-control or relaxation procedures are now available [13]. Still, they offer no options to adjust to patients' needs, problems and characteristics or even the particular therapy stage the patient is going through.

Several web-based self-help applications and websites are also available [1]. Overall, in spite of the advantages inherent to this type of solutions, such as remote assistance and costs lowering, they have many disadvantages [17]. For instance, patient disengagement is frequent, as well as patient misinterpretation of the site's objectives. Moreover, albeit non mobile, there are some examples of multimodal systems applied to therapeutic procedures. For instance, in [3] the authors developed a system directed for the support of on-consultation heart stroke rehabilitation. These involve multimodal interaction methodologies (e.g., movement recognition) that were introduced in order to capture patient's biofeedback. Furthermore, they enable creation, storage and manipulation multimodal annotations [19] but lack the necessary support for the off-session activities. In fact, most of the work found in the available literature does not address therapy stages where the patient is away from the therapist (e.g. home work), which are, in many cases, paramount.

In summary, the ability to configure therapies that can be accessed by patients on their mobile devices and, simultaneously, provide means to address different therapy approaches is scarce. None of the abovementioned systems, including our own previous work, addresses mobile multimodality in therapy activities, which seems to combine the advantages of richer therapies with the pervasiveness that mobile devices provide.

Our goal, and contribution over previous work, is the integration of multimedia content and multimodal interaction aiming at providing therapists with new means to create therapeutic artefacts that suit a wider universe of patients and a broader range of therapies. Additionally, by taking advantage of new modalities, we extended the data collection features that support the pervasive therapy procedures. Besides facilitating the therapy and diagnosis process, it provides augmented analysis means for therapists to improve the support for their patients. Taking advantage of the modalities that we provide, we enable advanced modes for data gathering and analysis.

III. New Perspectives and Requirements

The motivation behind this work emerged as a result from the positive impact that SCOPE had while applied for the support of pervasive therapy within real-world case studies. SCOPE is a framework that targets the support of ubiquitous Cognitive Behavioural Therapy (CBT), by facilitating the tailoring of personalized therapies and artefacts in order for these to suit patients' needs and goals. Throughout the experiments that validated it, it provided great results and high levels of satisfaction from both therapists and patients. Still, from the several questionnaires and evaluation sessions that took place, it was noticeable that improvements could be made, especially those concerning the accessibility and usability of the resulting artefacts as well as the data collected during treatment.

As different patients started to use and interact with the tools, new requirements emerged, addressing both the users' needs towards the device and artefacts and towards the locations and settings in which they were used. For therapists, the tool revealed enticing opportunities on data collection and new therapies. In fact, experimental sessions showed that, if augmented, the tools and pervasive support that they provided could be applied to new therapies and, more interestingly, new health-care domains. Besides overcoming cost related issues, the appeal of mobile devices, games, and different interactive modalities appeared to be an effective way to reach different patients, with different disorders, in new and improved ways. In concert with these advances, the ability to capture data in alternative ways, facilitating the user's tasks and opening new doors in regards to the richness of the therapy and resulting information, could compose a wider ranged tool with added benefits. Moreover, allowing therapists to define their own persuasion mechanisms that encourage patients to act and to (co)respond to their therapies, acted as a motivation to further improve SCOPE's tools.

Based on this, the main goals that emerged gravitated towards the support to new domains, new users, and consequentially new data collection features.

A. New Users

In order to support new users, (e.g., younger children or user with physical disabilities), the initial requirements regarding the artefacts' usability have to be extended. In

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particular, it is paramount to provide alternative interaction mechanisms that facilitate interaction in different locations and by users with different dis/abilities. As such, the ability to interact and complete the therapeutic artefacts through a hands-free interactive experience was immediately one of the first functionalities that had to be included. Moreover, this new functionality would benefit users with visual impairments (some that tried SCOPE had difficulties using it) and a new eyes-free mode would be a significant step towards the construction of universally accessible artefacts as well.

In concert with these new interaction modes, it was also necessary to create more appealing artefacts that would maintain some users' level of interest throughout therapy, which is particularly important to users that react better to more visual or auditory stimuli. Accordingly, new multimedia content and persuasion mechanisms were also established as requirements for the new version of SCOPE.

B. New Therapy Domains

Different domains require different types and different arrangements of content. For instance, in order to compose richer artefacts that could suit therapies based in sound and in video content, it became clear that SCOPE's artefacts had to be augmented with multimedia features. Moreover, taking advantage of richer artefacts by augmenting their richness of interactivity, thus allowing users to interact with the added content in different ways, was also necessary.

C. Augmented Data Collection

One of SCOPE's greatest features was the ability to capture and collect data in different ways, providing several means for therapists to monitor, to analyze and diagnose patient evolution throughout therapy. Accordingly, it includes means for patients to annotate thoughts and collect their data directly on the used artefact. This data can be analyzed, on a later stage, by the therapist. Additionally, SCOPE automatically collected usage/interaction data, creating logs that could be reviewed by the therapists, showing patients' hesitations, changes of mind and overall, a wide set of important details that were related to the artefact usage process.

Nevertheless, details about the patient (e.g., his/her voice, his/her breathing rhythm), details about the situation that triggered a specific event (e.g., location, environment), etc., could pass unnoticed unless explicitly provided by the patient. Moreover, the results of specific types of therapy are difficult or impossible to capture/explain through words. This pointed out the need to provide new means to gather data and for patients to provide the results to their therapeutic endeavours.

D. Necessary Upgrades

Summarizing, to cope with the new requirements and to target new therapies and domains, it is necessary to introduce the following extensions to the original SCOPE environment.

Multimedia Content: In order to address different domains and different users, the framework needed extensions that supported the ability to create richer artefacts. By containing multimedia components (e.g., video and audio clips) that could overcome and enhance paper-based therapies and their digital counterparts, it opens the scope for new therapy approaches.

Multimodal Interaction: As a consequence from adding new therapy approaches and new targeted disorders, the universe of potential users is also widely broadened. Accordingly, new interaction modalities are required so that users with and without disabilities are able to benefit from OmniSCOPE and its artefacts.

Multimodal Data Collection: As new therapy approaches are available, new means to collect patient data and for patients to engage on therapy procedures are also necessary.

IV. THE STARTING POINT - SCOPE FRAMEWORK

SCOPE is a software environment that includes a set of tools for the definition, distribution and utilization of paper-based therapeutic artefacts (e.g., forms, questionnaires, activity plans, thought registers) [14] directed to psychotherapy. The tools were specifically oriented to the support of Cognitive Behavioural Therapy (CBT) and the adjustment of the common artefacts that are currently used for the diagnosis of disorders and the therapy procedures that are usually related to this type of approach. As such, its features are specific and focused on CBT's needs.

On the development side, directed to power users, a role generally assumed by therapists and clinicians, its goal is to support the construction of digital counterparts of paper-based artefacts (Figure 1.). These can be configured with different types of presentation modalities (e.g., text, images) that can be combined with several interaction options (e.g., free-text, multiple-choice, gauges, direct interaction – touch screen). Additionally, the artefact construction tools include features that enable therapists to define rules and triggers that can set the artefacts to (re)act according to the patients' behaviour. On this facet, SCOPE includes the composition of rules that can be triggered by the patients' answers to specific questions ("yes" or "no" or a value from a list; to the patients' interaction with the device (e.g., tapping the screen) or to time (e.g., force an action after 4 minutes).

On the other end of the spectrum, patients can interact with the resulting artefacts that therapists create, on their own personal devices, through their individual patients' tool. SCOPE offered alternatives for varied platforms (e.g., PocketPCs, PalmOS, DesktopPCs). This patient tool's main function is to recreate and materialize the artefacts according to their specification, including both presentation details and the interaction possibilities that it entails. It is composed by a straightforward, simple to use, user interface that allows for the selection of any stored artefact and interaction with it. However, one of its greatest benefits and contributions is the underlying mechanism that stores every interaction and result that is generated by the user while utilizing the artefact. This feature is supported by a logging mechanism that collect the usage data and time-stamps it for posterior analysis.

Finally, SCOPE also provides the ability to review and analyse the interaction logs or the revision of usage results. This can be achieved by reviewing list of the provided answers

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or by analyzing a video like reproduction of patient's entire interaction with the artefact (Figure 1.).

V. RICHER ARTEFACTS

One of OmniSCOPE's main goals was to provide therapists with the ability to create richer and more interactive artefacts. The artefacts developed using SCOPE can be created by the composition of different pages, each containing a set of presentation or interaction elements. Additionally, these elements can be augmented with behaviour, which allows power users (e.g., therapists) to adjust triggers and actions that activate different reactions to the user's interaction with the artefact.

With OmniSCOPE, artefacts maintain the same structure but elements are organized in a different way. Now elements can be used for output (e.g., text, video clips, audio files, images), for input (e.g., textboxes, voice recorders) or combinations of these (e.g., gauge that provides output but can be interacted with). Each type is described, along with examples, on the following sections.

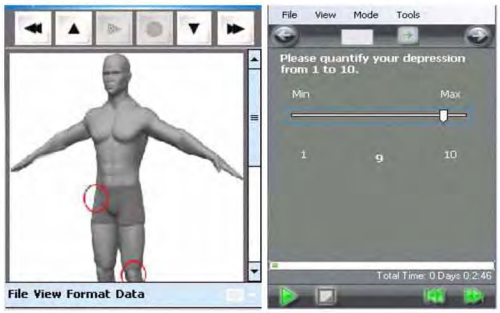

Figure 1. Left - An artefact that allows users to point on the image the areas where they feel pain and record thoughts that are associated to that pain. Right - The log-played allows therapists to review every action that the patient performed while interacting and using the artefact.

A. *Output Elements*

Output elements are mainly used for presentation purposes. They can be configured to display content to users on several ways using three media types:

- **Text** - output elements are used to present textual content (e.g., book excerpts, questions) and can assume different configurations. For instance, labels can be used to show text with several characteristics (e.g., colours or font sizes).
- **Images** – elements display images, drawings, and pictures.
- **Audio and Video** - output elements can be used with imported audio/video files; can be recorded directly on the wizard through a microphone or webcam or, for audio only, can be synthesized from text.
- **Combined** - elements are composed by two or more output elements that present the same content. For instance, a text label can be used in concert with an audio file that contains the audio version of that same text.

B. *Input Elements*

Input elements can be interacted with, providing users with the necessary mechanisms to create content and store it on the artefact. Here, elements can also assume various configurations and limitations or specific characteristics can be imposed. The same media types are available:

- **Text** - input elements allow users to type and store content on a textual format (e.g., text-boxes). These can be limited regarding size, font, characters, etc.
- **Images** – based input elements are also available. These can be captured by the user (if a camera is available) or can be composed by drawings, made directly on the artefact.
- **Audio and Video** - input elements give users the ability to record sound or video clips directly into the artefact. The maximum length of the recording can also be configured during design.
- **Combined** - input elements can also be used. For instance, a specific element can be configured to request the user the same answer in two modalities that complement each other (e.g., text plus audio or video).

C. *Mixed Elements*

Mixed elements entangle output and input possibilities into one single element. They display content but also allow users to interact with, selecting or introducing data. The most common examples are track-bars or choice lists (e.g., radio button groups, combo-boxes), where each item of the list displays a particular type of media (e.g., text sentence, audio or video clips, image) and the user interacts with it by selecting the correct option(s).

In addition to the previous elements, and taking advantage of the actions and triggers that define elements' behaviour, more complex mixed elements can be configured. For instance, combining a time-based trigger with a video allows therapists to create an interactive video. By defining a trigger that sets a time interval on the video and associating an action (e.g., play a different video) to it, therapists can set the video to stop and change if the patient identifies that specific interval and clicks on the screen while watching it. The same mechanism applies to audio files and images. In the latter case, instead of time-based intervals, therapists can define areas that can be clicked or interacted with (e.g., double click, gestures) triggering different actions within any given image.

D. *Facilitating Artefact Construction*

Given the new content and diversity of elements that can compose artefacts, the creation process had to be improved and facilitated so that therapists, with different backgrounds and with no programming experience could easily interact with the design tool. Accordingly, the creation process is guided by a new, revamped wizard based user interface. With it, users are able to use pre-existent elements or create their own, arrange them as needed and define the overall behaviour, composing fairly elaborated artefacts. As shown in Figure 2. , the wizard is composed by an editing canvas on the middle, where designers have the view of each final page that is being edited. Artefacts are edited page by page.

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On the left, a toolbox displays the available elements. Therapists can add elements and edit them by the push of a button. The editing process for each element is also wizard-based and offers automatic content generation. For instance, audio versions of the typed text can be automatically added to the element if desired by the therapist (Figure 3.).

On the right side of the wizard, the page/screen list allows direct manipulation of the artefacts sequence and organization and the selection of the screen that is currently being edited.

Figure 2. The artefact creation wizard.

The tool is also able to offer design alternatives when available (e.g., replacing radio buttons by drop-boxes when there are many options) [15]. Additionally, it can also enforce usability guidelines if desired, limiting the number of elements per screen, setting their location, size and even screen arrangements, which is needed for non-experienced users and therapists with no UI design knowledge.

As an example, an artefact representing an anxiety test can be composed by an introductory screen which contains a brief motivational text. The following screens can be composed by questions that can be represented by images, videos, text and answered through voice, audio and video recordings (if supported by the device). Figure 2. shows a screen under construction containing an element with an image of a human body and a choice-list where the user can select a specific anatomy part. Also, the screen includes a audio recording element that allows the patient to record a brief thought about that body part. Within this element, if the user selects a specific body part (e.g., head or arm), a message will be popped playing a sound that tells the user what his/her choice was.

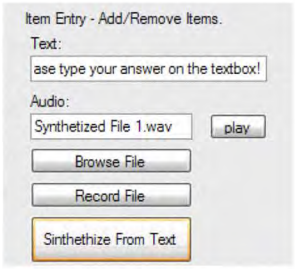

Figure 3. Element edition wizard. The wizard allows users to associate audio to a text label. The audio can be generated from a file, directly by the therapists – using a microphone – or syntethised from the text.

For extension purposes, the environment's architecture is designed in such a way that all elements can be programmatically extended and augmented with any desired features. The only requirement is that the programmer of a new element includes the necessary methods to store and restore the element's data at any given time.

The user interface design guidelines are also based on a rule-set file that defines elements' size, location, amount and type criteria. These guidelines can be loaded at will and adjusted by any expert user by editing the corresponding XML-file in which the guidelines are contained.

VI. Universal Artefacts

By enlarging the scope and number of supported therapies by OmniSCOPE, the universe of possible patients and users is also enlarged. Moreover, even within psychotherapy and CBT, patients with disabilities had difficulties while interacting with some of the developed artefacts. Accordingly, it was necessary to include new means to interact with the artefacts and new means to provide data for therapists to analyze.

Accordingly, the runtime tool, which is used by patients on their mobile devices to interact with the artefacts, besides having the new multimodal/multimedia elements, is now equipped with an eyes-free and a hands-free usage mode.

For the former, all elements are augmented with a short audio description. For text-based elements, a synthesized version of the same content is automatically created. For images or videos that do not contain audio, an audio recording, by the therapist can be added to each element, allowing patients to interact with the artefact, and be aware of its content, without looking at the device. The available options and navigational mechanisms were also augmented in a similar way. To facilitate navigation while patients are not looking at the device/interface, gesture-based navigation was added to the tool. Accordingly, the artefacts can now be interacted with just by using gestures to navigate, select, and perform the main commands over each element.

To support the hands-free interaction with the artefacts, a set of voice commands was added to the patient tool. All the navigational features (e.g., next, previous, select, play, stop) can be issued by a voice-command.

In concert with each other, these new navigational options allow users with disabilities (e.g., visually impaired users) to interact with the artefacts. Moreover, patients without disabilities are now able to use the artefacts in demanding situations (e.g., hands-free and eyes-free while driving a car).

Device specific elements, which depend on the used hardware and cope with its limitations, are also available. For instance, if the device has a touch screen, images or other elements can also be used as input elements. For example, an image divided into different areas can be used as a choice-list where the user selects, directly on the image, the correct choice. On the other hand, if using a normal cell phone, the element can be composed by the image and a corresponding drop-box with the available selections.

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The behaviour triggers and actions have also been updated in order to match the new navigational options and new multimedia content. For instance, if several sequential gestures fail to be recognized, the patient tool is able to automatically suggest an alternative interaction mode (e.g., speech recognition).

VII. Enhanced Data Collection

The new multimodal and multimedia elements that OmniSCOPE includes extended their impact to data collection purposes as well. SCOPE allowed the gathering of patient data through the logging of direct interaction with the used artefacts or, through a more interesting mode, especially for therapeutic purposes, by the patient him/herself. On the latter, input elements could be used for patients to register their thoughts, storing information through their own words, or as suggested by the therapist.

A. Multimodal Data Collection

The new input and output modalities that artefacts can include allow patients to gather data in diverse formats. For instance, when an artefact is popped, and in order to allow the patient to continue with another activity while responding to the artefact's questions, these can be answered using voice or text, depending on the user's activity. This increases the flexibility and ease of using the artefacts but also provides richer data and results. Moreover, it also allows therapists to have an idea of the environment in which the patient is interacting with the prototype (e.g., quiet/noisy, alone or accompanied by other users) which is particularly important for certain therapies (e.g., phobias). For instance, if the user completes the artefact by recording his/her answers with an audio recording element the surrounding noises can or might also be recorded.

Patients are also able to film or take pictures (if the device includes a camera) of any data that might be required on the activity that is taking, giving the therapist some sense of the situation that caused stress. Other possibility is to allow the patient to provide proof that he/she was able to go to a certain event (e.g., for depression treatment) or overcome a fear.

B. Intelligent Data Collection

Taking advantage of the behaviour engine and respective conditions and actions, OmniSCOPE provides means for users to define specific conditions or settings in which artefacts can or should be presented to patients. This technique, if well used, provides support for intelligent therapy scheduling since artefacts can be prompted according to time, location or behaviour triggers. For instance, if the user jumps a sensitive topic several times, or is taking more than 1 minute to respond to a question, an alternative questionnaire or an encouraging sentence can be automatically popped up.

C. Passive Data Gathering

Passive data gathering - without the user's intervention - is achieved through the creation of usage logs. OmniSCOPE patients' tool contains a logging engine which is responsible for gathering data according to the patient's interaction with the device and artefact. Logged events range from taps on the screen and their location, up to selections from lists, button presses or navigation history. However, taking into consideration mobile device's limited memory and battery, the granularity of the logged events can be easily configured both during usage (if allowed by the therapist) and during the artefact construction. Moreover, the adjustment of the logging granularity also serves analysis and evaluation purposes. For instance, if the therapist is particularly interested in understanding how the user navigates between the existing screens that compose the artefact, but has no interest in collecting data regarding the locations and taps on the screen, the latter event can be ignored, creating logs that are focused to particular events. If no adjustment is made, by default all events are automatically logged.

The definition of the log granularity is also important when taking into consideration the several modalities that are available within a particular artefact. Here, the selection of specific events, which pertain to specific modalities (e.g., play, pause) are also paramount in order to facilitate analysis and evaluation of usage logs (e.g., if the artefact is to be used by a visually impaired patient, only the audio modality will be logged). Overall, the logging engine and mechanism support a configurable data gathering tool that can be adjusted to the analysis and therapy purposes and goals.

D. Analysis

OmniSCOPE includes two different approaches to the analysis of data. The first provides therapists/power-users with quantitative lists of interaction details and simple results while the second provides a video-like reviewing mechanism that re-enacts every interaction detail and event that took place while the patient used the artefact.

The log player resembles a "movie player" which re-enacts every action that took place while the user was interacting with the artefact. Adjusting the speed in which events are (re)played is also possible (e.g., fast-forward; double speed). Other visualization options for the usage logs are available (e.g., event lists, selection tables). Events can be played sequentially and according to the time-stamps that were recorded or they can be aggregated and searched by type (e.g., heat maps that show all the taps in one screen or browsing every "next screen" event).

The player tool also includes a communication module that allows the player to be connected to another mobile device while a user is interacting with an artefact. Here, the logging mechanism forwards every event to the monitoring device, allowing the therapist to remotely review, in real-time, the user's interaction with the artefact. For instance, if the artefact is running on a Smartphone with a GPRS connection or within the range of a Wi-Fi network, the therapist is able to monitor and gather data on the patient's behaviour and interaction with the artefact directly on his/her desktop computer or even another mobile device.

VIII. Case Studies and New Oportunities

The development of the extensions that compose OmniSCOPE followed a user centred design methodology. During the entire

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process, psychotherapists that participated on the design of SCOPE were involved. Additionally, other therapists (e.g., physiotherapists) were also consulted. The tools were tested with therapists and simulated patients over a period of two weeks. During this period, therapists from four different health-care areas were introduced to the new tools and were requested to create some therapeutic artefacts for a set of users from different backgrounds (that were acting as patients). During the evaluation trial, except for the involved psychotherapists, none of the participants (therapists and simulated patients) had any previous contact with the tools. Some sessions took place at a laboratory but the involved users were also allowed to use the tools at home/office.

A. Psychotherapy Extensions

To validate the new inclusions to OmniSCOPE, the tool was provided to the therapists so that they could improve or recreate some of the artefacts that were already been using with their patients.

Throughout the process, therapist's opinions were gathered and the new artefacts were compared with previous versions. Overall, results showed that therapists were especially pleased with the inclusion of new multimedia content. Now, instead of using text-based elements to promote relaxation practices and for anxiety control tutorials, therapists were able to use their own words and use a specific tone while walking the patient through the procedure. According to one therapist, the possibility of using his voice, to which the patient is already familiar with, allowed for more control over the procedure and would provide better results.

Simulated patients were given their tasks and used the tools for two or three days each. Afterwards, results were analyzed by therapists and the patients were interviewed. The overall opinions were very positive and showed that the new navigational options were particularly appreciated since they offer alternatives that are adequate to several situations. Moreover, users also stated that the therapeutic procedures were very easy to understand and learn because they were provided in a natural language that they could relate to. Furthermore, because the artefacts reacted to their behaviour and adjusted the questions and modalities to suit the interaction at that given time, usage was considered easy and intuitive.

The therapists' analysis of the patient's results was also very positive. In general, the ability to detect the tone with which the patients responded to the artefacts was especially important since it allowed therapists to assess, with some degree of fidelity, the stress levels of the patient while describing a certain event and the surrounding environment.

B. Physiotherapy

During physiotherapy for mild injuries, patients are frequently given instructions on how to complete exercises at home in order to achieve improvements within a shorter period. Instructions are generally handed to patients through paper sheets containing images, pictures and short descriptions of the exercises. On the other hand, patients are required to annotate the exercises that they complete, including repetitions and the difficulty they felt while completing them.

OmniSCOPE was used by therapists to create a set of artefacts, materialized by descriptions of exercises and video tutorials, depicting how they should be performed (Figure 4.).

In order to evaluate the effectiveness of the artefacts, and simultaneously, to understand how the data collection features could improve this process, therapists also created two types of data gathering forms. The first included questions that users had to respond to after completing the exercises. The second took advantage of the device's camera and required patients to film and take pictures of them performing the exercises and stretches.

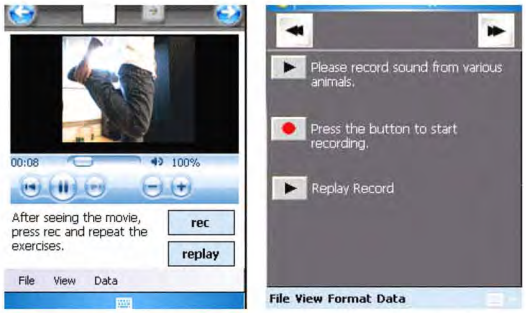

Figure 4. Left - This physiotherapy artefact allows patients to see a video of an exercise, repeat the exercise and record a video of it. Right - An artefact for patients with ASD and speech disorders. It allows patients to listen to animal sounds and record their own versions as a therapy process.

At the end of the trial period, both therapists and patients were interviewed in order to assess the results. Therapists were also given some time to review patients' results. On the latter analysis, the data collection and revision tools included in OmniSCOPE allowed therapists to detect a set of interesting behaviours. Firstly, analyzing the logs of users responding to the questionnaires that were created, therapists were able to detect that most patients were providing erroneous information about the time they took to complete each exercise and the time in which they completed their exercises. Since log events are time stamped, therapists noticed that in many occasions, the time spent between two different types of exercise was too short to allow a proper execution of the exercises. Secondly, on a more constructive perspective, when patients filmed their performances, therapists were able to review on the player, the captured videos, identifying and correcting patients on the exercises completed at home.

C. Aphasia and Speech Therapy

Patients with Aphasia are often required to undergo therapy in which they use associative techniques where images are matched with words. Other approaches try to provide support to conversation in face-to-face situations by providing patients with means to capture images and use them as tools to engage within such conversations [1]. Some work within this area also aims at obtaining reactions to visual and auditory stimuli by patients suffering from Autistic Spectrum Disorder (ASD) [8]. Similarly, young children with speech disorders can be treated with the use of computers and software that produce sounds and aid them while recreating these sounds [3]. Overall, the connecting thread between these issues is the need to provide

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artefacts that, taking advantage of visual and audio content, can stimulate patients and encourage them to react to these stimuli.

Accordingly, four therapists were asked to use OmniSCOPE to create artefacts that they felt would allow patients suffering from aphasia, ASD and speech disorders to use while undergoing therapy.

Figure 4. shows an example of one of the resulting artefacts. The screen that is depicted is preceded by one that contains the sound of animals (e.g., dog, cat, cow) and sounds from vehicles (e.g., car, train, airplane). Patients can listen to each sound as many times as desired. Afterwards, when faced with the following screen (Figure 4.) they are required to reproduce and record sounds of animals. Although it is not visible on the provided figure, the sounds are automatically played and, once ended; the questions are also immediately played, minimizing the need to interact with the device. A following screen plays the recorded sounds (produced by the patient) and presents some images so that patients can associate the sounds with the images (in a sequential fashion). Other examples of created artefacts allowed users to capture pictures and associate sounds and sentences to each picture. Speech training sentences that were played and had to be repeated and short games were also easily created by the therapists.

Overall, their assessment of the design process and the available options was extremely positive. The ability to use different types of content and create associations between these was regarded as a very useful feature. Moreover, the possibility of recording content created by the patients and replaying it as often as needed (both during therapy and afterwards for analysis) was also deemed extremely positive. When asked if they would use OmniSCOPE with their patients, all the involved therapists responded positively.

IX. Conclusions and Future Work

The evolution of mobile devices has turned them into indispensable tools that are used pervasively for diverse purposes. Their characteristics make them particularly efficient when supporting activities on-the-go that require personalized content. This fact has led to the emergence of tools that allow users to create and use digital artefacts on mobile devices within the field of health-care and related domains. However, existing tools that do take advantage of mobility and aim at providing pervasive support are generally too specific to certain issues and disorders and are limited in both scope and content. Moreover, they do not usually provide any therapist control over content and its delivery to patients.

This paper presented OmniSCOPE, a therapeutic artefact development environment that builds on the positive results that SCOPE has provided. OmniSCOPE introduced extensions that allow the creation of richer artefacts, using multimedia content, and artefacts that are easier to use by a wider range of patients, especially given the inclusion of multimodalities. Additionally, these extensions increased the possibilities that SCOPE's data collection features had previously introduced. By allowing patients to gather data through videos, sounds and images, therapists are now able to take advantage of this richer data to create and adjust therapy procedures and therapy artefacts to levels that were previously unavailable.

As validation, OmniSCOPE was used to create artefacts for four different types of disorders. Results showed that the new inclusions have provided benefits for therapists and patients and enhanced both the development and usage process. Moreover, they have opened new usage scenarios and the possibility to create artefacts for new domains and therapies.

Given the positive results that these initial case studies and tests have provided, new ones with real patients are already envisioned and being planned. Moreover, to further validate OmniSCOPE broadness and usefulness, new domain oriented elements will be developed with the assistance of domain-experts, in order to support the construction of new and different artefacts. Finally, group versions of the development wizard and the analysis log player are being created. These provide the ability for therapy teams to cooperate while creating therapeutic artefacts and while analyzing the results from individual or groups of patients.

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