

# OmniSCOPE: Composing Universal Therapies

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## Keywords

Mobile devices, paper-based artifacts, personalized therapy

## Summary

**Objectives:** This paper presents OmniSCOPE, an environment for the development of mobile pervasive therapy artifacts. OmniSCOPE builds on SCOPE, a tool for the support of mobile psychotherapy. It aims at providing therapists with means to adjust and compose new therapeutic artifacts to suit their patients' needs and new therapeutic approaches.

**Methods:** Given the positive results that emerged through the development and utilization of SCOPE, a previous single therapy version of OmniSCOPE, extensions were developed in order to enhance the artifacts, 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 and were developed following a user-centered design approach.

**Results:** As results, we detail the extensions and how they support new activities and therapies illustrated by two case studies in which they are being currently evaluated. Initial results from the involved therapists' assessment and future trends and directions are also discussed.

**Conclusions:** The features and accessible artifacts that can be composed with OmniSCOPE have provided therapists with the possibility to enhance their therapy procedures and to reach a wider audience of patients even while out of the office. Additionally, the data gathering options that can be included within the therapeutic artifacts provide much more detail which can clearly facilitate diagnosis and posterior therapy adjustments.

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## 1. 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 artifacts (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 artifacts on a single device up to the possibility of obtaining information and pervasive therapy support [1]. On the other hand, for therapists, it offers the opportu-

ity to extend their presence outside therapies, means to enhance the traditional paper-based artifacts and, more importantly, the ability to collect patient data through seamless and comprehensive methods [2, 3].

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 [4, 5]. 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) [1, 4, 6]. Contrastingly, desktop and web-oriented tools offer richer experiences [1, 4, 7], configurable access and support to a wider set of problems, especially given the use of multimedia content [7–9]. On the other hand, they fail to provide the pervasive therapy means that characterize 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 [1] is a software framework that offers some of the abovementioned features, including tools that support 1) the construction and adjustment of specific therapeutic artifacts for psychotherapy (e.g., questionnaires and registries for cognitive behavioral 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 [1, 10]. 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 artifacts 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,

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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, addressing the following issues: the extension of SCOPE's broadness in terms of patient support, offering new and richer artifacts 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 utilization by users with disabilities, which are, frequently, those more prone to require therapy.

This paper presents OmniSCOPE [11], a framework that extends SCOPE, addressing these issues and offering enhancements to the entire process. As its most significant contribution over existing and previous work it presents the data collection additions and the richness of the new created artifacts. Furthermore, it explains how 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.

## 2. Objectives 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 CBT, by facilitating the tailoring of personalized therapies and artifacts in order for these to suit patients' needs and goals. Throughout the experiments that validated it, results were very positive [10] and high levels of satisfaction from both therapists and patients were obtained. These results were gathered through an iterative process using follow-up interviews and questionnaires. For the latter, some were even included within the actual therapy-related forms that were completed and tested during the process. Still, from some of the 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 artifacts 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 artifacts 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. Moreover, allowing therapists to define their own persuasion mechanisms that encourage patients to act and to (cor)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 consequently new data collection features.

### 2.1 New Users

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

### 2.2 New Therapy Domains

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

### 2.3 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 artifact. 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 artifact 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 endeavors.

### 2.4 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 artifacts. 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 artifacts.
- **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.

### 3. Richer Artifacts

One of OmniSCOPE's main goals is to provide therapists with the ability to create richer and more interactive artifacts [11]. The artifacts 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 behavior, which allows power users (e.g., therapists) to adjust triggers and actions that activate different reactions to the user's interaction with the artifact.

With OmniSCOPE, artifacts 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).

To further extend configuration and personalization options, OmniSCOPE also includes 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' behavior, 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 events within any given image.

#### 3.1 Facilitating Artifact Construction

Given the new content and diversity of elements that can compose artifacts, 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 behavior, composing fairly elaborated artifacts. As shown in ► Figure 1, the wizard is composed by an editing canvas on the middle, where designers have the view of each final page that is being edited. Artifacts are edited page by page.

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.

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

#### 3.2 Design Guidelines

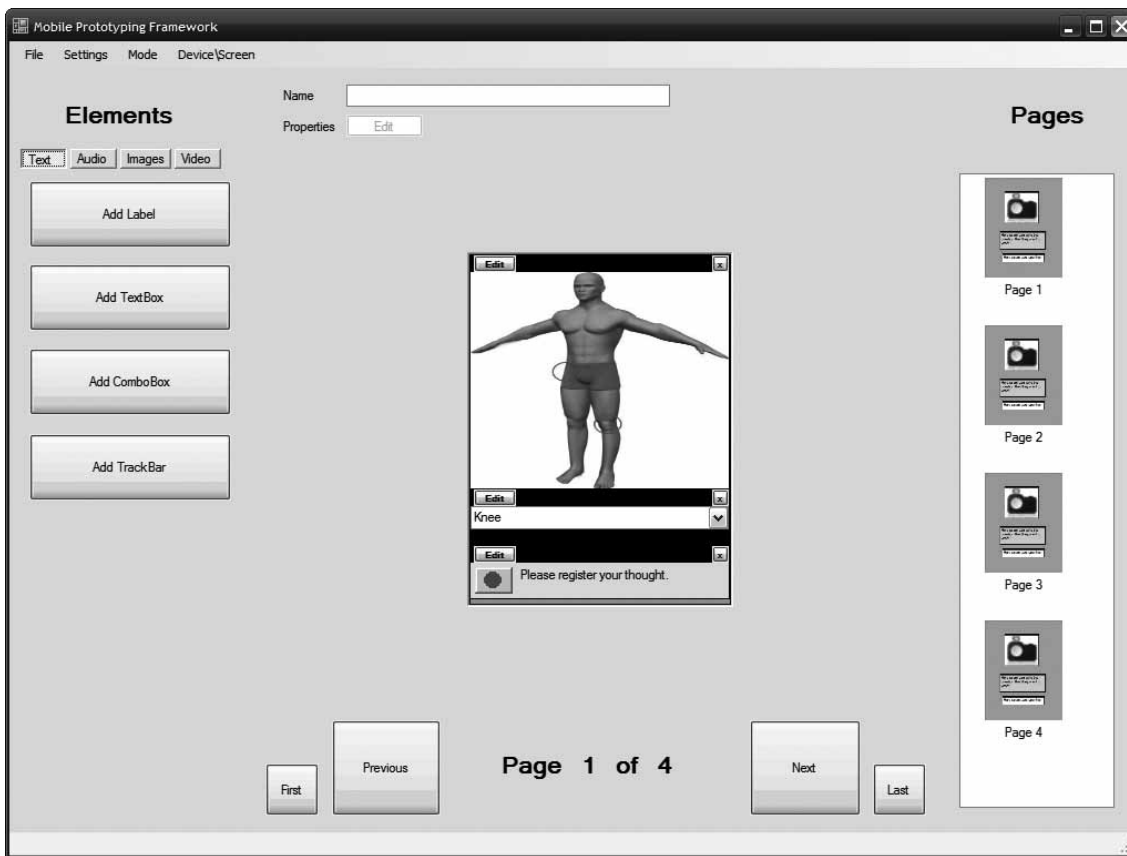
The tool is also able to offer design alternatives when available (e.g., replacing radio buttons by drop-boxes when there are many options) [3]. Additionally, it can also enforce usability guidelines if desired, limiting the number of elements per screen, setting their location, size and even screen arrangements, which is needed for non-experienced users and therapists with no UI design knowledge.

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. Amongst other details, the included guidelines can quickly correct the location of elements that are placed too close to the edges of the screen (thus hindering interaction on moving situations), the size of the elements so that they can be easily used with the patients' finger and not with the stylus, and even the sequence between the screens so that the transition between the various questions and items of the therapeutic artifact can be done automatically.

### 4. Universal Artifacts

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 artifacts. To overcome this problem, it was necessary to include new means to interact with the artifacts 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 artifacts, besides having



**Fig. 1**  
The artifact creation wizard

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 can be added by the therapist to each element, allowing patients to interact with the artifact, 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 artifacts 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 artifacts, a set of voice commands was added to the patient tool. All the navigational features (e.g., next, previous, se-

lect, 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 artifacts. Moreover, patients without disabilities are now able to use the artifacts in demanding situations (e.g., hands-free and eyes-free while driving a car).

The behavior 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).

## 5. Enhanced Data Collection

The new multimodal and multimedia elements that OmniSCOPE includes extended their impact to data collection pur-

poses as well. SCOPE allowed the gathering of patient data through the logging of direct interaction with the used artifacts 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.

### 5.1 Multimodal Data Collection

The new input and output modalities that artifacts can include allow patients to gather data in diverse formats. For instance, when an artifact is popped, and in order to allow the patient to continue with another activity while responding to the artifact'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 artifacts but also provides richer data and results. Moreover, it also allows therapists to have an idea of the environ-

ment 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 artifact 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 place, 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.

## 5.2 Intelligent Data Collection

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

## 5.3 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 artifact. 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 artifact 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 artifact, 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.

## 5.4 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, a log-player, provides a video-like reviewing mechanism that re-enacts every interaction detail and event that took place while the patient used the artifact.

The log player resembles a “movie player” which re-enacts every action that took place while the user was interacting with the artifact. 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).

## 6. Case Studies and New Opportunities

The development of the extensions that compose OmniSCOPE followed a user-centered design methodology, with strong emphasis on participatory design. During the entire process, psychotherapists that participated on the design of SCOPE were involved. Additionally, other therapists (e.g., physiotherapists) were also consulted.

For the posterior evaluation stage of the design process, 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 artifacts for a set of users from different backgrounds (that were acting as patients). During this 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. The following sections describe tests that were conducted in two of these new domains, the used methods and results for each experience.

## 6.1 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.

As part of the evaluation process, OmniSCOPE was used by therapists to create a set of artifacts, materialized by descriptions of exercises and video tutorials, depicting how they should be performed (► Fig. 2).

In order to evaluate the effectiveness of the artifacts, 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.

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 collec-

tion and revision tools included in OmniSCOPE allowed therapists to detect a set of interesting behaviors. 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. During the follow-up interviews, all the participants expressed their positive opinion on the ability to review patients' answers and attitudes through the logging mechanisms and were also very pleased with the artifact construction process. These results were further attested by the fact that every therapist was able to create, and even improve, the suggested artifacts.

## 6.2 Aphasia and Speech Therapy

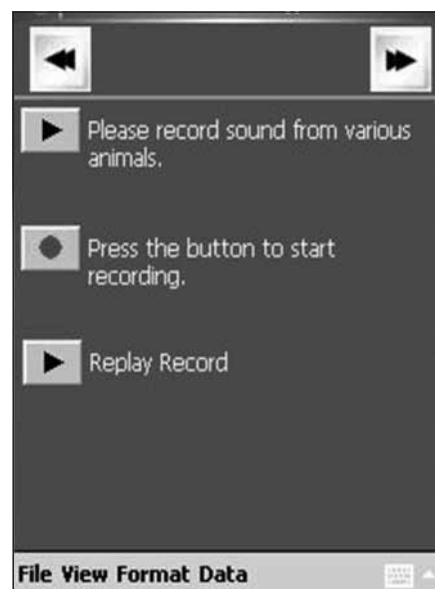
Patients with aphasia are often required to undergo therapy in which they use associative techniques where images are matched with words. Other approaches try to provide support to conversation in face-to-face situations by providing patients with means to capture images and use them as tools to engage within such conversations [12]. Some work within this area also aims at obtaining reactions to visual and auditory stimuli by patients suffering from autistic spectrum disorder (ASD) [5]. 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 [7, 13]. Overall, the connecting thread between these issues is the need to provide artifacts that, taking advantage of visual and audio content, can stimulate patients and encourage them to react to these stimuli.



**Fig. 2** This physiotherapy artifact allows patients to see a video of an exercise, repeat the exercise and record a video of it.

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

► Figure 3 shows an example of one of the resulting artifacts. On the screen that is depicted patients are required to reproduce and record sounds of animals. This can be



**Fig. 3** An artifact for patients with ASD and speech disorders. It allows patients to listen to animal sounds and record their own versions as a therapy process.

preceded, for instance, by one that contains the sound of animals (e.g., dog, cat, and cow) and sounds from vehicles (e.g., car, train, and airplane) where patients can listen to each sound as many times as desired, so they can repeat it properly when requested. Although not visible through a 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 artifacts 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, the involved therapists' 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.

## 7. Conclusions and Future Work

This paper presented OmniSCOPE, a therapeutic artifact development environment that builds on the positive results that SCOPE has provided. OmniSCOPE introduced extensions that allow the creation of richer artifacts, using multimedia content, and artifacts 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 artifacts to levels that were previously unavailable.

As validation, OmniSCOPE was used to create artifacts 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 artifacts for new domains and therapies.

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