Mobile Apps to improve ThErapy - The Health Practitioner in your pocket knows you

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ABSTRACT

There is an emerging consumer-driven demand for a more personalised health system and, there is no question, the rapid evolution of the mobile apps market became an important driver for personalisation in the health field. The MAiThE (Mobile Apps to improve ThErapy) project focuses on the deployment and study of personalised mHealth apps to provide patients and carers with self-management capabilities to help them feel empowered in their ability to find strategies in a more informed and collaborative way, and to optimise therapy outside the clinical context, with remote support from health practitioners. The insight gathered with the development and assessment of the apps tailored to the end-users' needs will result in a conceptual model to guide in the development of future mHealth apps. The project will produce an impact study based on thorough apps evaluations conducted on the field with participants from different contexts.

CCS CONCEPTS

• **Human-centered computing → Ubiquitous and mobile computing systems and tools**

KEYWORDS

Mobile health, self-management, personalisation, remote healthcare, user-centred, user studies, HCI

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1 INTRODUCTION AND MOTIVATION

The number of increasingly faster and more efficient mobile devices is continuously growing. They have changed the way people interact with information in a "ubiquitous computing world" much based on these computing devices that shape the "very fabric of an active world" [22]. So, it was inevitable that the healthcare area with the corresponding delivery of healthcare services would follow this scenario [11]. An adoption of these mobile devices has changed the way health practitioners are now engaging in their daily work.

Mobile Health (mHealth) solutions are developing very fast, becoming "the new edge of healthcare innovation" [23]. mHealth is defined as covering medical and public health practice supported by mobile devices, such as smartphones and tablets, patient monitoring devices, and other wireless devices. This new approach does not replace the health practitioners, including them in the process as a supporting element and a manager [8]. However, these new solutions depend on the users' acceptance to use them [12]. Thus, mHealth apps should meet the users' specific needs and interests in order to become truly integrated into their everyday lives. New proposals depend on this person-centred design principle, in which personalisation is essential [12].

This project aims to study how personalised mHealth apps can foster the therapy process actively involving the triad composed of the patient, carer (family included), and health practitioner. The project team will work on the concept of "The Health Practitioner in your pocket knows you" that will result in a common conceptual model to guide the future development of new

mHealth apps. The model will be based on the insight gathered with the development of three apps tailored to the end-users' needs: providing patients and their carers with self-management capabilities that help them feel empowered; while optimising therapy outside the clinical context. Each app will address a different pathology, namely, Parkinson's disease, phonological disorders and stuttering. These were selected for the study since our team already developed prototypes to respond to specific problems presented by each health practitioner's community, which are described in the section "Initial Prototypes".

The MAiThE project will address two important societal challenges (see Fig. 1), which reflects the policy priorities of the Europe 2020 strategy [5]. The challenge "Health, demographic changes and well-being" is addressed since the project aims to develop personalised mHealth apps towards the specific needs of their end-users (patients, carers, and health practitioners).

Furthermore, a second challenge, "Europe in a changing world - Inclusive, innovative and reflective societies", will also be addressed in distinct ways. Mobile devices have been important drivers of a change in the World, bringing natural innovations for the everyday life and allowing people to have a much easier access to content. They naturally enhance the feeling of inclusion in citizens. In particular, this project aims to contribute to a more inclusive society by empowering individuals suffering from a pathology and their carers/ family.

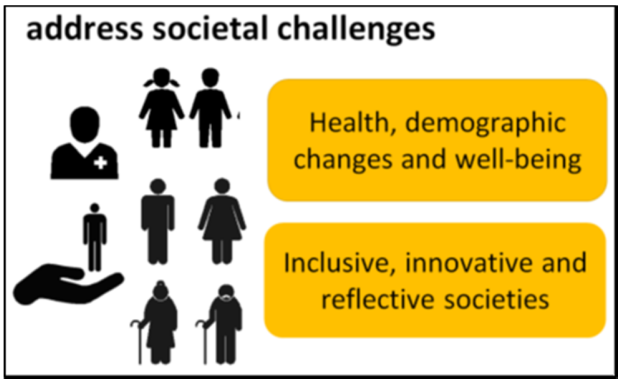

Figure 1: MAiThE addresses important societal challenges.

Additionally, this project embraces the challenge towards an innovative society by developing personalised mHealth apps, which is a fairly new concept. Moreover, these apps are expected to contribute to a more reflective society by engaging users and contributing to their awareness and understanding about the condition through the use of personalised information.

2 BACKGROUND

For the coming years, statistics estimate a continuous population decline and a progressive ageing of the population in Europe. The increasing ageing population is putting effort into the healthcare system, and mHealth can be an element to release such effort, by promoting self-management (self-care) [2]. A mHealth approach contributes to improving the safety, autonomy, and empowerment of users, as they can actively and independently manage their health and also receive information and treatment orientation anywhere, without the burden of displacement into a healthcare institution. It can be particularly advantageous in rural or remote areas, for patients with limited mobility, older adults and even children [8,21,24].

Those factors, associated with changes observed in the profile of pathologies, and linked to the increased life expectancy, leading to situations of prolonged illness and sociological changes, putting great pressure on the health and social services. This problem is transversal across Europe and the UE considered that a research and innovation area to support under "Health, demographic change and wellbeing" of Horizon 2020 is: "new digital media, web and mobile technologies and applications, as well as digital instruments that integrate healthcare and social care systems, and support health promotion and prevention" [4]. There is also a significant number of health practitioners using telepractice, and there is a need to give better responses to that demand [1].

mHealth has been the main driver in pervasive healthcare, which can be defined as a field following the characteristics of pervasive computing applied to healthcare, making it available everywhere, anytime and to anyone [3]. A pervasive healthcare app should proactively respond and adapt to individuals who use it, meeting their needs. Personalised healthcare should provide medical services that are truly effective "for me" instead of the today's general healthcare paradigm of "one size fits all" [25]. mHealth allows the collection of data that can contribute to improve evidence-based practice and research, creating conditions to "deliver highly personalised healthcare in general and suitable intervention for patients to manage their chronic conditions in particular" [24].

The success of mHealth apps depends decisively on the principle of user-centred design, in which personalisation is a key factor. Many times, people use the words personalisation and customisation interchangeably. However, there is a subtle difference between the two. Customization means that the user explicitly states interests and preferences through direct configuration of human-computer interfaces, system's options or screens. On the other hand, personalisation should be implicit and automatic, resulting in a "Wow" moment when the user feels that things appear tailored to her/his needs and preferences. "Personalisation goes a step beyond customisation in that it does not just affect the way things look to users, but it also is the way things feel to users" [9]. Customisation is considered user-led which results in an adaptable system, whereas personalisation is system-led resulting in an adaptive system [18]. Personalisation dynamically responds to users' demands automatically adapting the items based on their preferences, their past use or even their location.

Thus, personalisation can be seen as a method that provides users with what they want or need, without requiring them to ask for it explicitly [17], based on predictions of what the user wants [10]. The engagement of users with mobile apps can be achieved by personalisation. The frequent use of an app is related to

behavioural change and health improvement [10]. The integration of gamification [7] elements in apps also increases engagement, providing selective attention and promoting emotional involvement or social comparison of effort and progress [10].

3 INITIAL PROTOTYPES

Between 2013 and 2017, an interdisciplinary team designed and implemented three prototypes of mHealth apps for the Android system, which are "Brothers in Stuttering" (BroiStu), "Super-Fon" and "ONParkinson" (Fig. 2).

Figure 2: Prototypes: ONParkinson; Super-Fon; BroiStu.

3.1 Brothers in Stuttering

The BroiStu mHealth app [6,13] aims to promote a better understanding of the emotional and psychosocial impact of stuttering and contribute to finding strategies to increase people who stutter's activity, social participation and quality of life. The development of this app came from the need of having a better insight regarding the impact of stuttering on the person's everyday life. It also arose from difficulties reported by Speech Language Therapists (SLTs) on identifying in which patient's contexts and life events particular stuttering situations occur, which would allow them to improve the intervention.

Moreover, there are not efficient tools that allow SLTs to analyse stuttering situations recorded immediately after a real context situation. This lack of real context data hampers the therapeutic process, which was identified by both people who stutter and SLTs as being interesting and important to be addressed in the development of a mHealth app. Thus, BroiStu should support the assessment through the self-awareness and monitoring feelings and cognitions associated with stuttering.

3.2 Super-Fon

The Super-Fon app [14,15] is based on the gamification concept [7] and it was developed to support speech therapeutic intervention with children between three and eight years old, in the phonological development area. The app comprises a range of activities, divided by levels which represent different phases of a therapeutic intervention based on the Metaphon methodology.

This solution was developed for tablets with the main goal of motivating the child to the execution of a set of activities, allowing her/him to have a fun experience while improving her phonological competencies. Thus, diverse ludic mechanisms were implemented to motivate the usage of the application. Another important feature of Super-Fon is the possibility for the therapist to monitor the evolution of patients remotely. The therapist has access to the patients' game data in order to perform a more detailed analysis of their evolution.

3.3 ONParkinson

ONParkinson [19,20] aims to empower and support users within the triad: person with Parkinson's Disease (PD), carer and health practitioner. This app aims to facilitate the access to knowledge and provide professional support for both people with PD and carers in their homes. Results from a survey undertaken in the Associação Portuguesa de Doentes com Parkinson to thirty-six users highlighted the importance of developing a mobile app to support a remote health assistance. All user groups reported difficulty finding trustworthy information about the PD. Even for some health practitioners, searching for reliable data to support clinical decisions was identified as a need.

Thus, the first prototype of ONParkinson was designed to support the triad's users in finding relevant knowledge to support their clinical issues, as well as allowing the supervision of patients` daily routine and the recommendation for daily exercises. According to the literature and the study of the triad's needs, the development of a mHealth app was proposed, which is based on the empowerment of this triad's users to help both patients and carers to cope better with the PD. The app includes the following main modules: i) "questions and answers" with frequently asked questions (FAQ) related to the management of the disease and strategies for self-management of symptoms; ii) "calendar" with reminders to medication, consultations or other events/notes important to the user, enabling a better self-management, and iii) an "exercise program" created according to the person's needs and progression.

4 RESEARCH METHODOLOGY

This research work follows a person-centred approach, where the end-users are involved during all phases of the development process. The three initial prototypes were developed to promote a person-centred approach, starting from a commonly perceived need for increasing the patients' ability to self-manage long-term conditions, as well as optimising the communication and interaction between patients, carers, and health practitioners, with the involvement of all in a remote clinical support. From initial usability assessments with potential end users of the initial prototypes, a need for the inclusion of personalisation features was identified to optimise the mHealth benefits, engage users, and ensure the compliance among them.

Based on the initial prototypes, the plan of action for the project MAiThE is divided into seven activities (see Fig. 3).

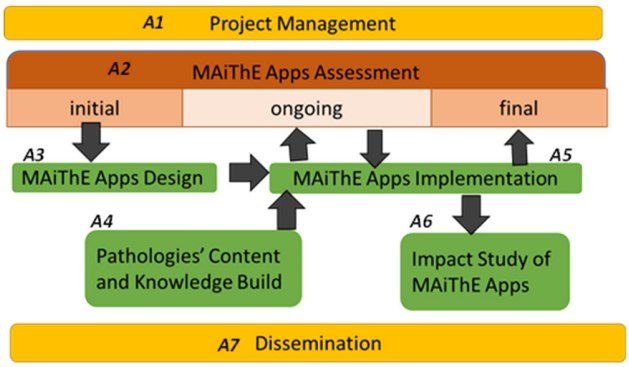

Figure 3: Main Research Activities.

Activity 1 (A1) is dedicated to the always necessary project management. Its tasks will be developed aiming to deliver a good performance regarding the project objectives, providing deliverables promptly as proposed according to the project timeline, through coordination of all participants who will actively collaborate among them. There will be a special care in management activities related to dissemination and exploitation of results to ensure a widespread and appropriately targeted dissemination.

Activity 2 (A2) is centred on the assessment of the MAiThE apps throughout the project, measuring the behaviour and attitudes of people as they interact with the apps. A group of users will be selected for participatory design [16].

The user experience will be quantified at three main stages: 1) initial assessment, where a study of usability will be conducted with the distinct end-users (patients, carers and health practitioners) in order to identify elements towards a novel user experience design and the main aspects for personalisation in each app; 2) on-going assessment that will be conducted with selected end-users during almost a year period in order to fine-tune the personalisation model and algorithms implemented in activity 3, and to make initial tests to the cognitive technology; 3) final assessment will be performed in the last months of the project using the same population used in the initial assessment. The study will assess the new apps regarding usability, acceptance by users, and engagement after the personalisation activation. The phases present the following main tasks.

Stage 2.1 (initial) is comprised of: (a) Design Initial Assessment Tests – it is specified the assessments protocol (questionnaires, observation, interviews, collected data) that will be applied to each existing app; (b) Refactoring Existing Apps – minor corrections to the existing apps will take place at the beginning of the project, in order to guarantee that each app is up-to-date without major issues; (c) Apply Initial Assessment Tests – The protocols are applied to the target users of each app.

On the other hand, stage 2.2 (on-going) is composed of: (a) Specification and key users' selection – the key users for each app will be selected from the initial set of end-users. These key users will use the apps throughout their development cycle (and Participatory Design will be applied); (b) Monitoring the apps Usage – The aim is to monitor the use of the apps, collecting data like time of usage, reaction times, number of logins, introduced data, etc., depending on the app.

Finally, stage 2.3 (final) presents the tasks: (a) Design Final Assessment Tests - assessment protocol will be adjusted and redesigned after the implementation of new functionalities and personalisation features; (b) Apply Final Assessment Tests – This task is similar to 2.1(c), but with the new assessment protocol; (c) Result Analysis – all data collected from questionnaires, interviews, among other sources, crossed with data from apps' monitoring, will be analysed.

Activity 3 (A3) is dedicated to the specification of the configuration model and the design of each app, which will be supported by the results obtained in activity 2.1. The configuration model will integrate customisation and personalisation approaches. Additionally, it is dedicated to the design of the integration of cognitive technology in the mobile apps.

In parallel with the technological improvements on each app, activity 4 (A4) aims to produce digital resources to support the apps. For this, both corpus of knowledge for each pathology and videos will be created according to the characteristics of each app. Building the corpus of knowledge for each pathology comprises the definition of the clinical terminology and main concepts associated with each pathology and the identification of synonymous for each term. This activity's study will pay special attention to the differences between medical technical language and lay language. Thus, it also aims to identify some language specificity of regional terms to describe symptoms to be included in the corpus of knowledge.

Activity 5 (A5) is dedicated to the implementation of the final apps, which will have new features, reworked user interfaces and personalisation and customisation components. Along with this activity, a group of users will gradually give feedback about the modifications applied to apps (in activity 2.2). This contribution will also be supported by undergraduate students from the physiotherapy and speech therapy courses, who will collaborate in the users' monitoring on the apps. After reaching the deployment of the MAiThE apps, a final assessment protocol will be defined and implemented with the same initial participants (in activity 2.3). Related to this, activity 6 (A6) is dedicated to the impact study extracted from the use of MAiThE apps.

Activity 7 (A7) focuses on the dissemination plan, which will be implemented from the beginning of the project in order to present the initial prototypes to the potential users and aims to guarantee the dissemination of knowledge and artefacts for the scientific and local communities.

We assembled an interdisciplinary research team that includes researchers with different profiles, from a solid knowledge in the mobile computing, personalisation techniques, human-computer interaction, and software engineering, to a deep understanding in the health and social fields, such as physiotherapy, speech therapy and social service (Fig. 4).

Figure 4: MAiThE's Interdisciplinary team.

In addition to the expertise of the research team, and in order to support the research activities, experts from the partner entities with sound experience in the aforementioned pathologies will collaborate in several important activities, mainly in the design of the solutions, assessment and final study.

5 EXPECTED CONTRIBUTIONS

The MAiThE project aims to solve specific problems presented by patients and health practitioners' communities, based on their daily reported challenges and clinical experience. MAiThE will disseminate results to the:

- scientific community through publications in peer-review journals and scientific events (e.g., conferences, workshops, congresses), both national and international;
- academic community through, for instance, the students who will collaborate in the project;
- society through the activities performed by the team involving both the health practitioners' communities and the potential end-users, especially patients.

The three mHealth apps that will be developed are expected to serve two main purposes. On the one hand, they address three specific areas of therapeutic intervention that have been presented by health practitioners, which are the Parkinson's disease, stuttering disorder, and phonological disorders. Each one of the three apps will have its specific value, since it will contribute individually to help people with a specific pathology, representing a novelty in its area of intervention, besides integrating new features based on personalisation and cognitive technology.

On the other hand, these mHealth apps also aim to support the development of the general model for the concept "The Health Practitioner in your pocket knows you", which will be achieved with the insights gathered with the analysis, design and implementation of the apps. Thus, these apps will be used to study how the mHealth approach behind the model actually works regarding effectiveness and utility in the scope of the regions addressed by the project.

6 CONCLUSIONS

This paper presented MAiThE, which is an innovative project focusing on the implementation and study of personalised mHealth apps to provide patients and carers with self-management capabilities. The apps can help them feel empowered in their ability to find strategies in a more informed and collaborative way, and optimise therapy outside the clinical context, with remote support from health practitioners.

Three mHealth prototypes are already implemented, serving to study how personalisation should be addressed to cope with the desired goal of providing more person-centred solutions to the society. In fact, the first results obtained with the user experience studies regarding those prototypes have been already published. Moreover, MAiThE also addresses two important societal challenges:

(i) Health, demographic changes and well-being and
(ii) Europe in a changing world - Inclusive, innovative and reflective societies.

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