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Personalising the User Experience of a Mobile Health Application towards Patient Engagement

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Abstract

Stuttering is a multifactorial speech disorder that usually has several impacts on daily life, especially regarding loss of confidence in social situations and increased anxiety levels. BroiStu is a mobile health application that was developed to address the impacts of stuttering on people who stutter, allowing them to be more aware of their speech disorder in their everyday life. The personalisation of the user experience may be particularly important to maintain the patient engaged with the application towards a long-term use to take full advantage of the application's features. This paper presents the implementation of personalisation aspects in BroiStu, introducing the model that is being followed, describing the features used, and presenting the results obtained with a preliminary experiment. The personalisation mechanisms are provided by a cloud-based platform that is designed to serve different applications. Interesting findings and further work are presented.

Keywords: mHealth; stuttering; self-management; self-reflection; personalisation; HCI; user experience; mobile; Speech and Language Therapy.

1. Introduction and Background

mHealth is defined as covering medical and public health practice supported by mobile devices [1]. This recent approach is not intended to replace health professionals, but rather to keep them integrated into the process as an element of support and a manager [1]. mHealth apps can support patient-centred models of healthcare, by enhancing

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patient involvement and self-management capabilities [2], in which frequent use is related to behavioural change and health improvement [3]. The new mHealth solutions substantially depend on the acceptance of users (mostly, the patients) to use them, mainly to reach the intended frequent and long-term use.

The engagement of users with mobile apps for healthcare can be achieved by personalisation [4], providing a better user experience towards greater patient participation to improve health outcomes and reduce economic costs. mHealth has been the primary driver in pervasive healthcare [5], meaning it should proactively respond and adapt to individuals who use it, meeting their needs. Personalised healthcare should provide health services that are effective "for me" instead of the more usual general healthcare paradigm of "one size fits all" [6]. Many times, people use the words personalisation and customisation interchangeably. However, there is a subtle difference between the two, which has a great impact on the real purpose of developing personalised computational solutions. Customisation means that the user explicitly states interests and preferences through direct configuration of human-computer interfaces (HCI), system's options or screens. On the other hand, personalisation should be implicit and automatic, possibly resulting in a "Wow" moment when the user feels that things appear tailored to her/his needs and preferences.

A personalised version of a mHealth solution, BroiStu [7], is being developed to provide a better insight on the impact of stuttering [8, 9] on the everyday lives of people who stutter (PwS). Stuttering is a multifactorial speech disorder that usually has several impacts on daily life, especially regarding loss of confidence in social situations and increased anxiety levels. PwS have the need of being aware of their therapy intervention's progress, while speech-language pathologists (SLP) present some difficulties in identifying in which contexts (life events) occur the stuttering related situations (SS) of their patients. There are not efficient tools that allow SLPs to analyse SS recorded immediately, or as soon as possible, after a real context moment. There is an emerging, but still small, research on technology-mediated support for stuttering, but it seems to centre mainly around the solutionist domain [10], with several mobile-focused projects looking at the development of tools to improve speech fluency (e.g., [11, 12, 13]).

On the other hand, McNaney et al. developed StammerApp [10], a mobile application to support goal setting, practice and reflection around situations seen as challenging for PwS in daily life. They based its design in a study from which they gathered insights on the challenges and barriers that PwS experience day-to-day, reflecting on the complexities of designing with this diverse group. However, none of the projects mentioned before implements a personalised approach. Besides this characteristic, they also do not provide appropriate self-management and self-reflection features for PwS, except StammerApp, but not as BroiStu's approach, and interfaces for efficient and close supervision by the SLP.

This paper introduces the implementation of personalisation aspects in BroiStu, summarising the model that is being followed, describing the selected features, and providing the first results obtained with the new personalised approach. The personalisation mechanisms are provided by a cloud-based platform that is designed to serve any application across different domains. Some preliminary interesting findings are exciting towards further work that is also presented in the paper.

2. Brothers in Stuttering

PwS need to cope with a large set of psychosocial impacts, where negative experiences associated with being mocked or teased may lead to the development of low self-esteem, poor confidence levels, high anxiety levels and some social isolation [14]. It can, in turn, cause long-term challenges around the avoidance of situations that may be construed as challenging [10]. It is especially important to track these situations, which can certainly lead to stuttering episodes.

The BroiStu prototype allows users to register their SS (see Figure 1) to self-monitor their speech moments as a means of controlling stuttering on a daily basis. Thus, they can track how their SS are evolving throughout the therapy process, as well as their SLT can link up with their account to understand which situations are causing stuttering, so that SLT can better tailor the treatment. The app provides reports and charts which help to visualise how the different SS progress and occur according to several features (e.g., mood, emotions felt (see Figure 2), the relation between context and the intensity of stuttering). BroiStu is available in English, Portuguese and Croatian languages. The system allows communication (messages exchange) between the SLP and their patients, and issues automatic notifications based on the patients' mood, progression or general profile, etc. More on BroiStu can be found in [7].

Fig. 1. BroiStu: first menu with the main functionalities.

Fig. 2. BroiStu: CAAT screen to select emotions felt in an SS.

3. BroiStu Personalisation

We are using P²MUCA, which is a personalisation platform for multimodal ubiquitous computing applications that provides tools and services to help developers in the implementation of personalisation solutions [15]. To use P²MUCA, we must instantiate its generic model for personalisation (called X-Users), but first, we need to select and define, at design time, what to personalise in BroiStu. Preliminary studies conducted with PwS and SLP/experts [7, 9] allowed us to collect interesting interaction data, and the latter even suggested a set of elements to personalise for a first approach. It was important that we knew the app's potential end-users, mainly the specific ones that could drive the requirements for the personalisations. The careful specification of personas can help to determine what to personalise (instances of personalisation) and the different options for each personalisation.

In X-Users, each personalisation instance (Personalisation) can have N different Personalisation Options according to the number of identified Personas (see Figure 3, entities on top and middle). On the other hand, a Persona can drive N Personalisation Options since an application can implement different Personalisations. As the model is generalised and made available through a cloud-based platform, the same Persona can be represented in different applications. Thus, it can even be the driver for Personalisations across those applications.

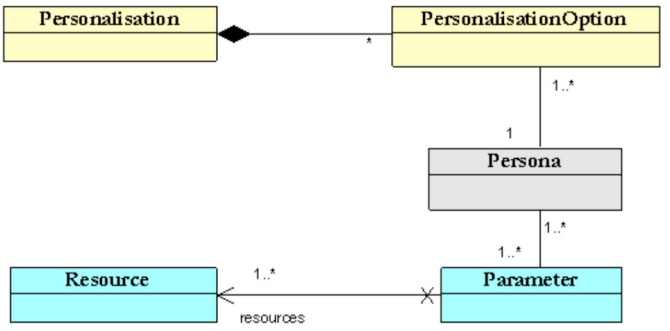

Fig. 3. X-Users' personalisation sub-model's core entities.

3.1. Design

In the BroiStu app, according to the patient's behaviour using the app and her/his clinical condition (updated by her/his SLP), the first approach for personalisations included two instances (see Table 3 for more details on them):

- P1 - notifications content impact
- P2 - notifications frequency

So, we had to select a set of resources (see Table 1) so that they could be combined to get two parameters (according to Figure 3, the two entities on the bottom) that would reach the notions of the intended behaviours using the app.

Table 1. Resources used in BroiStu's personalisations.

Resource	Description
reactionsSet	Set of reactions associated to an SS registration [data registered by the patient]
emotionsLevel	Emotions' level (basic vs complex) related to an SS [related to data registered by the patient]
emotionsType	Emotions' type (negative vs positive) related to an SS [related to data registered by the patient]
SScount	Total of stuttering situations [registered by the patient]
Slevel	Stuttering level (1 to 5) [inserted by the patient's SLP]
usesBroiStu	Counts app executions/day since the user is registered [interaction data gathered by the app]

Each parameter is given by a mathematical expression that results in a numeric value representing a specific user profile based on the resources included. Thus, users will have the values PwStype, represented by expression (1) and used in P1, and UserActiveness, represented by expression (2) and used for P2, each one matching a persona (cluster) that corresponds to a personalisation option (see Table 3). These expressions were determined after several simulations and the results obtained in the first trial of user tests (described in the Findings section) confirmed them as having the potential for being used in real context.

$$\text{reactionsSet} * 0.4 + \text{emotionsLevel} * 0.3 + \text{emotionsType} * 0.3 \quad (1)$$

$$\text{usesBroiStu} * 0.2 + \text{SScount} * 0.4 + 1/\text{Slevel} * 0.4 \quad (2)$$

We considered and defined three possible personas as a result for each parameter (Table 2), which are: High (H), Medium (M) and Low (L) for PwStype; Active in Therapy (AiT), Avoids Comm (AC) and Blame Others (BO) for UserActiveness. This way, P^{2}MUCA's clustering algorithm should divide users into three clusters for each parameter, receiving, as input, a parameter's vector composed of the parameter's values representing each user (see [15] for more details on this).

Table 2. Parameters and personas.

Expression	Parameter	Persona
1	PwStype	High (H)
		Medium (M)
		Low (L)
2	UserActiveness	Active in Therapy (AiT)
		Avoids Comm (AC)
		Blame Others (BO)

The personalisation options are returned to BroiStu when a personalisation request is made to P^{2}MUCA. They are interpreted by the app, which adapts the notifications content to have more, or less, impact on the user (P1) and the frequency of notifications based on the use of BroiStu and the stuttering condition level of the user (P2).

Table 3. The personalisations and their personalisations options.

P	Personalisation	Persona	Personalisation Option (description)
1	notifications content impact (NCI)	AiT	soft content only to maintain involvement
		AC	tries to persuade user to communicate more
		BO	hard content putting the effort on the user
2	notifications frequency (NF)	H	decreases NF if above a threshold value
		M	maintains NF
		L	increases NF until it makes sense

3.2. Findings

We collected enough data from 7 users, after a trial of 30 days of use, to build relevant user profiles surpassing the usual cold start issue. The parameters' expressions were determined after several iterations of simulations based on collected data and domain knowledge supported by the experts. The weights have been slightly refined during this user experiments study. At the end of the study period of 30 days, personalisation requests would result in the personalisation options by user, seen in Table 4. It means that, at this moment, for instance, user one will receive notifications with soft content, only to maintain the involvement, decreasing the notifications frequency.

Table 4. The personalisations' state for each user obtained after a trial of 30 days.

User	Personas/Personalisation Options	
	P1	P2
1	Active in Therapy	High
2	Blame Others	Medium
3	Active in Therapy	Medium
4	Active in Therapy	High
5	Avoids Comm.	Low
6	Avoids Comm.	High
7	Active in Therapy	Medium

4. Conclusions and Further Work

We described a new concept that uses personalisation to enhance the user experience under a mHealth solution. This work constitutes an important milestone as it provides a technology-independent and persuasive solution for PwS's positive behaviour change and maintenance over the long-term. The introduction of personalisation in BroiStu may lead to a patient engagement that will better support the self-management goal and the SLP's supervision over a long-term process of therapy.

We are already planning user tests to select more resources for new personalisation instances and adjust the current parameters to achieve the best solution for reliable results. Finally, we will conduct end-user studies to evaluate BroiStu in real context of use to further scope its potential for making a difference in the lives of PwS. It is required that we conduct larger field trials of BroiStu, over longer periods of time and with a wider sample of the stuttering community. Future evaluations to determine the effectiveness of the app should consider the use of informal attitudinal rating scales (e.g., Overall Assessment of the Speaker's Experience of Stuttering [16]).

References

[1] European Comission. 2014. Greenpaper on mobile Health ("mHealth"). Retrieved April 30, 2018 from https://ec.europa.eu/digital-single-market/en/news/green-paper-mobile-health-mhealth.

[2] Marsha J. Handel. 2011. mHealth (mobile health)-using Apps for health and wellness. In Explore (NY) journal,7, 4 (Jul-Aug 2011), 256-61. http://dx.doi.org/10.1016/j.explore.2011.04.011.

[3] Christopher Helf and Helmut Hlavacs. 2016. Apps for life change: Critical review and solution directions. In Entertainment Computing, 14, 17–22. http://dx.doi.org/10.1016/j.entcom.2015.07.001.

[4] Nitesh V Chawla and Darcy A Davis. 2013. Bringing big data to personalized healthcare: a patient-centered framework. Journal of general internal medicine 28 Suppl 3, Suppl 3: S660-5. https://doi.org/10.1007/s11606-013-2455-8.

[5] Bert Arnrich, Oscar Mayora, Jakob Bardram and Gerhard Tröster. 2010. Pervasive healthcare: paving the way for a pervasive, user-centered and preventive healthcare model. In Methods Inf. Med. 49, 1 (2010), 67-73. http://dx.doi.org/10.3414/ME09-02-0044.

[6] Daqing Zhang, Zhiwen Yu, Chung-Yau Chin. 2005. Context-aware infrastructure for personalized healthcare. In Studies in Health Technology and Informatics journal, 117, pp. 154-163.

[7] Rui Neves Madeira, Patrícia Macedo, Pedro Pita, Íris Bonança, and Helena Germano. 2013. Building on Mobile towards Better Stuttering Awareness to Improve Speech Therapy. In Proc. International Conference on Advances in Mobile Computing & Multimedia (MoMM '13). ACM, New York, USA. http://dx.doi.org/10.1145/2536853.2536911.

[8] Michael Blomgren. 2013. Behavioral treatments for children and adults who stutter: a review. In Journal Psychol Res Behav Manag. 6, 9–19. http://dx.doi.org/10.2147/PRBM.S31450.

[9] Iva Demarin, Ljubica Leko, Maja Škrobo, Helena Germano, Patrícia Macedo, and Rui Neves Madeira. 2015. The Impact of Stuttering;: How Can a Mobile App Help?. In Proc. of the 17th International ACM SIGACCESS Conference on Computers & Accessibility (ASSETS '15). ACM, New York, USA, 399-400.

[10] Roisin McNaney, Christopher Bull, Lynne Mackie, Floriane Dahman, Helen Stringer, Dan Richardson, and Daniel Welsh. 2018. StammerApp: Designing a Mobile Application to Support Self-Reflection and Goal Setting for People Who Stammer. In CHI '18 Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems. ACM, New York. ISBN 9781450356206.

[11] HonestAbe. 2013. Stutter Help. Retrieved Sep 01, 2018 from https://play.google.com/store/apps/details?id=com.honestabeapps.stutterhelp.

[12] Michael Oates. 2013. Stutter Rater. Retrieved Sep 01, 2018 from https://play.google.com/store/apps/details?id=com.oatau.stutter.

[13] Smart Ears apps. 2013. Fluency Tracker. Retrieved Sep 01, 2018 from https://itunes.apple.com/pt/app/fluency-tracker/id352274124?mt=8.

[14] Ashley Craig, and Yvonne Tran. 2006. Fear of speaking: chronic anxiety and stammering. Advances in Psychiatric Treatment 12, no. 1 (2006): 63-68.

[15] Rui Neves Madeira, Pedro Albuquerque Santos, André Vieira, and Nuno Correia. 2014. Model-Based Solution for Personalisation of the User Interaction in Ubiquitous Computing. In Proc. of the 2014 IEEE 11th Intl Conf on Ubiquitous Intelligence and Computing (UIC '14). IEEE Computer Society, Washington, USA, 311-318. DOI=http://dx.doi.org/10.1109/UIC-ATC-ScalCom.2014.139.

[16] J. Scott Yaruss, and Robert W. Quesal. 2006. Overall Assessment of the Speaker's Experience of Stuttering (OASES): Documenting multiple outcomes in stuttering treatment. Journal of fluency disorders 31, 2, p. 90-115.