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Concept and Pictogram-Based User-Interface Design of a Helper Tool for People with Aphasia

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Abstract. Background: Aphasia describes the lack of the already gained ability to use language in a common way. “Language” here covers all variations of forming or understanding messages. Objectives: The APH-Alarm project aims to develop a service concept that provides alternative communication options for people with Aphasia to trigger timely help when needed. It considers that a typical user may not be familiar with modern technologies and offers several simple and intuitive options. Methods: The approach is based on event detection of gestures (during daytime or in bed), movement pattern recognition in bed, and an easy-to-use pictogram-based smartphone app. Results: Agile evaluation of the smartphone app showed a promising outcome. Conclusion: The idea of a versatile and comprehensive solution for aphasic people to easily contact private or public helpers based on their actions or automatic detection is promising and will be further investigated in an upcoming field trial.

Keywords. Aphasia, Augmentative and Alternative Communications Systems, Ambient Assisted Living

1. Introduction

Figures differ and diagnosis methods vary worldwide, but on average, about one out of 200 people can be considered to live with Aphasia [1] [2]. It can be estimated that around 30% [3] of all people facing their first stroke are affected by Aphasia. With around 24-25.000 people having a stroke each year [4], that means about 8.000 new Aphasia patients every year.

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For these people, APH-Alarm's R&D aim is to provide alternative communication possibilities, through gesture detection, pictogram arrangements, and automatic situation assessment (e.g., fall detection). Another main goal is to provide a solution that is available 24-7, suitable for indoor and outdoor usage. To achieve these goals, APH-Alarm focuses on two basic use cases:

- Daytime support through a smartphone running a dedicated app;
- Nighttime support through wearables or room-mounted sensors.

To make communication possible in almost every situation of daily living, the APH-Alarm smartphone application provides alternative and augmentative communication. Based on text, symbols and automated text-to-speech output the user can choose which interfacing method suits best. The goal is to help users to stay safe everywhere at any time by providing:

- Simple shortcuts for emergency messages;
- Gesture-triggered alarm and gesture-based dialogue;
- Pictogram-based message composition;
- Detection of abnormal events while lying in bed.

For flexibility, the destination of the help communication is configurable or selectable, so that – as is mostly preferred by users – it can be directed to a private contact such as a relative or a formal caregiver (“helper”), but alternatively also to a public emergency center (112 in Europe). For the recipient of a help message, a “secondary app” is being developed so that the receipt of the message can be acknowledged to the sender (the person with Aphasia).

2. Methods to Send a Help Message

The APH-Alarm solution provides four different methods for generating and sending a message:

1) Smartphone manual use (app with pictograms);
2) Smartphone automatic use (gestures: stomping, tapping, falls);
3) Bed manual use (gesture-based dialogue);
4) Bed automatic use (seizures and abnormal events).

For manual use of the app (currently Android-based), a multi-modal user interface (UI) around easy-to-understand user co-designed pictograms (see Figure 1), text labels, and text-to-speech output has been designed and translated to several languages for our end-users. As simplicity is key, APH-Alarm focuses on providing only the functions really needed by the user [5] [6] [7] [8] in a flat hierarchy to cover the most frequent emergency situations. This allows handling the app even in stressful situations.

Figure 1. Some screen examples with pictograms for the app for users with Aphasia.

After a message is composed, the app also shows when the message has been sent and whether it has been accepted by the recipient. The latter is done by a supplementary app developed for the receiver (helper) showing the name and location of the person needing help and any provided information about the type of help needed together with a button to accept the request (see Figure 2).

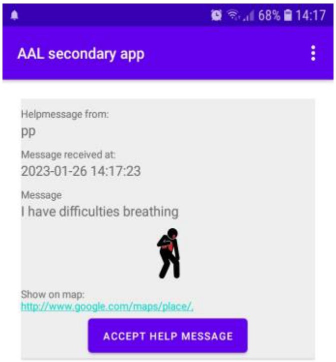

Figure 2. Screen example from the "secondary app" dedicated to being used by the helper.

Based on an earlier development from EvoAId Kft. [9], gestures (tapping on the phone or stomping with the feet while the phone is in a pocket or purse) can be used to trigger a message via the APH-Alarm app. Fall detection on the smartphone is also included. This is suitable for daytime use, especially when outside the home and the phone is not directly or quickly at hand.

For coverage of the in-bed scenario, where the phone may not be within reach, a solution for supporting two-way remote communication was developed by the University of Aveiro. This solution relies on arm gestures, some involving the bed (e.g., knocking on the mattress), for input interaction by the primary user (i.e., a person with Aphasia) while lying in bed [10] [11] [12]. Gesture recognition is based on wearable (smartwatch) sensor data and machine learning. The gestures can be used to activate the system and answer questions sent by the secondary user (e.g., caregiver) with his/her smartphone app (see Figure 3).

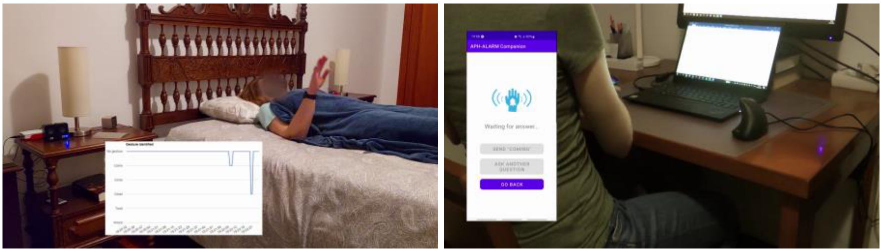

Figure 3. Demonstration of the two-way remote communication solution being used by two users simulating a person with Aphasia in bed and another person (e.g., caregiver) [12].

Apart from these gestures, research also covered the recognition of epileptic seizures while in bed. As it is difficult to collect data during seizures, because most patients have medications to prevent seizures after their first one, we are cooperating with an institute dealing with patients with severe cases of epilepsy, which cannot be fully suppressed with medications. A sensor placed below the mattress (Figure 4) allows data recordings of sleep patterns, which are hoped to enable the training of an algorithm to detect seizures as a trigger for a help message [13] [14]. We intend to record and analyze the motion signatures associated with medical conditions like epileptic seizures, paralysis and stroke. The abovementioned events could have differentiating features that a machine learning or rule-based algorithm can recognize. Therefore, the sensor could also be useful for persons who had a stroke previously and fear having another stroke in their sleep.

Figure 4. The bed sensor below the mattress is connected via Bluetooth to the app.

The app for users with Aphasia allows to pre-configure the receiver of automatically triggered messages as being either a user of the helper app or an emergency center (112). In the first case, communication is handled directly between the apps (based on mutual registrations on an APH-Alarm server). For alarms to 112 services [15] [16], currently, SMS is used as the most widely available service. When the message is manually triggered by the use of pictograms, the user-interface allows the selection of the intended receiver from up to four pre-configured receivers and 112. In addition to the option to provide details about the help requested, there also are shortcut alarms by only few clicks.

3. User Interface development and evaluation of pictograms

For the evaluation of the APH-ALARM solution, we adopted an iterative process aligned with a user-centered design approach, which is briefly outlined below, focusing so far on the evaluation of the user interaction using pictograms, leaving aside the scenario of communicating through gestures. In the first phase, we obtained feedback from several end-users in Hungary, through qualitative interviews, regarding an initial proposal for the graphical user interface (GUI) hierarchy and different options for individual pictograms. Based on this feedback, TU Wien created a web-based app demonstrator as an intermediate step for gathering further feedback from end-user partners. Then, EvoAId developed the first version of the APH-Alarm pictogram-based application, which can be run directly on smartphones and tablets (Android) and was tested with 31 end-users, thereof 19 persons with Aphasia (PWAs) and 12 persons without Aphasia. The latter included 3 occupational therapists. Testing was done primarily in person, in some cases online (using the Zoom application).

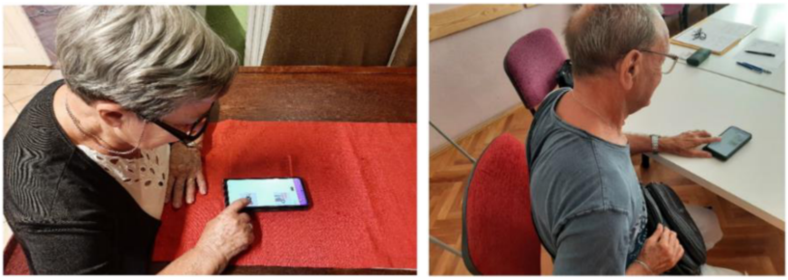

Figure 5. Users with Aphasia testing the mobile application.

A second evaluation of the smartphone app was carried out, by applying a task-based approach, involving again people with Aphasia, people without Aphasia, and some speech and occupational therapists (see Figure 5).

Among other aspects, rating the understandability and clarity of the pictograms was one of the main aims of the evaluation (see Figure 6). The results were analyzed and changes were made according to the feedback to further improve the prototype for the next evaluation step, which is currently underway. Improvements to the second app version included modified and new pictograms, a changed user interface hierarchy, and better feedback to the user.

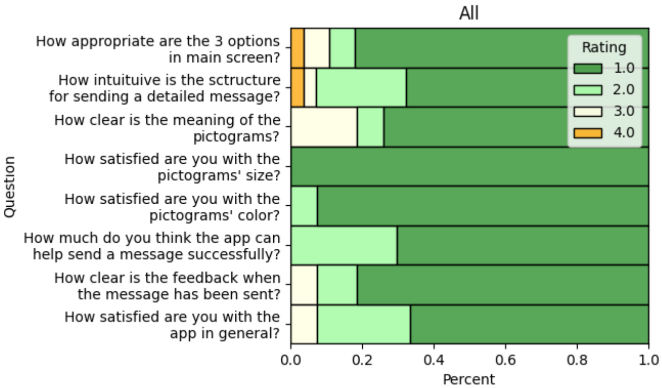

Figure 6. Exemplary results of the questions that were answered using a rating scale from 1 (very easy) to 5 (very difficult) for all participants (with and without Aphasia).

4. Conclusion and Outlook

The developed pictograms, structure and UI concept have been acknowledged by the involved users and experts and the proposed solution was rated as a very helpful support to send a help message in case of language difficulties. Based on the findings, the consortium is currently (January 2023) preparing a field trial of the final system's prototype.

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References

[1] Stroke Association, https://www.stroke.org.uk/what-is-aphasia/aphasia-awareness , last access: 13.3.2023.
[2] National Aphasia Association, https://www.aphasia.org/aphasia-resources/aphasia-factsheet/ , last access: 13.3.2023.
[3] Bundesverband Aphasie e. V., https://aphasiker.de/aphasie/ , last accessed: 17.3.2023.
[4] Bundesministerium für Soziales, Gesundheit, Pflege und Konsumentenschutz (BMSGPK), https://www.gesundheit.gv.at/krankheiten/gehirn-nerven/schlaganfall.html , last access: 17.3.2023.
[5] M. B. Johansson, et al. Communication difficulties and the use of communication strategies: From the perspective of individuals with aphasia, *Intern Journal of Language & Communication Disorders,* March 2012, DOI: 10.1111/j.1460-6984.2011.00089.x
[6] B. Bertoni, A.-M. Stoffel and D. Weniger (1991) Communicating with pictographs: A graphic approach to the improvement of communicative interactions, *Aphasiology*, **5**:4-5, 341-353, DOI: 10.1080/02687039108248535
[7] A. Beck, H. Fritz (1998) Can people who have aphasia learn iconic codes?, *Augmentative and Alternative Communication*, **14**:3, 184-196, DOI: 10.1080/07434619812331278356
[8] S. Banfield, Using Colours and Symbols (CAS) Researching a new low-tech AAC system for people with aphasia, 2020, https://www.bas.org.uk/Content/Media/CAS_A4_full_report_IRAS_250652.pdf , West Suffolk NHS Foundation Trust, last access: 27.1.2023.
[9] G. Németh, B. Gyires-Toth, B. Czeba, G.A. Nagy, 2019, System for detecting a signal body gesture and method for training, https://patents.google.com/patent/WO2019043421A1/en , last access: 13.3.2023.
[10] A. M. A. M. Guimarães (2021) *Bedfeeling - Sensing technologies for assistive communication in bed scenarios*. Master's thesis, University of Aveiro, Aveiro, Portugal. http://hdl.handle.net/10773/33877
[11] A. Guimarães, A. P. Rocha, L. Santana, I.C. Oliveira, J. M. Fernandes, S. Silva, and A. Teixeira (2021) *Enhanced Communication Support for Aphasia Using Gesture Recognition: The Bedroom Scenario*. In 2021 IEEE International Smart Cities Conference (ISC2) (pp. 1-4). IEEE. DOI: 10.1109/ISC253183.2021.9562810
[12] A. P. Rocha, A. Guimarães, I.C. Oliveira, F. Nunes, J.M. Fernandes, M. Oliveira e Silva, S. Silva and A. Teixeira (2022) *Toward Supporting Communication for People with Aphasia: The In-Bed Scenario*. In Adjunct Publication of the 24th International Conference on Human-Computer Interaction with Mobile Devices and Services (pp. 1-4). DOI: 10.1145/3528575.3551431
[13] APH Alarm Consortium, Newsletter #4, https://aph-alarm-project.com/index.php/en/blog/260-newsletter-4-en , last access: 26.1.2023.
[14] A. Avan, et al. Socioeconomic status and stroke incidence, prevalence, mortality, and worldwide burden: an ecological analysis from the Global Burden of Disease Study 2017, *BCM Medicine* 2019.
[15] DEC112 Silent Emergency https://www.dec112.at/en/ , last access: 25.1.2023.
[16] eena Next Generation 112, https://eena.org/our-work/eena-special-focus/next-generation-112/ , last access: 25.1.2023.