# VoxLaps: A Free Symbol-based AAC Application for Brazilian Portuguese

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**Abstract.** This paper aims to highlight the need for access to assistive technologies focused on augmentative and alternative communication (AAC), especially those available for the Brazilian Portuguese language, and the problems involved, as well as provide answers to these difficulties through the VoxLaps software, a free graphical symbol-based AAC application for the Android platform, developed under the supervision and support from a multidisciplinary rehabilitation team. This group of students and professionals evaluated the software functionality and usability, as well as other ACC tools, in order to compare their performances through the observation-based method and usability tests.

**Keywords:** Assistive Technology, Augmentative and Alternative, Communication, Voice Synthesizer and Human-Computer Interaction.

## 1 Introduction

Assistive technology (AT) is an interdisciplinary area of knowledge, encompassing products, resources, methodologies, strategies, practices and services aimed at promoting quality of life and social inclusion for people with special needs (PSNs) [1]. In recent years, the branch of AT has made substantial progress consolidating theoretical approaches, scientific methods and technologies, as well as exploring new fields of application. Recent developments in mobile technology field, especially the introduction of tablets, smartphones and mobile applications, created new opportunities in the field of AT. These advances have influenced the behavior of consumers of this technology, impacting on their participation and everyday life [2]. However, despite this development, the AT access is still restricted.

Indeed, current statistics [3] reveal that although Android and iOS stores have 3 million mobile applications, the research process of these applications to AT is still a difficult task, considering that the app stores do not use appropriate IDs, such as categories and classification of AT by disability. Furthermore, the descriptions of these applications do not always include appropriate keywords and in many cases, users do not know

the right keywords to use for searches in the app stores. Allied to these questions there are other factors that restrict this access, such as the language, reliability, stability, functionality and usability of applications, issues which according to [4] can only be properly addressed by a team of AT experts through appropriate evaluation methodologies. In addition to these factors, in developing countries like Brazil, the cost is also relevant because, according to the 2010 Census, about 60% of the population lives with an monthly income of less than one minimum wage per capita and 23.9% of total Brazilian population has at least one of the investigated disabilities: visual, hearing, motor, mental or intellectual.

Considering the market and current researches [5], a noticeable trend is the growing supply of AT products for communication, especially given the proliferation of mobile devices. As a result, individuals with disabilities, including those with complex communication needs, are also rapidly adopting augmentative and alternative communication (AAC) applications [6]. An inventory of several AAC applications is presented in [7]. In order to develop their own AAC tool, the authors analyzed approximately 40 applications available in the market, and among them only eight were chosen, using as criteria the number of resources, best practices and level of innovation. Among the selected set, only two provided support for the Portuguese language, which is an important aspect in the context of this work, since the effectiveness of visual communication using AAC symbols is also influenced by cultural differences, although to a lesser extent than language [8].

In response to these needs, we developed a free symbol-based AAC application for mobile devices using the Android platform, with support for the Brazilian Portuguese language, called VoxLaps, presented in this work through the following sections: 2) Augmentative and Alternative Communication: deals with the definition of AAC and presents well-know AAC tools and their main characteristics; 3) VoxLaps: details the development process, design and features of the proposed software; 4) Usability Tests: describes the applied usability testing procedure and participants; 5) Obtained Results: discusses the results obtained from the usability experiments; 6) Conclusion and Future Works.

## 2 Augmentative and Alternative Communication

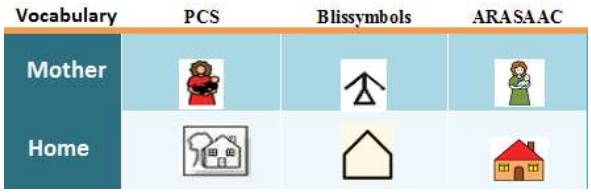
According to [9], alternative communication is any form of communication other than speech and used by a person in face-to-face communication contexts. Gestural and graphic signs, Morse code, among others, are alternative forms of communication for individuals who lack the ability to speak.

According to American Speech-Language-Hearing Association, AAC includes all forms of communication that are used to express thoughts, needs, wants, and ideas. Then, AAC provides to individuals with several speech or language problems special augmentative aids, in order to replace or supplement insufficient communication skills or abilities. It helps these people to communicate interactively, to gain better education, and to increase self-worth and self-esteem. In [10], the authors suggested the following terminology for AAC systems: no tech – rely on the user's body to convey messages;

low tech – these systems do not use electronics, but involve objects outside the individual's body; and high tech – based on electronic devices that allow the use of picture symbols and words to create messages. The message is activated by touch or any accessible external switch to produce a printout and synthesized (or digitized) speech.

Most AAC systems are based on the principle of communication boards with symbols associated to words (or buttons), as shown in Figure 1. These boards are organized into categories, such as actions, feelings, people, places and other subjects, extracted from pictographic collections (or libraries) allowing people with difficulties in communicating to create their message by tapping the buttons and then transforming it to voice and text message. There are many pictographic libraries, among these we quote: Picture Communication Symbols (PCS) [11], Pictogram Ideogram Communication Symbols (PIC) [12], Blissymbols [13] and the ARASAAC project [14], which is free distributed under the Creative Commons license. Figure 1 shows examples of words represented by such collections.

**Fig. 1.** Representing a vocabulary through different pictographic libraries




Some of the main AAC tools for Portuguese are described below:

1. **Livox – Liberdade em Voz Alta (Loud Voice Freedom) –** is a successful AAC product for tablets. It has communication boards organized by categories, allows the scanning of symbols to be enabled or disabled, and supports multiple users [15]. The acquisition of this product is subject to purchase of a tablet with the software pre-installed or the acquisition of the license agreement.
2. **Que-Fala** is a Web solution available for tablets, smartphones and desktops, to replace the former paperboards [16]. After purchasing one of the single use packages, the user must enter the boards to be used, considering that the application comes empty. In addition, for enabling speech synthesis, the user must click exactly on the sound icon over the figure, which may be a stress point, considering some groups of PSNs.
3. **Vox4All** is available for tablets and smartphones using Android and iOS operating systems. It is a commercial application, but its developers have provided one trial version for very limited use. The commercial version includes several features: create, edit and delete boards; and enabling or disabling the figure scanning system. Based on communication networks that enable the interconnection between boards, the application allows the use of the device's camera, image gallery and voice recorder, aiming to extend the graphic symbols database [7]. Despite offering many features and support for three languages, including Portuguese, the tool was considered little intuitive by rehabilitation professionals who participated in the tests carried

out through this work, according to Section 4. Cost is also important, considering that rehabilitation institutions need to acquire a sizeable number of licenses.

4. **Adapt** is a free tool available on the Google Play Store [17]. It has limited features, for example, the creation of new users and automatic scan of boards and buttons are not supported. However, it allows creating and editing communication boards. It uses only the images that are pre-defined in the application, i.e. not allow the use of the device's camera or gallery to acquire new symbols.
5. **Araboard** is divided into two distinct parts, called Constructor and Player. According to the authors [18] the part identified as Constructor allows tutors to create, edit and delete communication boards, enter pictographic from the system libraries or through the use of the device camera. The user accesses the boards through the Player module. The solution is free and available in the Google Play Store, but the Constructor module was experiencing failure during the process of creating boards, preventing its use because the application comes with no board option previously set, hence it was not used in our tests.

## 3 VoxLaps

VoxLaps is an application that has been developed for tablets and smartphones using the Android platform. It will be published under the Creative Commons license. This AAC software focuses on the Brazilian Portuguese language and its development process was divided into three phases. The goal was to start with an application that turns symbolic message into synthesized speech. Next, we extended the tool with the features present in different AAC software. The last step was the tool validation by rehabilitation professionals and students. The methodology consisted of:

- ***Learning about the user:*** Comprises of meeting relevant aspects of the individual with special needs, their environment and the AT used for supporting the activities of his daily routine. The implementation of this phase took place through the participation of professionals in the field of rehabilitation of the Development Center for Assistive Technologies and Accessibility (NEDETA), Brazil, who acted as the requirement providers.
- ***Project execution:*** Based on user needs, a survey was conducted for AAC applications in mobile app stores, databases, websites and blogs related to AT. From this research free and commercially tools were selected, which had relevant characteristics for the project.
- ***Testing selected tools:*** The selected tools were tested in order to identify strengths, weaknesses and opportunities for improvement. This analysis generated a list of initial requirements, which was evaluated and modified as requested by the requirements suppliers until its final approval.
- ***Initial prototype:*** System prototypes were developed based on the set of the collected requirements. The initial prototype consisted in boards arranged into categories called person, question, expression, verb, adjective, action, feeling, food, letters

and numbers. These categories were composed of images with texts, which when activated**,** transformed the text into synthesized speech.

- ***User rating:*** The developed prototypes were presented and evaluated by the requirements supplier, i.e. rehabilitation professionals. The problems identified were corrected, noting the user-identified considerations. Through this iterative process, all the highlighted requirements have been implemented.
- ***Current prototype:*** The involvement of users throughout the development process enabled a better understanding of the needs and goals of the target audience, favoring the use of strategies such as, for example, the Fitzgerald Key. Based on colors code, the Fitzgerald Key aims to understand the importance of ordering the words in the sentence and the implications of any change into the meaning. Thus, we have: Person - yellow, Verbs - green, Adjectives and Adverbs - blue, Nouns - orange, Miscellaneous - white and Social (signs that feature words facilitating social interaction) - pink [19]. Figure 2 illustrates the application of this concept.

**Fig. 2.** (a) Initial screen of VoxLaPS with 10 categories, identified by text and color, as well as "yes" and "no" buttons. (b) Communication board to express emotions.


(a) (b)

The current version of VoxLaps consists of 10 boards, distributed in the following categories: Individual, Questions, Expression, Verb, Adjective, Action, Feeling, Food, Letter, Number and the Yes / No buttons. The used symbols are works of Sergio Palao to CATEDU and published under the Creative Commons license [14]. The key features of VoxLaps are presented below:

- ***Manage users*****:** This feature allows creating, editing and deleting user profiles to which can be created multiple and different patterns of communication boards, being this one of the innovative features of the tool, since it helps adapt the tool to the needs of different users on the same device.
- ***Manage boards:*** This feature allows creating, editing and deleting communication boards for different user profiles. Through it, the tutor can set the number of rows and columns that will compose each board and the system will adapt the buttons to screen size, noting the amount reported.
- ***Manage buttons:*** This feature allows creating, editing and deleting buttons that will compose a communication board. To create and edit buttons, the user can use the device's sensors (camera and voice recorder) and gallery.

- ***Automatic scan of boards and buttons:*** This feature allows the user to dispense with the mouse and use the application as a trigger. When the user activates this function, the buttons present on the graphical interface are visited sequentially, and the system will synthesize the message corresponding to the visited item by touch any part of the screen. The user can adjust the scan speed.
- ***Message transcription:*** This feature keeps the selected words in a text box located at the top of the tool's interface. So, the user can repeat (i.e. synthesize) the formed phrase through activation of the Play button, reuse the content, in whole or in part, and navigate between the boards during the message composition.
- ***System settings:*** This feature allows setting the border color of the visited item and the scan speed.

## 4 Usability Tests

The evaluation experiments have compared the current version of VoxLaps with the free software Adapt and two commercial applications: Vox4all and Que-Fala. Brazilian rehabilitation students and professionals, unrelated to the development process, were invited to perform seven tasks using one of the chosen AAC tools. The selected applications were evaluated through observation-based method and usability tests. Table 1 presents the activities associated with the preparation and execution of these tests.

**Table 1.** Activities for the usability tests [20]

| Activity | Task |
|---|---|
| **Preparation** | ✓ Set tasks for participants to perform.<br>✓ Define the participants' profile and recruit them.<br>✓ Prepare material for observing and recording.<br>✓ Run a pilot test. |
| **Data collection** | ✓ Observe and record the performance and opinion of the participants during controlled use sessions. |
| **Interpretation and consolidation of results** | ✓ Collect, account for and summarize the data collected from participants. |
| **Reporting results** | ✓ Report performance and opinion of the participants. |

The testing team was composed by 12 Brazilian evaluators recruited as follows: a) **two** speech therapists; b) **three** occupational therapists; c) **one** psychologist; d) **one** educational psychologist; e) **one** neuropsychologist; f) **three** undergraduate students in occupational therapy; g) **one** master student of postgraduate studies in linguistics.

Each task describes a situation that allows the user to explore the tools' features. The tests were recorded and observed on-site. At the end, the volunteers answered a questionnaire that evaluates user satisfaction, user profile and user perception related to the employed tools. Table 2 presents the tasks used with a simple description and related goals.

**Table 2.** Description and goals of the tasks

| Task | Description | Goal |
|---|---|---|
| 1. Pre-recorded phrase reading | The professional wants to use the speech synthesizer to demonstrate to the patient, how he must proceed to transmit a pre-recorded message from the device. To accomplish this task, the professional accesses the desired category and clicks on the corresponding image to select the message to be transmitted, which is expected to be emitted by speech synthesizer. | It evaluates the performance of a basic functionality of vocalizers, comprising the voice synthesizing of messages formed by selection of images or symbols. |
| 2. Enabling automatic scan of buttons | You want to make available to a patient with multiple disabilities, the automatic scan of buttons feature. In this feature, the system visits each button on a board, in constant speed, highlighting it in order to allow the impaired user to select a button at the time of its scan by tough or click on suitable trigger. Based on this information, activate the system scan. | It comprises enabling/disabling the automatic scanning feature, functionality that allows buttons in a particular category to be automatically visited, simplifying the user selection. |
| 3. Creating new user for a new patient | The institution receives constantly new patients, so it is necessary to provide the appropriate boards as treatment support. These boards are individual and personalized. Currently, these boards are made manually, grouped by categories and identified with the name of the patient. In this way, using the tools listed, create a new user (patient) called “Johnny”. | It includes the insertion of new users (PSNs) into the system. |
| 4. Creating new communication boards | During the treatment, you realize the need to create new communication boards appropriated to the patient’s stage of evolution. This board must contain a name that identifies its category, as well as a related image. Several buttons may be included on it, which will facilitate the communication process. So, using the indicated tool, create a new custom board for your new patient, named “Family”. | It comprises the insertion of new categories of communication boards for patients registered in the system. |
| 5. Inclusion of buttons in communication boards | The boards are composed of buttons, which have an image and a text. When a button is selected, the associated text is synthesized. After you create a new board, you must insert the buttons relating to the created category. Now that you have created a new user and a new board named “Family”, insert a new button with the text “I'm Johnny” and use the mobile device's camera to take a picture of the patient to be used as identification of the new button. | It includes the insertion of buttons (images) into categories of existing boards. |
| 6. Recording new messages on buttons | The speech synthesizers use TTS, i.e. a text-to-speech system that converts natural language text to voice. However, that voice is not familiar to the patient. In order to let the patient better suited to the use of the tool, you want to insert, in the “Family” board, new buttons that perform the voice of the patient's mother as well. To create these new buttons, you should use the device’s voice recorder. In this way, you should record a new message in a button. | It comprises recording the message (voice) for the message to be transmitted. |
| 7. Editing buttons and boards | You have already created a new button on the “Family” board, named “godmother”, and after performing the whole process, you realize the word was misspelled and you want to fix it. Using the Edit feature, change the message of an existing button and then change the name of the board, which contains the button that was changed. | It comprises performing changes of boards and buttons present in the tool. |

## 5 Obtained Results

For carrying out the tests, each of the 12 participants used only one tool and they were distributed as follows: Adapt (2); Que-Fala (2); Vox4All (4); and VoxLaps (4). Due to restrictions in the number of volunteers, the tools with more features were privileged. Table 3 shows the tasks performed and the hit percentage for each tool. The features not covered are identified by DNE (i.e. does not exist).

**Table 3.** Comparing the selected tools through seven tasks

| Tasks | Tools | | | |
|---|---|---|---|---|
| | **Adapt** | **Que-Fala** | **Vox4All** | **VoxLaps** |
| | **%** | **%** | **%** | **%** |
| 1. Pre-recorded phrase reading | 100 | 100 | 100 | 100 |
| 2. Enabling auto scan of buttons | DNE | DNE | 25 | 75 |
| 3. Creating new user | DNE | DNE | DNE | 75 |
| 4. Creating new communication boards | 0 | 50 | 0 | 50 |
| 5. Inclusion of buttons in communication boards | 50 | 50 | 25 | 50 |
| 6. Recording new messages on buttons | DNE | DNE | 25 | 75 |
| 7. Editing boards and button | 50 | 50 | 25 | 75 |

- ***Task 1:*** all the selected tools come with this functionality and all participants were able to satisfactorily perform the task.
- ***Task 2:*** Vox4All offers this functionality, but the users felt difficulties to locate it and considered the screen polluted, making it hard the perception of the desired information. Considering VoxLaps, the users' justification was the ease to locate the functionality at the interface.
- ***Task 3:*** among the selected applications, only VoxLaps introduces support for this functionality.
- ***Task 4:*** all the selected tools support this functionality, however, the results were almost non-satisfactory, considering that: participants who tested Adapt managed to locate this feature within the application, but could not complete the task, giving up from it after a few tries. The justification presented was the low intuitiveness of the interface and the lack of labels indicating the function of important icons on the screen, such as "insert image". In Que-Fala, the user who did not complete this task reported that the application was uninviting, as it started blank, leaving to the user the responsibility of populating the tool with images for communication, i.e. the user spends much time trying to figure out and configure the tool. Vox4All presents a rich configuration area, which allows the creation of boards, linking them with other existing boards, and the use of available resources on the device, such as camera and voice recorder, among others. Nevertheless, none of the four participants who tested Vox4All managed to complete the task, because of the following reasons: difficulties to understand the icon represented by a pencil, on the top of the screen, indicated the "setup area"; those who understood it and were able to access this area, passed

through the option of creating a new board without noticing it, or performed the task inserting images into existing boards, believing to be performing the task correctly. In the end, all participants evaluated the tool as little intuitive. Among the 4 participants who used VoxLaps, only two were able to complete the task. The justification presented was the tool needed labels to identify the icons on screen, as they were not intuitive. Moreover, the closeness of the create button and board icons, caused confusion to the user, that executed the action of create button instead of create board. Another problem pointed was the lack of identification of the user location during navigation in the tool.

- ***Task 5:*** this task reflects the results of the previous activity, because to create buttons it is required a board inserted on the tool, thus, the failures that occurred in the previous step are reflected in this task. In Adapt, the participants were unable to insert new boards, however, as the tool came with some native boards, they allowed the execution of this task. In Que-Fala, only the user who has succeeded in task 4 performed this activity, as there is a dependency between boards and existing buttons in this application. In Vox4All, the justification for the results is similar to that of Adapt, considering that despite task 4 not been carried out, the fact that this application has native boards allowed the completion of the task. In VoxLaps, the results obtained in previous step reflected in the current task.
- ***Task 6:*** Considering Vox4All, the users felt it difficult to find this functionality, and only one participant completed this task. In VoxLaps, one of the participants was unable to perform the task, for the same reason pointed by the Vox4All users.
- ***Task 7:*** This task is similar to task 5 and was inserted in order to validate the results obtained there. Note that the results were similar.

## 6 Conclusion and Future Works

Based on the tests with students and rehabilitation professionals, there are relevant factors that restrict or even inhibit the use of AAC tools for some of the users, who often end up opting for manual boards. Although these boards are useful during the treatment sessions, they are restricted to the training environment, because patients do not feel the urge to use such boards in other social environments, like school, cinema, parks and others.

Therefore, the development of robust and intuitive tools is essential in this context, because the tutors (rehabilitation professionals, parents, teachers, etc.) need to expand communication boards according to the patient evolution, and this activity should be carried out in a simple and objective way, so there is no waste of time or too much effort from tutors, and consequently from the PSNs. Through the usability tests, it was possible to demonstrate that the user-centered development favored the increase of user satisfaction levels compared with other tools used in our tests, with a decrease in errors occurrence being observed during the execution of the proposed scenarios.

Furthermore, our tests also identified new features, and items to be improved for a next version of the VoxLaps software. Tests with patients are being conducted and for future works, we propose the presentation of these evaluation results, together with

comparisons with other tools, in order to identify negative and positive points and opportunities for improvement. Another work intends to adapt VoxLaps to recognize Bluetooth devices in order to expand the target audience that can be benefited.

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