

Requirements and Quality Attributes of High-Tech AAC Solutions: An In-Depth Analysis

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ABSTRACT

Communication is an essential multimodal process, yet certain disabilities can critically restrict interaction. Augmentative and Alternative Communication (AAC) solutions have the potential to promote inclusion for individuals with Complex Communication Needs (CCN); however, these computational solutions require accessible and highly customizable interfaces. This paper investigates high-tech AAC, with a focus on pictographic applications for Autism Spectrum Disorder and Cerebral Palsy (CP). Grounded in the theory of organizational knowledge creation, the study aims to expand the understanding of functional and quality requirements for these systems. The research combines a rapid systematic literature mapping (RLM) and an exploration of app stores, providing a descriptive analysis of leading academic and commercial solutions. We identified functional and non-functional requirements and validated them through the development and evaluation of an open-source AAC system, conducted in collaboration with Occupational Therapists. Additionally, personas representing non-verbal autistic individuals and children with CP were developed to support the identification of user needs and system requirements. The study outlines key requirements and limitations, highlighting significant gaps in accessibility, portability, and customization. Based on these findings, the AAC platform VivaVox was developed to address these challenges and better support diverse user needs. A comparative analysis of three freely available platforms – VivaVox, AsTeRICS Grid, and SymbolTalk – revealed that alternative access methods (scanning and eye tracking) remain the critical differentiator, with AsTeRICS Grid providing the broadest coverage.

KEYWORDS

AAC, CCN, Assistive Technology, Autism, Cerebral Palsy

1 INTRODUCTION

Communication is intrinsic to human beings and is directly related to interpersonal interaction, participation, autonomy, and expression across different spheres of social life, encompassing everything from the family environment to broader

societal experiences, from the community to the global level. Communication is understood as indispensable, serving as a means of ensuring personal, social, and economic well-being, and therefore should be recognized as a fundamental right, regardless of age, status, ability, or communicative capacity [27]. Furthermore, all people have the right to receive and transmit messages, to hold opinions, and to express themselves, thereby guaranteeing equality, justice, and human dignity [42].

However, physical, neurological, and psychological conditions can cause an individual to have or develop a communication disorder. The American Speech-Language-Hearing Association [4] defines a communication disorder as an impairment in the ability to receive, send, process, or comprehend verbal, nonverbal, or graphic symbol systems. Regarding the production of communication, speech and language disorders are particularly relevant. A speech disorder is characterized by an impairment in the articulation of speech sounds, fluency, or voice, ranging from distortions that interfere with intelligibility to the complete absence of vocal production. In contrast, a language disorder refers to an impairment in the use of spoken, written, and/or other symbol systems.

A communication disorder may be developmental or acquired, resulting from different disabilities, whether permanent or temporary [44], such as Cerebral Palsy (CP) [34], Autism Spectrum Disorder (ASD), Amyotrophic Lateral Sclerosis (ALS), Spinal Muscular Atrophy (SMA), stroke [39], syndromes (e.g., Down syndrome or Rett syndrome) [6], or neurological and psychiatric disorders, which may even result from trauma and abuse [1].

In this context, Assistive Technology (AT) solutions support the communication of individuals with communication limitations, promoting independence, social inclusion, and quality of life [21]. In this context, tools to support Augmentative and Alternative Communication (AAC) have been developed, ranging from paper-based boards to computational systems capable of capturing user interactions and synthesizing speech. AAC tools are designed to improve communication for individuals with diverse communication needs, including those with severe motor limitations, such as in CP and ALS [36], or speech and language disorders, as in some cases of ASD [41], among others. For some children, an AAC system may provide fundamental support for the development of language and communication [30].

Murray and Goldbart [30] classified AAC tools according to the level of technology required to support or replace speech.

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Among “high-tech” solutions, notable examples include systems that support the creation of pictographic boards [13], vocabulary personalization [10], context-aware text prediction and recommendation, and alternative input techniques such as eye tracking [43], gesture mapping [16], and electroencephalography (EEG) [46].

Despite the availability of several commercial AAC solutions, their adoption in Brazil remains limited. Many of these solutions are unaffordable for a large portion of the population and require specialized training to be learned and used effectively. In this context, this paper aims to understand how AAC technologies address communication challenges by analyzing different types of tools, providing an overview of the state of the art and the challenges of supporting individuals with Complex Communication Needs (CCN). Specifically, the focus is on users with ASD and CP who have difficulties with spoken communication.

Our main goal was to identify and validate the requirements of pictographic AAC solutions. To achieve this, we identified the tools most commonly used in both academic research and the commercial market and extracted their functional and non-functional requirements. We then validated these requirements in collaboration with a team of academic occupational therapists and through Barrier Walkthroughs using personas. A rapid systematic literature mapping (RLM) was conducted to investigate the main solutions proposed and used in academia, along with an exploration of mobile app stores to identify the main commercial applications used abroad and, in particular, in Brazil. We developed personas representing non-verbal autistic individuals and children with CP to support the evaluation of three freely available AAC tools (including ours) and the identification of user needs and system requirements.

The analysis was conducted from the perspectives of Information Systems (IS) and Human-Computer Interaction (HCI), discussing points of interest in terms of computational requirements while considering end-user needs. The discussion aims to be useful for both academic and commercial audiences, benefiting researchers and developers of new AAC applications. However, the importance of free and open-source software in the AAC context is emphasized [25]. Furthermore, organizing knowledge about AAC solutions may benefit the community, especially users of these systems and their support networks, by enhancing communication and social interaction.

2 METHODOLOGY

2.1 Rapid Systematic Mapping

To identify the tools used in academic research, the search focused on systematic reviews and mappings investigating the use of high-tech AAC solutions for individuals with ASD and CP. The RSM followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [28]. The search string consisted of the terms “*Augmentative AND Alternative Communication AND Review*” in article titles. The CAPES Journal Portal was selected as the search

database. The inclusion criteria were: (1) studies discussing high-tech pictographic AAC solutions and (2) studies identifying and listing AAC tools. The search was limited to the period from 2018 to 2024, as earlier reviews and mappings might include outdated solutions that are no longer available. We conducted the search in October 2024 and used terms in both English and Portuguese.

Additionally, to identify the main commercial systems available in the Brazilian market, we explored the Android and iOS app stores (i.e., grey literature). AAC applications were selected according to the following inclusion criteria: (1) applications that do not require dedicated AAC devices and can be used on general-purpose devices (e.g., tablets, smartphones, or desktop computers); and (2) the use of pictographic elements. Applications that were no longer available for download from official sources were excluded (e.g., *PictoTEA app*). Dedicated AAC devices and applications designed exclusively for teaching, rather than supporting everyday communication, were also excluded.

We analyzed the identified solutions in terms of their functional and non-functional requirements. Requirements were elicited through a detailed analysis of the selected AAC tools, combining a literature review with hands-on testing to assess each tool’s strengths and weaknesses. The requirements were discussed considering the needs of the target audience and their frequency across the analyzed applications. Finally, we compared the most widely used solutions and created a table summarizing the main features of each solution identified in the literature and the market.

2.2 Evaluation

To validate the identified requirements, we collaborated with Prof. Dr. Gerusa Ferreira Lourenço and her research group from Federal University of S/ ao Carlos, specialists in Occupational Therapy with practical experience in AAC for children, particularly those with CP. Their expertise was essential to ensure that the final set of requirements reflected practical needs and real-world AAC use. Based on the identified requirements and the experts’ analysis, we developed an open-source AAC platform focused on personalization and accessibility. This stage of the study was approved by the Research Ethics Committee of Certificate of Presentation for Ethical Consideration (CAAE) under approval number 80724824.2.0000.5467.

To further evaluate the adequacy of our platform with respect to real user needs, we conducted Barrier Walkthroughs [8] using personas. The personas were constructed representing two distinct groups of pictographic AAC users: individuals with CP and individuals with ASD. Personas with CP were described using the Gross Motor Function Classification System (GMFCS), Manual Ability Classification System (MACS) and Communication Function Classification System (CFCS) profile [23, 33], covering an intentional spectrum of AAC use: as a supplement to speech (CFCS II), as the primary communication modality (CFCS III), and through alternative access via eye tracking (CFCS IV). Personas representing

autistic children were structured based on two support levels defined in the DSM-5-TR [3], ranging from functional speech with social interaction difficulties (Level 2) to the absence of intelligible speech requiring very substantial support (Level 3). The five personas were then used to evaluate our platform and compare it with two other freely available AAC solutions – AsTeRICS Grid and SymbolTalk – focusing on disability-related access barriers rather than feature preferences.

3 RESULTS

We present AAC requirements identified through the rapid systematic literature mapping and the exploration of digital platforms and mobile applications. After presenting the search results, we analyze the functional and non-functional requirements of each platform, highlighting characteristics relevant to the development of AAC systems. Based on the identified requirements and their validation with occupational therapists, we then present the open-source AAC system developed in this work. Finally, we evaluate its accessibility through a persona-based analysis and compare it with other two freely available AAC solutions.

3.1 Analyzed Tools

Considering the RSM, the searches in the CAPES Journal Portal returned 87 studies published between January 2018 and October 2024. Since one of the inclusion criteria for the literature reviews and mappings was the identification of AAC tools, the full texts of all studies whose titles and abstracts met the initial screening criteria were reviewed. In the end, nine studies were selected. The in-depth analysis of requirements focused on the most comprehensive and widely used solutions identified in the literature and app store exploration. TD Snap, Proloquo2Go, SoundingBoard, and CBoard were the most frequently cited applications in the literature, with Proloquo2Go being the most frequently cited in international studies. AsTeRICS Grid was the only free and open-source solution offering extensive customization features and has also been used by collaborators in this research. The app store exploration identified Matraquinha, Livox, and Expressia as popular applications among Portuguese-speaking users.

Proloquo2Go [38] was the most widely used AAC solution in academic research and is one of the most popular AAC applications for iPad and iPhone. The application uses a pictographic communication system and primarily targets individuals with ASD, CP, and Down syndrome who require communication support. Its main features include: support for four languages (English, Spanish, French, and Dutch); a digital keyboard for composing complex words and sentences; a library of more than 27,000 symbols; sentence construction using symbols; and customization options, including the import of personal images. The application also allows boards to be printed, facilitating communication when an electronic device is unavailable.

TD Snap [40] is an AAC application focused on literacy and communication development for individuals with Down syndrome, ASD, apraxia, CP, and other conditions. Compatible with Windows and iPadOS, it is one of the most well-known AAC systems due to its extensive customization capabilities, allowing users to import personal images and create board sets with variable grid sizes. Users can easily organize pages by topic through an intuitive navigation system. A distinguishing feature is its native support for Tobii Dynavox eye-tracking devices, enhancing accessibility for users with limited mobility. The company also offers other AAC solutions, such as Sono Flex.

AsTeRICS Grid [26] is an open-source AAC platform that enables the creation and customization of communication boards, either from the system's existing board library (which can be shared with the community) or from scratch. This web-based application supports multiple input methods, including switches, joysticks, and eye tracking, which can also be combined. It includes pictographic cards (images and text) that can be customized with user-defined images, text, and recorded speech for voice output. Despite its flexibility, usability remains a challenge due to the complexity of the board authoring process.

Matraquinha [29], developed by a Brazilian startup, is a mobile AAC application available for Android and iOS, primarily designed for individuals with ASD. It functions as a visual communication board, providing pre-categorized pictographic cards (e.g., emotions, needs, food, clothing, leisure, pain, greetings, animals, places, school, colors, shapes, the alphabet, and numbers). Selecting a card triggers speech synthesis to verbalize its meaning, although the application does not support sentence construction. It also includes educational games and activities designed to stimulate cognitive skills, such as logical reasoning and memory.

Livox [32], another Brazilian AAC application, employs AI to enhance user interaction. According to its website, it has pedagogical potential and uses machine learning to adapt to different motor, visual, and cognitive abilities. Its main features include imperfect touch correction, eye-blink interaction, customizable cards with adjustable contrast and size, support for videos, images, and music embedded in cards, card import, and board sharing. However, it does not support sentence construction, and no free trial is available, limiting the evaluation of advanced features such as multi-board management.

Expressia [2] is an AAC application designed for individuals with speech impairments. It allows the creation of personalized boards with images, sounds, and voice recordings, alongside an online library of pre-made boards. Its main features include voice recording for cards, vocal scanning for users with visual or motor impairments, and cognitive stimulation activities designed to improve attention, visual perception, logical reasoning, memory, and vocabulary. It also includes storytelling activities for children.

CBoard [24], although not free, is open source and available for desktop and mobile devices. Designed for children and

adults with speech and language impairments, it offers customizable cards (images, text, and voice), pre-made thematic boards, user-created boards, and board export, printing, and sharing capabilities.

SoundingBoard [20] is available for iOS devices and is a pictographic AAC application with customizable board layouts, cards, and images. It supports the customization of audio and images and includes a built-in symbol library.

It is worth noting that AAC technologies have evolved from dedicated communication devices to software applications for desktop and mobile platforms. Several older systems (e.g., PictoTEA, Pick a Word, EasyVSD, TalkMobile, and AustiMate) were excluded from this study because reliable and up-to-date information was no longer available, suggesting that these applications have been discontinued.

It is important to highlight the cost associated with AAC solutions. Although free tools and limited free versions are available, most AAC systems require a paid license or subscription, creating a significant barrier to their adoption. In Brazil, where access to these technologies is often constrained by socioeconomic factors, many individuals with speech or language disorders cannot afford the recurring cost of commercial AAC software.

We provide supplementary material¹ listing all analyzed tools, together with their key functionalities and pricing. Additional systems included only in the supplementary material were: GoTalk Now [17], iCAN [11], TouchChat [12], Pic-A-Talk [37], SymboTalk [18], MyTalkTools Mobile [31], Avaz [5], Spoken [7] and VoxLaPS [15]. The following sections detail the requirements extracted from the analyzed tools.

3.2 Common Requirements

It is important to emphasize the primary common requirement, which was also adopted as an inclusion criterion in this study: all identified AAC tools are pictographic, based on communication boards that combine illustrations, words, and/or spoken expressions to support effective communication for individuals with Complex Communication Needs. Verbal communication involves the use of spoken or written words to convey a message, whereas non-verbal communication relies on non-linguistic representations [13]. In this context, pictographic communication plays a fundamental role, as images provide effective visual support that helps direct attention and facilitate communication for individuals with CCN, particularly those who communicate non-verbally. This modality is especially relevant for some individuals with ASD and CP, particularly during language and communication development.

Pictographic AAC solutions feature a board structure. Whether customizable or not, the presence of board sets is a common element across the analyzed tools. The systems usually include predefined (default) boards, which can be used and modified according to the user's needs and progress. Customization is an essential requirement in AAC tool development, significantly impacting usability and increasing

user adoption and acceptance [13]. The set of cards available on the boards gradually expands as users' language and technology proficiency improve, while thematic organization facilitates the search for specific objects or actions. Category-based card organization is crucial for enhancing system usability, as it makes card retrieval more efficient, avoiding excessive scrolling or keyword-based searches. This requirement is particularly important, as studies estimate that 30% of Assistive Technology users abandon these tools due to usability difficulties and low efficiency [14]. Most analyzed systems also allow the creation of custom cards, even if only to a limited extent, through the insertion of user-defined images and text. For children with ASD, this feature is particularly relevant, as sensory differences directly influence their experiences [35]. In this context, incorporating familiar and routine-specific elements is essential for supporting daily activities and enabling comfortable communication.

One point of divergence among the tools concerns the use of audio. While all tools have an audio system for playing words and short phrases, few allow the recording of personalized audio to be used on a card. The lack of personalization may create a sense of detachment, as voice generation through Artificial Intelligence (AI) can reduce user trust in the system. Furthermore, few tools allow the formation of sentences by combining multiple cards. The absence of this function affects the user's communication process, as using only detached keywords hinders communication fluency. In this context, it is essential to encourage users to construct sentences, even incomplete ones, since AAC aims to enhance and enrich verbal communication.

3.3 Accessibility Requirements

In Assistive Technology (AT) systems, accessibility is a fundamental requirement and must be carefully considered to accommodate a wide range of abilities and needs. Given the widespread use of AAC tools on mobile devices, touch interaction is the most common input modality. However, this can pose an accessibility barrier, as individuals with reduced mobility, particularly those with impaired fine motor coordination, may struggle to accurately select small touch targets. Several approaches can mitigate this issue, ranging from simple solutions, such as customizing card size, to more advanced techniques, such as automatic touch target correction.

Regarding card visualization, individuals with low vision may experience reading difficulties due to factors such as low color contrast and small font sizes. Again, customization is an essential requirement, as these barriers can be addressed by allowing users to adjust the board layout, card size, font size, and color contrast according to their individual needs [22].

For individuals with severe motor disabilities, such as those users affected by conditions like CP and SMA, support for multiple interaction modalities is essential. It is crucial that AAC solutions incorporate redundant interaction mechanisms, allowing users to complete the same task through

¹<http://bit.ly/4f7dtTs>

different input methods, such as touch, adaptive mice, joysticks, scanning, keyboard shortcuts, eye-tracking devices, or even hand and facial gestures. Implementing these functionalities is not trivial and involves many variables, as they require interface adaptation and testing for each interaction scenario. Only a few systems provide native support for scanning or eye-tracking devices.

From another perspective, individuals with ASD often exhibit atypical processing of sensory stimuli, which may be faster and more intense than in neurotypical individuals [45]. Considering this sensory profile is important in the design of computational solutions, as it may influence how users perceive and interact with their surroundings. Therefore, applications should follow accessibility guidelines specifically designed for this population, such as those proposed by [9].

Another fundamental requirement for inclusion is portability, which refers to a system's ability to operate across different execution environments, such as desktop computers and mobile devices. In the context of AAC, compatibility with smartphones and tablets is particularly important, as it allows users to carry their communication system wherever they go, promoting greater independence. Some systems still present limitations regarding this requirement, running primarily in web browsers and performing better on desktop operating systems.

Regarding the authoring of pictographic boards, the process of creating cards and boards is often complex. This complexity can make content authoring prohibitive for end-users, requiring boards and cards to be created by therapists or other third parties. Navigation between boards is another point of concern. Among the analyzed tools, there is no standard approach to organizing and navigating boards. While some systems allow cards to be grouped within a board, most applications treat each board as an independent unit. This design complicates the reuse of word groups across boards, as well as the configuration of linguistic variations such as plurals, verb conjugations, and other grammatical forms.

Finally, the importance of flexibility within the system must be emphasized. AAC tools are generally focused exclusively on communication. However, in some contexts, there is a need to include additional activities to improve communication and social interaction for the target audience. For example, [19] investigated the use of the Livox app in developing extra activities by public school teachers working with autistic children. Requirements were gathered from teachers to identify the most relevant activities, including memory games, themed quizzes, puzzles, and connect-the-dots games. A prototype was tested with children with ASD aged 6 to 14. The research demonstrates progress in AAC tool development by incorporating a co-design paradigm with end-users, giving them an active voice in the solution's development. Ultimately, the study highlights the relevance of complementary activities beyond communication, as they can contribute to literacy while strengthening the bond between users and the tool, increasing engagement and trust in the system.

3.4 VivaVox

VivaVox is an open-source AAC application available for web browsers and mobile devices. Its development followed an iterative process guided by the requirements identified through the systematic literature mapping presented in this study. These requirements were further refined through use case modeling and validated in collaboration with occupational therapists. The platform was designed with a strong emphasis on usability, accessibility, and adaptability. To support users with different motor abilities, VivaVox implements a row-column scanning mechanism that enables card selection through multiple input methods, including a dedicated keyboard key, touch interaction anywhere on the screen, and eye-blink activation. In addition, the platform supports fully customizable cards with user-defined images, promoting greater identification with pictographic content, which is particularly important for children and younger users during language and communication development.

The development of the platform also aimed to better understand the user experience involved in the authoring and management of AAC resources, while simultaneously producing the platform as a proof of concept. In this context, the customization features allow users and caregivers to create communication interfaces tailored to individual needs, which is essential for evaluating the effectiveness of different interaction models for the target audience.

A qualitative evaluation of the platform was conducted to collect feedback on its usability and relevance. The evaluation involved experts in Occupational Therapy, led by Dr. Gerusa Ferreira Lourenço from Federal University of São Carlos. All participants had prior experience with AAC systems, including TD Snap and AsTeRICS Grid. Overall, the feedback was positive, highlighting the platform's ease of use compared with existing AAC tools and the design of the retractable side menu. Regarding the AAC functionalities, the hierarchical organization of vocabulary categories was identified as a major strength, with the potential to support vocabulary expansion.

Several opportunities for improvement were also identified. Participants suggested allowing users to customize the synthesized voice (e.g., selecting female or male voices), as well as personalizing the eye, skin, and hair colors of pictographic characters to promote greater user identification with the platform. They also highlighted the need for more advanced board customization, including support for different layout organizations, a variable number of cards, and nested boards. As the platform is still under development, the feedback was essential in guiding its next stages. Future work will focus on addressing the identified improvements to further enhance the platform's accessibility, usability, and adaptability for a broader range of users.

The implemented functionalities reflect several of the requirements identified throughout this study. VivaVox supports alternative access through a row-column blink-scanning mechanism, improving accessibility for users with severe motor impairments. The platform is also portable, providing

native interfaces for smartphones, tablets, and web browsers. Communication boards can be organized and managed through a dedicated board management interface, while users and caregivers can create and edit pictographic cards by customizing text, images (through ARASAAC² library or image upload), according to individual communication needs. In addition, user authentication enables personalized AAC resources to be securely stored and synchronized across devices, supporting long-term use and facilitating access in different contexts. Figure 1 illustrates the VivaVox interface and highlights some of its implemented functionalities.

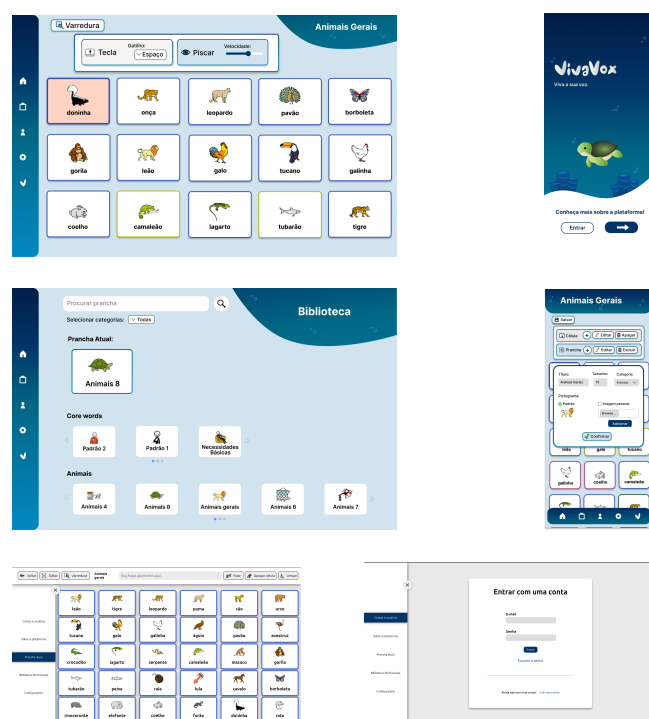


Figure 1: VivaVox platform demonstration: (a) tablet board with blink-scanning navigation; (b) smartphone home screen; (c) tablet board selection panel; (d) smartphone card editing interface; (e) web board management panel; and (f) web login page.

3.5 Walkthroughs with Personas

To evaluate the platforms against concrete user profiles, six personas were constructed representing two distinct groups of pictographic AAC users: individuals with Cerebral Palsy (CP) and individuals with Autism Spectrum Disorder (ASD).

3.5.1 Cerebral Palsy

The three CP personas (Figure 2) represent distinct functional profiles in mobility, manual ability, and communicative

function, as described by the GMFCS, MACS, and CFCS systems.

Mariana, 8 years old - GMFCS II / MACS II / CFCS II. Mariana attends the third year of primary school in a mainstream setting. She presents mild dysarthric speech, intelligible to familiar partners, with preserved receptive language. She handles most objects with slightly reduced quality or speed, making direct touchscreen interaction viable [33]. She communicates with both familiar and unfamiliar partners, though may require extra time [23]. She uses a pictographic app as a complementary resource to speech in noisy environments and at the end of the school day when fatigue reduces her intelligibility, combining pictograms with a predictive keyboard for longer texts.

Pedro, 11 years old - GMFCS IV / MACS IV / CFCS III. Pedro attends the fifth year of primary school in a setting with a multifunctional resource room. His mobility depends on a powered wheelchair and he handles only a limited selection of objects in adapted situations, making precise direct touch unfeasible [33]. His speech is severely reduced and unintelligible to unfamiliar partners, though receptive language remains preserved [23]. He uses a tablet mounted on his wheelchair, accessed via a switch fixed near the head support with automatic scanning configured to his motor rhythm. The app is his primary communicative output modality, and vocabulary is updated remotely by his speech-language pathologist without requiring direct access to the device.

Helena, 14 years old - GMFCS V / MACS V / CFCS IV. Helena lives with her mother and attends regular therapeutic sessions at a rehabilitation center. She is transported in a manual wheelchair with limited head and trunk control; direct touchscreen interaction is completely unfeasible [23]. She has no functional speech, and her communication is inconsistent even with familiar partners – inconsistency that, as noted by Hidecker et al. [23], is a property of the communicative exchange and not a failure attributable to the user. One year ago, she began using an eye-tracking system coupled to a tablet. Messages are short, organized in boards with few high-frequency items and shortcuts to pre-built phrases. Helena tires quickly, and use is organized in brief sessions with planned breaks.

3.5.2 Autism Spectrum Disorder

The two ASD personas (Figure 3) represent the two support levels of the DSM-5-TR [3], covering profiles with significant difficulties in verbal communication and requiring substantial to very substantial support.

Enzo, 14 years old - ASD Level 2. Enzo attends both a resource room and mainstream classes. He can speak, but in stressful or noisy situations his speech becomes repetitive (echolalia) and he loses the ability to organize sentences. He requires a tool that functions as a “visual anchor” to structure what he wants to say before verbalizing. He has preserved motor ability for screen interaction and a strong focus on logical and hierarchical systems.

²<https://arasaac.org/>

Clara, 8 years old - ASD Level 3. Clara presents classic autism with no intelligible speech and markedly isolated behavior. She communicates primarily through her body, pulling adults by the hand, and experiences extreme distress at any change in routine. She can identify basic colors and geometric shapes and is capable of making simple choices between two visual stimuli. Pictographic AAC is her primary bridge to the world, requiring an extremely simplified interface with accidental touch prevention to address stereotypical motor movements and contrast controls to manage visual sensory hypersensitivity.

3.6 Platform Adequacy Analysis

3.6.1 Platform Selection

From the analysis of the tools in Section 3.1, three free platforms were selected for persona-based analysis: VivaVox (primary focus of this study), AsTeRICS Grid, and SymbolTalk. Two candidates were excluded: Matraquinha, due to its restricted trial version, which limits card customization, disables progress tracking, and caps pictogram use at 60, and Sounding Board, which is exclusive to Apple devices, precluding consistent testing across the research team.

3.6.2 Personas with Cerebral Palsy

The three CP personas, illustrated in Figure 2, represent distinct functional profiles across mobility, manual ability, and communicative function.

Mariana (GMFCS II / MACS II / CFCS II). Mariana's profile is physically compatible with all three platforms, as direct touchscreen interaction is viable at her MACS II level. AsTeRICS Grid stands out for its integrated predictive keyboard and browser-based portability, both relevant to Mariana's situational alternation between speech and AAC in the school context, though the predictive keyboard requires manual activation. SymbolTalk supports phrase construction with audio output and allows personalized cards with recorded voice, but lacks a predictive keyboard and offers only general vocabulary without school-specific contextualization. VivaVox addresses Mariana's core requirements through ARASAAC integration, TTS output, and board customization with native web portability; the absence of a predictive keyboard is its main limitation, shared with SymbolTalk.

Pedro (GMFCS IV / MACS IV / CFCS III).

The determining requirement for Pedro is scanning access with an external switch, as precise touch is unfeasible at his MACS IV level. AsTeRICS Grid is the only platform that fully and documentedly meets this requirement, connecting the physical switch mounted on his powered wheelchair to configurable automatic scanning, while also supporting remote vocabulary management by his speech-language pathologist. SymbolTalk does not offer switch-based scanning, making it unusable as Pedro's primary communication modality regardless of its other features. VivaVox provides scanning with configurable timing, partially meeting the requirement, but compatibility with physical external switches (via Bluetooth

or USB) is not documented, conditioning its viability to empirical confirmation; the absence of a caregiver profile for remote management is an additional relevant limitation.

Helena (GMFCS V / MACS V / CFCS IV). For Helena, whose MACS V level makes any form of touch unfeasible, eye-tracking is the fundamental access requirement. AsTeRICS Grid enables this access through computer vision plugins and complements it with low-density boards, phrase shortcuts, and age-appropriate visual customization — a set that directly addresses Helena's fatigue management and motivational needs as an adolescent. SymbolTalk offers no eye-tracking or single-switch support, making it unusable for Helena regardless of other features. VivaVox confirms the availability of eye-tracking, opening a potential access pathway; however, the absence of configurable dwell-time - an essential parameter for distinguishing intentional gaze from involuntary movements in users with limited postural control - and the lack of documentation on adapted calibration compromise the practical viability of access.

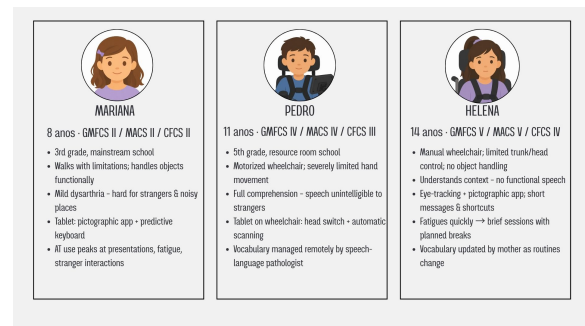


Figure 2: Personas representing individuals with Cerebral Palsy: Mariana, Pedro, and Helena.

3.6.3 Personas with Autism Spectrum Disorder

The two ASD personas, illustrated in Figure 3, represent Level 2 and Level 3 support profiles, covering users who rely on AAC as a visual anchor and as their primary communication bridge, respectively.

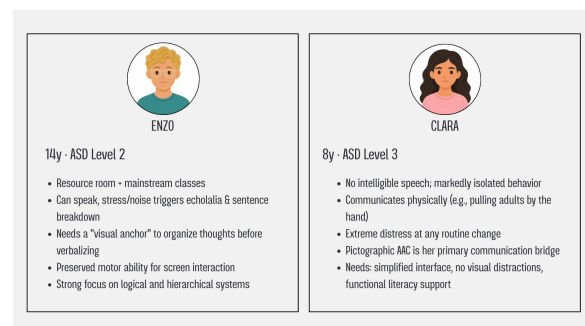


Figure 3: Personas representing individuals with Autism Spectrum Disorder: Enzo and Clara.

Enzo (ASD Level 2). Enzo's central need is a visual anchor to organize his thoughts before verbalizing, particularly in stressful situations that trigger echolalia. All three platforms offer some support for this mechanism, but with different depths. AsTeRICS Grid is the most comprehensive: static menus and immediate visual feedback meet the cognitive functional requirement of ASD Level 2, support for real photos in cards reduces abstraction, and — critically — custom audio recording eliminates the social estrangement caused by synthetic voices. SymbolTalk partially addresses the need through its sequential phrase bar and configurable grid density, but lacks an emergency layout for crisis situations and does not support custom audio. VivaVox confirms the predictable interface and supports real photos via ARASAAC, but the absence of voice recording — replaced solely by synthetic TTS — constitutes a functional barrier to social interaction for a profile whose central challenge is already peer communication.

Clara (ASD Level 3). Clara requires three access adaptations directly linked to her condition: prevention of accidental touches caused by stereotypical movements, contrast and brightness controls for visual hypersensitivity, and an extremely simplified interface. AsTeRICS Grid meets all three requirements: dwell-time filters prevent involuntary commands, contrast and color palette settings manage sensory hypersensitivity, and low-density boards (as few as two options per screen) ensure the necessary simplicity. SymbolTalk allows grid density reduction and supports cards with real images and recorded voice — positive aspects for Clara's profile — but offers neither fine-grained sensory control nor accidental touch prevention. VivaVox provides TTS and ARASAAC integration but does not implement accidental touch prevention or contrast and brightness controls — two absences that compromise access before the communicative function can even be reached.

3.6.4 Comparative Summary

Table 1 summarizes the accessibility verdicts by platform and persona.

Table 1: Functional accessibility summary by platform and persona.

Persona	SymbolTalk	AsTeRICS Grid	VivaVox
Mariana	Partial	Accessible	Accessible
Pedro	Inaccess.	Accessible	Partial*
Helena	Inaccess.	Accessible	Barriers
Enzo	Partial	Accessible	Partial
Clara	Partial	Accessible	Barriers

* External switch compatibility unconfirmed; requires empirical validation.

The analysis reveals distinct patterns across platforms. SymbolTalk covers the basic spectrum of pictographic AAC with direct touch support, functioning well for profiles with preserved motor access, but systematically excluding users who depend on alternative input methods. AsTeRICS Grid

presents the broadest coverage, addressing all analyzed profiles through multimodal accessibility, remote curation, and configuration flexibility; its main limitation is the high technical complexity of setup, which generates a steep learning curve for caregivers and therapists. VivaVox occupies an intermediate position: it advances beyond SymbolTalk by incorporating configurable scanning and eye-tracking, but has not yet consolidated the fine-tuning configurations, dwell-time, accidental touch prevention, and sensory controls, that would make these features reliable for profiles with greater functional complexity. As an open-source platform under active development, these gaps represent priority directions for improvement with significant potential impact for communicative inclusion.

4 CONCLUSION

This paper analyzed the state of the art of AAC solutions in both the scientific literature and the Brazilian market, identifying functional and non-functional requirements, as well as current limitations and opportunities for improvement. Despite advances, accessibility continues to be the main barrier, highlighting the need for AAC systems that accommodate diverse interaction profiles through alternative access methods and extensive customization. Authoring and communication board management also remain usability challenges, requiring intuitive interfaces that support users and caregivers in creating personalized communication resources. Financial accessibility is another critical issue, as most commercial AAC solutions remain unaffordable for many users, particularly in developing countries.

The Barrier Walkthroughs conducted with six personas, representing three CP profiles (GMFCS II, IV, and V) and two ASD profiles (Levels 2 and 3), provided concrete evidence of these gaps. The comparative analysis of VivaVox, AsTeRICS Grid, and SymbolTalk revealed that alternative access methods remain the critical differentiator across platforms. AsTeRICS Grid was the only solution to fully address the needs of users dependent on switch-based scanning and eye-tracking, though at the cost of significant configuration complexity. SymbolTalk, limited to direct touch, was inaccessible to users with MACS IV and V levels. VivaVox demonstrated intermediate coverage: its configurable scanning and eye-tracking support advance beyond SymbolTalk, but the absence of dwell-time configuration, accidental touch prevention, and sensory controls — identified as functional requirements for profiles such as Clara (ASD Level 3) and Helena (GMFCS V) — represent priority targets for future development.

Overall, AAC technologies have made significant progress but still require improvements in accessibility, customization, affordability, and portability to better support diverse user needs. Strengthening the collaboration between academia and industry is essential to develop open, accessible, and user-centered AAC solutions grounded in the principles of Universal Design.

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