Development of a Gamified Environment with AI for Aphasia Rehabilitation: A Work in Progress

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Introduction: Aphasia is a neurological disorder that significantly impairs communication skills, affecting speech, writing, reading, and comprehension. Current rehabilitation methods often require constant professional supervision and rely on repetitive, non-interactive exercises. Objective: This work proposes an innovative gamified platform to support the rehabilitation of people with aphasia through interactive, 3D environments integrated with advanced speech recognition and artificial intelligence. Methods: The system offers mission-based tasks in which users interact with objects and environments inspired by daily life. Voice commands, captured and transcribed via Google Cloud Speech-to-Text, are interpreted by a natural language AI to enable free-form verbal interaction, going beyond predefined commands. Tasks include object naming, word recognition, and reading activities, with multimodal feedback (visual, verbal, and written). Expected Impact: The platform enables home-based, unsupervised practice while maintaining therapeutic quality, potentially enhancing lexical retrieval, improving patient engagement, and supporting speech-language pathologists in treatment planning. This approach combines gamification, accessibility, and AI-driven personalization to deliver a more dynamic, immersive, and adaptable rehabilitation process.

Keywords: Gamification. Rehabilitation. Aphasia. Speech Therapy. Artificial Intelligence.

Gamified environments have been consolidating as an effective strategy in various sectors, such as education, arts, industry, and especially healthcare. By incorporating playful elements, these environments foster patient engagement in medical treatments, encouraging positive behavioral changes. Such strategies have proven effective in disease management, in motivating the adoption of healthy habits, and in improving adherence to correct medication use [1].

Aphasia is a neurological disorder that impairs communication skills, affecting speech, writing, reading, and comprehension. As illustrated in Figure 1, there are different types of aphasia, such as: Broca's, Wernicke's, conduction, anomic, global, mixed transcortical, transcortical sensory, and transcortical motor. This condition is usually caused by strokes (CVAs), although it can also result from brain tumors, head trauma, infections, or other disorders that affect brain function [2,3].

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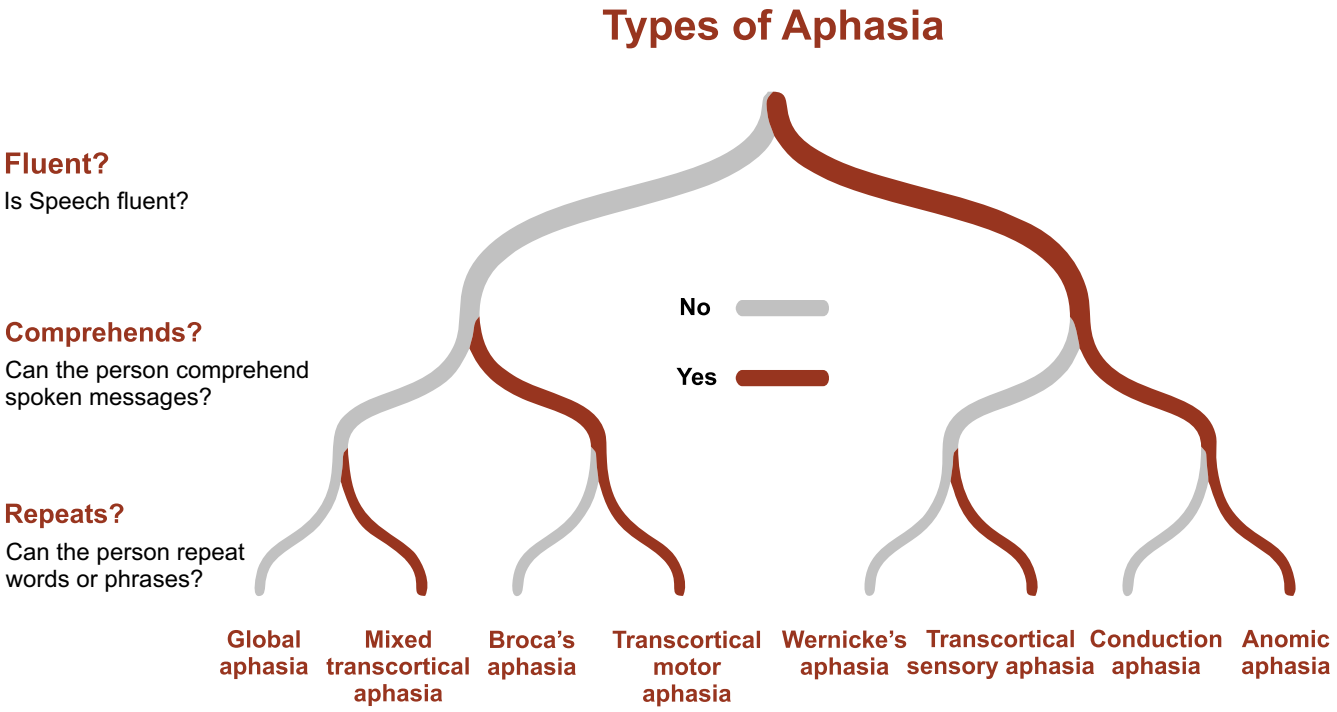
Additionally, therapeutic training methods stand out, such as the "Look, Listen, Repeat" approach, in which the patient verbally repeats objects or phrases after seeing and hearing them. Other resources include semantic feature analysis and response elaboration training, where an image is presented to the aphasic patient, who must then identify and name the represented object [4].

Menke and colleagues 2009 [6] show that the traditional intensive naming protocol — based on figure repetition with cards and verbal correction — is effective in treating patients with chronic aphasia, as it stimulates the activation of alternative brain areas. To improve this method, authors such as Rodrigues, 2015 [7], and Rybarczyk and Gonçalves, 2016 [8], highlight the use of the three-dimensional graphic environment of the WebLisling system, which allows patients to interact with everyday items, making treatment more immersive and ecologically valid. This approach differs from conventional methods, which are traditionally based on two-dimensional figures, such as static images.

The study developed by Pereira and Debatin, 2022 [9], led to the creation of a two-dimensional (2D) digital game implemented using the Unity3D engine. The game adopts an innovative control system

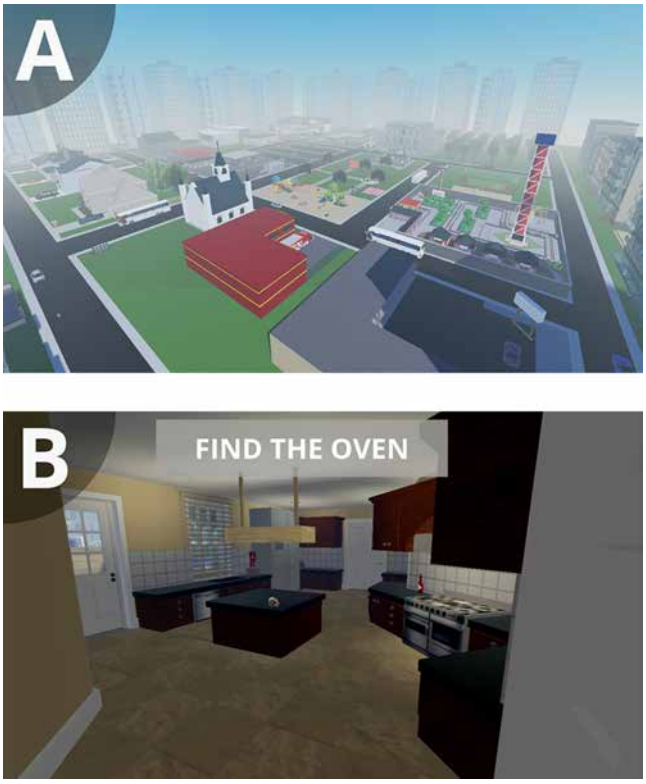
Figure 1. Types of aphasia from the National Aphasia Association.



through voice recognition, using the Google Cloud Speech-to-Text API. This solution was designed to provide digital accessibility for people with motor impairments, allowing them to interact with the virtual environment through predefined voice commands — such as "jump," "right," and "left" — carefully selected after tests to optimize response time.

In this context, the game is proposed as a complementary tool for speech therapy aimed at people with aphasia, enabling its use even without constant supervision from a speech-language pathologist. Moreover, it offers interactive environments inspired by daily life, supporting the development of naming and object recognition skills in a playful way. Players will be able to explore a city — as illustrated in Figure 2, image A — visiting places such as stores, pharmacies, museums, or supermarkets. In each of these environments, there will be a set of objects previously defined by the game; for example, in the house (Figure 2, image B), the player is expected to recognize items such as the stove. In this article, only one of the proposed scenarios will be addressed, as the project is still in the early stages of implementation.

Figure 2. Prototype of a city (A) and prototype of an environment (B).



Related Works

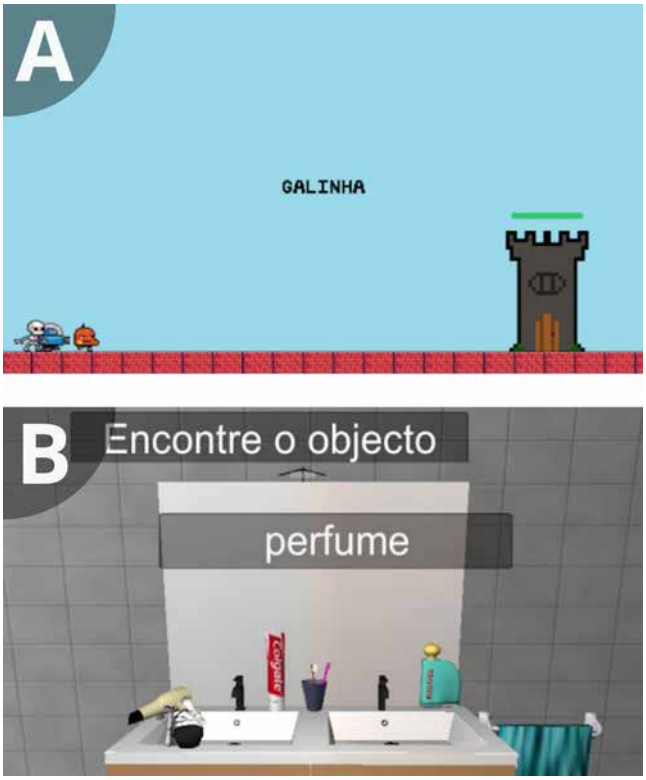
Gamification has proven to be a promising approach in supporting speech therapy treatments, particularly in the rehabilitation of patients with speech disorders. An example of this application is the Tower Defense–style game Voice Hero, developed with the intention of promoting speech training through playful activities [10]. In the game, the user must correctly pronounce the words displayed on the screen to launch attacks against enemies approaching a castle, as illustrated in Figure 3, image A. This game mechanic integrates gamified elements into the therapeutic process, fostering patient motivation and engagement.

Another relevant example is the virtual therapeutic platform WebLisling, aimed at treating Portuguese-speaking aphasic patients. Initially developed by Rodrigues, 2015 [7], and later enhanced by Rybarczyk and Gonçalves, 2016 [8], the platform uses gamification features combined with three-dimensional graphic environments to provide a more realistic and interactive therapeutic experience[7,8]. The therapeutic exercises offered by the platform are organized into four main categories: written expression, oral comprehension, written comprehension, and motor tasks. Each of these categories is contextualized within its own virtual environment, contributing to the naturalization of the learning and rehabilitation process.

In this way, the projects discussed demonstrate the potential of gamification as a support strategy in the healthcare field, particularly in speech-language pathology. By providing more interactive experiences tailored to the specific needs of patients with aphasia, gamified environments contribute significantly to the effectiveness and continuity of treatment. However, none of the reviewed works integrates all the elements that make up the present proposal.

Our project stands out by combining explorable 3D environments, voice commands interpreted by artificial intelligence to enable free verbal interactions (not limited to predefined commands), and multimodal feedback (visual, textual, and

Figure 3. Images of the game 'Voice Hero' (A) and the WebLisling platform (B).



verbal) in everyday contextualized tasks. This approach aims not only to increase patient engagement but also to make it possible to conduct high-quality therapy sessions at home, without the need for constant supervision. Thus, the proposed solution fills a gap identified in existing studies, offering an innovative and potentially more effective path for aphasia rehabilitation.

Materials and Methods

Building on the gap identified in existing studies, the project under development incorporates elements found in other therapeutic platforms, such as WebLisling and similar solutions, but goes further by integrating additional features that enhance its potential clinical impact. Among these are the possibility of home-based practice, the provision of instant feedback, integration with voice recognition APIs, and the use of artificial intelligence to interpret free verbal interactions,

enabling more natural and contextually relevant communication within the virtual environment.

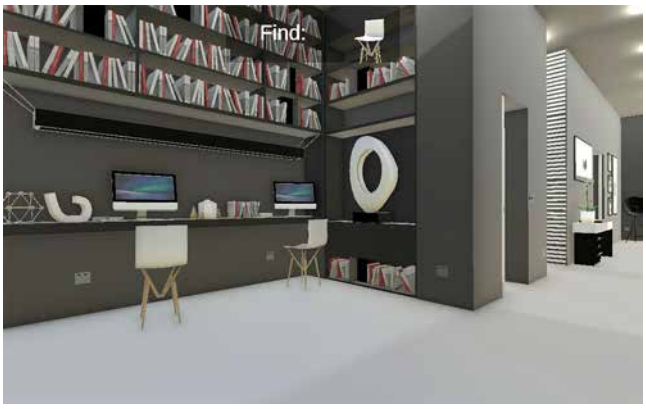
The key differentiator, however, lies in the implementation of resources capable of expanding verbal communication beyond predefined commands or patterns, through the use of artificial intelligence (AI) to interpret the content of spoken sentences. This approach aims to stimulate lexical retrieval during the exploration of the virtual environment, allowing verbalizations to occur in varied and contextually appropriate ways.

The game under development adopts an approach based on an explorable world, in which players can choose which locations in a city they wish to explore. Within these locations, there will be a set of objects, and the goal is for the person with aphasia, through missions, to be able to recognize and name such objects. These missions may involve recognizing environments — such as a kitchen, for example — and objects, with the system pronouncing or displaying their names. During the execution of each mission, the user will be shown what they must do in different ways: a three-dimensional visualization of the object (Figure 4), a written form, and a verbal form, where the player must interpret what was said. It is also possible to combine these display methods.

Character movement is controlled by voice commands processed by the Google Cloud Speech-to-Text API, allowing individuals with aphasia who have a reasonable level of comprehension and lexical retrieval — as in the case of conduction aphasia — to explore the city interactively. The captured speech is transcribed by the API and sent to a natural language AI — such as DeepSeek or ChatGPT — responsible for interpreting the utterance and converting it into specific in-game commands. This structure enables the creation of an environment where the player not only recognizes available objects but also practices naming them in a contextualized manner.

Development takes place on the Unity platform, chosen for its high adaptability to different systems, including Windows and mobile devices. Other key factors in this choice include the wide availability of assets (digital resources), the use of the C# language

Figure 4. Mission from the game under development.



— considered more intuitive than C++ (used in Unreal Engine) and more performant than GDScript (from Godot) — as well as good optimization for devices with less powerful hardware.

Expected Results

The gamified environment Fala+ represents an innovative and promising proposal in the field of speech-language pathology, combining emerging technologies — such as immersive 3D environments, multimodal feedback, and natural language processing with artificial intelligence — into a therapeutic resource aimed at the rehabilitation of people with aphasia. The solution was designed to serve as a complementary tool to traditional treatment, enabling patients to make significant progress in their rehabilitation process without relying exclusively on constant mediation by the speech-language pathologist.

The therapeutic core of Fala+ is based on performing object naming and recognition tasks through different modalities — speech, writing, or visual reading — combined with verbal interactions that allow controlling movement within the virtual environments. This approach seeks, in a playful and motivating way, to stimulate cognitive and communicative skills essential to rehabilitation, while also fostering engagement and adherence to treatment.

The platform also stands out for addressing a critical gap in healthcare: the provision of high-

quality therapeutic practice conducted remotely, with professional supervision support. This feature has the potential to reduce treatment costs, improve continuity of care, and promote greater patient autonomy.

So far, development has already incorporated mission mechanics and multiple display modes—essential elements to make interaction more dynamic. However, technical challenges remain, such as improving the object recognition system—which, in its current version, identifies structural elements like floors, walls, and ceilings instead of therapeutic items—and optimizing mission displays to ensure clarity and consistency in task communication. Other critical points include creating richly detailed interiors without compromising performance, especially on mobile devices, and visually adapting objects to avoid cognitive overload or navigation blind spots.

The development plan foresees significant expansion in both content and applicability. New modalities and activities aimed at speech therapy stimulation are scheduled, such as rhyme exercises, writing practices, and matching games, all adaptable to different profiles and stages of rehabilitation. The proposal also includes expanding environments from a single setting to a set of cities with distinct characteristics—such as coastal, urban, and rural locations—to enrich sensory and narrative experiences, fostering patient immersion and motivation.

Conclusion

The implementation of these stages will be accompanied by continuous validation with healthcare professionals, ensuring that therapeutic objectives are effectively met and that proposed activities maintain clinical relevance. If the expected results are confirmed, Fala+ could establish itself as a highly relevant technological tool, integrable into formal rehabilitation programs and scalable for treating other neurological disorders and conditions requiring cognitive and communicative stimulation. Thus, the project not only innovates in the use of technology for therapeutic purposes but also contributes to making healthcare more accessible, dynamic, and personalized.

The project is currently in the development and refinement phase. Although it has already been validated, in terms of concept and applicability, by a speech-language pathologist as a potentially useful resource for rehabilitation support, it has not yet undergone formal clinical validation. We reinforce our commitment to conducting more in-depth studies, including trials in a real rehabilitation setting with both aphasic and non-aphasic users, to evaluate its efficacy, usability, and therapeutic impact.

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