



**ÇANKAYA UNIVERSITY FACULTY
OF ENGINEERING COMPUTER
ENGINEERING DEPARTMENT**

Project Report
Version 2

CENG 408
Innovative System Design and Development II

APPHASIA

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Abstract

Aphasia is a neurogenic language disorder caused by damage to the brain, most commonly due to stroke, traumatic brain injury, or neurodegenerative diseases. It impairs core language functions such as speech, comprehension, reading, and writing, varying in severity depending on the location and extent of the damage. This study provides an in-depth analysis of the clinical aspects of aphasia, its classification into fluent and nonfluent types, and its significant impact on communication and quality of life.

The review also highlights the roles of speech-language pathologists in assessment, therapy, and advocacy, emphasizing personalized and community-driven approaches. Innovative technologies, including mobile applications, have emerged as valuable tools to support rehabilitation. These applications offer language exercises, alternative communication methods, and cognitive support, particularly benefiting patients in regions with limited access to traditional therapies.

Finally, the study outlines recommendations for developing a Turkish-language mobile app tailored to aphasia patients, focusing on user-friendly design, accessibility, and offline functionality. By integrating advancements in therapy and technology, this research aims to enhance communication, promote independence, and improve the overall well-being of individuals with aphasia.

Key words:

- ☐ Aphasia
- ☐ Neurogenic Language Disorder
- ☐ Assistive Technology

1. Aphasia Literature Review

Neurological Disorders (Second Edition)

Course and Treatment

Chapter 25 – Aphasia

This chapter presents a study on the clinical aspects of aphasia. In most adults the regions that are most vital for symbolic communication are located in the perisylvian region of the left cerebral hemisphere. Depending on the size and location of the damaged area there may be preferential loss of the capability to express or to comprehend spoken or written language. The set of clinical presentations denoting any acquired disorder of language is labeled with the general term aphasia. Aphasia must be distinguished from abnormalities of the motor or sensory systems that are utilized by, but are outside of the language network. At the border between aphasic and nonaphasic deficits are certain uncommon perceptual deficits that are specific for linguistic sensory information, such as "pure word deafness" and "pure word blindness." Most investigators classify these, as well as other forms of alexia and the various agraphias, under the general classification of aphasia or aphasia-related syndromes. It is important to distinguish between disturbances of the language network and those of other higher cortical modules, including those mediating memory, attention, and executive function. Despite these distinctions, aphasia frequently coexists with one or more motor, sensory, or cognitive abnormalities. The chapter discusses classical aphasiology and cognitive neurolinguistics, cortical lesions affecting language, and subcortical aphasic syndromes. The discussion on principles of therapy include reactivation of linguistic functions, pragmatic therapy, pharmacotherapy, and others.

This section addresses the clinical aspects of aphasia and treatment principles. Depending on the extent and location of damage in the brain's language areas, the abilities to express or comprehend language may be affected. Treatment approaches involve various methods such as restoring language functions, pragmatic therapy, and pharmacotherapy.

American Speech-Language-Hearing Association

National Aphasia Association

National Institute on Deafness and Other Communication Disorders

What is Aphasia:

Aphasia is an acquired neurogenic language disorder resulting from an injury to the brain, typically the left hemisphere, that affects the functioning of core elements of the language network. Aphasia involves varying degrees of impairment in four primary areas:

spoken language expression

written expression

spoken language comprehension

reading comprehension

Aphasia may also result from neurodegenerative disease. For example, primary progressive aphasia is a subtype of frontotemporal dementia in which language capabilities become progressively impaired.

What types of aphasia are there?

Aphasia is often described as *nonfluent* or *fluent*, based on the typical length of utterance and amount of meaningful content a person produces. There are various subtypes of aphasia within these two categories based on differences in other aspects of expressive and receptive language skills. Clinicians should be aware that a person's presentation may not fit into a single aphasia type or subtype, and should use care if designating a type or subtype. Aphasia's presentation may also change over time as communication improves with recovery.

Incidence and Prevalence of Aphasia:

- **Incidence:** Refers to the number of new cases within a specific time period.
- **Prevalence:** Refers to the number of people living with aphasia during a specific time period.

Aphasia in the United States:

- Approximately 100,000–180,000 people develop aphasia each year.
- It is estimated that 2–4 million people live with aphasia.

Causes of Aphasia:

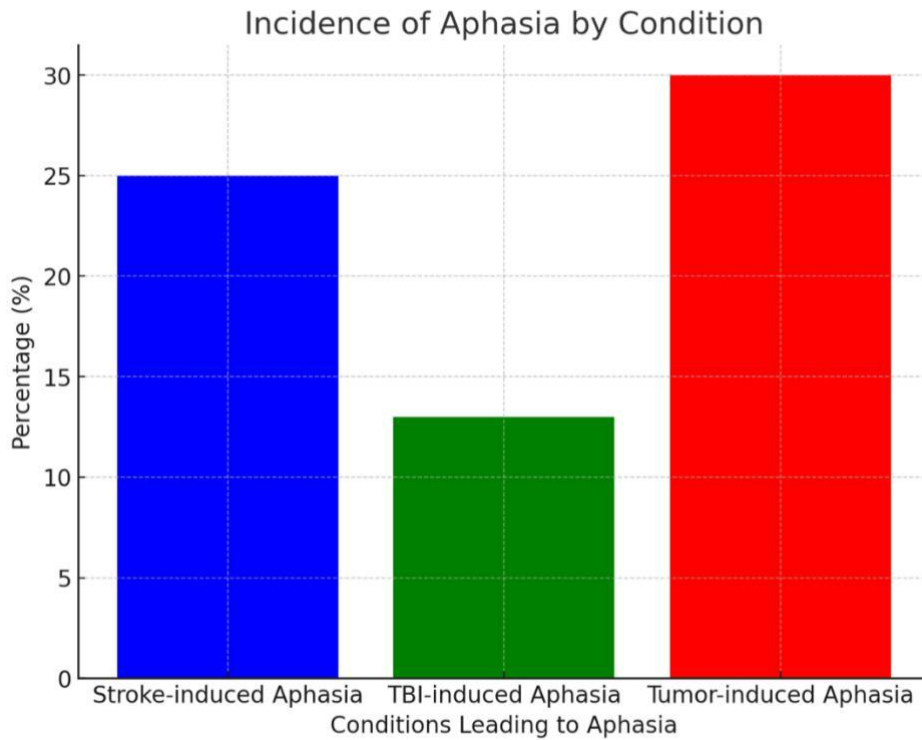
- Traumatic brain injury (TBI), brain tumors, infections, dementia, or other neurodegenerative diseases can lead to aphasia. However, it most commonly occurs after a stroke.
- It is estimated that about 25–50% of all stroke cases result in aphasia.
- Aphasia is generally more common in older individuals. While 15% of individuals under the age of 65 experience aphasia after their first ischemic stroke, this rate rises to 43% in individuals aged 85 and older.

Aphasia Related to TBI:

- There are very few statistics regarding aphasia caused by TBI. In one study, 1% of veterans from the Iraq and Afghanistan wars were diagnosed with aphasia following TBI.
- Two other studies found that 13–19% of individuals with TBI developed aphasia.
- The prevalence of TBI-related aphasia is estimated to be between 64,653 and 1,228,421.

Aphasia Related to Brain Tumors:

- One study estimated the incidence of aphasia resulting from primary brain tumors to be between 30% and 50%. Based on this data, the prevalence of tumor-related aphasia is estimated to be between 198,028 and 330,048.



Yukarıda, afaziye yol açan koşulların (inme, travmatik beyin hasarı (TBI), ve beyin tümörü) afaziye yol açma yüzdelerini gösteren basit bir çubuk grafik yer almaktadır. Bu grafik, afazi görülme oranlarının bu koşullar arasında nasıl değiştiğini görsel olarak ortaya koymaktadır. [\[3-\]](#)

Figure 1 Graphics

1.1 Signs and Symptoms:

Signs and Symptoms:

The signs and symptoms of aphasia vary depending on the location and extent of the damage and can affect verbal expression, auditory comprehension, reading, and writing skills. Anomia (difficulty finding words) is universal in individuals with aphasia. Alexia refers to difficulty reading, and agraphia refers to difficulty writing, both of which can occur together or separately.

Aphasia can affect bilingual individuals differently, depending on how and when the languages were learned and used.

Common Symptoms:

- **Speech:** Difficulty finding words, using nonsensical words, neologisms (inventing new words), word or sound substitutions (phonemic and semantic paraphasias), telegraphic speech (omitting conjunctions), and lack of awareness of mistakes.
- **Comprehension:** Difficulty understanding complex sentences, struggling to understand long or fast speech, and failing to grasp figurative language.
- **Writing:** Difficulty writing words or sentences, writing nonsensical syllables, and making grammar and spelling errors.
- **Reading:** Difficulty recognizing and understanding words, and trouble understanding functional words (conjunctions, pronouns).

1.2 Causes/ Roles and Responsibilities/ Assessments:

1.2.1 Causes of Aphasia

Aphasia is primarily caused by damage to the brain's language network, usually due to injury in the left hemisphere. However, in some rare cases, right-hemisphere damage can also lead to aphasia, particularly in left-handed individuals who may have language networks that are more bilaterally organized or located in the right hemisphere. This phenomenon is known as crossed aphasia when it occurs in right-handed individuals.

The most common causes of aphasia include:

Stroke:

Ischemic Stroke: Results from a blockage that disrupts blood flow to a part of the brain.

Hemorrhagic Stroke: Occurs due to a ruptured blood vessel, causing damage to surrounding brain tissue.

Traumatic Brain Injury: Damage caused by external forces, such as a blow to the head.

Brain Tumors: Abnormal growths in the brain that can interfere with normal functioning.

Brain Surgery: Surgical procedures that may inadvertently damage language areas.

Brain Infections: Infections that affect brain tissue, potentially impacting language processing.

Roles and Responsibilities of Speech-Language Pathologists (SLPs)

Speech-language pathologists are integral in managing aphasia through various roles, including:

Assessment:

Conducting screenings to identify individuals who may need further evaluation.

Diagnosing aphasia and documenting its presence or absence.

Referring patients to other professionals for comprehensive care.

Counseling and Education:

Counseling patients and their caregivers about communication issues and facilitating social participation.

Providing preventive information to individuals at risk for conditions leading to aphasia.

Educating other professionals and the public about the needs of individuals with aphasia and the role of SLPs.

Connecting families with long-term resources for managing aphasia.

Treatment:

Developing and implementing culturally relevant treatment plans.

Working collaboratively with other healthcare professionals to support patient recovery.

Ensuring the use of appropriate communication systems during recovery stages.

Advocacy and Research:

Advocating for the needs of individuals with aphasia and staying informed about ongoing research to enhance knowledge and treatment approaches.

SLPs must adhere to ethical guidelines, ensuring they work within their professional competencies and continue to advance their understanding of aphasia.

Assessments for Aphasia

Assessments of aphasia can be both static and dynamic. Static assessments evaluate current functioning, while dynamic assessments are ongoing and focus on identifying effective intervention strategies.

Key components of the assessment process include:

Screening: Identifies the need for further evaluation and does not provide a comprehensive diagnosis. It considers cultural and linguistic diversity and is conducted in the languages used by the individual.

Comprehensive Assessment: This involves evaluating:

Impairments in language and communication.

Comorbid conditions affecting communication performance.

Activity and participation limitations.

Environmental factors impacting communication.

Typical assessment methods include:

Case History: Gathering information about medical history, mental health, education, and cultural background.

Motor Speech Examination: Assessing articulation processes to differentiate between apraxia and dysarthria.

Language Assessment: Evaluating expressive and receptive language skills across various contexts.

Environmental and Personal Factors: Considering the support systems and barriers affecting communication.

Assessment results can lead to the diagnosis of language disorders, characterization of functional impacts, prognostic evaluations, and recommendations for intervention. It is essential to approach assessments holistically, recognizing the interrelationship between language skills and cognitive functions.

1.2.2 How is aphasia treated?

1.2.2.1 Aphasia Treatment Overview:

Aphasia treatment focuses on helping individuals recover and enhance their communication abilities following a brain injury. Initial recovery often occurs naturally within the first few months, with many patients experiencing significant improvements even without formal treatment. However, residual aphasia may persist, necessitating speech-language therapy to aid in communication recovery.

Key Aspects of Aphasia Treatment:

Brain Recovery Dynamics:

After brain injury, the brain undergoes substantial changes that facilitate recovery.

Improvements can continue for years, often accompanied by new activity in brain tissue adjacent to the damaged areas.

Factors influencing recovery include the cause and extent of the brain injury, the affected brain region, and the individual's age and overall health.

Therapeutic Goals:

Enhancing Communication: Therapy aims to utilize remaining language skills, restore lost abilities, and explore alternative communication methods, such as gestures, pictures, or electronic devices.

Individual vs. Group Therapy: Individual therapy tailors to specific needs, while group therapy fosters the practice of new skills in a supportive environment.

Innovative Technologies:

Virtual speech therapy provides flexibility, allowing patients to engage with therapists remotely via computers.

Speech-generating applications on mobile devices offer additional communication tools for those with spoken language difficulties.

Community Engagement:

Participation in social activities, such as book clubs, technology groups, and art/drama clubs, can enhance communication skills and boost confidence and social self-esteem.

Support groups, like stroke clubs, assist individuals and families in adapting to the life changes associated with aphasia.

Family Involvement:

Family members play a crucial role in the treatment process by learning effective communication strategies and actively participating in therapy.

Recommended family strategies include:

Attending therapy sessions.

Using simple, clear language with short sentences.

Repeating key words or writing down important points for clarity.

Maintaining natural, adult-appropriate conversational styles.

Reducing distractions during conversations.

Involving the person with aphasia in discussions and valuing their input, especially on family matters.

Encouraging all forms of communication, including speech, gestures, and drawings.

Avoiding corrections to the person's speech and allowing ample time for them to express themselves.

Supporting community involvement through groups like stroke clubs.

Conclusion:

Aphasia treatment is a comprehensive process that emphasizes the importance of personalized therapy, innovative communication technologies, community engagement, and active family participation. Through these combined efforts, individuals with aphasia can work towards regaining their communication abilities and enhancing their quality of life.

Resources:

Neurological Disorders (Second Edition) American

Speech-Language-Hearing Association National

Aphasia Association

National Institute on Deafness and Other Communication Disorders

Video refereances:

<https://www.youtube.com/watch?v=RMa9BVPJkYQ>

<https://www.youtube.com/watch?v=G94TvTvjeeU>

<https://www.youtube.com/watch?v=-GsVhbmecJA>

<https://www.youtube.com/watch?v=X9OtI-IuhJY>

<https://www.youtube.com/watch?v=zjkgSCIXo3k>

Developing a Turkish Mobile App for Aphasia: Guide and Recommendations

Aphasia Apps: Overview and Use Cases

Apps developed for aphasia patients typically serve three primary purposes:

1. **Language Therapy:** Provides structured exercises to help patients improve their language skills.
2. **Alternative Communication Tools:** Offers alternative communication methods for individuals who struggle with speech (e.g., communication through image selection or written messages).
3. **Cognitive Support:** Supports cognitive functions such as memory and attention to assist the language therapy process.

Considering these three purposes in the app development ensures that the users' needs are effectively addressed.

What Should a Turkish Aphasia App Be Like?

1. **User-Friendly Interface:** One of the biggest challenges for aphasia patients is understanding complex instructions. Therefore, the app's interface should be simple and easy to understand. Using simple buttons, large icons, and minimal text will simplify the process.

Sample Interface Design:

- **Home Screen:** Large, prominent buttons such as "Start," "Exercises," "Communication Assistance," and "Therapy Resources."
- **Exercise Screen:** The user is directed to select the correct word from a set of images. Tasks can also be explained via audio.

2. **Language Therapy Exercises:** Providing personalized exercises that cater to the needs of aphasia patients is essential. Apps like Tactus Therapy and Lingraphica offer various exercises to improve language skills. In a Turkish app, exercises focusing on the following language skills should be included:
 - **Speech:** Tasks such as completing spoken words, sentence formation, and repetition.
 - **Comprehension:** Tasks that involve deriving meaning from a given text or audio recording and answering questions.
 - **Reading and Writing:** Tasks that involve reading short texts, writing, and recognizing words.

Example Exercise:

- **Exercise:** Which of the four images on the screen is an 'apple'?
 - **Audio Prompt:** "Select the apple." These types of exercises reinforce learning by providing both visual and auditory support.
3. **Alternative Communication Tools:** A Turkish aphasia app should include alternative communication tools supported by pictures and icons for patients who have difficulty speaking. For example, users could form simple sentences by selecting a sequence of icons (e.g., "I want to drink water"). This tool can be a vital aid for patients facing communication difficulties.
 4. **Therapy Tracking and Personal Development:** The app should provide monitoring tools for therapists and patients to track progress. Feedback on personal development through progress charts and daily achievements can increase motivation.

Progress Tracking Screen:

- **User Name:** Ahmet
 - **Progress:** Weekly success rate 80%
 - **Most Improved Area:** Comprehension
- This kind of data helps patients and therapists stay informed about the process.

Technological Features and App Infrastructure

1. **iPad and Android Compatible Features:** Developing an app that works on both iOS and Android platforms is crucial for reaching a broad user base. Leveraging the native features of iPad, such as screen sharing, multi-touch support, and built-in voice commands, can enhance the experience for aphasia patients.
2. **Visual and Audio Support:** The app should work with visual and auditory aids. Instead of written instructions, tasks should be explained through audio guidance for aphasia patients. Additionally, correct answers should be reinforced with audio feedback (e.g., "Correct, this is an apple!").
3. **Multi-Language Support and App Customization:** While the primary language of the app should be Turkish, multi-language support could also benefit some users. For instance, languages like English or Arabic could be offered as additional options, especially for foreign aphasia patients in Turkey.

Challenges and Recommendations for Developing an Aphasia App

1. **Data Privacy and Security:** Strong security measures should be in place since personal information will be stored during the therapy process. Encrypting data is essential to protect user information.
2. **Social Support and Family Involvement:** Family support plays a crucial role in the recovery process of aphasia patients. The app should offer simple guides for family members to help them engage in the patients' communication processes.
3. **Integration with Modern Technologies:** By utilizing AI-based speech recognition systems and learning algorithms, it is possible to monitor the development of aphasia patients and offer personalized exercises. This will enhance the effectiveness of the app.

Conclusion

A Turkish aphasia app should aim to facilitate the daily lives of aphasia patients through language therapy and alternative communication tools. A user-friendly interface, personalized language therapy exercises, and visual and auditory support should be the core components of the app. Additionally, when used with the support of families and therapists, the app can become an essential tool in aphasia treatment. Ensuring that the developed app is responsive to patient needs and compatible with modern technology will make a significant difference in their rehabilitation process.

Kaynaklar:

AbilityNet – Best Apps for Aphasia: [Link](#)

Beukelman, D., Fager, S., & Nordness, A. - Using Mobile Technology with Individuals with Aphasia: Native iPad Features and Everyday Apps: [Link](#)

National Aphasia Association – Aphasia Apps: [Link](#)

Tactus Therapy – 3 Ways to Integrate Apps into Aphasia Therapy: [Link](#)

Google Play Store – Aphasia Apps: [Link](#)

IEEE Xplore – Development of Speech Therapy Mobile Application for Aphasia Patients: [Link](#)

1.3 APHASIA APPS:

1.3.1 APP-1: My Aphasia Coach

Simplicity:

The interface is designed to be very simple and easy to understand. Considering the language and cognitive difficulties that individuals with aphasia experience, this straightforward design increases the application's accessibility. Complex and overly detailed interfaces could make it challenging for patients to use the app. However, this application contains only a few simple buttons and clear functions, allowing users to utilize it effectively without added cognitive load.

Additionally, the minimalistic structure of the app enables users to focus on their therapy sessions without confusion. Such a simple interface is crucial for individuals with impaired cognitive abilities, like those with aphasia.

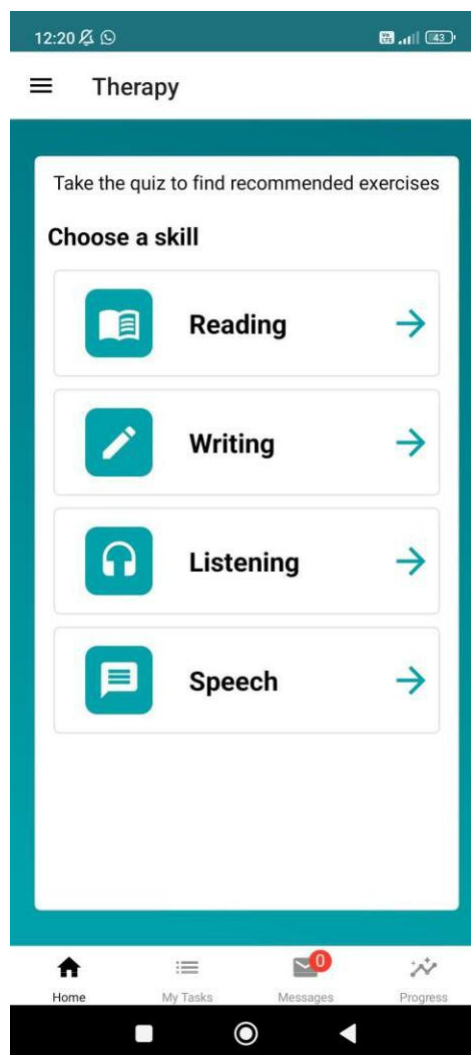


Figure 2 My Aphasia Coach

Large, Clear Text and Buttons:

The use of large buttons and fonts in the application is a key accessibility feature, especially for aphasia patients who may struggle with vision or reading difficulties. The ease with which users can navigate through the app using these large text and buttons contributes to its user-friendly nature. The large, simple icons that provide quick access to the app's core functions allow users to reach what they need without exerting too much effort.

For users with weaker reading and writing skills, these large, clear texts can be highly beneficial. Additionally, the absence of unnecessary information in the interface, presenting only essential text, is another advantage.

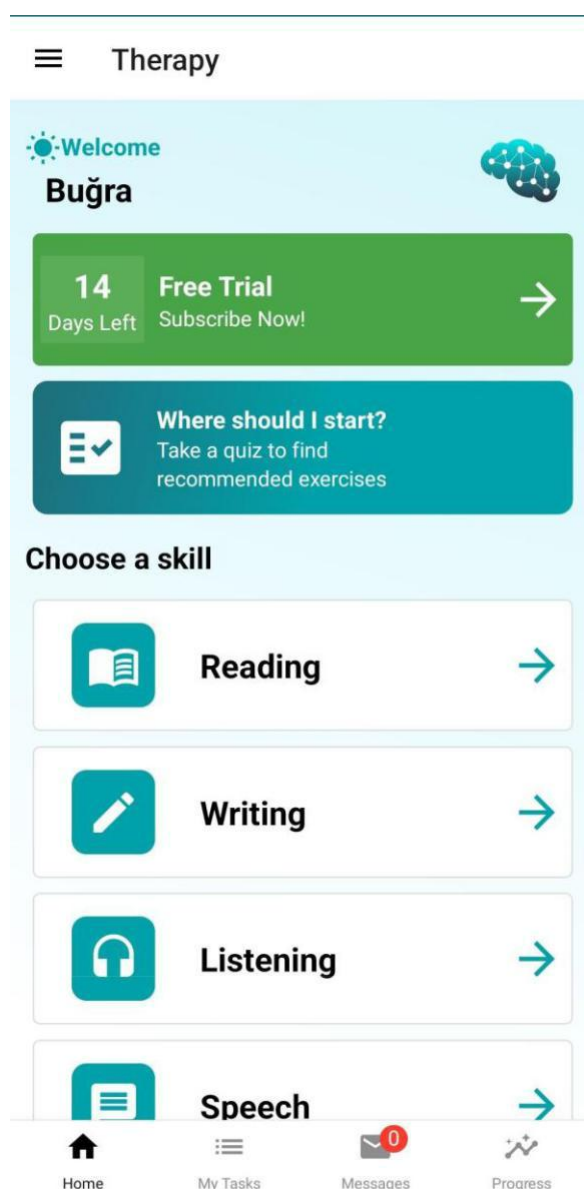


Figure 3 My Aphasia Coach

Video-Based

Therapy:

The app provides therapy through video, allowing users to practice verbal communication. Visually supported lessons can be especially effective in overcoming the comprehension difficulties that aphasia patients frequently face when developing their language skills. Through these videos, the combined use of auditory and visual elements makes learning more effective by allowing users to both hear and see the language.

Additionally, the clear and simple presentation of videos and the precise pronunciation of words provide users with accurate examples, helping them improve their language skills. The slow and deliberate speech of the speakers in the videos is particularly noteworthy; this is an essential feature for aphasia patients.

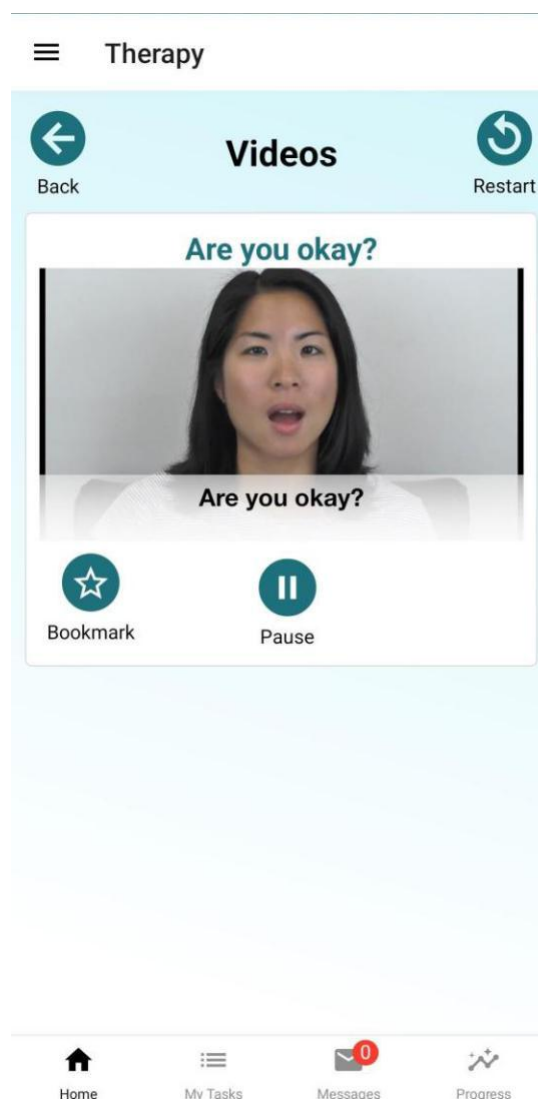


Figure 4 My Aphasia Coach

Bookmark Feature:

The app includes a "Bookmark" feature that allows users to mark videos. This enables them to easily access the videos they wish to repeat or frequently use. Language therapy is built on repetition, and the ability to bookmark and frequently watch specific videos helps users practice regularly, thus accelerating their learning process.

This feature is especially beneficial for users in organizing their therapeutic progress and gaining quick access to specific exercises.

By clicking the star next to a word, users can add it to their favorites. This allows patients to quickly access words they find challenging.

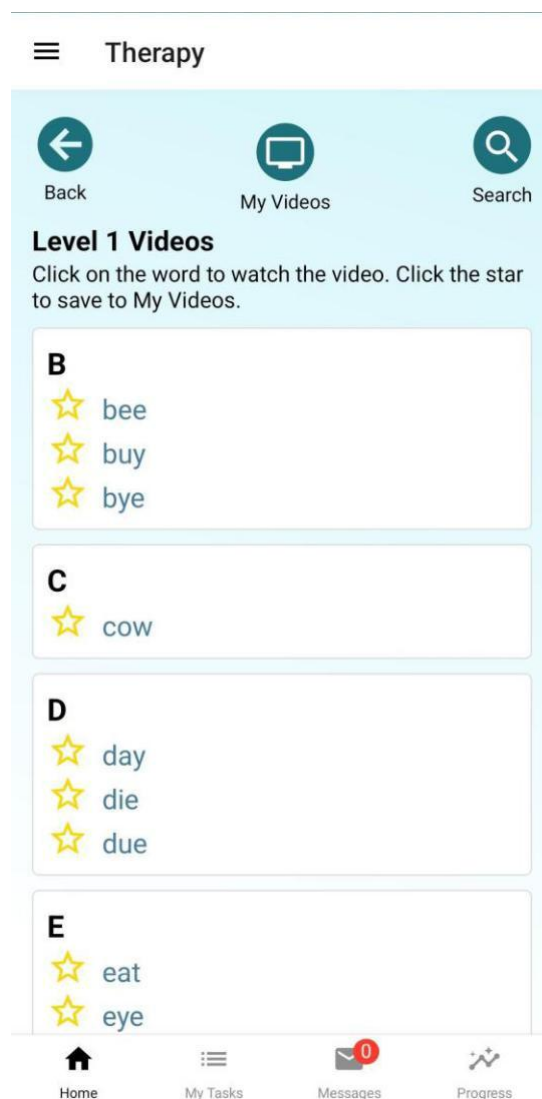


Figure 5 My Aphasia Coach

Weaknesses

Lack of Feedback:

The app appears to lack an interactive feedback mechanism. Users can only watch and repeat the videos, but there is no system for real-time feedback. For instance, a feature that allows users to record their own pronunciation and receive feedback from the app could be added. This would provide an opportunity for users to recognize and correct their mistakes, resulting in a more effective learning process.

Error Messages:

Some screenshots show error messages being presented in an overly simple way. More descriptive error messages could be provided to users. For example, if users are informed about why they encountered an error and how to resolve it, they would face fewer issues while using the app. Providing guidelines or tips for resolving errors could improve the user-friendliness of the app.

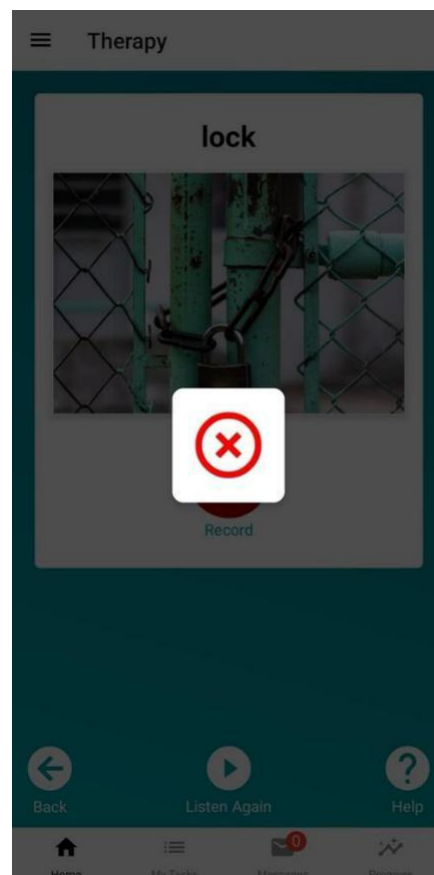


Figure 6 My Aphasia Coach Error

Internet Connection Requirement:

One major disadvantage is that the app cannot be used without an internet connection. Aphasia patients may not always have access to the internet, especially in hospitals, rural areas, or places with limited connectivity. Offering an offline mode would be crucial to ensure users can continue their therapy without interruptions.

Relying on an internet connection may cause disruptions in users' therapy sessions, negatively impacting their language development. Offline functionality would make the app more accessible and user-friendly.

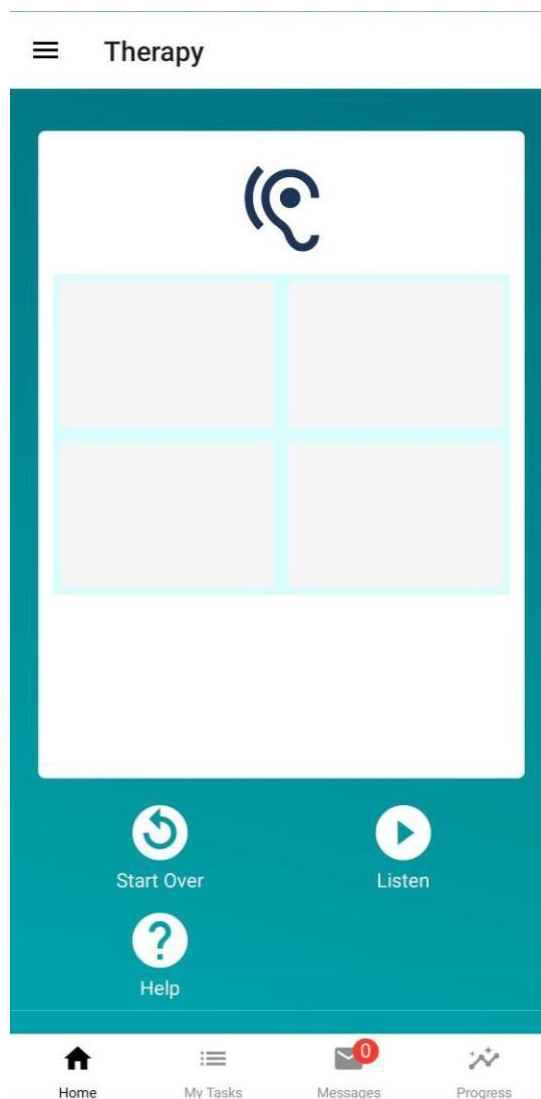


Figure 7 My Aphasia Coach Therapy

As seen on the screen, when I turned off my internet connection, the video-based exercises in the app stopped loading. This can interrupt pronunciation practice for patients without a stable internet connection and cause disruptions in therapy.

1.3.2 APP-2: Language Therapy Lite

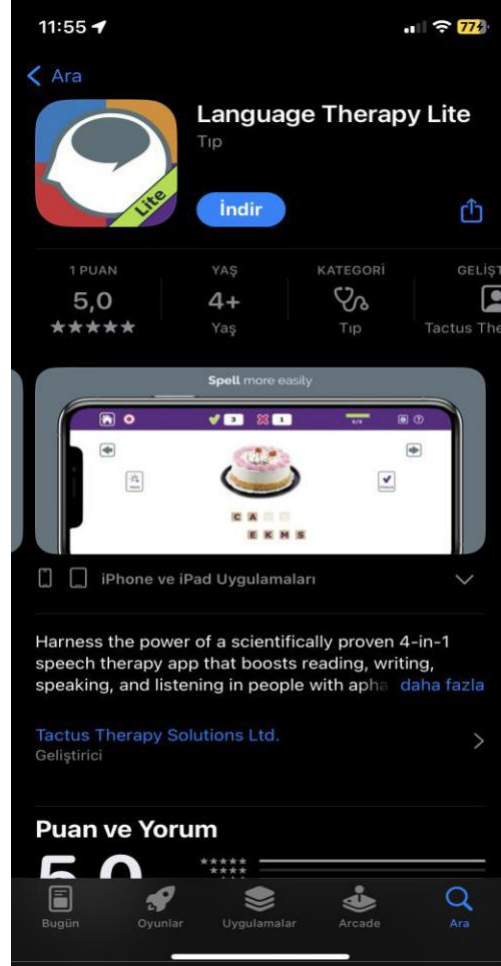


Figure 8 Language Therapy Lite

The **Language Therapy Lite** app is a speech therapy tool designed to help individuals improve their language skills, particularly those with aphasia, brain injury, or communication difficulties. Developed by Tactus Therapy Solutions, this app offers a preview of the full version by providing free exercises from four key therapy modules.

Features and Services:

1. **Comprehension Therapy:** Aims to improve listening and reading skills. Users work on activities such as listening to words and selecting the corresponding image or finding the related word by both listening and reading.
2. **Naming Therapy:** Includes exercises that improve object naming and word-finding skills. Users can expand their vocabulary through activities supported by helpful prompts.

3. **Reading Therapy:** Offers practice at both the sentence and word level, helping to improve attention and independent reading skills.
4. **Writing Therapy:** Provides exercises that enhance writing and spelling skills. Users can practice by completing missing letters or arranging letters in the correct order.

Each module offers customizable activities, performance tracking tools, and varying difficulty levels, making the app suitable for use at home or in a clinical setting. The app supports multiple languages, including English, Spanish, German, and French.

Pros:

- **Backed by scientific research:** Proven to improve aphasia symptoms with regular use.
- **Customization options:** Users can personalize activities by adding their own photos or words.
- **One-time purchase:** No subscription is required, allowing unlimited use after a single purchase.
- **Suitable for clinical needs:** Offers progress tracking and easy usability for therapists.

Cons:

- **Limited content in the Lite version:** The full version must be purchased for more comprehensive use.
- **Requires regular use:** Daily use is necessary for the best results, which might be challenging for some users.

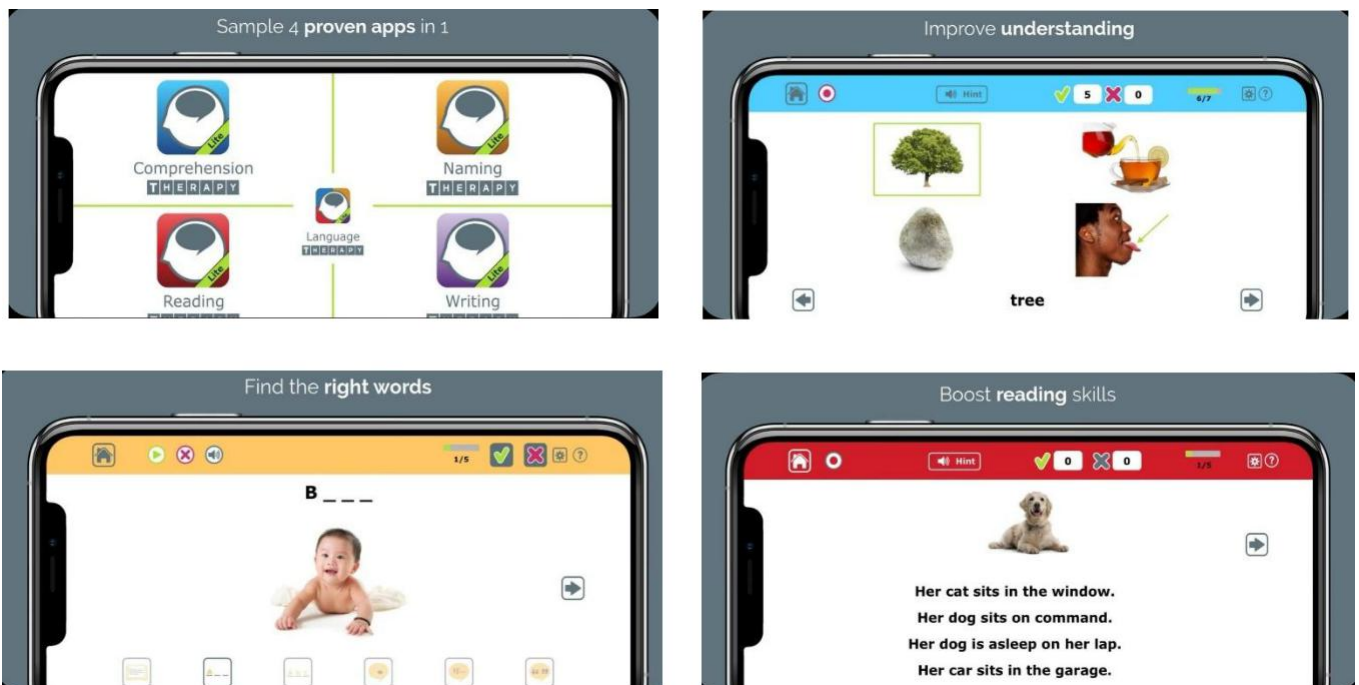


Figure 9 Language Therapy Lite Screens

1.3.3 APP3- Aphasia Talk Help Text Speech

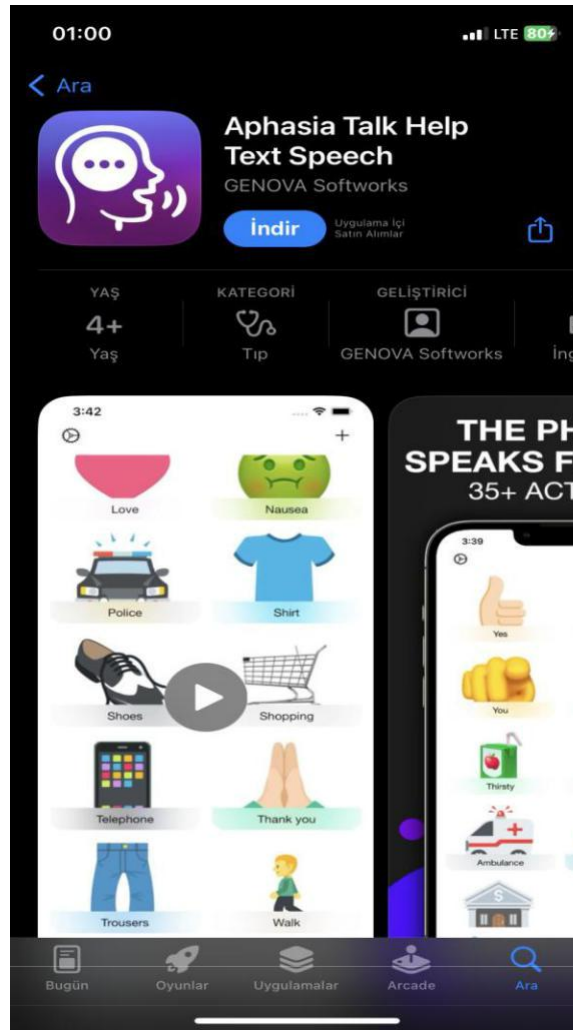


Figure 10 Aphasia Talk Help Text Speech

The Aphasia Talk Help Text Speech app is designed to assist individuals with aphasia or speech difficulties in communicating. The app allows users to write text and convert it to speech, while also providing visual aids where users can click on words or phrases for auditory playback.

Features:

- **Text-to-Speech:** Users can hear the text they have written through the app.
- **AI Predictive Text:** Offers suggested words while typing.
- **Customization:** Allows users to add new images and phrases.
- **Hand-drawing:** Provides the ability to draw by hand to facilitate communication.

Pros:

- Easy-to-use interface with customizable content.
- Supports daily communication, enhancing quality of life.
- Can speed up recovery after aphasia.

Cons:

- Consistent use is required for full performance.
- In-app purchases may be needed to access all features.

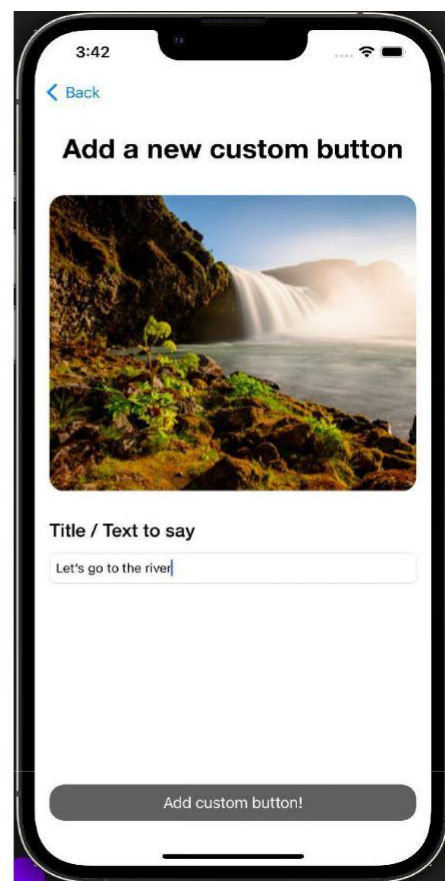
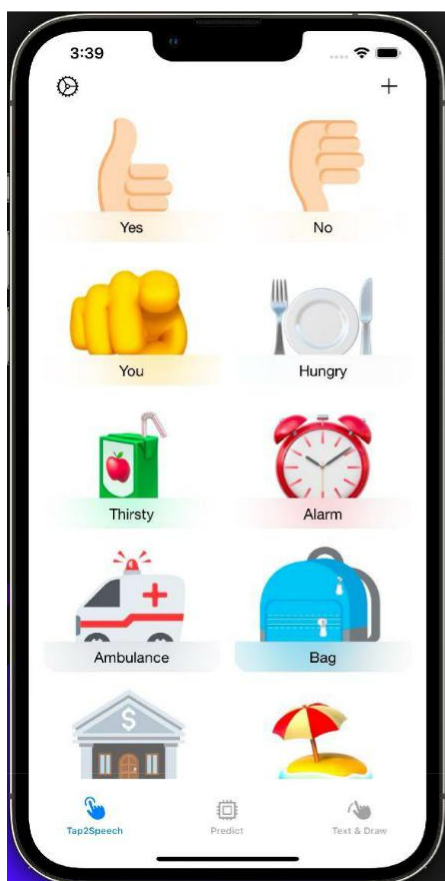


Figure 11 Aphasia Talk Help Text Speech Screens

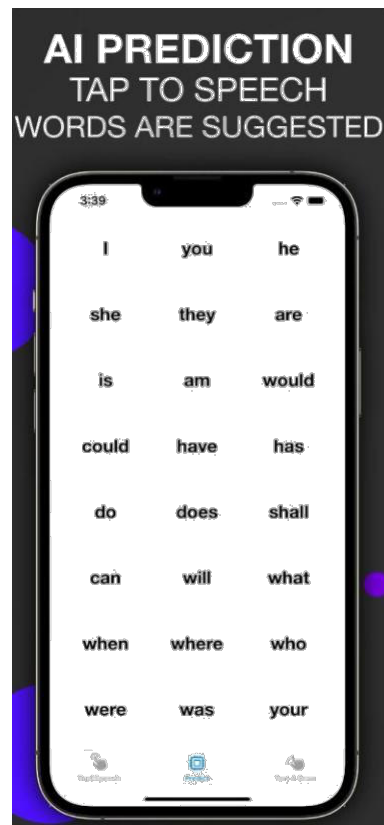
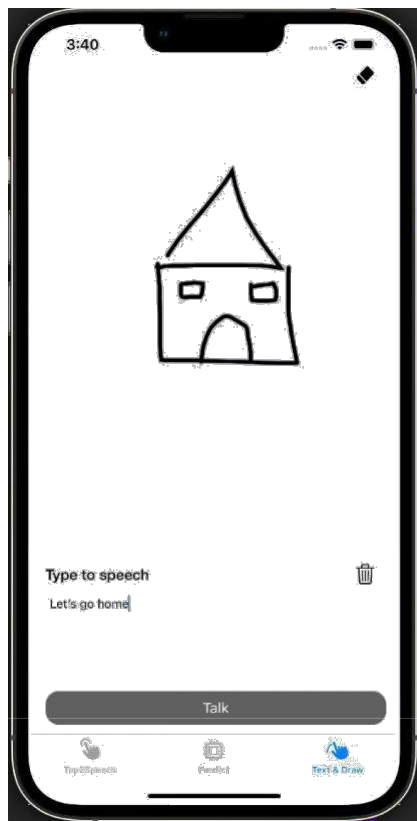


Figure 12 Aphasia Talk Help Text Speech Screens

2. SOFTWARE REQUIREMENT SPECIFICATIONS - SRS

2.1 Introduction

2.1.1 Purpose

The purpose of this Software Requirement Specification (SRS) document is to define the functional and non-functional requirements for the development of a mobile application tailored for individuals with aphasia. This application “Apphasia” will enable users to express themselves effectively and efficiently, addressing their specific communication needs in a Turkish-language environment. The document serves as a guideline for stakeholders involved in the design, development, and deployment of the application, ensuring a clear understanding of the project objectives.

2.1.2 Scope

The software product to be developed is a mobile application for individuals with aphasia, named “*Apphasia*”. This application is designed to enable users to express themselves through a user-friendly interface featuring pre-configured phrases, images, and gestures. It allows customization of frequently used expressions, ensuring faster and more effective communication. Additionally, it provides features for managing user profiles and preferences.

The primary goal of this application is to address the communication challenges faced by Turkish-speaking aphasia patients, empowering them to convey their needs, emotions, and thoughts independently.

This scope aligns with the broader objective of creating accessible and practical assistive technology solutions for individuals with speech impairments, ensuring consistency with any higher-level project requirements or specifications. The application aims to provide intuitive, and reliable communication tool, particularly beneficial in environments with limited or no internet connectivity.

2.1.3 Definitions, acronyms, and abbreviations

This section provides the definitions of terms, acronyms, and abbreviations used within this SRS document to ensure clarity and proper interpretation.

- **Aphasia:** A language disorder caused by brain damage that affects a person's ability to communicate.
- **Offline Mode:** The capability of the application to function without requiring an active internet connection.

2.2 References

1. **"Aphasia and Communication Disorders: An Overview,"** National Institute on Deafness and Other Communication Disorders (NIDCD), 2022. Available: <https://www.nidcd.nih.gov>.
2. **"ISO/IEC 25010:2011 - Systems and Software Quality Requirements and Evaluation (SQuaRE),"** International Organization for Standardization (ISO), March 2011. Available: <https://www.iso.org>.
3. **"User Experience Design for Accessibility: Best Practices,"** Interaction Design Foundation, 2021. Available: <https://www.interaction-design.org>.
4. **"Existing Aphasia Communication Tools - Comparative Analysis,"** Aphasia Access Organization, 2020. Available: <https://www.aphasiaaccess.org>.
5. **"Android Accessibility Features: Development Guidelines,"** Google Developers, 2023. Available: <https://developer.android.com>.

All referenced documents are publicly available online and can be accessed through the provided links or through their respective publishing organizations.

2.3 Overview

This SRS document provides a comprehensive outline of the requirements and constraints for the project.

- **Section 1** introduces the purpose, scope, and key definitions relevant to the project.
- **Section 2** provides an overview of the broader context and background of the software product.
- **Section 3** details the precise functionalities and constraints of the application, including all necessary specifications for software development.
- **Section 4** lists references and appendices, including supporting materials and additional references for further clarification.

2.4 Version History

Provide a table of table of changes to this document.

Version No	Description of change	Date
1.0	Initial Release	15.10.2024
1.1	Adding Mockups and Related Diagrams	30.10.2024
1.2	Revision	01.12.2024
1.3	Control	02.12.2024

2.5 Overall (General) Description

2.6 Product Perspective

The "Aphasia" mobile application is a standalone product, fully self-contained and designed specifically for individuals with aphasia to facilitate their communication needs in a Turkish-language environment. The application is independent and does not rely on any external systems, ensuring its utility even in offline scenarios. However, its design incorporates for accessibility and user experience.

The application operates within the following constraints:

2.6.1 System interfaces

The application does not require integration with external systems but can export user data for backups if desired by the user.

2.6.2 User interfaces

Logical Characteristics:

The interface is structured to support users with limited technical skills. It includes:

- A highly visual layout with customizable sets of pre-configured phrases, images, and gestures.
- Large, clear buttons and icons for improved usability.
- Support for left-handed users with customizable layout options.

Usability Considerations:

- Accessible navigation with voice output in Turkish for textual elements.
- Simple navigation paths ensuring ease of use for individuals with cognitive or motor impairments.

2.6.3 Hardware interfaces

The application supports Android and iOS devices and requires basic hardware capabilities. These capabilities are touchscreen, microphone, and speakers, for effective interaction.

2.6.4 Software interfaces

The application does not rely on third-party software libraries or external frameworks. Instead, it utilizes the built-in accessibility features provided by Android and iOS platforms to enhance usability for individuals with aphasia. Below are the details of the software interfaces:

1. Android Accessibility Suite

○ Purpose:

The Android Accessibility Suite provides essential features like voice feedback (TalkBack), magnification gestures, and customizable text size. These features ensure that users with speech impairments can navigate and use the application efficiently.

2. iOS Accessibility Framework

○ Purpose:

The iOS Accessibility Framework provides assistive features such as VoiceOver, dynamic text resizing, and switch control. These features enhance the app's usability for individuals with limited communication capabilities.

2.6.5 Communications interfaces

The application operates offline by default, ensuring continuous functionality without an active internet connection. However, certain optional features, data sharing, updates, and backup, require network connectivity. Supported communication protocols include:

- **Wi-Fi:** Utilized for high-speed data exchange when the device is connected to a wireless network.
- **Mobile Data:** Provides on-the-go synchronization and updates, ensuring users can maintain data consistency without being reliant on Wi-Fi.

2.6.6 Memory constraints

The application is optimized to run efficiently on devices with limited resources, ensuring compatibility with older or lower-spec devices:

- **Primary Memory (RAM):** Requires less than 150 MB of RAM during operation, minimizing the app's impact on device performance.
- **Secondary Memory (Storage):** The app's installation footprint is under 50 MB, designed to conserve storage space and reduce clutter on devices.

2.6.7 Operations

The application is designed to function in user-initiated mode, with the following key operations:

- **Interactive Operations:** Users engage directly with the application by selecting pre-configured phrases or accessing voice output, all through simple, intuitive interactions.
- **Backup and Recovery:** Backup operations are handled locally, allowing users to save and restore profiles, customizations, and preferences. This is done without relying on cloud services, ensuring that data remains secure and accessible even in offline mode.

2.6.8 Site adaptation requirements

The application allows customization based on regional and cultural preferences, including:

- **Dialects:** Support for regional variations in Turkish.
- **Culturally Relevant Symbols:** Images and gestures tailored to local norms.

2.7 Product functions

This subsection outlines the major functionalities of the mobile application for individuals with aphasia. The following features are designed to ensure that the application addresses the unique communication needs of the target audience. The functions are organized logically for clarity and accessibility:

2.2.1 User Registration and Authentication

The app will provide a secure user registration system for individuals with aphasia. During registration, users are expected to register with an apple account or google account. Registered accounts will provide secure access and functionality personalised to user needs.

2.2.2 Login

Users will log in to the app with their apple or google account. Successful authentication will provide access to personalised features of the application and stored user data.

2.2.3 Customisable Emoticon Library

The application allows users can add and delete images in daily routine to improve comprehension and usability.

2.2.4 Phrase Selection and Communication

The application provides a library of pre-configured phrases organised according to common communication categories. Selected phrases are displayed in a large, readable format to facilitate communication.

2.2.5 Offline Functionality

The application is designed to work without an internet connection, ensuring reliability in environments with limited or no connectivity.

2.2.6 Accessibility Features

The app includes left-handed navigation, simplified controls to cater for users with physical or cognitive limitations.

2.2.7 Exercise Management

The application provides exercises aimed at developing communication skills. The exercises are organised level by level according to difficulty level and type. (e.g. matching pictures).

2.2.8 Routine Scheduling

Users can create daily routines, including reminders for therapy exercises, meals, and other activities.

2.2.9 Drawing and Symbol Based Communication

The application has a drawing interface where users can create visual representations or symbols for communication.

2.8 User characteristics

The primary users of the mobile application are individuals with aphasia, a condition that significantly impairs their ability to communicate verbally. The following characteristics of the target user group guide the application design:

1. **Diverse Educational Backgrounds**

Users may range from primary to higher education levels. The application must be accessible and intuitive regardless of educational background.

2. **Cognitive and Physical Challenges**

Users may face difficulty understanding complex instructions or have limited dexterity. These challenges necessitate a straightforward and adaptive interface.

3. **Minimal Technical Expertise**

Most users are expected to have little to no familiarity with advanced technological tools. The application must provide a simple and easy-to-navigate interface.

2.9 General Constraints

The development of the application is subject to the following constraints, which impact the design and implementation:

- a. This product is a new and self-contained product designed as a mobile and tablet application for individuals with aphasia, emphasizing simplicity and ease of use.
- b. Since sensitive user data will be handled, all data transmission must be encrypted when shared via optional features, adhering to **HTTPS** protocols.
- c. The application must be optimized for devices with limited hardware resources, including low-cost Android and iOS devices with **2GB RAM** and **16GB storage**.
- d. The application will primarily support **Turkish** as the default language.
- e. The system should handle up to **5000 user interactions per hour**, ensuring smooth operation even during peak usage.
- f. The application will be designed for **offline use**; however, any shared content (e.g., optional backups) must be securely stored for a maximum of **24 hours**. After this duration, shared data must be automatically deleted from the system.
- g. Content types will include pre-defined **phrases** and **symbols**, with potential expansion to include user-customized content .
- h. Controls will be optimized for users with limited dexterity, including a specific focus on **left-handed usability** and larger, accessible UI components.

2.10 Assumptions and Dependencies

The following assumptions and dependencies may impact the application's requirements and must be considered during development:

1. **Operating System Availability**

Assumes support for Android (8.0 and above) and iOS (13 and above). Updates to these systems may necessitate adjustments.

2. **Device Specifications**

Assumes devices have at least 2GB of RAM, 16GB of storage, and a touchscreen. Performance optimizations may be required for lower-spec devices.

3. **Language Support**

Focused on Turkish as the primary language.

4. **Third-Party Tools and Libraries**

Relies on the availability of framework. Changes in their support or licensing could affect development.

5. **User Demographics**

Designed primarily for individuals with aphasia. Shifts in target demographics could influence feature priorities.

2.11 Apportioning of Requirements

The following features are not critical for the initial release but may be included in future versions:

1. **Integration with Wearables**

Supporting devices like smartwatches for quick phrase access.

2.12 Specific Requirements

This section details the specific requirements for the aphasia mobile application, ensuring a comprehensive understanding of its functionalities, inputs, outputs, and behaviors. The requirements are organized for clarity and align with the principles of being externally perceivable, uniquely identifiable, and readable.

2.13 External Interface Requirements

This section details all inputs and outputs of the system, including their content and format. Each interface is described in terms of its purpose, source or destination, valid ranges, timing, relationships, and other relevant parameters.

2.13.1 User Interfaces

This section describes the user interfaces of the mobile application for individuals with aphasia, detailing the purpose and functionality of each page. The design focuses on accessibility, simplicity, and ease of navigation, ensuring a seamless experience for users with communication difficulties.

2.13.1.1 *Landing Page*

The landing page is the entry point of the application, welcoming users and providing access to registration. It features a user-friendly design with large buttons and text for easy navigation. The page briefly describes the app's purpose: assisting individuals with aphasia in communication. For first-time users, the registration option is emphasized. Image 1 is the mockup design of the page.

2.13.1.2 *User Page*

The user page provides personalized information and serves as the user's profile section. It displays details like the user's name. Also, users can add the photo. Image 2 is the mockup design of the page.

2.13.1.3 Main Page

The main page acts as the central hub of the application, providing access to all primary features. Users can select from options: Patient routine ,drawing buttons, and exercises. Users can also access the user page. Image 3 is the mockup design of the page.

2.13.1.4 Patient's Routine Page

The patient's routine page helps users control their daily activities. The interface presents tasks. Each task is displayed with icons and brief descriptions to support easy comprehension. Additionally, when the user clicks of the any routine in this page, this button turns the green color. Image 4 is the mockup design of the page.

2.13.1.5 Add/ Delete Page

The add/delete page enables users to manage the app's routine activities. The interface is divided into two sections: one for adding new items and another for deleting existing ones. The design includes clear prompts and confirmation dialogs to avoid errors, ensuring user-friendly interactions. Image 5 is the mockup design of the page.

2.13.1.6 Drawing Page

The drawing page provides a creative and interactive space for users to express themselves visually. It includes a simple drawing canvas with tools like color selection, brush, and eraser options. Image 6 is the mockup design of the page.

2.13.1.7 Exercise Page

The exercise page offers personalized activities to support rehabilitation and communication skill development. Exercises include matching symbols. The interface provides immediate feedback and progress tracking, motivating users to engage consistently. The layout emphasizes simplicity, ensuring that users can focus on tasks without unnecessary distractions. Image 7 is the mockup design of the page.

2.13.1.8 Picture Matching Exercise Page

On the picture matching exercise page, we have a tiny game as shown in the figure. this game, which will strengthen hand functionality and memory, will be a useful exercise for users. Image 8 is the mockup design of the page.

2.13.2 Hardware interfaces

The aphasia mobile application interacts with various hardware components of the device to enhance usability and ensure accessibility. These interfaces are designed to work seamlessly across a range of mobile devices, including smartphones and tablets.

2.13.3 Software interfaces

The aphasia application interacts with several software components and services to ensure smooth operation and functionality. These interfaces allow the application to integrate with the mobile operating system and external APIs effectively.

Mobile Operating System (iOS/Android)

Cloud Storage API

2.13.4 Communications interfaces

- **Wi-Fi:** Utilized for high-speed data exchange when the device is connected to a wireless network.
- **Mobile Data:** Provides on-the-go synchronization and updates, ensuring users can maintain data consistency without being reliant on Wi-Fi.

2.14 Functional Requirements

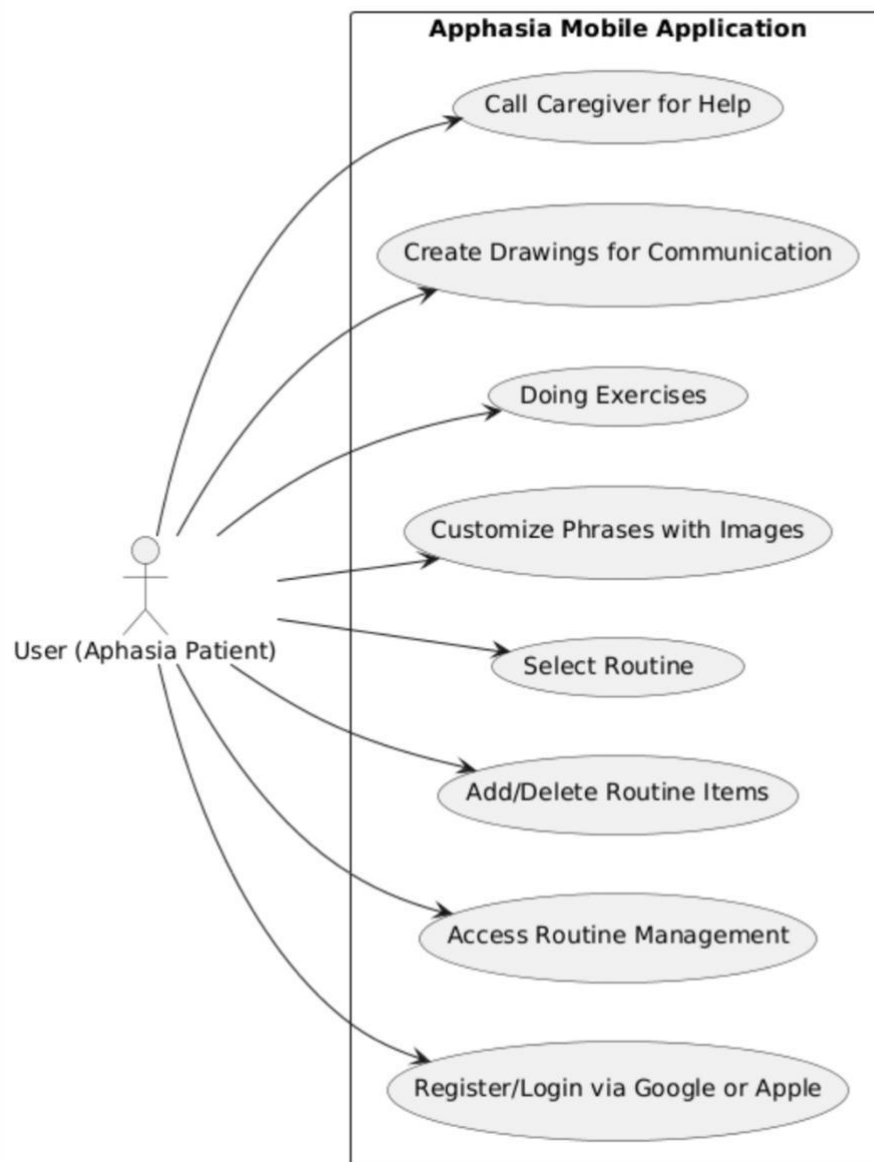


Figure 13 Use-Case Diagram



Figure 14 Activity Diagram

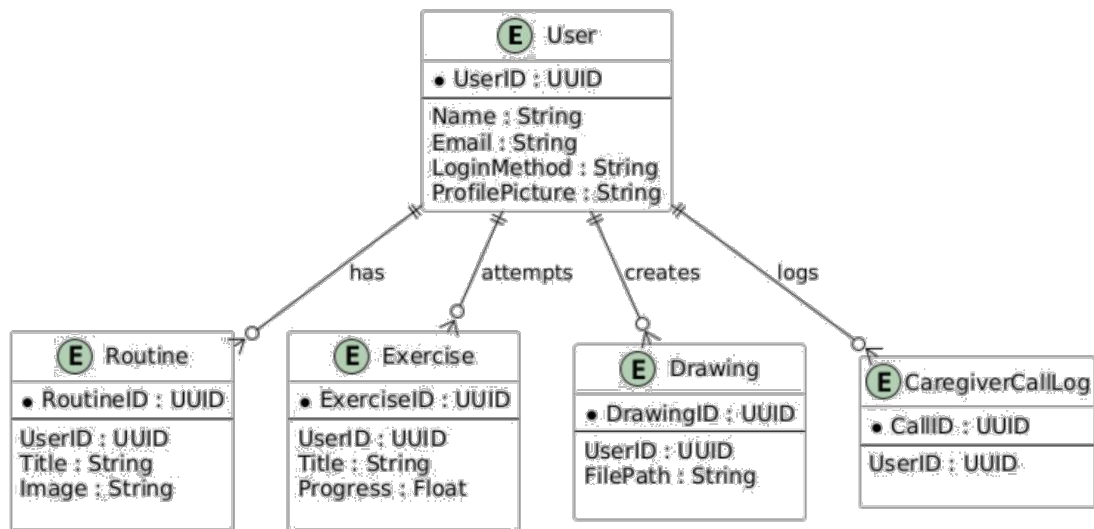


Figure 15 Data Model

2.14.1 Landing Page

Description and Priority: The landing page serves as the entry point of the application, providing a welcoming experience for users. It ensures easy navigation to the registration and login features, particularly emphasizing first-time users. This page is critical for user onboarding and navigation.

Stimulus/Response Sequences:

1. **User:** Launches the application.
System: Displays the landing page with large buttons for easy access to "Login with Apple Account" and "Login with Google Account."
2. **User:** Clicks "Login with Apple Account" or "Login with Google Account."
System: Navigates to the corresponding page.

Functional Requirements:

1. The system must display a welcoming interface with clear navigation to "Login with Apple Account" and "Login with Google Account" options.
2. Buttons and text must be large and accessible for users with cognitive or physical impairments.
3. The footer must not appear on this page to prevent distractions during the login process.



Figure 16 Landing Page

2.14.2 User Page

Description and Priority: The user page provides a personalized experience, displaying profile information and allowing updates such as adding a profile photo. This page has medium priority but is essential for personal customization.

Stimulus/Response Sequences:

1. **User:** Navigates to the user page.
System: Displays the user's name, profile details, and a profile photo.
2. **User:** Updates personal information or profile photo.
System: Saves changes and displays confirmation.

Functional Requirements:

1. The system must display the user's name and profile details.
2. Users must be able to update personal information and add a profile photo.
3. Changes must be saved securely, with feedback provided to the user.
4. The footer must display the following icons:
 - **Home Icon:** For returning to the main page.
 - **Pencil Icon:** For navigating to the Drawing Page.
 - **Dumbbell Icon:** For navigating to the Exercise Page.
 - **User Icon:** For accessing the User Page.
 - **Caregiver Call Button:** For emergency contact functionality.



Figure 17 User Page

When the user click on the “Bakıcı Çağır” button, anyone screen shows the this feedback message. This feedback usefull for users understand and feel confident.



Figure 18 feedback message

2.14.3 Main Page

Description and Priority: The main page acts as the central hub, providing access to key functionalities (routines, exercises, and drawing). It is highly prioritized as it facilitates seamless navigation to core features.

Stimulus/Response Sequences:

1. **User:** Opens the main page.
System: Displays buttons for "Patient Routine," "Drawing," "Exercises," and "User Page."
2. **User:** Selects a feature.
System: Navigates to the respective page.

Functional Requirements:

1. The system must display buttons for all primary features.
2. Navigation should be smooth and intuitive.
3. The footer must display the following icons:
 - **Home Icon:** For returning to the main page.
 - **Pencil Icon:** For navigating to the Drawing Page.
 - **Dumbbell Icon:** For navigating to the Exercise Page.
 - **User Icon:** For accessing the User Page.
 - **Caregiver Call Button:** For emergency contact functionality.



Figure 19 Main Page

2.14.4 Patient's Routine Page

Description and Priority: This page enables users to manage daily routines effectively. Each task is visually represented, enhancing comprehension. This page is essential for organizing daily activities.

Stimulus/Response Sequences:

1. **User:** Views daily tasks.
System: Displays tasks with icons and descriptions.
2. **User:** Marks a task as complete.
System: Changes the task's color to green.

Functional Requirements:

1. The system must list tasks with clear visual cues.
2. Users must be able to mark tasks as complete.
3. The system should update the task status in real time.
4. The footer must display the following icons:
 - **Home Icon:** For returning to the main page.
 - **Pencil Icon:** For navigating to the Drawing Page.
 - **Dumbbell Icon:** For navigating to the Exercise Page.
 - **User Icon:** For accessing the User Page.
 - **Caregiver Call Button:** For emergency contact functionality.



Figure 20 Patient's Routine Page

2.14.5 Add/Delete Page

Description and Priority: This page allows users to add or remove routine items, ensuring flexibility and customization. It has medium priority but is critical for routine management.

Stimulus/Response Sequences:

1. **User:** Adds a new task.
System: Saves the task and updates the list.
2. **User:** Deletes an existing task.
System: Confirms deletion and updates the list.

Functional Requirements:

1. The system must support adding new tasks.
2. Users must be able to delete existing tasks with confirmation.
3. The footer must display the following icons:
 - **Home Icon:** For returning to the main page.
 - **Pencil Icon:** For navigating to the Drawing Page.
 - **Dumbbell Icon:** For navigating to the Exercise Page.
 - **User Icon:** For accessing the User Page.
 - **Caregiver Call Button:** For emergency contact functionality.



Figure 21 Add/Delete Page

2.14.6 Drawing Page

Description and Priority: The drawing page provides a creative space for users to communicate visually. It is a medium-priority feature with a significant impact on usability.

Stimulus/Response Sequences:

1. **User:** Opens the drawing page.
System: Displays a canvas with drawing tools.
2. **User:** Draws or erases content.
System: Updates the canvas in real time.

Functional Requirements:

1. The system must provide drawing tools, including color selection and erasers.
2. Users must be able to save or clear the canvas.
3. The footer must display the following icons:
 - **Home Icon:** For returning to the main page.
 - **Pencil Icon:** For navigating to the Drawing Page.
 - **Dumbbell Icon:** For navigating to the Exercise Page.
 - **User Icon:** For accessing the User Page.
 - **Caregiver Call Button:** For emergency contact functionality.



Figure 22 Drawing Page

2.14.7 Exercise Page

Description and Priority: This page supports rehabilitation through personalized exercises. It is a high-priority feature that encourages skill development.

Stimulus/Response Sequences:

1. **User:** Opens the exercise page.
System: Displays a list of exercises.
2. **User:** Selects an exercise.
System: Starts the exercise and tracks progress.

Functional Requirements:

1. The system must offer a variety of exercises with immediate feedback.
2. Progress tracking must be clear and accessible.
3. The footer must display the following icons:
 - **Home Icon:** For returning to the main page.
 - **Pencil Icon:** For navigating to the Drawing Page.
 - **Dumbbell Icon:** For navigating to the Exercise Page.
 - **User Icon:** For accessing the User Page.
 - **Caregiver Call Button:** For emergency contact functionality.



Figure 23 Exercise Page

2.14.8 Picture Matching Exercise Page

Description and Priority: This page features a game to enhance memory and hand functionality. It has medium priority but is engaging and therapeutic.

Stimulus/Response Sequences:

1. **User:** Opens the page and starts the game.
System: Displays matching pairs for the user to select.
2. **User:** Completes the game.
System: Displays feedback and progress.

Functional Requirements:

1. The system must present an interactive matching game.
2. Feedback on performance must be immediate and informative.
3. The footer must display the following icons:
 - **Home Icon:** For returning to the main page.
 - **Pencil Icon:** For navigating to the Drawing Page.
 - **Dumbbell Icon:** For navigating to the Exercise Page.
 - **User Icon:** For accessing the User Page.
 - **Caregiver Call Button:** For emergency contact functionality.



Figure 24 Picture Matching Exercise Page

2.15 Performance requirements

Performance requirements specify both the static and dynamic numerical criteria for the software system and its interaction with users.

2.15.1.1 *Static Numerical Requirements*

- The system shall support up to **5000 user interactions per hour** without degradation in performance.
- The system shall operate efficiently on devices with a minimum of **2GB RAM** and **16GB storage**.

2.15.1.2 *Dynamic Numerical Requirements*

- **Response Time:**
 - 95% of user actions shall receive a system response within **500 milliseconds**.
 - Data updates, such as adding a new phrase, shall complete within **2 seconds**.
- **Offline Operations:**
 - The application shall maintain full functionality without an internet connection for up to **30 days** after installation.
- **Synchronization:**
 - Optional data backup and synchronization features shall occur within **10 seconds** when network connectivity is available.
- **Peak Load Handling:**
 - During peak usage, the system shall maintain a response time of less than **1 second** for critical operations.

2.16 Logical database requirements

This section defines the logical requirements for the data that the application manages.

- **Types of Information Used by Functions:**
 - Pre-configured phrases, categorized by scenarios .
 - User-customized phrases, including associated images/icons.
 - User profiles, containing personal details : name, aphasia level, and preferences.
- **Integrity Constraints:**
 - Each phrase must have a unique identifier.
 - Profile updates must pass validation checks to ensure data completeness.
- **Data Retention:**
 - User profiles and associated data shall be retained locally on the device indefinitely.
 - Optional synchronized backups shall be automatically deleted from cloud storage after **24 hours**.

2.17 Design constraints

Design constraints outline external limitations that influence the system's design and implementation.

2.17.1 Standards compliance

- The system shall adhere to **ISO/IEC 25010** standards for software quality, emphasizing usability and accessibility.
- All data transmissions for optional backup features shall use encrypted protocols, such as **HTTPS**.
- The application shall comply with **Android Accessibility Suite** and **iOS Accessibility Framework** guidelines to ensure inclusivity.

2.18 Software system attributes

This section specifies the attributes required for reliability, availability, security, maintainability, and portability.

2.18.1 Reliability

- The application shall maintain **99.9% uptime** during offline usage.
- Recovery mechanisms shall ensure no data loss during unexpected shutdowns.

2.18.2 Availability

- The system shall be available for use **24/7**, irrespective of internet connectivity.
- Backup and synchronization features shall function only when network connectivity is stable.

2.18.3 Security

- The system shall encrypt sensitive user data using **AES-256 encryption**.
- The system shall prevent unauthorized access through secure authentication mechanisms.

2.18.4 Maintainability

- The codebase shall follow modular design principles to facilitate maintenance and updates.
- The system shall include error logs to aid in debugging and support.

2.18.5 Portability

The system shall be built using portable programming languages.

2.19 References

- [1] Software Engineering Department, "Graduation Projects," SENG, [Online]. Available: <https://seng.cankaya.edu.tr/graduation-projects/>. [Accessed 28 June 2024].
1. **"Aphasia and Communication Disorders: An Overview,"** National Institute on Deafness and Other Communication Disorders (NIDCD), 2022. Available: <https://www.nidcd.nih.gov>.
 2. **"ISO/IEC 25010:2011 - Systems and Software Quality Requirements and Evaluation (SQuaRE),"** International Organization for Standardization (ISO), March 2011. Available: <https://www.iso.org>.
 3. **"User Experience Design for Accessibility: Best Practices,"** Interaction Design Foundation, 2021. Available: <https://www.interaction-design.org>.
 4. **"Existing Aphasia Communication Tools - Comparative Analysis,"** Aphasia Access Organization, 2020. Available: <https://www.aphasiaaccess.org>.
 5. **"Android Accessibility Features: Development Guidelines,"** Google Developers, 2023. Available: <https://developer.android.com>.

3. SOFTWARE DESIGN DOCUMENT - SDD

3.1 Introduction

3.1.1 Purpose

The purpose of this Software Design Document (SDD) is to provide a comprehensive overview of the architectural and design decisions made for the Aphasia Communication Aid Application. This document serves as a detailed reference to guide the development team, ensuring that the functional and non-functional requirements are effectively addressed in the system design. It outlines the strategies and components used to create an accessible and efficient application tailored to the needs of individuals with aphasia, taking into account their physical and cognitive limitations. The SDD is intended for the development team to ensure accurate implementation, project stakeholders to validate the alignment of the design with project goals, the quality assurance team to facilitate effective testing, and future developers to support maintenance and further development.

3.1.2 Scope

This Software Design Document (SDD) covers the following aspects:

- **System Architecture:** Describes the overall architecture of the application, including components such as clients, application server, and database server.
- **User Interface Design:** Details the design of screens and interface components.
- **High-Level Design:** Defines the core modules of the application and their interactions.
- **Low-Level Design:** Provides technical details and the internal workings of each module.
- **Database Design:** Includes the data model, E-R diagram, and the structure of database tables.
- **References:** Lists the resources and materials used in the development and design process.

This document does not include specific implementation details such as coding practices, third-party libraries, or deployment instructions.

3.1.2.1 Definitions, Acronyms and Abbreviations

This section provides definitions of key terms, acronyms, and abbreviations used in the Software Design Document (SDD) to ensure clarity and proper interpretation.

- SDD: Software Design Document - A document outlining the design and architecture of a software system.
- UI: User Interface - The visual and interactive components through which users interact with the application.
- DB: Database - A structured collection of data stored and managed electronically.
- E-R Diagram: Entity-Relationship Diagram - A graphical representation of entities and their relationships in a database.
- API: Application Programming Interface - A set of protocols and tools for building and interacting with software applications.
- Offline Mode: A feature allowing the application to function without an active internet connection.
- Aphasia: A language disorder affecting a person's ability to communicate, often caused by brain injury.

Further terms and acronyms may be detailed in an appendix or referenced from external documentation as necessary.

3.1.3 References

This section lists all documents and resources referenced in this Software Design Document (SDD). It provides the necessary details for identifying and obtaining these references.

1. IEEE Standard 1016-2009
 - Title: IEEE Standard for Information Technology - Systems Design - Software Design
 - Date: June 25, 2009
 - Publishing Organization: IEEE
 - Source: <https://ieeexplore.ieee.org/Xplore/home.jsp>
2. Aphasia Research Report
 - Title: Communication Challenges and Solutions for Individuals with Aphasia
 - Report Number: N/A
 - Date: 2023
 - Publishing Organization: Aphasia Institute
 - Source: <https://www.aphasia.ca>

3. Database Design Principles

- Title: Database System Concepts (7th Edition)
- Report Number: N/A
- Date: 2020
- Publishing Organization: McGraw-Hill
- Education o Source: <https://www.mheducation.com>

4. UI/UX Design Guidelines

- Title: Material Design Guidelines
- Report Number: N/A
- Date: 2024
- Publishing Organization: Google

3.2 Overview

This Software Design Document (SDD) provides a comprehensive description of the architectural and design elements of the Aphasia Communication Aid Application. It serves as a detailed guide for developers, stakeholders, and quality assurance teams, ensuring alignment on system implementation and functionality. The SDD is organized to facilitate ease of understanding and navigation.

The document is structured as follows:

- Introduction: Defines the purpose, scope, intended audience, and references used in the document.
- Architecture: Describes the high-level system architecture, including components such as clients, application servers, and database servers.
- User Interface Design: Details the design and layout of application screens, focusing on usability and accessibility.
- High-Level Design: Provides an overview of the core modules and their interactions within the application.
- Low-Level Design: Explains the technical specifics of each module, including detailed workflows and interactions.
- Database Design: Includes the entity-relationship diagram and a detailed description of database tables.
- References: Lists all documents and resources referenced throughout the SDD for further reading and validation.

The document is organized into clearly defined sections to ensure logical flow and readability, enabling the audience to easily locate specific details and understand the system's design comprehensively.

3.3 Architecture

3.3.1 Clients

3.3.1.1 Mobile Phones

Minimum requirements:

- Operating System (OS): Android 9.0 (Pie) or higher, iOS 13 or higher
- Memory (RAM): At least 2 GB
- Storage: At least 100 MB of free space
- Screen: 5 inches or larger, 720x1280 resolution
- Internet Connection: Not required (optimized for offline use)
- Additional Hardware: Touchscreen support

3.3.1.2 Tablets

Minimum requirements:

- Operating System (OS): Android 9.0 (Pie) or higher, iPadOS 13 or higher
- Memory (RAM): At least 3 GB
- Storage: At least 150 MB of free space
- Screen: 7 inches or larger, 1280x800 resolution
- Internet Connection: Not required (optimized for offline use)

3.3.1.3 Application Server

Minimum requirements:

- Operating System (OS): Ubuntu 20.04 LTS, CentOS 8, or Windows Server 2019
- Memory (RAM): At least 8 GB
- Storage: At least 50 GB SSD
- Processor: Dual-core 2.5 GHz or higher
- Network: 1 Gbps network connection
- Additional Software: Node.js (v18 or higher), Nginx or Apache

3.3.1.4 Database Server

Minimum requirements:

- Operating System (OS): Ubuntu 20.04 LTS, CentOS 8, or Windows Server 2019
- Memory (RAM): At least 16 GB
- Storage: At least 100 GB SSD (scalable)
- Processor: Quad-core 3.0 GHz or higher
- Network: 1 Gbps network connection
- Additional Software: PostgreSQL 14 or higher, or MySQL 8.0 as an alternative

3.4 User Interfaces

3.4.1 Greetings Screen



Figure 25 Greetings Screen

Greeting Text	Displays "Merhaba" as a welcoming text at the top of the screen.
Apple Login Button	Button labeled "Apple Hesabı ile Giriş" to log in using an Apple account.
Google Login Button	Button labeled "Google Hesabı ile Giriş" to log in using a Google account.

3.4.2 Create Profile



Figure 26 Create Profile

Application Title	Displays "Apphasia" at the top of the screen.
Patient Profile Button	Button labeled "Hasta Profili Oluştur" to create a new patient profile.
Caretaker Profile Button	Button labeled "Bakıcı Profili Oluştur" to create a new caretaker profile.

3.4.3 Simple Main Page



Figure 27 Simple Main Page

Patient Routine Button	Allows the user to access the patient's daily routine.
Drawing Mode Button	Enables the user to express themselves through drawing.
Typing Mode Button	Allows the user to type text using the keyboard for communication.
Home Button	Icon representing the home screen navigation.
Write Button	Icon for accessing text or note-based tools.
Call Caretaker Button	Central circular button labeled "Bakıcı Çağır" to call the caretaker.
ABC Icon	Switches to the typing mode.

3.4.4 Drawing Screen

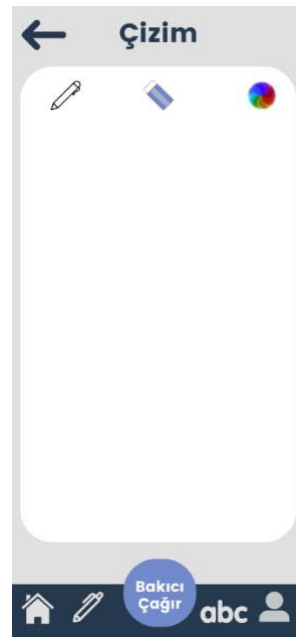


Figure 28 Drawing Screen

Screen Title	Displays "Çizim" at the top of the screen.
Pen Icon	Allows the user to draw on the screen.
Eraser Icon	Allows the user to erase parts of the drawing.
Color Picker Icon	Enables the user to select different colors for drawing.
Drawing Canvas	A blank area where the user can create drawings.
ABC Icon	Switches to the typing mode.
Home Button	Icon representing the home screen navigation

3.4.5 Patient Routine Screen



Figure 29 Patient Routine Screen

Icons and Buttons	Provides options for navigating through patient-related features:
Tıbbi Şikayetler	Button with an icon of a stethoscope to log or view medical complaints.
Duygular	Button with an emotion chart icon to express or select feelings.
İlaç	Button with a medication icon to manage and track medicines.
Ben	Button with a personal avatar icon to access self-related routines.
Basit Diyaloglar	Button with speech bubbles icon to navigate to simple dialogues for communication.
Scroll Bar	Horizontal scroll bar at the bottom for accessing additional categories if needed.

3.4.6 Routine Detail Screen



Figure 30 Routine Detail Screen

Option Buttons	Provides three options for the user to select:
Deniz Kenarı	Button for choosing "Beach."
Şehir Merkezi	Button for choosing "City Center."
Orman / Doğa	Button for choosing "Forest / Nature."
Confirm Button	Button labeled "Tamam" to confirm the user's selection.
Back Button	An arrow icon at the top-left corner to navigate back to the previous screen.
ABC Icon	Switches to the typing mode.
Home Button	Icon representing the home screen navigation

3.4.7 Routine Detail Screen 2



Figure 31 Routine Detail Screen 2

Question Text	Displays the question "Ne Yemek İstersin?" to ask the user what they would like to eat.
Option Buttons	Provides four options for the user to select:
- Et (etc.)	Button for choosing "Meat."
Confirm Button	Button labeled "Tamam" to confirm the user's selection.
Back Button	An arrow icon at the top-left corner to navigate back to the previous screen.
ABC Icon	Switches to the typing mode.

3.4.8 Routine Add/Delete

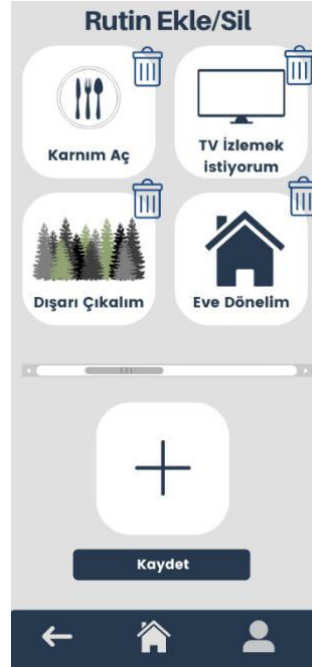


Figure 32 Routine Add/Delete

Add Routine Button	A large "+" icon to add a new routine to the list.
Save Button	Button labeled "Kaydet" to save the changes made to routines.
Trash Icons	Allows the user to delete individual routines by clicking on the trash icon next to them.
Routine Cards	Displays a grid of existing routines with icons and labels.
Home Button	Icon representing the home screen navigation.
Back Button	An arrow icon at the top-left corner to navigate back to the previous screen.

3.4.9 Routine Deleted Screen

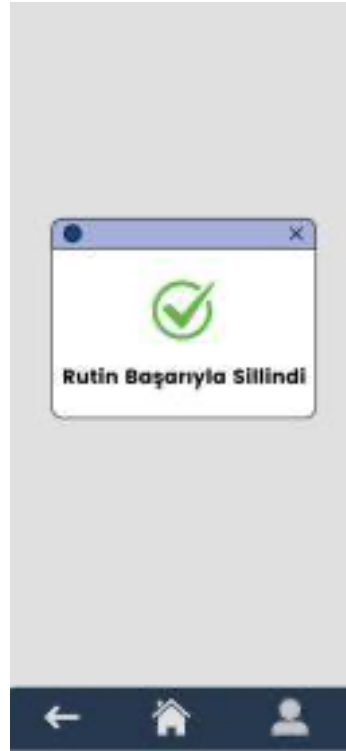


Figure 33 Routine Deleted Screen

Popup Window	Displays a confirmation message in a modal-style window.
Message	Displays "Rutin Başarıyla Silindi" confirming the successful deletion of a routine.
Icon	Green checkmark icon to indicate success.
Close Button	An "X" button at the top-right corner to close the popup.
Back Button	An arrow icon at the top-left corner to navigate back to the previous screen.
Home Button	Icon representing the home screen navigation.
Profile Icon	To go to profile page.

3.4.10 Routine Added Screen



Figure 34 Routine Added Screen

Popup Window	Displays a confirmation message in a modal-style window.
Message	Displays "Rutin Başarıyla Eklendi" confirming the successful addition of a routine.
Icon	Green checkmark icon to indicate success.
Close Button	An "X" button at the top-right corner to close the popup.
Back Button	An arrow icon at the top-left corner to navigate back to the previous screen.
Home Button	Icon representing the home screen navigation.

3.4.11 Send Notification to Caretaker



Figure 35 Send Notification to Caretaker

Popup Window	Displays a confirmation message in a modal-style window.
Message	Displays "Bakıcıya bildirim gönderildi" confirming that a notification has been sent to the caretaker.
Close Button	An "X" button at the top-right corner to close the popup.
Home Button	Icon representing the home screen navigation.
ABC Icon	Switches to the typing mode.
Pen Icon	To go to drawing page.

3.4.12 Notification Screen On Caretaker's Screen



Figure 36 Notification Screen On Caretaker's Screen

Popup Window	Displays an emergency notification in a modal-style window.
Message	Displays "Hastanızın Size İhtiyacı Var!" indicating that the patient needs help.
Icon	A red flashing emergency icon to emphasize the urgency of the situation.
Close Button	An "X" button at the top-right corner to close the popup.
Home Button	Icon representing the home screen navigation.
Back Button	An arrow icon at the top-left corner to navigate back to the previous screen.

3.4.13 Patiente User Page



Figure 37 Patiente User Page

Profile Picture	Displays a placeholder profile image with the option to "Fotoğraf Ekle" (Add Photo).
Greeting Text	Displays "Merhaba X," where "X" is the patient's name.
Patient Email	Shows the patient's email address, e.g., " <u>hasta@adres.com</u> ".
Caretaker Info Section	Displays a label "Bakıcı Bilgileri" to indicate caretaker details.
Caretaker Email	Shows the caretaker's email address, e.g., " <u>bakıcı@adres.com</u> ".
ABC Icon	Switches to the typing mode.

3.4.14 Caretaker Settings



Figure 38 Caretaker Settings

Profile Picture	Displays a placeholder profile image with the option to "Fotoğraf Ekle" (Add Photo).
Greeting Text	Displays "Merhaba X," where "X" is the caretaker's name.
Email Display	Shows the caretaker's email address, e.g., " bakıcı@adres.com ".
Patient Info Button	Button labeled "hasta bilgilerim" to navigate to patient information.
Bottom Navigation Bar	Contains the buttons to go other pages.
Home Button	Icon representing the home screen navigation.
Back Button	An arrow icon at the top-left corner to navigate back to the previous screen.

3.4.15 Keyboard Screen



Figure 39 Keyboard Screen

Back Arrow Icon	Allows the user to navigate back to the previous screen.
Text Input Field	Allows the user to type messages or phrases for communication.
Send Icon (Arrow)	Sends the typed message to be displayed or processed further.
Suggested Words Bar	Provides predictive text suggestions based on what the user is typing.
Keyboard	Standard virtual keyboard for typing messages.
Home Icon	Redirects the user to the home screen.
Pen Icon	Switches to the drawing mode.
ABC Icon	Indicates the user is currently in typing mode.

3.4.16 Show Patience for Caretaker

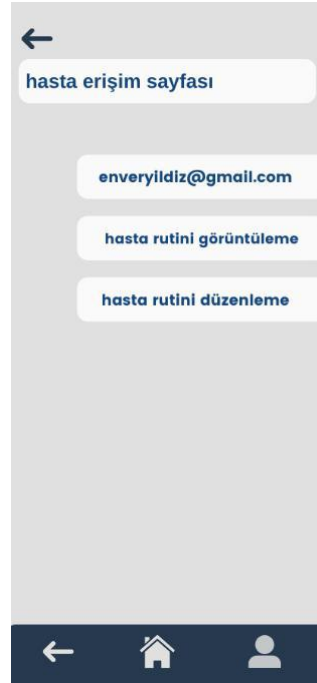


Figure 40 Show Patience for Caretaker

Screen Title	Displays "hasta erişim sayfası" at the top of the screen.
Email Display Button	Button labeled "hasta mail adresi" to show the patient's email address.
View Routine Button	Button labeled "hasta rutini görüntüleme" to view the patient's routine.
Edit Routine Button Back	Button labeled "hasta rutini düzenleme" to edit the patient's routine.
Button	Icon representing the home screen navigation.
Home Button	Icon representing the home screen navigation.
Profile Icon	To go to profile button.

3.4.17 Adding Routine



Figure 41 Adding Routine

Image Display	Displays an image at the top, representing the request theme.
Question Text	Displays the question "Ne istersin?" to ask the user to make a selection.
Option Buttons	Provides two options for the user:
- Öneri-1 Home	Button labeled "Öneri-1" as the first suggestion or option.
Button Save	Icon representing the home screen navigation.
Button Back	Button labeled "Kaydet" to confirm and save the user's selection.
Button	Icon representing the home screen navigation.

3.5 Architectural Design

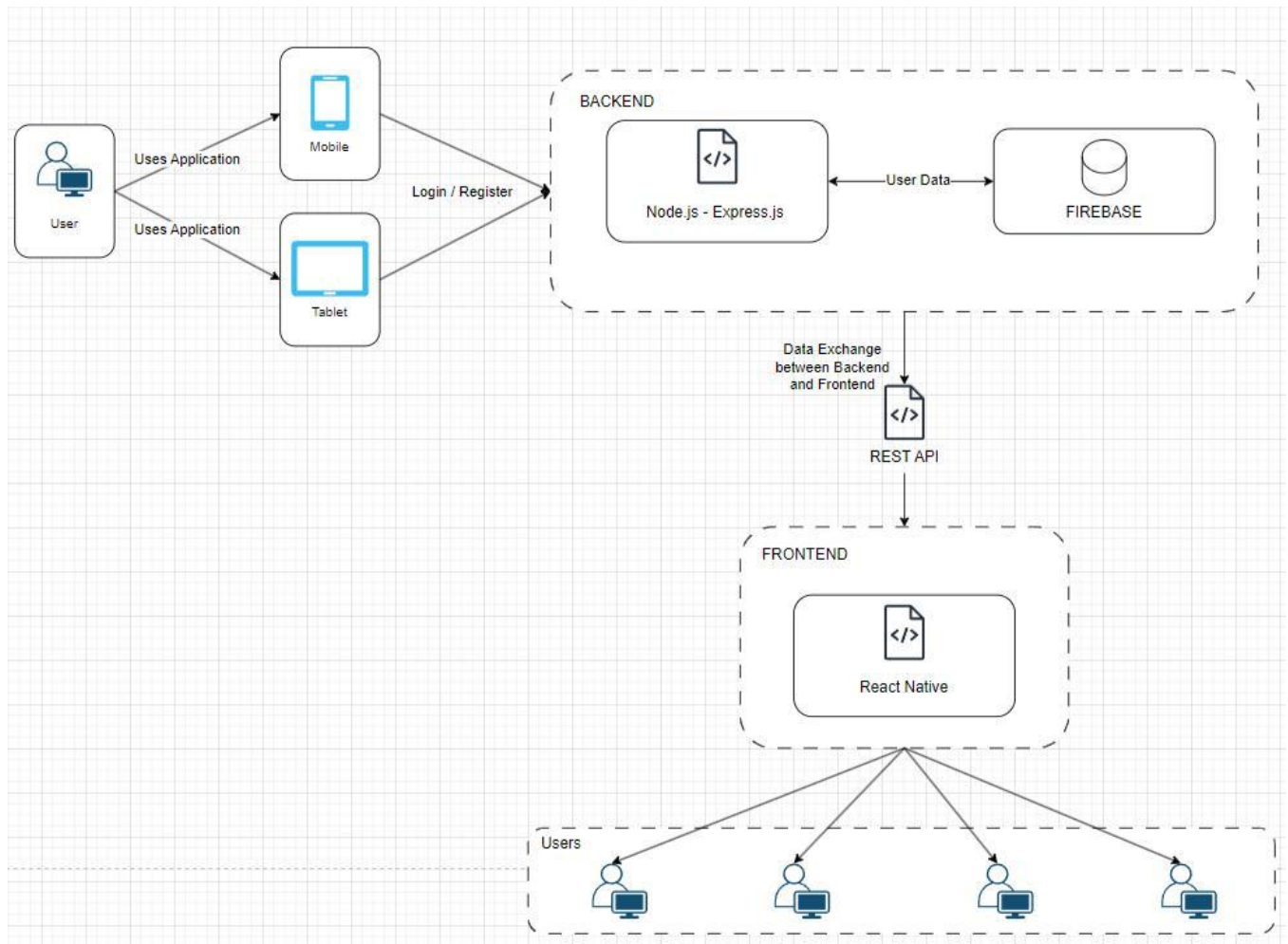


Figure 42 Diagram

1. User Interaction:
 - a. The user interacts with the application via mobile or tablet devices.
 - b. The application provides the ability to log in or register for accessing features.
2. Backend (Server-Side):
 - a. The backend is built using Node.js and Express.js to handle server-side operations.
 - b. User data, such as authentication and profile information, is stored and managed in Firebase.
 - c. The backend ensures secure and efficient communication between the user and the database.

3. REST API:
 - a. A REST API acts as the intermediary for data exchange between the backend and the frontend.
 - b. This ensures that the application can send and receive data reliably and efficiently.
4. Frontend (Client-Side):
 - a. The frontend is developed using React Native, providing a smooth and responsive user interface for mobile and tablet users.
 - b. It consumes the REST API to fetch and send data to the backend.
5. Users:
 - a. The final users of the application interact with the frontend on their devices to utilize the app's features like communication, data access, or customization.

3.6 Database and Deployment

3.6.1 Database

For our application, we have chosen **Firebase Realtime Database** as our primary database solution. Firebase offers a cloud-hosted NoSQL database that is highly suitable for mobile applications requiring real-time data synchronization. Its ability to provide seamless data updates across devices ensures that users' custom communication templates and preferences are always accessible, regardless of the device they use.

Firebase Realtime Database supports offline capabilities, allowing users to interact with the application even without an active internet connection. Data is stored locally on the device and synchronized with the cloud once the connection is re-established, ensuring continuity and reliability.

Additionally, Firebase provides robust security features, such as user-based authentication and access rules, to protect sensitive user data. Its scalability and global infrastructure also ensure that our application can efficiently handle increasing user demand and data volume as the project grows.

By leveraging Firebase, we ensure a simplified yet powerful database solution that aligns with the accessibility and functionality requirements of our target users.

3.6.2 Deployment

To host and manage our backend services, we chose **Firebase** for its simplicity and integration with mobile platforms. Firebase provides a robust infrastructure, enabling seamless hosting, database management, and analytics within a single platform.

For mobile app deployment, the application is distributed through:

- **Google Play Store** (for Android users).
- **Apple App Store** (for iOS users).

The deployment process includes:

- **Version Control:** Managed via **Git** to ensure traceability and collaboration.
- **Continuous Integration (CI):** Automated builds and tests using **GitHub Actions**, ensuring high-quality releases.
- **Monitoring and Analytics:** Leveraging Firebase Analytics to track user engagement and identify potential issues in real-time.

This deployment strategy ensures a smooth and scalable delivery of our application, meeting the needs of our target users while allowing future updates to be implemented seamlessly.

4.WORK PLAN

start date 30/09/2024	Sütun1	Sütun2	Sütun3	Sütun4	Sütun5	Sütun6	Sütun7	Sütun8	Sütun9	Sütun10	Sütun11	Sütun12	Sütun13
Procedural Steps	Current State	11.10.2024	18.10.2024	25.10.2024	1.11.2024	8.11.2024	22.11.2024	6.12.2024	13.12.2024	27.12.2024	3.12.2025	10.12.2025	15.12.2025
Team Setup	Completed												
Project Selection Form	Completed												
GitHub Repository	Completed												
Project Work Plan	Completed												
Literature Review	Completed												
Software Requirements Specification	Completed												
Project Webpage	Completed												
Software Design Description	Completed												
Project Report / Project Tracking Form	Completed												
Presentation	On 17/01/25												

Figure 43 Work Plan Image

5. TEST PLAN SECTION

5.1 Test Cases

AC.LG.fn.01 – Patient Login

- **Purpose:** Login with valid credentials as a patient
- **Requirement:** 1.1.1
- **Priority:** High
- **Category:** Acceptance
- **Estimated Time:** 5 Minutes
- **Dependency:** None

Setup:

- App installed, internet connected, valid patient account exists

Procedure:

1. Launch the app
2. Select "Patient" role
3. Enter username and password
4. Tap "Login"

Expected Result:

- Patient's main screen loads successfully

Cleanup: Log out

AC.LG.fn.02 – Caregiver Login

- **Purpose:** Login with valid credentials as a caregiver
- **Requirement:** 1.1.2
- **Priority:** High
- **Category:** Acceptance
- **Estimated Time:** 5 Minutes
- **Dependency:** None

Procedure:

1. Launch the app
2. Select "Caregiver" role
3. Enter credentials
4. Tap "Login"

Expected Result:

- Caregiver's dashboard loads

Cleanup: Log out

AC.RL.fn.01 – Role-Based Interface Verification

- **Purpose:** Ensure correct UI loads for different roles
- **Requirement:** 1.1.3
- **Priority:** High
- **Category:** Functional
- **Estimated Time:** 4 Minutes
- **Dependency:** AC.LG.fn.01, AC.LG.fn.02

Procedure:

1. Log in as patient → expect patient UI
2. Log out
3. Log in as caregiver → expect caregiver UI

Expected Result:

- Each role gets corresponding interface

Cleanup: Log out

AC.NT.fn.01 – Patient Sends “Need Help” Notification

- **Purpose:** Verify that the patient can notify caregiver
- **Requirement:** 2.1.1
- **Priority:** High
- **Category:** Functional
- **Estimated Time:** 4 Minutes
- **Dependency:** AC.LG.fn.01, AC.RL.fn.01

Procedure:

1. Patient logs in
2. Navigates to notification screen
3. Taps “Need Help”

Expected Result:

- Caregiver receives real-time notification with patient name and timestamp

Cleanup: Clear caregiver notifications

AC.NT.fn.02 – Real-Time Notification Display on Caregiver Side

- **Purpose:** Notification appears instantly to caregiver
- **Requirement:** 2.1.2
- **Priority:** High
- **Category:** Functional
- **Estimated Time:** 3 Minutes
- **Dependency:** AC.LG.fn.02, AC.NT.fn.01

Procedure:

1. Patient sends a “Need Help”
2. Caregiver is idle on main/notification screen

Expected Result:

- Notification appears in real-time with correct content

Cleanup: Caregiver dismisses notification

AC.SC.fn.01 – Main Category Selection (e.g., Food)

- **Purpose:** Patient selects a category
- **Requirement:** 3.1.1
- **Priority:** High
- **Category:** Functional
- **Estimated Time:** 3 Minutes
- **Dependency:** AC.LG.fn.01, AC.RL.fn.01

Procedure:

1. Log in and go to main screen
2. Tap “Food” category

Expected Result:

- Sub-options under “Food” (e.g., Chicken, Soup) are displayed

Cleanup: Navigate back

AC.SC.fn.02 – Sub-option Selection (e.g., Chicken)

- **Purpose:** Patient selects a sub-item
- **Requirement:** 3.1.2
- **Priority:** High
- **Category:** Functional
- **Estimated Time:** 3 Minutes
- **Dependency:** AC.SC.fn.01

Procedure:

1. Tap “Food”
2. Tap “Chicken”

Expected Result:

- Option is confirmed visually or via caregiver notification

Cleanup: Reset selection

AC.RT.fn.01 – Open Routine Creation Screen

- **Purpose:** Verify patient access to create routine screen
- **Requirement:** 4.1.1
- **Priority:** Medium
- **Category:** Functional
- **Estimated Time:** 2 Minutes
- **Dependency:** AC.LG.fn.01, AC.RL.fn.01

Procedure:

1. Tap "Create Routine"
2. Screen with “Routine Name” appears

Expected Result:

- Routine creation screen loads with input fields

Cleanup: Return to main screen

AC.RT.fn.02 – Add Custom Options to Routine

- **Purpose:** Verify patient can type and add words
- **Requirement:** 4.1.2
- **Priority:** Medium
- **Category:** Functional
- **Estimated Time:** 4 Minutes
- **Dependency:** AC.RT.fn.01

Procedure:

1. Enter name (e.g., “Movie”)
2. Add options like “Horror” and “Excitement”

Expected Result:

- Tags or labels appear for each custom word

Cleanup: Clear inputs or return

AC.RT.fn.03 – Voice Recording for Custom Options

- **Purpose:** Record voice for added option
- **Requirement:** 4.1.3
- **Priority:** High
- **Category:** Functional
- **Estimated Time:** 4 Minutes
- **Dependency:** AC.RT.fn.02

Procedure:

1. Tap microphone next to word
2. Record, stop, and play

Expected Result:

- Voice saved, play button works

Cleanup: Delete or reset audio

AC.RT.fn.04 – Add Image to Custom Option

- **Purpose:** Add image to routine item
- **Requirement:** 4.1.4
- **Priority:** Medium
- **Category:** Functional
- **Estimated Time:** 4 Minutes
- **Dependency:** AC.RT.fn.02

Procedure:

1. Tap “Add Image”
2. Take photo or select from gallery

Expected Result:

- Image appears next to option

Cleanup: Reset or remove image

AC.RT.fn.05 – Save Complete Routine

- **Purpose:** Save a fully created routine
- **Requirement:** 4.1.5
- **Priority:** High
- **Category:** Acceptance
- **Estimated Time:** 5 Minutes
- **Dependency:** AC.RT.fn.02, AC.RT.fn.03, AC.RT.fn.04

Procedure:

1. Fill in name, options, voice, and image
2. Tap “Save Routine”

Expected Result:

- Confirmation appears, routine added to list

Cleanup: Delete test routine if needed

5.2 TEST PLAN

5.2.1 Overview

This test plan outlines a comprehensive strategy to validate the correctness, usability, and robustness of the Aphasia Assistant mobile application. It focuses on communication features, interactive routines, caregiver integration, and accessibility support.

5.2.2 Scope

Covered in this plan:

- Registration and login (patient & caregiver)
- Word/sentence selection and playback
- Routine creation (with images, audio, custom tags)
- Notification features
- Non-functional aspects (offline use, device compatibility)

Excluded:

- Cloud sync integration
- Multilingual support
- NLP-based sentence prediction

5.2.3 Approach

We use **black-box**, **grey-box**, and **exploratory testing**:

- Functional tests for user interaction
- API response validation
- Manual UI/UX validation
- Device-based compatibility tests (Android 8.0+)

5.2.4 Pass/Fail Criteria

- Test **passes** if expected and actual output match with no major bugs
- Test **fails** if there's a crash, wrong data, or deviation from requirements
- All critical bugs must be fixed before final delivery

5.2.5 Risks and Mitigation

Risk	Mitigation
Android version incompatibility	Limit support to API 24+
Firebase service outage	Use local mock data
Lack of patient test users	Use simulation scripts

5.3 TEST CASE PLAN TABLE

Test Case ID	Test Scenario	Type	Description	Expected Result	Status
TP-001	Login with Apple/Google Account	Functional	User should be able to log in via Apple/Google	Success login	Pass
TP-002	Add Routine Task	Functional	User should be able to add daily routine task	Task added successfully	Pass
TP-003	Mark Task as Completed	Functional	User clicks on a task to mark it complete	Task turns green	Pass
TP-004	Drawing Page Accessibility	UI/UX	User should be able to draw and erase freely	Canvas responds in real time	Pass
TP-005	Exercise Feedback Response	Functional	User performs picture matching	Immediate feedback shown	Pass
TP-006	Call Caregiver Button	Functional	User presses 'Bakıcı Çağır' button	Feedback popup appears	Pass
TP-007	Offline Functionality	Non-Functional	Use app without internet	App works fully offline	Pass
TP-008	Voice Output for Routine	Accessibility	Clicking a routine triggers voice output	Audio plays correctly	Pass

5.4 TEST RESULTS TABLE

Result ID	Feature Tested	Device	Test Description	Result	Date
TR-001	Login	iPhone 15 Pro Max	User logged in with Apple ID	Success	2025-05-15
TR-002	Routine Add	iPad 10th Gen	Routine task 'Drink Water' added	Success	2025-05-15
TR-003	Routine Voice Output	iPhone 15 Pro Max	Audio output played after tapping task	Success	2025-05-15
TR-004	Drawing	iPad 10th Gen	User drew shapes and used eraser	Success	2025-05-16
TR-005	Picture Matching	iPhone 15 Pro Max	User received correct/incorrect feedback	Success	2025-05-16
TR-006	Call Caregiver	iPad 10th Gen	Button triggered caregiver alert popup	Success	2025-05-17
TR-007	Offline Use	iPhone 15 Pro Max	Tested all core functions offline	Success	2025-05-17
TR-008	Content Customization	iPad 10th Gen	User added and removed custom images	Success	2025-05-17

6.CONCLUSION

The development of the “Apphasia” mobile application represents a significant step toward empowering individuals with aphasia in their daily lives. By combining innovative technology with an empathetic understanding of user needs, this project addresses communication barriers through features such as customizable routines, offline functionality, and intuitive interfaces. The application’s design reflects a deep commitment to accessibility, ensuring that users with diverse cognitive and physical abilities can navigate and benefit from its tools effectively.

Throughout this project, our team explored advanced methodologies, including user-centric design principles, cloud-based database integration, and real-time synchronization, to deliver a reliable and practical solution. The emphasis on culturally relevant content and support for Turkish-speaking users further enhances its utility in underserved regions.

Moving forward, this project sets a foundation for further innovation. Future iterations may include enhancements like AI -driven speech recognition, wearable integration, and multilingual support to broaden its impact. By prioritizing user feedback and embracing technological advancements, “Apphasia” can evolve into a comprehensive tool that not only facilitates communication but also improves the overall quality of life for individuals with aphasia.

In conclusion, this endeavor underscores the transformative potential of technology in addressing human challenges. It highlights the importance of interdisciplinary collaboration, creative problem-solving, and a user-first approach in achieving meaningful outcomes. “Apphasia” is not just an application; it is a testament to the power of technology to create inclusive solutions for real-world problems.