



AUDIOFY – An AID for AUDITORY PROCESSING DISORDER (APD) in CHILDREN

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Abstract

Auditory Processing Disorder (APD) is a neurological condition that affects the processing of auditory information by the brain. It primarily manifests in children and can significantly impact their ability to understand, interpret, and respond to auditory stimuli [1]. Approximately 2-7% of schoolaged children are considered to have Auditory Processing Disorder (APD) worldwide. The studies report that approximately 30-70% of children with APD exhibit reading and language-related difficulties, impacting their communication, academic performance, and overall quality of life [2]. Children with APD often pose unique challenges including understanding speech in noisy environments, processing verbal instructions, struggles with phonics, reading comprehension, poor auditory memory, and a tendency to misunderstand or misinterpret verbal information [5]. To address this issue, we developed an interactive website that offers a variety of memory games specifically designed to enhance auditory processing skills in children. Our website aimed to overcome Auditory Processing Disorder at the early stage [4]. The website incorporates evidence-based techniques and principles of auditory processing intervention. It features a range of captivating visuals, audio cues, and interactive elements to create an immersive and enjoyable learning experience [6]. The games are designed to gradually increase auditory processing which allows children to develop their auditory skills progressively.

Keywords: Auditory Processing Disorder (APD), Auditory Processing, Children, Memory, Sequencing, Website, Skills, Games, Verbal instructions, Learning.

1. INTRODUCTION

Auditory processing skills play a crucial role in children's overall cognitive and language development. Children with APD often experience difficulties in academic settings, with studies reporting that approximately 30- 70% of children with APD exhibit reading and language-related difficulties [7]. In fact, APD is a hearing disorder that causes the brain to have a hard time processing, remembering, and understanding words that have been spoken which can be significantly improved with proper training. For example, they may not recognize the difference between *cat*, *that*, and *bat*. The words *seventy* and *seventeen* may sound the same.

The main objective of our website is to support individuals with APD, empower them with the knowledge and resources needed to effectively address auditory processing difficulties. It is tailored to target different aspects of Auditory Processing, including Auditory Discrimination, Sequencing, Memory, and Auditory Attention [8]. Auditory discrimination is the capability to make a distinction between various sounds and differentiating verbal communication. Auditory sequencing refers to the ability to understand and process a series of auditory stimuli in the correct order which is essential for various cognitive and linguistic processes, including language comprehension, following directions, and problem-solving [9].

The application incorporates a set of exercises designed for the targeted deficits and offers a range of intervention strategies and resources to support children with APD [10]. These include evidence-based techniques for enhancing auditory discrimination and improving auditory memory which can include games that help users remember and recall sounds they have heard. Regular practice can gradually Strengthen auditory sequencing and boost auditory attention.

2. LITERATURE SURVEY

Ana-Marta Gabaldón-Pérez, María Dolón-Poza, Martina Eckert, Nuria Máximo-Bocanegra,

María-Luisa Martín-Ruiz, Iván Pau De La Cruz [1] presented Amalia's Planet, a game conceived for use in school environments, which allows a first assessment of a child through a series of events in relation to the execution of the tasks related to different aspects of auditory performance, which were evaluated for the subsequent optimization of its performance and the improvement of its usability.

Guzek, A.; Iwanicka-Pronicka, K. [2] The study aimed to examine the ability to discriminate sounds by children with and without APD, assessed through the FPT and phoneme discrimination test (PDT) administered to participants. Additionally, we are trying to determine the need to modify the APD diagnostic standards by the PDT test in the battery of regularly administrated APD diagnostic tests.

Morteza Farazi, Zahra Hosseini Dastgerdi & Bahare Khavarghalani [3] This study aimed at presenting a comprehensive review of the literature to better explain the role of the auditory system and auditory processing disorder in stuttering. The evidence suggests that auditory processing deficits may be involved in stuttering.

Liu Panting, Zhu Huiqin, Chen Mingxia, Hong Qin, Chi Xia [4] This research aimed to provide evidence for the early identification and intervention of children at risk for auditory processing disorder (APD). Electrophysiological studies on children with suspected APDs were systematically reviewed to understand the different electrophysiological characteristics of children with suspected APDs.

C. N. Price and D. Moncrieff [5] The study reviewed relevant theories that guide the present understanding of attentional processes, discuss current electrophysiological evidence of attentional involvement in auditory processing across subcortical and cortical levels and propose areas for future study that will inform the development of more targeted and effective clinical interventions for individuals with speech-in-noise deficits.

Rouillon I, de Lamaze A, Ribot M, Collet G, de Bollardière T, Elmir R, Parodi M, Achard S, Denoyelle F, Loundon N [6] The study is about the evaluation of a new battery of tests that involves speech, psychometric, phonemic, and ENT assessments to diagnose children with auditory processing disorder (APD). The article reports that 45% of the children suspected of APD were confirmed with the diagnosis and that dichotic testing and pattern recognition were the most effective tests. It also suggests that a multidisciplinary protocol can help identify other associated difficulties in children with APD.

Ahn JH, Oh SH, Jang H, Lee JB, Chung JW [7] The article is a study that investigated the impact of auditory processing disorder (APD) on the academic achievement of children aged 8–12 years. The article found that children with APD performed significantly worse than typically developing children on all academic tests, and similarly to children with dyslexia on reading and spelling tests. The article also found that children with APD had difficulties with phonological awareness, verbal working memory, and rapid naming, which are skills that are important for learning. The article concluded that APD can have a negative impact on academic achievement in children and that early identification and intervention are needed.

Choudhury, Manisha & Sanju, Himanshu [8] This paper provides an overview of the definition, etiology, diagnosis, and management of CAPD in children. It also discusses the challenges and controversies in this field, such as the lack of consensus on the criteria and methods for diagnosing CAPD, the overlap with other developmental disorders, and the limited evidence for the effectiveness of interventions. The study suggests some recommendations for the assessment and management of CAPD in children, such as using a multidisciplinary approach, involving parents and teachers, providing individualized intervention plans, and monitoring progress and outcomes.

Jain, Chandni & M B, Priya & Joshi, Kirti [9] The aim of the study was to investigate the auditory processing abilities in children with speech sound disorders and compare it with typically developing children. Results showed that there was a significant difference between both groups in all tests except for the masking level difference. The study revealed the correlation between temporal processing and syllable and phoneme oddity. There was also a high correlation between speech perception in noise and segmentation.

Nasiri, Nahid & Shirmohammadi, Shervin & Rashed, Ammar [10] This study is about Speech impediment affecting children with hearing difficulties and speech disorders that requires speech therapy and much practice to overcome. To motivate the children to practice more, serious games can be used because children are more inclined to play games. In this paper, we have designed and implemented a serious game in which children can learn to speak specific words that they are expected to know before the age of 7. This allows the child to practice long hours, compared to

clinical approaches under the supervision of a therapist, which are time-limited.

3. SYSTEM ARCHITECTURE

The system incorporates HTML, CSS, and Java Script for frontend Graphical User Interface (GUI) and used PHP My Sql for database connectivity to store user information(refer figure 1). The developed web application provides a personalized user experience through separate login for each user. The application allows the user to log in to the system to access the games that are specially designed with the purpose of training children who are suffering from Auditory Processing Disorder (APD).

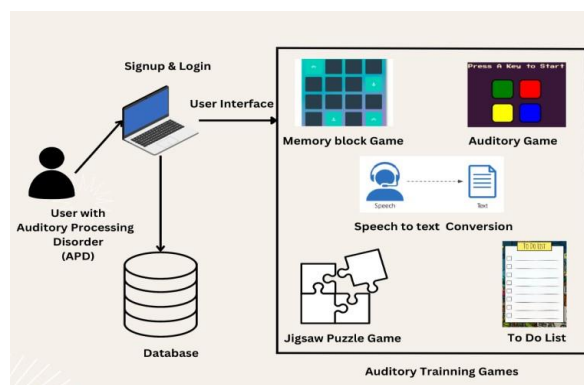


Figure 1 System Architecture

The user interface layer (i.e.) GUI provides the interface through which users interact with the application. The application layer consists of the core logic and functionality of the application(refer figure 2). The data layer handles the storage and retrieval of audio files, metadata, and user-related data using MySQL database connectivity. The infrastructure layer comprises the underlying servers, networking components, and security services that support the application's operation.

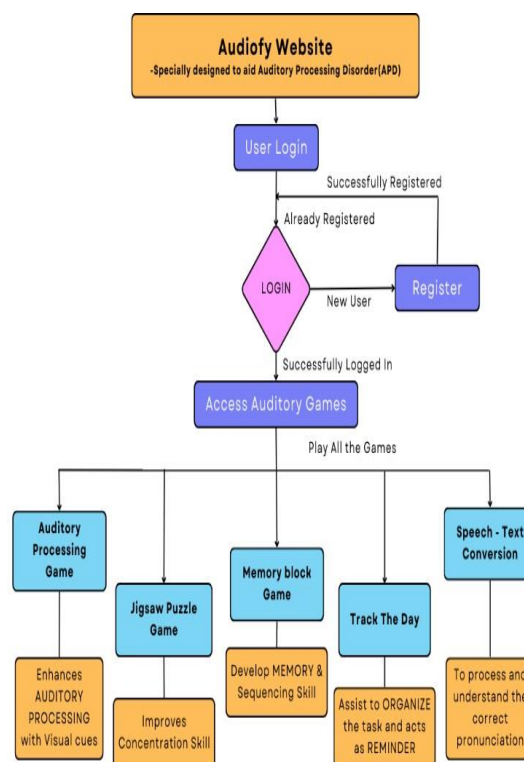


Figure 2 Flow of process

4. DESIGN AND IMPLEMENTATION

The Web Application facilitates a user-friendly interface to access the Auditory games which are designed to teach strong listening and cognitive skills through fun, interactive auditory training modules. These games provide targeted training for specific auditory processing skills, Memory, attention, and Concentration [4]. The benefits of the games are explained below.

We have come up with an effective and enjoyable tool for enhancing auditory skills. The auditory Training game (refer Figure 3) challenges children to remember a sequence of instructions and sounds [10]. Recalling the sounds and executing the commands in the correct order, strengthen their auditory processing skills. Playing a Jigsaw puzzle and Memory block games Figure 4 helps to increase brain functions such as attention level, concentration, intellectual skills, visual recognition, and

develop short-term memory [7]. Speech to Text system Figure 5 incorporates a multisensory approach by combining auditory stimuli with vocal cues or feedback [3] [9]. This integration of multiple senses helps children with APD better understand and process auditory information. Additionally, To-Do List

Figure 5 can assist children to organize tasks offering a clear and structured representation of tasks and responsibilities [6].

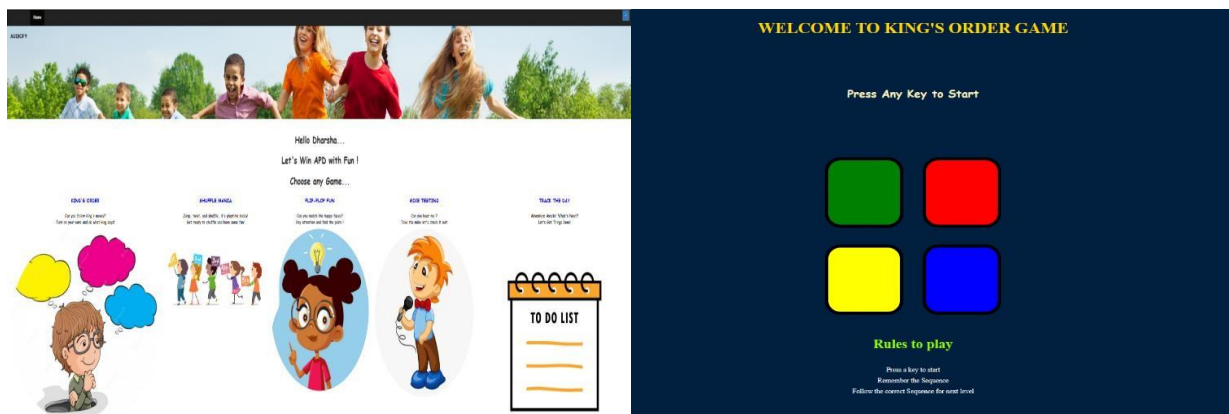


Figure 3. User Profile and Auditory Training Game

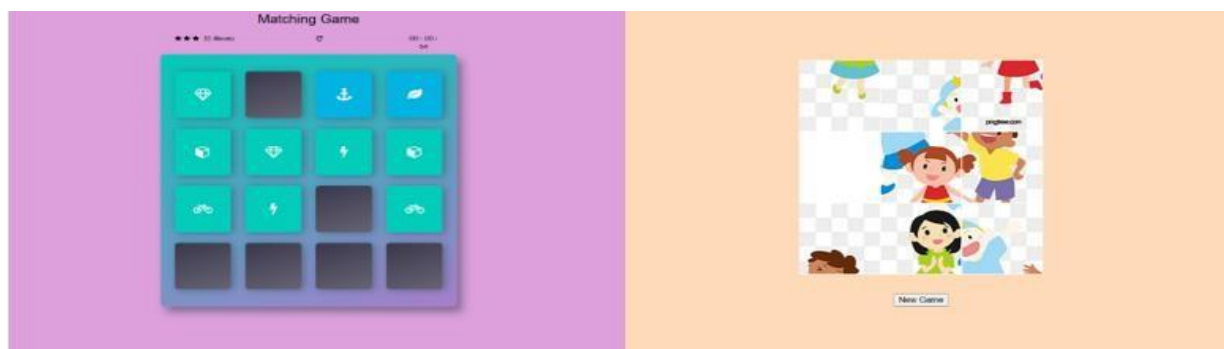


Figure 4. Jigsaw Puzzle Game & Memory Block Game

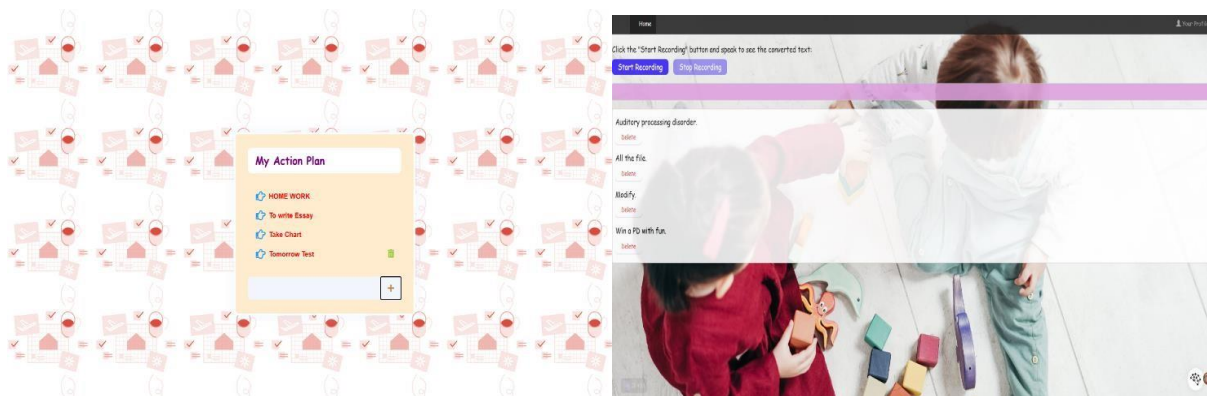


Figure 5 To-Do List Figure & Speech to Text Conversion

5. RESULT AND DISCUSSION

The vision and mission of the application is to overcome Auditory Processing Disorder in the early stage of detection [4]. It is exclusively designed for children with Auditory Processing Disorder (APD) in order to train and upgrade their Auditory processing and memory skills.

The specialized advantages of our proposed application include:

- i. Provide targeted training specifically focused on auditory processing skills such as auditory discrimination, auditory memory, and auditory sequencing.
- ii. Attractive and specially designed website easily kindles children who are reluctant to physical training [10].
- iii. Features Multimodal Learning [6] [9] with visual cues and respond to audio stimuli.
- iv. Repeated practice and regular engagement with the game can lead to significant improvements.
- v. The visual components can provide additional support and reinforcement, facilitating learning and comprehension.

6. CONCLUSION

This paper proposes and implements a responsive website with practically proven games [10] for children affected with Auditory Processing Disorder. Practicing these games on a regular basis can effectively elevate Auditory Processing skills and Memory [1]. This paper also highlights the comprehensive overview and impacts of APD on children. With appropriate strategies and interventions, children with APD can enhance their

communication, academic performance, and overall quality of life.

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