

# Interactive Serious Gaming for Children with Auditory Processing Difficulties in the Arabic Language

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**Abstract.** Sada is an interactive multimedia program for auditory discrimination therapy in the Arabic Language. Sada was designed to extend speech therapy beyond clinical settings and provide patients with a computer-based therapy system which can be used between sessions with speech therapists; at school or at home on an 'on-demand' basis. The program provides local Arabic dialects and a configurable knowledge-base which allows for extending the therapy and customizing the pronunciation of words for different Arabic-speaking populations. The Sada architecture and its interaction design are described and the advantages of computer-based therapy for auditory perceptual problems are discussed.

**Keywords:** Speech Therapy, Auditory Processing Disorders, APD, SpLD, Dyslexia.

## 1 Introduction

In recent years, there has been proliferation of technology solutions available for users with special needs. However, there remains a scarcity in assistive technologies for native Arabic speakers, especially people with disabilities. In the field of speech therapy, aural rehabilitation often involves complex programs to rehabilitate disorders of the auditory system [1]. Examples of disorders that involve auditory discrimination difficulties include cochlear implants; attention deficit disorders with and without hyperactivity (ADHD and ADD); Auditory Processing Disorders (APD); Specific Learning Difficulties (SpLDs) such as dyslexia; and autism spectrum disorders.

The rehabilitation process of auditory perceptual difficulties often involves a medical specialist and continuous training, which are often hard to find in large geographic regions such as the context of Saudi Arabia. In this context, families face the challenge of providing essential training for their children. In addition, there are several software programs for speech therapy activities that have been shown to be effective in improving auditory skills [e.g. 3-5]; however these programs inadequately support speech therapy in the Arabic language. Technology solutions for this user populations include auditory rehabilitation programs in English such as AUDIX [3], Hearing your Life [4], Sound and Way Beyond [5]. The most comprehensive program

designed for Arabic-speaking users is Rannan which is based on Modern Standard Arabic (MSA) [6]. Moreover, exploratory studies and field studies that we have conducted in our local context have suggested that some bespoke software is actually used in clinics; however, these are not available as products accessible to a wide range of specialists or for the general population.

In this paper, we describe the background, motivation, and nature of the problem that this interactive multimedia program, called Sada, addresses. Sada was designed to address the need for accessible auditory discrimination therapy programs for auditory perceptual problems (i.e. inability to perceive differences between phonemes) by providing training techniques in MSA and local dialects through interactive exercises that aim to improve auditory perceptual skills of children with auditory-related problems and learning difficulties, and assist them in effective communication. This design can be extendable for other dialects in a configurable interface. The novelty of this system is the contribution towards Arabized technology for our local context as well as the approach adopted in the design cycle. In this project, we followed the User Centered Design ISO 13407 standard in the analysis and design of the system [2]. The goal was to develop a system that provides effective solutions through interactive games to improve the auditory skills of children with auditory discrimination difficulties beyond clinics and in home environments.

## 2 Sada's Interactive Therapy Programs

The system is comprised of three types of activities which include auditory discrimination, articulation, and auditory attention as depicted in the interface screenshots of Figures 1 and 2. From within categories, the child can select the type of game to launch an activity.

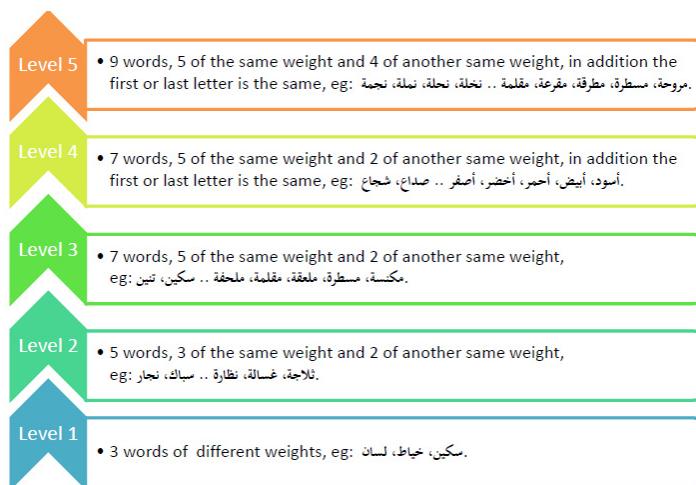


**Fig. 1.** Configurable Visual Design of Sada's Interface



**Fig. 2.** Auditory Attention Training

Sada was designed to be configurable by an administrator to adapt the program flow and the interface, to fit the needs and personal preferences of the target user populations. Accessibility standards have been adhered to by allowing key aspects of the interface to be configurable by users including font type, size, color as well as background color. Algorithms were developed in collaboration with Arabic Linguists to include a gradual increase in complexity to ensure motivation and engagement in the user experience in the therapy program. Advancing levels in the game involves accomplishing at least 60% of the active level. Furthermore, presentation of Arabic words in activities is based on randomization of selection from a pool of words which were pre-categorized based on the weight of the Arabic word as depicted in Figure 3.



**Fig. 3.** Algorithm for word-based auditory discrimination

For auditory discrimination training of Arabic letters, categories were used based on the classification in the Cops program developed for Specific Learning Difficulties (SpLDs) [7]. Words used in Sada's interactive games are selected from a database designed with a corpus of weighted Arabic words that vary in pronunciation similarity indices. This set was created in close collaboration with an Arabic Linguist as part of the design activities in our UCD design cycles. Each word in Arabic language has a specific “weight” (وزن) by which its pronunciation along with other grammatical characteristics are determined. To identify the weight of a word, its root – (أصل الكلمة) – which is a word composed of three letters that map to the three basic letters (ف، ع، ل) that constitute a word weight – should be determined. Once the weight of the root of a word is determined, its weight can be concluded by adding any of the “addition letters” – (حروف الزيادة) – which are these ten letters (س، أ، ل، ت، م، و، ن، ي، ه، ا) – the word may have in addition to the weight of its root. Table1 shows some examples of words and its roots and weights.

**Table 1.** Examples of weights of Arabic words used in Sada

| The word | The word root | The root weight | The word weight |
|----------|---------------|-----------------|-----------------|
| آخر      | آخر           | آخر             | آخر             |
| ذهب      | ذهب           | ذهب             | ذهب             |
| كثير     | كثير          | كثير            | كثير            |
| لهم      | لهم           | لهم             | لهم             |

### 3 Conclusion

This paper describes the conceptual design of Sada, an interactive game suite designed to support practitioners in speech therapy with computerized-training for auditory discrimination. There is a dire need for technology support for speech and language therapy in Arabic-speaking regions, and in Saudi Arabia in particular. The prohibitive costs and the limited availability of specialists have led to limited availability of rehabilitation programs for children who need auditory discrimination training beyond clinical settings. This system aims to bridge this gap with an innovative bespoke solution for Arabic speaking populations.

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