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Development of Speech Therapy Application for Children with Stuttering (STACS)

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ABSTRACT

Background: There is a growing need for online therapy due to various factors, such as the COVID-19 pandemic, long travel distances, and the duration of speech therapy sessions. This study aimed to develop an application to assist parents in providing speech therapy for children with stuttering. This app aims to facilitate dynamic interaction between Speech Language Pathologists (SLPs) and the families of children with stuttering.

Methods: A cross-sectional study design was carried out to develop and evaluate the effectiveness of an app for parents of children with stuttering aged 3 to 12 years. The app included brief descriptions of analogies for stuttering, accompanied by video demonstrations of these analogies. Three speech and language pathologists evaluated the app's content with at least five years of experience working with children with fluency disorders. Thirteen parents of children with stuttering participated in the study. The parents and their children used the app. Descriptive statistics and percentage analysis were applied to assess background variables.

Results: The findings revealed that almost all parents found the instructions provided in the app to be easily understandable. Seventy percent of the parents rated the app as highly satisfying in its usefulness. Regarding the app's functionality, nearly 77% of parents found it highly satisfying. Additionally, approximately 85% of parents found the app very user-friendly.

Conclusion: Most parents found this prototype app easy to use, efficient in training their children, and highly functional. The app appears to impact children's speech positively and facilitate effective communication. In the future, this app has the potential to reach a large number of clients, promoting better fluency skills cost-effectively and efficiently.

Introduction

Stuttering, or stammering, is a developmental speech disorder that typically appears in children between 3 and 8 years [1]. It is considered a socio-communicational problem that can negatively affect an individual's mental, emotional, and social well-being and other aspects of life. Recognizing the dimensions of quality of life (QOL) in adults who stutter can be helpful in treatment planning and in preventing later mental, emotional, and social disorders

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[2]. Stuttering affects individuals of all ages and disrupts speech's usual fluency and timing patterns. More male children are affected by stuttering than female children [3]. Stuttering has been associated with differences in brain anatomy, functioning, and dopamine regulation, which are thought to be related to genetic causes. Accurate diagnosis or timely referral for children is crucial, as there is growing consensus that early intervention with speech therapy for children who stutter is critical. The mainstay of treatment for both children and adults remains speech therapy.

During the COVID-19 pandemic, a study examined the effectiveness of speech-language teletherapy services for school-aged children in the United States [4]. The study focused on how school-based Speech-Language Pathologists (SLPs) maintained clinical services via teletherapy during the pandemic closures. An online questionnaire survey was used to assess the provision of teletherapy following COVID-19 school closures, the types of technologies used to deliver teletherapy, the support offered by school districts, and the challenges in providing consistent therapy. Several online speech therapy systems have been designed and proposed in the literature; however, implementing these systems is still lacking. Additionally, the technical knowledge required to use these programs remains challenging for SLPs [5].

Collaboration between computer programmers and Speech-Language Pathologists (SLPs) can contribute to developing automated programs or applications that facilitate speech rehabilitation services. The increasing use of artificial intelligence in speech-language pathology has proven effective, as it provides various treatment approaches that patients can carry out at their convenience [6]. Due to the COVID-19 pandemic, it became difficult for children who stutter (CWS) to attend regular speech therapy sessions. Although online therapy sessions were offered, parents lacked understanding of how to use specific analogies for children with stuttering effectively. Consequently, there was a need to develop a prototype that would assist parents in teaching these specific analogies easily and efficiently, thereby reducing the frequency of in-person visits to therapy centers. This study was undertaken to develop a Speech Therapy Application for CWS (STACS). The prototype was designed to facilitate therapy for children with stuttering and evaluate its usefulness among parents of children with stuttering.

Methods

This study was conducted after obtaining approval from the Sri Ramachandra Institutional Ethics Committee (Reference No: CSP/21/OCT/100/535).

Development of the App

The app was developed based on three analogies commonly used in fluency therapy for children who stutter (CWS): the Lily Pad, Finger-Thumb, and Garden Hose analogies [7]. Initially, the content for each analogy was created. This content was then reviewed and discussed with IT professionals from the communications team at SRIHER. A skilled professional in artificial intelligence developed the application. The app was created using Flutter software, with particular attention to constructing an engaging landing page featuring all three analogies. A word list was also designed for children aged 3–6.

The app includes a brief description and a video demonstration for the three analogies. The app's main domains are categorized as follows:
1. Lilly Pad Analogy
2. Garden Hose Analogy
3. Finger-Thumb Analogy

Lilly Pad Analogy

This analogy features an animated video of lily pads and a frog (see Figures 1 & 2). The child is asked to pretend to be a frog. They are then prompted to repeat words from the word list. The frog moves smoothly to the next lily pad if the child can fluently articulate a word or syllable. However, if the child exhibits dysfluencies, the frog stays on the current pad or jumps into the water. The video helps parents identify dysfluencies and guides them in assisting the child in modifying their speech behavior.

Garden Hose Analogy

This analogy (Figures 3 & 4) features an animated depiction of a garden hose connected to a faucet. This technique compares the larynx to a faucet, the tongue to a garden hose, and the lips to a nozzle. If there is an obstruction in the hose, the water flow is reduced; similarly, any obstruction in the airway disrupts airflow and interrupts speech. This animated video illustrates the underlying cause of stuttering and demonstrates how to modify the child's speech to promote greater fluency.

Finger-thumb Analogy

This analogy (Figures 5 & 6) uses the thumb and an opposing finger. The child is instructed to say a list of age-appropriate words sequentially from the word list. If the child can say the words fluently, the thumb will move smoothly from one finger to the other. However, if there is any block or dysfluency, the fingers will become stuck to the thumb and not move to the next finger. The child will be asked to repeat the words and demonstrate that the finger and thumb move smoothly as they speak fluently. The video demonstration aims to aid in providing an effective intervention.
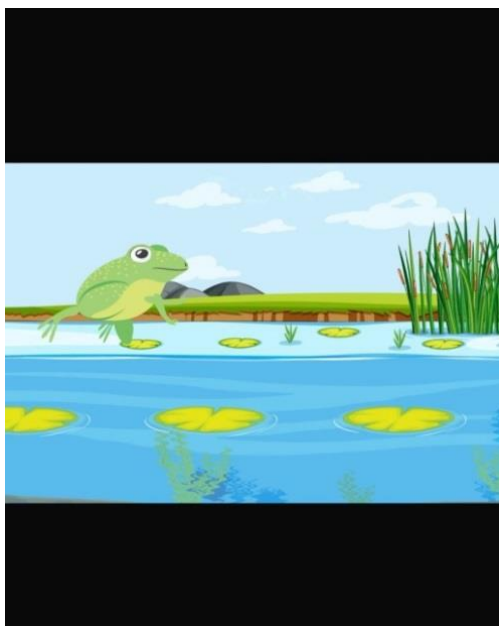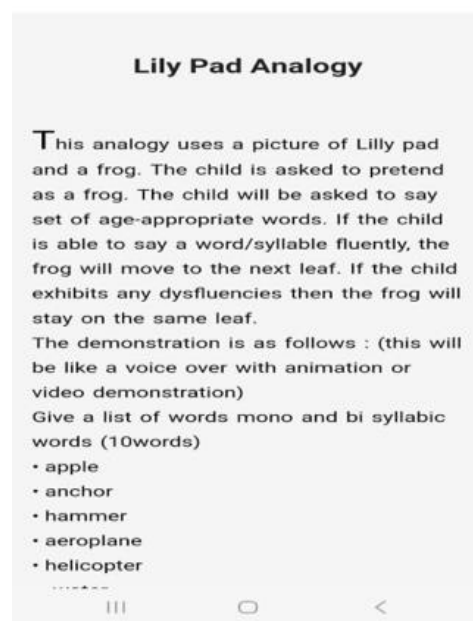
Figure 1: Lilly Pad Analogy (image from the app)

Lily Pad Analogy

This analogy uses a picture of Lilly pad and a frog. The child is asked to pretend as a frog. The child will be asked to say set of age-appropriate words. If the child is able to say a word/syllable fluently, the frog will move to the next leaf. If the child exhibits any dysfluencies then the frog will stay on the same leaf.

The demonstration is as follows : (this will be like a voice over with animation or video demonstration)

Give a list of words mono and bi syllabic words (10words)

- apple
- anchor
- hammer
- aeroplane
- helicopter

Figure 2: Lilly Pad Analogy (description from the app)
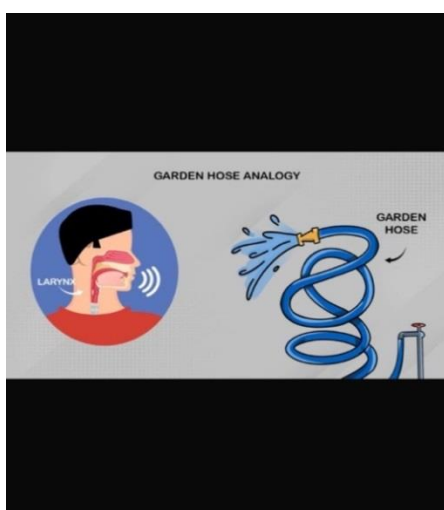
Figure 3: Garden Hose Analogy (image from the app)

Garden Hose Analogy

This analogy comprises of a garden hose with a faucet. In this technique we assume that the larynx is compared to that of faucet, tongue is compared to that of garden hose and the lips are compared to nozzle.

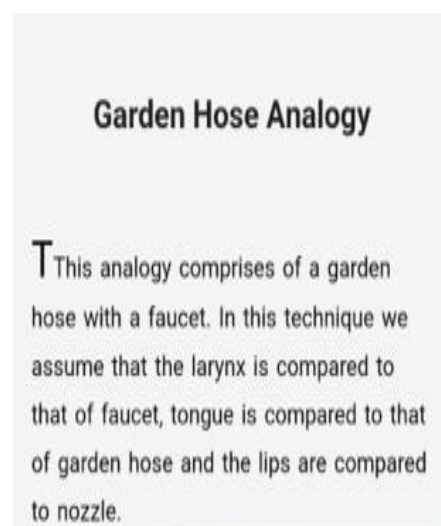**Figure 4:** Garden Hose Analogy (description from the app)

Figure 5: Finger-Thumb Analogy (image from the app)

Finger Thumb Analogy

T This analogy mainly uses only thumb and opposing finger. The child will be asked to say the list of of age appropriate words one after the other. If the child is able to say the words fluently, the thumb should smoothly move from one finger to the other. If there is any dysfluency the fingers will not move smoothly.The child is asked to produce words according to their age.

Ask the child to read out the words and sentences that are given below the video, If the child is able to say the words fluently, the thumb should smoothly move from one finger to the other.
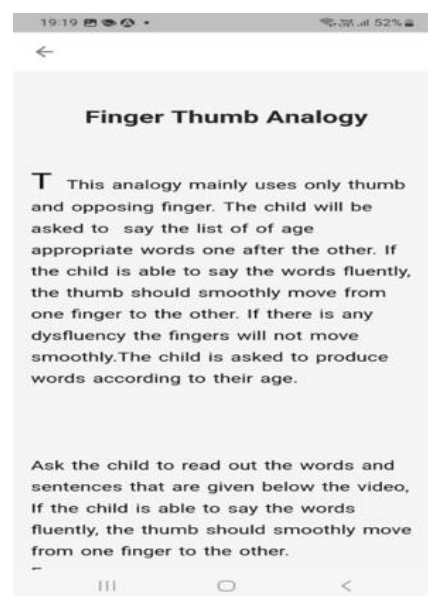
Figure 6: Finger-Thumb Analogy (description from the app)

Content and Face Validation of the App

The content and relevance of the app were evaluated by three experts in the field of fluency disorders. Changes were made to the application based on their suggestions regarding the content and animation videos. The experts subsequently re-verified the app, after which the prototype was evaluated by the parents of children with stuttering.

Evaluation of the App among Parents

A cross-sectional study design was conducted to evaluate the effectiveness of the application among parents of children with stuttering, aged between 3 and 12 years. Thirteen parents participated in this study. Informed consent was obtained from all parents before data collection. All parents had at least an undergraduate degree and were highly proficient in English.

Data was collected at the Sri Ramachandra Faculty of Audiology and Speech Language Pathology, Sri Ramachandra Institute of Higher Education and Research (Deemed to be University). The sample size was calculated as follows: it was assumed that 90% of the parents would consider the helpful application, with a 20% relative precision and a 95% confidence level. The minimum required sample size was determined to be 11. Assuming a 20% non-response rate, the sample size was increased to 13. Data was collected using a structured questionnaire to evaluate the effectiveness of the application from June 2022 to May 2023 at SRIHER, after obtaining written informed consent from the participants.

The questionnaire was divided into two sections. The first section focused on the demographic details of the participants, while the second section contained questions that evaluated the app's contents, including clarity of instructions, user-friendliness, ease of navigation between sections, and overall usefulness. Three experts in Speech-Language Pathology verified the questionnaire. The final version of the questionnaire was administered to evaluate the effectiveness of the application on 13 parents of children with stuttering.

Initially, the principal investigator introduced "what stuttering is, its types, and causes." The parents were given a general orientation on how the application works and how it can be used with their children. Subsequently, the parents were asked to explore the contents of the application and demonstrate the analogy to their child, helping them to understand it. Parents were given adequate time to familiarize themselves with the app's flow. Later, the parents were given a demonstration on how to administer the application with their children. After the data was collected, parents provided their valuable feedback.

Statistical Analysis

Data were entered into an Excel sheet, and data analysis was performed using SPSS software. Descriptive statistics were calculated for background variables. Parent feedback on the application was presented as percentages.

Results

The results were tabulated based on the responses obtained from each parent regarding the use of the application. Findings revealed that almost all parents found the instructions provided in the app to be easily understandable. Seventy percent of the parents rated the application highly satisfying regarding its usefulness for training their children with stuttering. Nearly 77% of parents found the application's functionality highly satisfying. Approximately 85% of the parents found the app user-friendly (Table 1).

When evaluating the app, it was revealed that parents easily understood the instructions provided. Regarding user-friendliness, 85% of the study population reported being highly satisfied. Regarding the app's usefulness, 69% of the population expressed high satisfaction, while around 77% were highly satisfied with its functionality.

The responses provided by the parents for each analogy were as follows:

The Lilly pad analogy was evaluated, and the results revealed that about 85% of the parents answered both questions correctly. The parents could relate the Lilly pad analogy to their child's speech and understand how to use it for effective communication. They also gained a fair understanding of the various types of dysfluencies present in stuttering (Table 2).

The finger-thumb analogy was evaluated, and the results revealed that about 85% of the parents answered both questions correctly. The parents understood this analogy and found it relatively easier to use with their children compared to the other analogies. They could identify specific words that were more tense and difficult to produce, as opposed to other words that were produced more easily and fluently (Table 3).

The garden hose analogy was evaluated, and the results revealed that about 92% of the parents answered both questions correctly (Table 4).

Table 1: Parents' responses on the usage of the application

Variable	Highly satisfied	Partially satisfied	Not satisfactory
Ability to understand	100%	0%	0%
Helpful in training the children	69%	31%	0%
Functioning of the application	77%	23%	0%
User-friendliness of the prototype	85%	15%	0%

Table 2: Parents' Responses for Lilly Pad Analogy

Variable	Correct responses	Incorrect responses
A frog jumping from one leaf to another	85%	15%
A frog hopping up and down on the same leaf	85%	15%
A frog standing too long on the same leaf	69%	31%

Table 3: Parents' Responses to the Finger-Thumb Analogy

Variable	Correct responses	Incorrect responses
Thumb moves smoothly from one finger to another	100%	0%
Thumb presses too hard on a finger	85%	15%
Repeated contact of the finger on the thumb	85%	15%

Table 4: Parents' Responses on the Garden Hose Analogy

Variable	Correct responses	Incorrect responses
Free flow of water	92%	8%
The hose is twisted	92%	8%

Discussion

The present study revealed that parents had a very favorable opinion regarding the prognosis and treatment of their child. The results show that parents found the app user-friendly and expressed confidence in its potential for effective treatment. Existing literature on the collaboration between AI and stuttering mainly focuses on building machine learning systems to identify and classify different types of dysfluencies, such as blocks, prolongations, sound repetitions, and interjections in speech utterances. These systems are typically trained on speech samples annotated for various dysfluencies [8]. However, several other apps for stuttering, such as Delayed Auditory Feedback, Speech Easy, STAMURAI, Speech Tutor, and Fluency Corner, provide various methods of assessment and treatment for stuttering [3].

Some apps above are primarily used to detect stuttering severity and cannot be incorporated into management [9]. Other apps focus on stuttering treatment, primarily emphasizing feedback systems. In contrast, the current study's app provided training to parents of children with stuttering, enabling them to monitor their child's fluency skills. The main goal behind the development of this app was to ensure it was user-friendly for both the child and the parent, making it possible for them to engage in interactive therapy sessions at home or in a convenient location.

A qualitative study conducted in Sri Lanka [10] revealed that parents had limited awareness about the impact of stuttering and its management. Raising awareness about the adverse effects of stuttering and the available management techniques is essential. In response to this need, a prototype application was developed to serve as a guide for parents and to support their education. Studies conducted by [11] have confirmed that parents play a significant role in managing stuttering and bear increasing responsibility for their child's prognosis.

The current application can be further enhanced by including additional analogies related to stuttering and an integrated feedback system. A significant strength of this study is that the application is the first of its kind to teach stuttering analogies practically and interactively to children with stuttering. However, a notable limitation is the absence of AI-generated feedback within the app.

Conclusion

The primary objective of this study was to develop an application that enables children with stuttering to engage in therapy conveniently from their homes. This app aims to reduce the need for frequent in-person visits to speech-language pathologists, particularly for families facing challenges in accessing therapy services due to distance or time constraints. Future research should focus on transforming this prototype into a more advanced application featuring AI-generated feedback to support parents in monitoring and improving their child's fluency skills effectively at home.

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Author contributions

Dr. Amudhu Sankar and Mr. Janith Raj J have contributed to:

1. The study's conception, design, data analysis, and interpretation.
2. Drafting the article and critically revising it for important intellectual content.
3. Final approval of the version to be published.

Conflict of interest: The authors declare no conflict of interest.

References

1. Ludlow CL. Stuttering: Dysfunction in a complex and dynamic system. Brain. 2000 Oct 1;123(10):1983-4. https://doi.org/10.1093/brain/123.10.1983
2. Yaruss JS. Assessing quality of life in stuttering treatment outcomes research. Journal of fluency disorders. 2010 Sep 1;35(3):190-202.
3. Drayna D, Kilshaw J, Kelly J. The sex ratio in familial persistent stuttering. The American Journal of Human Genetics. 1999 Nov 1;65(5):1473-5.
4. Attwell GA, Bennin KE, Tekinerdogan B. A systematic review of online speech therapy systems for intervention in childhood speech communication disorders. Sensors. 2022 Dec 11;22(24):9713. https://doi.org/10.3390/s22249713
5. Bothe AK, Davidow JH, Bramlett RE, Franic DM, Ingham RJ. Stuttering treatment research 1970–2005: II. Systematic review incorporating trial quality assessment of pharmacological approaches.
6. Ratner NB. Evidence-based practice: An examination of its ramifications for the practice of speech-language pathology. Language Speech and Hearing Services in School. 2006 October 1; 37(4):257-267.
7. Conture EG. Childhood stuttering: What is it and who does it? ASHA Reports Series (American Speech-Language-Hearing Association). 1990 Apr.
8. O'Donnell JJ, Armson J, Kiefte M. The effectiveness of SpeechEasy during situations of daily living. Journal of Fluency Disorders. 2008 Jun 1;33(2):99-119.
9. Yairi E, Ambrose N. Stuttering: Recent developments and future directions. The ASHA Leader. 2004;9(18):4-15.
10. Nonis D, Unicomb R, Hewat S. Parental perceptions towards childhood stuttering in Sri Lanka. Journal of communication disorders. 2022 Jan 1;95:106162. https://doi.org/10.1016/j.jcomdis.2021.106162.
11. Logan KJ, Caruso AJ. Parents as partners in the treatment of childhood stuttering. In Seminars in Speech and Language 1997;18(4): 309-327.