DEVELOPMENT AND VALIDATION OF VISUAL SCENE IMAGE DATASET FOR INDIAN AAC USERS

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Reg. No: 20SLP024

A Dissertation Submitted in Part Fulfillment of Degree of

MASTER OF SCIENCE

(Speech-Language Pathology)

University of Mysore

Mysuru

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CERTIFICATE

This is to certify that this dissertation entitled "**Development and Validation of Visual Scene Image Dataset for Indian AAC users**" is a bonafide work submitted in part fulfillment for the degree of Master of Science (Speech-Language Pathology) of the student with Registration Number: **20SLP024**. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other university for the award of any other Diploma or Degree.

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This is to certify that this dissertation entitled "**Development and Validation of Visual Scene Image Dataset for Indian AAC users**" has been prepared under our supervision and guidance. It is also being certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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This is to certify that this dissertation entitled "**Development and Validation of Visual Scene Image Dataset for Indian AAC users**" is the result of my own study under the guidance of Dr. Reuben Thomas Varghese, Scientist-B, Department of Speech-Language Sciences and Co-guidance of Dr. R. Rajasudhakar, Associate Professor, Department of Speech-Language Sciences at All India Institute of Speech and Hearing, Mysuru and has not been submitted earlier to any other university for the award of any other Diploma or Degree.

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DEDICATED TO MY PARENTS

ACKNOWLEDGEMENT

"Take one more step than you feel you are capable of!"

I express my deepest gratitude to my guide, **Dr. Reuben Thomas Varghese**, for accepting me as his student and guiding me throughout this year. The patience, understanding, and intellect he put into guiding me throughout the year was incredible. Sir, thank you for being the most excellent guide and making this dissertation journey so smooth and enjoyable. I'd also want to express my heartfelt gratitude to my co-guide, **Dr. Rajasudhakar**, for his invaluable contributions. Thank you so much sir, for all your support, patient listening, feedback, and advice which has always been a great learning experience. I'm grateful that I was able to work under your guidance.

I'd also want to express my gratitude to our director, **Dr. M. Pushpavathi**, for allowing me to undertake this study. I also like to express my thanks to **Dr. Vasanthalakshmi ma'am** and **Mr. Srinivas sir**, for the timely help and for clarifying my queries during the statistical analysis.

I sincerely thank **Dr. Ajish K Abraham** for his unwavering support and direction throughout my work. I'd also like to thank **Mr. Karthik sir,** for his invaluable input in developing the Visual scene image dataset. I extend my sincere thanks to **Dr. Shijith Kumar C** for the immediate support during the issues that I faced during Turnitin use. Sir, thank you so much for being kind, patient, and helpful.

I would like to express my sincere gratitude to **Dr. Sangeetha** and **Dr. Jayashree C Shanbal** for permitting me to conduct a study on clients from the Department of clinical services, AIISH, Mysore. I also want to thank all the validators for volunteering your time and for your insightful and valuable contributions to this study.

I'm thankful to **Swathi C., Jahnavi, Hiba, Shruthi, Audrey, Aishwarya, Ilakkiya,** and **Trupti** for helping me with the contact details of the participants in the study. Thanks to dear **Mahima** for being a part of my study. I also extend my sincere thanks to all those who have participated in this study, without whom this venture would not have been successful. I also thank the parents of those children for their support and cooperation.

I also want to thank **Soham** and **Nishant** for helping me with developing line drawings. **Nishant**, thank you so much for the perfect line drawings!

I'd like to express my gratitude to my pillars of support, my dissertation partners, **Swathi C** and **Bhavani**, for always being supportive, understanding and motivating. **Bhavani**, the most amazing part of our dissertation was capturing visual scene images; your company made it fantastic. Without you, this wouldn't be possible!

And most importantly, I would like to thank my family**- Mammi, Pappa,** and **Jiji** to whom I humbly owe what I am today. Thank you for your unconditional love, support, and encouragement throughout my life. I will take this opportunity to thank all my beloved cousins, **Sanjana di, Kanchi, Shubhu, Avdha,** and **Darsh**. I feel truly blessed to have such an amazing family.

I'm grateful for my "Room no 202" family, **Aiza ma'am**, **Ann ma'am** and **Gopika ma'am**, for lifetime! Thanks to my forever "Velle log" **Nishtha** and **Bushra**! Thanks to **Siddhi di, Tanvi di, Priyanka di, Jeevan Sir** and **Delna Di** for your direct and indirect assistance throughout the journey.

I would like to thank all my "Jaane meri janemans", **Yasha, Mudra, Vrushali, Bhavani** and **Harshada,** for always being there for me!! Our "Shanivaar raat" deserve special mention. Grateful for limitless laughs, countless memories and endless friendship. Thanks, **Amit, Ashish** and **Sahil**.

I'm thankful to my dearest friends **Nadia, Madhurya, Navya, Hiba, Haripriya, Ayisha, Gopika, Aishwarya, Arzoo, Kiruthika** and all my classmates (**20SLP, B**) for the best memories! **Ayisha**, thank you for trusting us with your camera and helping us use it. Thanks **Madhu**, for all the patience during the Kannada translation and for taking screenshots during the sessions.

Let me extend my heartfelt thanks to all my teachers at AIISH for their guidance and the wonderful learning experience they have given me. Finally, I would also like to place my sincere gratitude to all those who directly or indirectly, lent a hand in making this study a success.

Thank you!!

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Chapter I

INTRODUCTION

Communication is an interpersonal process involving exchanging ideas, opinions, and emotions using verbal (e.g., words or phrases) and non-verbal symbols (e.g., facial expressions, gestures, sign language). Augmentative and alternative communication (AAC) refers to communication strategies, tools, systems and devices that replace or supplement natural speech (Beukelman & Mirenda, 2005). Augmentative communication is when you add something to your verbal speech, including gestures, facial expressions, etc. This can help listeners to understand what you're saying. Alternative communication is when you are not able to communicate. It also occurs when others do not understand what you are speaking. In this instance, you must communicate in a different manner. Basically, AAC can help when the individual is unable to speak, has not yet begun to speak, has unintelligible or inconsistent speech and even as support during regular communication. It is incredibly beneficial for many individuals with communication challenges, speech impairments, or disorders.

Speech-Language Pathologists (SLPs) are one of the core team members in the rehabilitation of children with communication difficulties. For SLPs, it is necessary to evaluate a person's underlying ability by presenting appropriate representations. Failure to use proper representations may inhibit the learning process and prevent the persons from deriving maximum benefit from various intervention strategies. The colour, size, amount of detail, and fidelity of the representation show a more significant impact on learning and language usage (McDougall et al., 2000; Uttal et al., 1997). In a clinical context, several methods are used to elicit responses from the children who are presented either in spoken form, written form, or visual form. One of the diagnostic tools for evaluating the speech and language abilities of children with or without disabilities, visual forms such as flashcards/ pictures are the most commonly preferred. This is because pictures are processed in the human brain 60,000 times quicker than words, and 90 percent of information conveyed to the brain is visual (Brewer et al., 2019). The brain also processes data from pictures all at once, whereas the text is in a linear manner.

Various symbol systems such as line drawings, pictures, signs, etc., are integral elements of most AAC systems, such as multiple high-tech voice output communication aids and low-tech communication boards, to facilitate communication and learning in children. Iconicity is the degree to which a visual sign relates to its referent. The iconicity of the symbols must be considered while selecting a symbol system. The visual scene is considered one of the most iconic symbol systems used in AAC devices. It's an image taken in a naturalistic environment which has the ability to display ideas, people, events, objects and circumstances holistically (Babb et al., 2020). Visual scenes are visually attractive and easily correlate with the actual surroundings, especially for young children.

Early language is learned in a rich, context-based environment where varied experiences assist in the child's expanding conceptual understanding. Hence, children at the initial stages of communication development benefit more when provided with all the possible natural environmental cues, which can be easily achieved using photo visual scene displays (VSDs) (Chazin et al., 2018). It allows – (a). the AAC user to quickly relate to the conversational subject, (b). the communication partner to correct any communication failures, and (c). greater social engagement in general (Light et al., 2019). Visual scene displays (VSDs) are very well suited for language development through semantic and pragmatic development in AAC users (O'Neill et al., 2019). They lessen the cognitive load on the AAC user (since they do not have to know the meaning of individual symbols) (Drager et al., 2019; Wagner et al., 2012). VSDs can be extensively personalised according to the communication need and environment of the individual.

According to research, VSDs can be incredibly useful and successful for emergent communicators and people with significant cognitive and/or verbal challenges. Earlier studies have indicated that VSDs have been utilised most frequently with children with Autism Spectrum Disorders (ASD), young children with complicated communication demands, and individuals with acquired language impairments such as aphasia (Babb et al., 2020; Beukelman et al., 2015; Drager et al., 2003; Light et al., 2004; Thistle & Thiessen, 2021). Thus, this shows that VSDs can help a wide range of persons with communication impairments. Further, VSDs also have the potential to benefit children with ASD as they have a significant inclination toward visual learning (Ganz et al., 2011). Also, visual scenes help them increase their familiarity, thereby assisting them in understanding the organisation of surroundings, people, and activities quickly. It also provides a variety of cues due to the presence of natural background, which helps understand the ongoing communication.

1.1 Need for the study

Numerous studies have reported that children with communication disabilities struggle to attend and identify traditional AAC symbols like line drawings, signs, etc. Research suggests that visual scenes are much easier to attend to, identify and relate with the natural context. VSDs are easier to do on dynamic display touch screens, which are now standard and available with various software options in fast-developing countries like India. Even though numerous studies indicate the need for meaningful, personally relevant, realistic and natural visual scenes for maximising the benefits, there is a paucity of such visual scene image datasets in the Indian context. Also, there is a lack of studies to determine the effectiveness of such visual scene images in the Indian context. Hence, the present study was conducted to bridge this clinical and research gap. The present study includes the development of a visual scene image dataset in the Indian context and then assesses the efficacy of the developed dataset by comparing its identification accuracy with traditional line drawings in ASD children.

1.2 Aim of the study

- To develop and validate the Visual scene image dataset for Indian AAC users.
- To assess the efficacy of developed visual scene image dataset over line drawings by administrating on children with autism spectrum disorders (ASD).

1.3 Objectives of the study

- To develop a visual scene image dataset based on different naming categories, i.e., fruits, food items, furniture, animals, vehicles, electrical appliances, flowers, vegetables, common objects and daily routines.
- To validate the visual scene image dataset with the help of Speech-Language Pathologists (SLPs) and parents of AAC users.
- To compare the identification accuracy between line drawings and developed visual scene images for children with autism spectrum disorders (ASD) in the age range of 5 to 12 years.

Chapter II

REVIEW OF LITERATURE

2.1 Augmentative and Alternative Communication

Augmentative Alternative Communication (AAC) has the potential to give a consistent mode of communication. AAC aims to supplement speech and build on the communicator's existing skills. When speech is impaired due to a developmental or acquired disorder, an alternative mode of communication is adopted, which can start with a simple paper-based system to a more complicated voice-producing system.

According to current evidence, there are no specific criteria (e.g., age, linguistic cognitive, or motor) to begin using AAC. A range of AAC options are available to initiate the intervention process. The user, family, and a team of specialists should all be involved in deciding to use AAC. However, no individual should be without communication, and everyone should have access to AAC systems that help them communicate effectively. Individuals with some speech or speech that is incoherent may consider AAC. AAC may be used to help these people communicate more effectively. Others may use speech in low-demand situations but use AAC to supplement their communication in high-demand situations. The presence of speech should not prevent AAC from being considered as a support.

AAC uses a person's capacity to blend several modes of expression to create a communication message. AAC refers to tools and tactics that a person with speech or language impairments can use to supplement or even replace speech or writing (Brignell et al., 2018; Schirmer, 2020). AAC is mainly divided into two broad categories.

1. ***Unaided AAC:*** It is not relying on any technology or physical tools. It could include nonverbal communication forms including body language (including gestures), facial expression, sign language, etc.

2. ***Aided AAC:*** It entails the need for physical devices or tools. Low, mid, and high-tech systems are all available. Using a simple pen to point written alphabets or words on a customised board is a low or basic method. Mid-tech includes using simple technology for speech output via electronic devices. The employment of increasingly advanced and complex instruments, like touch screens or eye-gazing devices, is considered high-tech (Butt et al., 2022).

Using AAC technologies and apps can potentially improve communication and language development. Unfortunately, this potential has not yet been fully realised for children with complex communication needs (CCN). One component is the scarcity of AAC applications or technologies suitable for young children with CCN. The display is one of the most crucial aspects of AAC applications or technologies. If AAC displays are well designed, then they can be beneficial in improving the communication and language outcomes of young children with CCN (Light et al., 2019).

2.2 Visual Scene Display (VSD)

Visual Scene Display (VSD) is a typical form of aided AAC display design. In VSDs, linguistic concepts (symbols) are directly integrated into a picture or image of a natural event. A virtual scene illustrates and represents a moment, place, or experience through a picture, photograph, or virtual environment (Light et al., 2019). Isolated photographic icons and images are not the same as visual scenes. To be termed as a visual scene, a contextualised image must depict events, concepts, or circumstances entirely (Dietz et al., 2006; Shane, 2006).

Wilkinson et al. (2012) reported on the composition of VSDs and talked about the characteristics of VSDs and how they relate to an individual's visual and cognitive processing. They considered three particular ways in which visual cognitive science sources of information may be associated with the composition of VSDs - (a) the concept of VSD "complexity," (b) the significance of people in VSDs, and (c) the incorporation of events in VSDs. They concluded that the presence of context in naturalistic scenes enhances attention, detection, interpretation and classification of scenes and their constituent components. The additional components do not appear to increase the difficulty of the processing; instead, they appear to facilitate processing. According to research in cognitive visual processing, VSDs, particularly those involving significant human social activities, may reduce the processing demand imposed by AAC systems. This study, however, was not conducted on a population that would utilise AAC.

O'Neill et al. (2019) conducted research on visual attention to the components within the VSD in children with CCN (ASD, Down syndrome, intellectual disability) and younger children with normal development at a similar developmental level. They observed that participants spent most of their time concentrating on the meaningful components (like shared activity and people) in both groups. They focused on the people the most and the shared activity the rest of the time. These findings encourage incorporating people participating in social activity as crucial elements in VSDs.

Furthermore, background features in VSDs are not a considerable distraction for children with CCN, who concentrate on the scene's primary elements: the individuals and the shared activity (Light et al., 2019; O'Neill et al., 2019).

2.3 Comparison of Visual Scene Images with Traditional Symbols

In AAC systems, various symbols (image types) have been used to convey messages. Here are several examples: Icons, standalone images, visual scenes and photographic images, etc. Every one of these different forms of symbols has distinct advantages and disadvantages. The AAC team should carefully analyse the AAC symbols for their learning requirements and communication capabilities.

Line drawings (icons) of items or persons with plain, decontextualised surroundings were among the most widely utilised image types. Even though icons were and still are used in many high-tech products, they are not the most appropriate message representation approach due to their difficulty representing abstract components of speech (Wilkinson et al., 2012).

Compared with line drawings, images contain colours, tones, shadows, and textures. Hence, images tend to provide a more detailed and profound description of a scene. They are relatively efficient at portraying specific objects (Lin & Chen, 2018). Research suggests that a picture iconic system may be easier to acquire, maintain, and generalise to everyday situations (Bloomberg et al., 1990; Eells et al., 2000). Photos are highly iconic representations that are easier to understand than line drawings for children with intellectual disabilities (Mirenda & Locke, 1989; Mizuko & Reichle, 1989).

Line drawings depict items and/or individuals on a plain background. The lack of context may raise the communicative expectations placed on people with complex communication requirements and their conversational partners. One reason is that background context can help to represent events, relationships and locations (Blackstone et al., 2007; Dietz et al., 2006). Individuals need to depend on other techniques to communicate this information if it is unavailable. This may be difficult for those with severe communication difficulties who have trouble using expressive language.

The communication partners of people with CCN might also benefit from image context. Communication partners, in particular, might use items in the context/background of an image to explain, clarify or simplify their messages. Context could help persons with complicated communication problems communicate more effectively (Hux et al., 2010).

Light, Drager, and Wilkinson (2012) published the results of an exploratory research study with infants of normal development (9–12 months) that employed a split screen pattern to assess visual attention to distinct display types: photo VSDs vs grids of four AAC symbols (line drawings). The results suggest that infants looked at the photo VSDs first and longer than the grids, indicating that photo VSDs can be a great initial point for beginning communicators. In addition, it was noted that toddlers' and pre-schoolers' vocabulary production was more accurate when presented with VSDs rather than grid displays (Drager et al., 2003; Light et al., 2004).

In another study, Wilkinson et al. (2012) compared conventional grid-based displays and VSDs in typically developing children. The results revealed that VSDs increase visual attention, leading to more accurate performance and supporting faster lexical development and learning. This shows that VSDs may be better suitable for infants, toddlers, pre-schoolers and other beginning communicators than grid displays.

2.4 Benefits of VSDs for Typically Developing Children

According to research studies, children learn initial language ideas in a context-based, reach environment where varied experiences contribute to the child's increasing conceptual understanding. VSDs are designed to offer the same context by integrating linguistic concepts in images of routines or events with which the kid is familiar, resulting in a visual representation of this supporting context for conceptual understanding. They also retain the visual as well as functional relationships between individuals and objects in the actual world (Light et al., 2004).

The visual scene displays aid a child's potential to locate and learn symbols on displays as the contextual nature of the scene tunes into the child's episodic memory, which is linked with autobiographical information, personal events and experiences that occur at a specific time and place in individual's life (Zangari & Van Tatenhove, 2009). The use of VSDs with younger children is justified because they tune into the complex, event-based and context-supported learning mechanisms that underpin language development (Drager et al., 2003; Light et al., 2004; Wilkinson et al., 2012). Beginning communicators are additionally benefitted from more transparent symbols, such as photographs (e.g., Mirenda & Locke, 1989), and ones that give contextual assistance for the learning, such as photo VSDs (e.g., Babb et al., 2020; Light et al., 2019).

2.5 Advantages of VSDs for Children with Complex Communication Needs

Researchers have tried to make AAC systems more usable by incorporating visual scenes as a message representation option. Visual scenes can be used as communication aids on their own or as part of VSDs that include one or several visual scene images, text, and other supporting materials. People with CCN and communication partners have shown that visual scene displays improve conversational complexity and information transfer (Thiessen et al., 2016).

VSDs are used in various therapeutic situations and have been integrated into commercially available equipment. Blackstone (2004) reviewed a few of the clinical applications of VSDs. The author reported that digital photos could be exclusively personalised, contain broad context to aid learning, and are primarily used to support conversation, social interaction, education, and overall communication activities such as storytelling, involvement and play. Furthermore, decontextualised photographs are more difficult to comprehend than visual scene photos. Dietz et al. (2006) suggested that individuals must be capable of grasping the "gist" of a visual picture quickly and readily. VSDs may minimise cognitive demands, make learning easier, and provide rapid success to starting communicators and people with low cognitive and linguistic skills. When introduced to AAC applications or technologies that use VSDs, beginning communicators with CCN increase the number of communication turns and the concepts conveyed significantly (Drager et al., 2019; Holyfield et al., 2017; Light et al., 2019).

VSDs are effective at all stages of communication for children with specific developmental disabilities. Children in the early stages of language development can benefit from it by adding appropriate vocabulary just-in-time during engaging and meaningful interactions throughout the day. Children who struggle to maintain joint attention might benefit from VSDs by introducing favourite activities or books in the form of VSD into their AAC systems. Children can use VSD to express events that occur outside the present moment. It is helpful for preliterate people because it aids in orthographic and phonological processing by associating graphic symbols with written text and spoken output, respectively (Light et al., 2019). Individuals with various developmental challenges who use AAC benefit from VSDs because they increase communication results (Caron et al., 2017; Holyfield et al., 2017; O'Neill et al., 2019).

Light and Drager (2012) conducted a study to assess the efficacy of using VSDs in early intervention, which included special needs children with Down syndrome, cerebral palsy and other developmental disabilities, showing a significant increase in turn-taking rates. They all improved their vocabularies significantly, learning many new words and concepts. As the children grew older, they learned to combine concepts to convey more complex messages. Many children developed phonological awareness and literacy skills as pre-schoolers and entered school as readers. For people with complex communication needs, the goal of visual scene displays was to minimize the navigation and message formulation requirements of traditional grid-based displays which are composed of symbols and isolated photographs (Dietz et al., 2006).

VSDs and just-in-time programming aids are AAC technology features that have the potential to help starting communicators of all ages. Just-in-time programming allows partners to instantly and easily snap images of motivating and meaningful events and immediately present them as VSDs with appropriate terminology to facilitate communication in response to the preferences of beginning communicators (Holyfield et al., 2019). AAC technologies with VSD and just-in-time programming decrease the time and effort required by parents and professionals to add new vocabulary to the child's AAC system by allowing them to do so quickly during everyday interactions. During interactions with children with specific developmental disabilities, VSDs can also give contextual assistance and subject cues to parents and other communication partners who have difficulties comprehending the child's communication (Light et al., 2019).

According to a review of studies, incorporating VSDs in AAC systems benefits all AAC users by assisting in vocabulary building, language expansion, minimising joint attention demands, increasing turn taking, and strengthening preliteracy skills. Using VSD also simplifies incorporating new language ideas throughout the day.

Communication partners may better utilise the context in the visual scene to grasp the language of children with complex communication requirements.

2.6 AAC for Persons with Autism Spectrum Disorders (ASD)

Persons with ASD use AAC for a variety of reasons, listed as below:

1. Some people with ASD do not have a solid vocal or motor imitative repertoire and may struggle to produce complicated motor movements necessary for speaking. On the other hand, the motor movements needed to make a manual sign or point to/exchange a graphic symbol are less complicated and easier to learn than those needed for speaking.

2. Learning to correlate a symbol, such as a manual sign or picture, with a referent would be less challenging than verbal memory, speech and conceptual understanding. This could be especially true for graphic symbols, which require recognition memory rather than recall memory to be produced accurately. Recognition memory does not require searching one's memory for potential symbols (e.g., graphic symbols on a display board) as they are readily visible. In contrast, recall memory does because the potential options (e.g., manual signs) convey a specific message.

3. Many people with ASD have both auditory processing deficits (Roth et al., 2012) and comparatively good visual-spatial skills (Mitchell & Ropar, 2004), which may help them learn and use graphic symbols like photographs or line drawings. Most autistic children understand and respond to information better when presented visually (Fleury et al., 2014).

4. AAC may aid in overcoming the adverse learning history linked with speech production that many people with ASD experience due to a protracted period of

stagnation. AAC offers an alternative learning way that can help with language, literacy and maybe even speech development while providing functional communication (Beukelman & Mirenda, 2005).

AAC systems positively improve children's communication, challenging behaviours, and social and academic skills of ASD children (Aydin & Diken, 2020; Syriopoulou-Delli & Eleni, 2021). AAC is one of the effective modes of communication for individuals with ASD, and research has shown that it does not limit speech development (White et al., 2021). Compared to unaided AAC, aided AAC is more efficient at offering functional communication for individuals with ASD because aided AAC can provide more vocabulary options, and it takes less effort for the addition of new vocabulary (Ganz et al., 2015; Lima Antão et al., 2018; White et al., 2021).

2.7 Potential benefits of VSDs for children with ASD

AAC has frequently prioritised the expressive aspect of communication. While the expression is unquestionably a concern in ASD, the communication challenges faced by this population are far more extensive, implying that successful communication intervention also needs to be wider in range. Shane and Simmons (2001) suggested a framework that takes into account three types of visual assistance for people with ASD:

1. Visual Expressive Mode (VEM) is a set of visual aids for expressive communication.
2. Visual Organizational Mode (VOM): A visual representation of how an activity, routine, script, or timetable is organised.

3. Visual Instructional Mode (VIM): A visual aid that can be used instead of or in addition to written or verbal language. The goal is to improve instruction by including a visual component that complements or replaces oral language.

VSDs have significant potential as a tool to enhance communication and communication learning for individuals with ASD. Along with Visual Expressive Mode (VEM), VSDs also support organizational mode and the instructional mode.

Use of Visual Scene Display cues as a Visual Organizational Mode (VOM):

People with ASD have difficulty grasping time and sequence, and even minor changes in their routine might cause them to become disoriented. Visual scenes give elaboration about the environment, individuals, and organisation of activities provide the most help for those on the autism spectrum to interact safely and efficiently in their environment. By expanding the knowledge regarding the activity or event, the visual scene may boost preparation to endure a novel circumstance. When a new activity or event is introduced, such simultaneous knowledge's usefulness may be greatest. The person with ASD can be guided not only to the single who, the isolated what, or the single where but to all of these crucial aspects (and more) in a coherent, concise and intuitive manner. An approach that can systematically offer a plethora of vital information appears desired for people who are not flexible about their daily routines, intolerant or resistive to change and/or confused by the flow of occurrences throughout the day.

This technique may be effective simply because it acts as a foundation for learning and training and gives helpful information for the people who exhibit a high intolerance to change. The visual scene aids in the organisation of data. The activities within that context and the individuals who will or might be present are clearly specified if that is a playground scene location. This lays the basis for branching out to other words that can be used to discuss the entire event.

Use of Visual Scene Display cues as a Visual Instructional Mode (VIM):

Visual scene presentation is considered a form of cue for understanding the scenario as they have the ability to portray an entire concept or notion in a single image. When the substance of a spoken message is not comprehended, scene cues can help comprehension while immediate speech production (Shane, 2006).

Visual learning benefits children with ASD (Ganz et al., 2011). Also, children with autism have consistently demonstrated excellence in a variety of visual search tasks (Joseph et al., 2009), so they may be anticipated to perform particularly well when it comes to locating information within a VSD. Hence, the present study examines the developed visual scene image dataset in children with ASD.

2.8 Research gaps

A review of previous research indicated that VSDs are effective in language acquisition, language development, decreasing attention demands and increasing social skills. According to research, incorporating VSD in AAC systems can benefit all AAC users, including children with ASD. In order to be more effective in communication development, visual scene images should be in meaningful, personally relevant, and realistic contexts. In the Indian context, however, no visual scene image dataset is available. As a result, the present study aimed to develop and validate the Visual scene image dataset that is relevant in the Indian cultural context, as well as determine the efficacy of the developed visual scene image dataset by comparing its identification accuracy with traditional line drawings in ASD children.

Chapter III

METHODS

The aim of the present study was to develop and validate the Visual scene image dataset for Indian AAC users and to assess the efficacy of the developed visual scene image dataset over line drawings by administrating it on children with Autism Spectrum Disorders (ASD).

3.1 Research Design

This was a descriptive study to develop the Visual scene image dataset and validate the developed Visual scene images for Indian AAC users. Also, a standard group comparison method was employed to compare the identification accuracy scores between line drawings and visual scene images in children with ASD.

3.2 Procedure

The study was carried out in three phases which were as follows:

PHASE 1
Development of the Visual scene image dataset

↓

PHASE 2
Validation of the developed Visual scene images

↓

PHASE 3
Field testing of the developed Visual scene image dataset

3.2.1 Phase 1- Development of the Visual scene image dataset

Development of the visual scene image dataset was carried out in two steps, which included selecting the categories and developing the visual scene image dataset.

3.2.1.1 Step 1: Selecting the categories

To develop the image dataset, categories were selected from the Assessment of Language Development (ALD) vocabulary checklist (Lakkanna et al., 2007) and the storybooks of school-age children based on the Indian sociocultural context. ALD is a comprehensive tool which assesses receptive and expressive language skills. It also consisted of a vocabulary checklist which comprises various categories. A total of ten categories were chosen, as shown in Table 3.1. Including items within each category, a total of 120 items were selected for developing a visual scene image dataset.

Table 3.1

Selected categories for the Visual scene image dataset

Sr. No.	Categories	No. of items in each category
1.	Fruits	10
2.	Food items	14
3.	Furniture	10
4.	Animals	18
5.	Vehicles	10
6.	Electrical appliances	10
7.	Flowers	10
8.	Vegetables	11
9.	Common objects	16
10.	Daily routines	11
	Total	120

3.2.1.2 Step 2: Developing the Visual scene image dataset

Effective visual scene images for all the items were taken by the experimenter using the Nikon D5300 DSLR Camera in a naturalistic environment. The parameters of lighting, colour, size of object, depth of photography, and focus on the object of interest were kept in check while capturing the photographs. Photos taken were highly iconic representations of the actual surroundings and as per the inputs given by Light et al. (2019) and Wilkinson et al. (2012). All the captured visual scene images were combined to develop a visual scene image dataset.

3.2.2 Phase 2- Validation of the developed Visual scene images

Validation of the developed image dataset was done by three Speech-Language Pathologists with at least three years of clinical expertise in AAC and three parents whose children have used AAC for at least six months. Parents of AAC users were chosen for validation because parents are the secondary stakeholders in communication, and children spend most of their time with caretakers.

They had to judge the appropriateness of each visual scene image on the four parameters (i.e., Clarity, Relevance, Colour, Iconicity) based on the 4-point rating scale (0-Not satisfactory, 1-Satisfactory, 2-Good, 3-Excellent). Parameters were defined in the validation form (as shown in Appendix A), adapted from Manual for Non-fluent Aphasia Therapy in Kannada, Goswami et al.(2012). All images with ‘2’ and ‘3’ ratings in all four parameters were considered for the final image dataset. Judges were also asked for modifications, and changes were made based on the feedback and suggestions received from the judges (Appendix B).

The suggestions given by judges were listed below:

- To modify the depth of field in some images

- To employ more natural background for a few images
- To adjust the focus of a few images
- To modify a few images for improved identification

The suggestions and modifications given by all the Speech-Language Pathologists and parents of AAC users were incorporated. Again, the approval was taken from all the validators regarding suggestions and modifications incorporated, and then the final visual scene image dataset was developed. The sample of captured visual scene images is included in Appendix D. Finalized visual scene image dataset is provided on CD.

3.2.3 Phase 3- Field testing of the developed Visual scene image dataset

The efficacy of the developed dataset was assessed by conducting field testing on a particular group of the population who are potential AAC users. In this study, field testing was done on children with Autism Spectrum Disorders (ASD). The efficacy of the developed visual scene image dataset was assessed by comparing the performance with traditional line drawings when presented to children with ASD.

3.2.3.1 Ethical Considerations

The study was carried out while adhering to the AIISH ethical committee guidelines for Biobehavioral Sciences for human subjects. All ethical standards were met for participant selection and their participation. Prior to the field testing, the study and its purpose were explained to the caregivers and consent was obtained from them (Appendix C). Then the clinician interacted with the child (through online mode) in order to build a rapport with the child. After having the rapport, each participant presented the stimuli in a noise-free environment.

3.2.3.2 Participants

Twelve ASD children within the age range of 5 to 12 years (mean age, *M* =7.64 years) were chosen as participants. Selected participants were subdivided into two groups, and the groups were matched according to the participant's receptive language performance scores. Receptive language performance scores were obtained using Assessment Checklist for Speech-Language Skill (ACSLS) (Swapna et al., 2010). Group I consisted of 6 ASD children (mean receptive language performance score = 41.3) who were tested using line drawings, and Group II consisted of other 6 ASD children (mean receptive language performance score = 39.5) who were tested using the developed visual scene image dataset. The participants were selected from the Department of clinical services, AIISH, Mysore.

Table 3.2 below includes details of children with ASD, including the chronological age, receptive language age and receptive language performance score obtained using ACSLS (Swapna et al., 2010).

Table 3.2

Details of the participants in Group I and Group II

Group I				Group II			
Sr. No.	Age (yrs)	Receptive language age (yrs)	Receptive language performance score	Sr. No.	Age (yrs)	Receptive language age (yrs)	Receptive language performance score
1	6.11	2.1-2.3	28	1	8.7	1.10-2.0	24
2	5.7	2.4-2.6	33	2	9	2.1-2.3	28
3	5.5	2.4-2.6	33	3	5.7	2.4-2.6	33
4	7.11	2.10-3.0	40	4	7	2.7-2.9	36
5	8.4	3.0-3.6	46	5	5.9	3.0-3.6	46
6	11.6	5.1-5.6	68	6	11	5.7-6.0	70

Note. ‘yrs’ = ‘years’

3.2.3.3 Inclusionary criteria

The participants were selected based on the following inclusionary criteria:

- Children who are diagnosed with spoken language delay secondary to ASD.
- They should be using AAC for the first time.
- They should have normal/corrected vision.
- They should be predominantly exposed to the Kannada language at home (based on the parent report).

3.2.3.4 Exclusionary criteria

The participants with the following characteristics were excluded from the study:

- Children with spoken language delay secondary to other communication disorders.

- Children with associated visual and intellectual deficits.
- Children with severe gross motor deficits.

3.2.3.5 Experimental Identification Task

The child was asked to sit in front of the screen, and the caregiver was seated next to the child. Then the experimenter further oriented the child about the task through online mode, which is as follows:

"Let's play a game on the computer. You will see three pictures on the screen, and then I will tell you the name of one particular item, and you have to point that particular item from the given three choices".

After this, the child was presented with either three choices of visual scene images or line drawings at a time, and then the experimenter named one particular item, and the child responded by pointing. Every time, the child was given breaks after the presentation of 5 slides.

For Group I, three-line drawings (3 choices) were displayed at a time on the computer screen. For Group II, three visual scene images were displayed simultaneously through a computer screen. Figure 3.1 and 3.2 depicts the online identification task using line drawings and visual scene images, respectively. Line drawings were adapted by the qualified professional artist according to the Indian context as per Mayer-Johnson's (1992) PCS (Picture Communication Symbols) line drawings. The sample of line drawings is included in Appendix D. All the line drawings used as stimuli are provided on CD. The stimuli were presented using a DELL Inspiron 15 5570 laptop computer with a 15.6-inch HD display, 1 TB Intel Core i5-8205U processor, and 8GB of RAM, which was displayed in Windows 10 Microsoft

PowerPoint. The order of presentation of a particular item in both line drawing and visual scenes was consistent across both groups.

Figure 3.1

Photo depicting online identification task using the Line drawings (Group I)

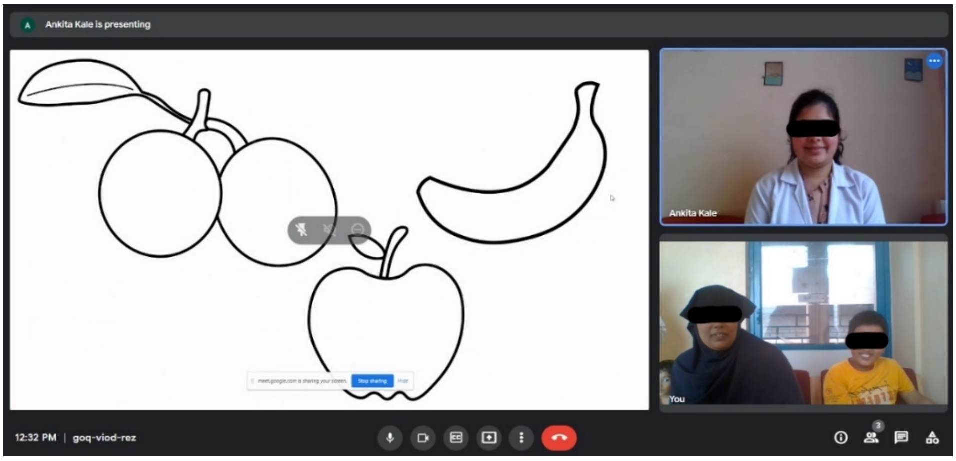
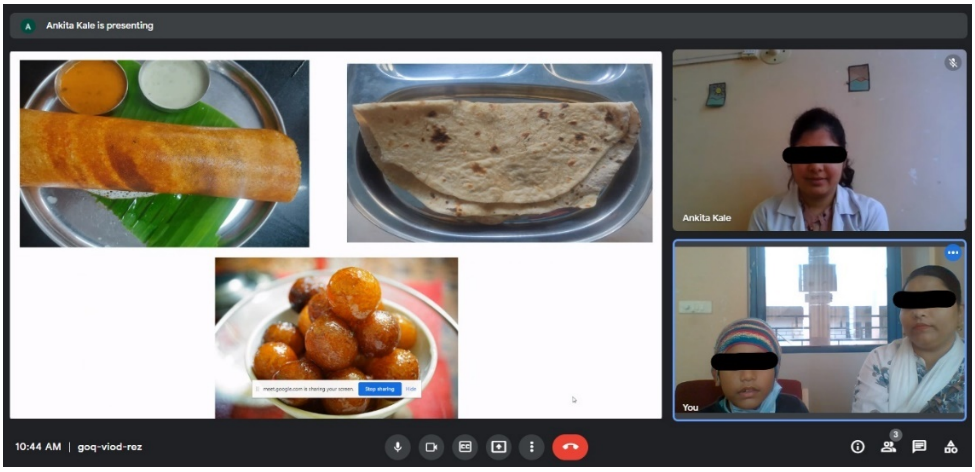


Figure 3.2

Photo depicting online identification task using the Visual scene images (Group II)



3.2.4 Test-retest reliability

Test-retest reliability was measured by following the same procedure on 40% of the participants using all the stimuli two weeks later in order to determine whether there was a statistically significant change in the results between the tests and retests.

3.2.5 Analysis of the experimental identification task

Identification accuracy: The identification accuracy of both visual scene images and line drawings was assessed to examine transparency. Transparency refers to the ability of the person to correctly interpret a symbol (Mizuko, 1987). In the present study, the transparency of symbols was assessed by calculating identification accuracy in terms of frequency of 'Accurate responses', 'No responses' and 'Inaccurate responses' for both Group I and Group II.

Correctly identified stimuli (line drawings/ visual scene images) were given a score of "1", and for no response and inaccurate identification "0" score was given. The raw scores obtained from the two groups of participants were tabulated and subjected to statistical analysis using the SPSS software (Statistical Package for the Social Sciences package, version 20) to compare the performance of both the groups. To analyze the data, the following statistical measures were used:

a) Mean, Median and Standard Deviation to measure the identification accuracy scores for each of the ten categories and overall frequency of no responses and inaccurate identification when presented with line drawings vs visual scene images.

b) Shapiro-Wilk test of normality to check the normality distribution of the data and Mann-Whitney U test to analyze the significant difference between identification accuracy scores for line drawings vs visual scene images overall and in each category in children with ASD.

c) Cronbach's alpha test to assess the test-retest reliability of the obtained scores.

Chapter IV

RESULTS

The present study investigated the identification accuracy of Line drawings in comparison with Visual scene images in children with Autism Spectrum Disorders (ASD) in the age range of 5-12 years. The objective of conducting field testing was to assess the efficacy of the developed visual scene image dataset over line drawings by administrating it on children with ASD. Twelve children with ASD participated in the study. Group I consisted of 6 ASD children (with a mean receptive language performance score of 41.3) who were presented with line drawings, and Group II consisted of other 6 ASD children (with a mean receptive language performance score of 39.5) who were presented with developed visual scene image dataset. All the participants were instructed to identify the particular line drawing or visual scene image from the presented three choices on the laptop screen, and then the scoring was done according to the accuracy of identification in each category, frequency of no responses and inaccurate identification. Further, using SPSS software (version 20), the results of the identification task administered to the participants were analyzed in various aspects.

The findings of the present study are presented broadly under each of the following headings:

1. Comparison of Identification accuracy scores in each category between Group I and Group II.
2. Comparison of Total identification accuracy scores between Group I and Group II.
3. Comparison of frequency of "No response" elicitation between Group I and

Group II.

4. Comparison of "Inaccurate identification" between Group I and Group II.

4.1 Comparison of Identification accuracy scores in each category between Group I and Group II

To describe and summarize the characteristics of the current data set, descriptive statistics were done. Identification accuracy scores for the categories of fruits, food items, furniture, animals, vehicles, electrical appliances, flowers, vegetables, common objects and daily routines were computed for both groups. Group I was presented with line drawings, and Group II was presented with developed visual scene images. The Mean, Median, and, Standard Deviation (SD) were calculated for each category and are tabulated in Table 4.1.

Table 4.1

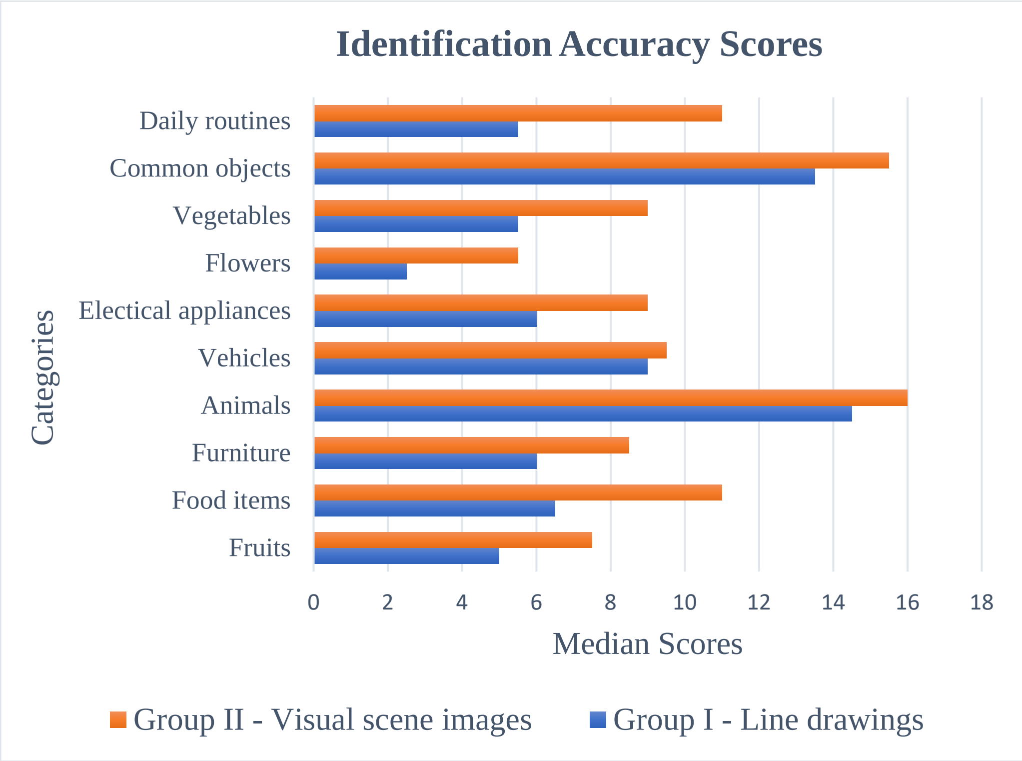
Mean, Median and Standard Deviation (SD) of Identification accuracy scores for Group I and Group II across all the categories

	Group I			Group II		
Categories	Mean	Median	SD	Mean	Median	SD
Fruits	5.00	5.00	1.41	7.83	7.50	1.47
Food items	6.50	6.50	3.93	11.50	11.00	2.07
Furniture	6.00	6.00	2.75	8.33	8.50	1.63
Animals	14.00	14.50	2.82	15.00	16.00	3.95
Vehicles	8.50	9.00	1.76	9.17	9.50	1.16
Electrical appliances	6.33	6.00	1.86	8.50	9.00	1.64
Flowers	3.00	2.50	2.60	5.33	5.50	2.16
Vegetables	5.67	5.50	1.63	9.00	9.00	1.54
Common objects	13.50	13.50	1.87	15.00	15.50	1.26
Daily routines	6.17	5.50	1.94	10.17	11.00	1.60

Thus, the results of descriptive statistics revealed that Group II, who was presented with developed visual scene image dataset, performed better on the identification task than Group I, who was presented with line drawings in all the ten categories. The median scores obtained by both groups are represented in Figure 4.1.

Figure 4.1

Bar graph representing Median Identification accuracy scores obtained by Group I and Group II across all the categories



On visual inspection and comparing median values of the scores, there is a difference between scores obtained by the two groups. However, the data were subjected to further analysis to confirm further whether a statistically significant difference was present between the two groups.

First, the Shapiro-Wilk test of normality was done to check the normality distribution of the data. The result of the Shapiro-Wilk suggested that the data did not follow a normal distribution. Hence, a non-parametric Mann-Whitney U test was administered for the comparison of identification accuracy scores between Group I and Group II. The results of the Mann-Whitney U test are tabulated in Table 4.2.

Table 4.2

Results of the Mann-Whitney U test between Group I and Group II across all the categories

Categories	**|Z|**	***p*-value**
Fruits	2.508	0.012*
Food items	2.185	0.029*
Furniture	1.540	0.124
Animals	0.812	0.417
Vehicles	0.515	0.607
Electrical appliances	1.895	0.058
Flowers	1.529	0.126
Vegetables	2.513	0.012*
Common objects	1.475	0.140
Daily routines	2.613	0.009*

Note. '*' indicates the significance of the 'p'-value at 0.05 level

The results of the Mann-Whitney U test revealed a statistically significant difference i.e., $|Z| > 1.96$ ($p<0.05$), between the identification accuracy scores in the category of fruits, food items, vegetables and daily routines, as shown in Table 4.2.

Therefore, it is evident that the performance of Group II, which was presented with developed visual scene image dataset, was statistically significantly better than Group I, which was presented with line drawings in the category of fruits, food items, vegetables and daily routines.

4.2 Comparison of Total identification accuracy scores between Group I and Group II

Total identification accuracy scores for line drawings and visual scene images were calculated. A score of 1 was given for correct identification and the total maximum score of 120 was considered, which included all the ten categories. Descriptive statistics were carried out to compare the scores across both groups, i.e., Group I and Group II. The descriptive scores of each group of participants are indicated in Table 4.3 below.

Table 4.3

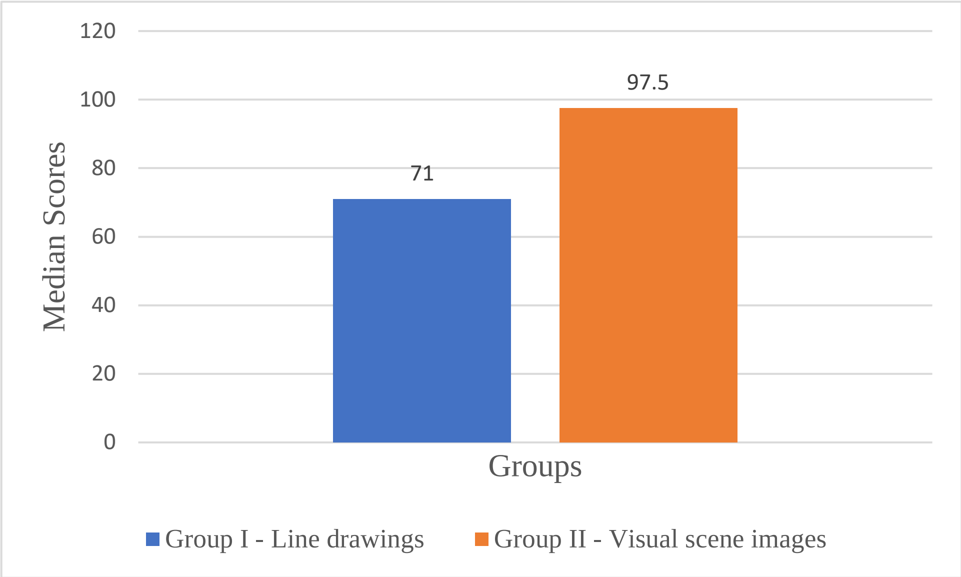
Total Mean, Standard Deviation (SD), and Median Values for Group I and Group II

Group	**Mean**	**SD**	**Median**
Group I	74.67	20.695	71.00
Group II	99.83	14.999	97.50

From the mean, standard deviation and median values, it is clearly evident that the performance of Group II, who were presented with visual scene images (Mean: 99.83, SD: 14.99, Median: 97.50), was better compared to the Group I who were presented with line drawings (Mean: 74.67, SD: 20.69, Median: 71). The median scores for the two groups are depicted in Figure 4.2 below.

Figure 4.2

Graph representing Total Median Identification accuracy scores for Group I and Group II



The data was further analyzed using the Mann-Whitney U test to see if there was any significant difference between the two groups. It yielded a statistically significant difference ($|Z| = 2.0$, $p = 0.037$) between the two groups. Hence, the total identification accuracy scores for Group II are statistically significantly different from Group I.

Therefore, it is evident that the overall performance of Group II, which was presented with developed visual scene image dataset, was significantly better than that of Group I, which was presented with line drawings.

4.3 Comparison of frequency of "No response" elicitation between Group I and Group II

The frequency of no responses during the identification of line drawings and visual scene images was calculated. To compare the frequency of no responses across both the groups, i.e., Group I and Group II, descriptive statistics were carried out. The descriptive values of each group of participants are indicated in Table 4.4 below.

Table 4.4

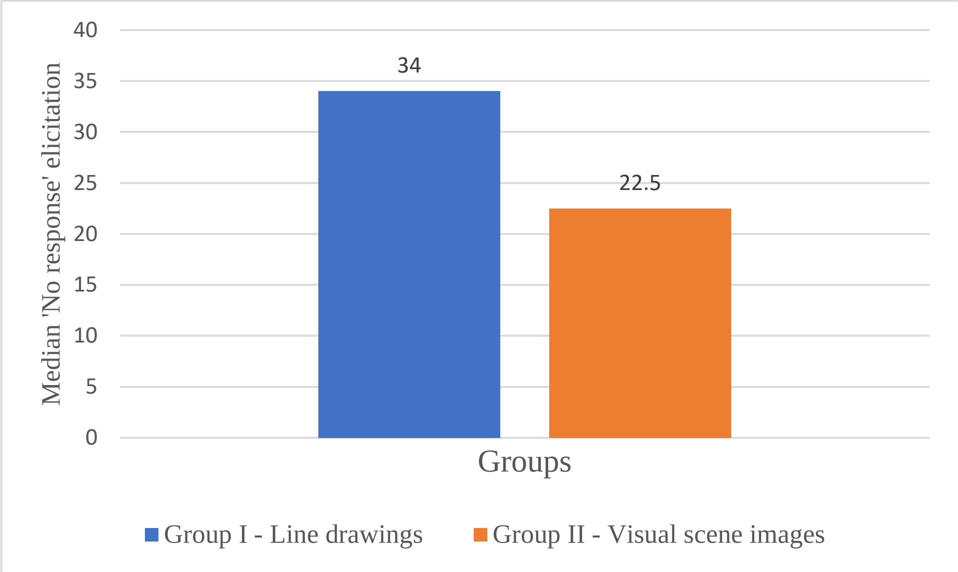
Mean, Standard Deviation (SD), and Median Values for the frequency of No response elicitation

Group	**Mean**	**SD**	**Median**
Group I	31.67	15.782	34.00
Group II	19.83	14.372	22.50

From the mean, standard deviation and median values, it is clearly evident that no responses were more in Group I, who were presented with line drawings (Mean: 31.67, SD: 15.78, Median: 34) compared to Group II who were presented with visual scene images (Mean: 19.83, SD: 14.37, Median: 22.50). The data were further analyzed using Mann-Whitney U test, which reveals that there is no statistically significant difference ($|Z| = 1.203$, $p = 0.229$) between the frequency of no response elicitation between the two groups. The median frequency of no responses for the two groups is depicted in Figure 4.3, which shows that the overall occurrence of no responses in Group I are greater than in Group II.

Figure 4.3

Graph representing Median frequency of No response elicitation for Group I and Group II



4.4 Comparison of "Inaccurate identification" between Group I and Group II

The frequency of inaccurate identification for line drawings and visual scene images was calculated. Descriptive statistics were used to compare the frequency of inaccurate identification across the groups, i.e., Group I and Group II. The descriptive values of each group of participants are indicated in Table 4.5 below.

Table 4.5

Mean, Standard Deviation (SD), and Median Values for the frequency of Inaccurate identification

Group	**Mean**	**SD**	**Median**
Group I	13.67	6.653	13.00
Group II	0.33	0.816	00

From the mean, standard deviation and median values, it is clearly evident that the inaccurate identification was more in Group I who were presented with line drawings (Mean: 13.67, SD: 6.653, Median: 13) compared to Group II who were presented with visual scene images (Mean: 0.33, SD: 0.816, Median: 0). The data were further analyzed using Mann-Whitney U test to see if, there is any significant difference among the frequency of inaccurate identification in two groups. It yielded a statistically significant difference ($|Z| = 2.99$, $p = 0.003$) between the two groups.

Therefore, it is evident that the frequency of inaccurate identification was statistically significantly higher in Group I, who was presented with line drawings, compared to Group II, who was presented with developed visual scene image dataset.

4.4 Results of Test-retest reliability

Test-retest reliability was measured using Cronbach's alpha test after the gap of two weeks by following the same procedure on 40% of the participants (five children with ASD) using an entire set of stimuli (i.e., either line drawings or visual scene images) as earlier. The test results revealed that $\alpha = 0.999$, which indicates higher internal consistency (α ≥ 0.9) between the test and retest scores obtained at different point of time.

To summarize, upon visual inspection of the graph as well as when comparing the mean and median values, there was a marked difference between the identification accuracy scores of Group II, which was presented with the visual scene image dataset and Group I, which was presented with line drawings in all the ten categories displayed. Further, the Mann-Whitney U test was done to check for the statistical difference. The results of the Mann-Whitney U test suggested a statistically significant difference in the total identification accuracy scores, identification accuracy scores in the category of fruits, food items, vegetables and daily routines, as well as in the frequency of inaccurate identification between the two groups. To check the test-retest reliability between the two different time points, Cronbach's alpha test was carried out, demonstrating that the task findings are highly reliable (α ≥ 0.9).

Chapter V

DISCUSSION

Studies have reported that children with communication disabilities struggle to attend and identify traditional AAC symbols like line drawings, signs, PicSyms, etc. Research suggests that visual scenes are much easier to attend to, identify and relate with the natural context. Incorporating visual scenes into the AAC system is beneficial for children with complex communication needs at all stages of communication development. Even though numerous studies indicate the need for familiar, meaningful, and naturalistic visual scenes to be more efficient and effective for developing communication, there is a paucity of such visual scene image datasets in the Indian context. Also, there is a lack of studies to determine the effectiveness of such visual scene images in the Indian context. As a result, the purpose of this study was to develop and validate a visual scene image dataset for Indian AAC users and determine the efficacy of the developed visual scene image dataset over line drawings by administering it on children with Autism Spectrum Disorders (ASD).

The study was conducted in three phases. Phase I involved developing the visual scene image dataset in the Indian context. In phase II, the developed visual scene image dataset was validated by Speech-Language Pathologists and parents of AAC users. Phase III consisted of field testing the developed visual scene image dataset in children with ASD.

Categories for the image dataset were selected from the Assessment of Language Development (ALD) vocabulary checklist (Lakkanna et al., 2007) and story books of school-age children based on the Indian sociocultural environment. The vocabulary chosen was common and appropriate according to the development and culture of the

Indian children. Visual scene images for all specified categories were captured using a Nikon D5300 DSLR camera. All the relevant information provided in the published research articles was used to create the visual scene images (Light, Wilkinson, et al., 2019; Wilkinson et al., 2012). The parameters of lighting, colour, size of object, depth of photography, and focus on the object of interest were kept in check while taking the photographs. Visual scene images were captured in a rich, context-based natural environment. According to the Indian cultural context, the background chosen for capturing the visual scenes was relevant and familiar.

Three Speech-Language Pathologists with at least three years of clinical expertise in the area of AAC and three parents whose children have utilized AAC for at least six months validated the developed visual scene image dataset. All images with good or excellent ratings (0-Not satisfactory, 1-Satisfactory, 2-Good, 3-Excellent) in all four parameters (Clarity, Relevance, Colour, Iconicity) were considered for the final image dataset. The remaining images were updated in accordance with validator recommendations, which included modifying the depth of field, employing a more naturalistic background, adjusting the focus, and editing certain images for improved identification. All the validators gave their approval after implementing all the suggestions and modifications. Then the final visual scene image dataset was developed, which included 120 images grouped into ten categories.

The efficiency of the developed visual scene image dataset was assessed by comparing its identification accuracy with line drawings in children with ASD between the age range of 5 to 12 years.

5.1 Identification accuracy between Line drawings and developed Visual scene image dataset

The study's results make this image dataset potentially the first visual scene image dataset available in the Indian context that can be successfully used in the AAC system for communication development in individuals with Complex Communication Needs. It might assist in language acquisition, expansion, generalization, and building social skills like joint attention and turn taking.

The identification accuracy was compared for the two groups. The current study's findings revealed that Group II, which presented with the developed visual scene image dataset, performed better than Group I, which was presented with line drawings. The results of the current study are consistent with earlier research studies.

Reasons for better identification in Visual scene images:

Visual scene images contain colours, tones, shadows and textures compared to line drawings which are plain and decontextualized, making visual scenes easier to identify (Lin & Chen, 2018). Also, images are highly iconic representations (Bloomberg et al., 1990; Eells et al., 2000; Mirenda & Locke, 1989) which makes them easier to identify than line drawings, even for children with intellectual disabilities (Mirenda & Locke, 1989; Mizuko & Reichle, 1989).

Another reason for the better identification accuracy scores in visual scene images is the presence of natural, meaningful context which helps in better identification of any object/thing or action (Babb et al., 2020; Blackstone et al., 2007; Dietz et al., 2006). Further, the presence of context is not a substantial distraction even for children with developmental disabilities (Light et al., 2019; O'Neill et al., 2019). In the present study, the presence of Indian cultural context in the visual scene image dataset leads to tuning into the child's episodic memory, which is linked with their personal experiences and events (Zangari & Van Tatenhove, 2009).

The significant difference between the performance can also be explained by the notion that younger children exhibit increased visual attention to visual scene images as they are attractive, familiar and hence easier to process, which results in more accurate performance (Drager et al., 2003; Light et al., 2004; O'Neill et al., 2019; Wilkinson et al., 2012).

According to Joseph et al. (2009), children with ASD demonstrate good visual searching abilities. Studies done by Shane & Simmons (2001) and Shane (2006) also support that the familiar contextual cues embedded in the visual scene help in better identification and understanding of visual scene images compared to line drawings in children with ASD.

Identification accuracy in the category of fruits, food items, vegetables and daily routines was significantly better in the group presented with visual scene images than the group presented with line drawings. The group presented with visual scene images for the categories of furniture, electrical appliances, flowers, and common objects had much higher mean values of identification accuracy. The identification accuracy results for animals and vehicles were similar between the two groups. However, the group presented with the visual scene images performed better. This finding indicates that the presence of colour, tone, shadow, texture, and context, which is natural, meaningful and familiar, is essential for identifying any item/ thing or action.

In terms of frequency of 'no responses' during the identification task, the frequency of 'no responses' was markedly greater in Group I, which presented with line drawings, compared to Group II, which was presented with visual scene images. Still, it was not statistically significant, which can be attributed to fewer participants. Further, ‘Inaccurate identification’ was significantly more in Group I, which was presented with line drawings, compared to Group II, which presented with visual scene images. This might be due to the inability to identify line drawings and the occurrence of conflation between the two-line drawings. These findings can be attributed to a lack of colour, texture, tone, shadow and context in line drawings which is rightly present in the developed visual scene image dataset. Therefore, the results of the present study support the findings by Babb et al. (2020), Blackstone et al. (2007), Dietz et al. (2006), Drager et al. (2003), Light et al. (2004), Light et al. (2019), Lin & Chen (2018), O’Neill et al. (2019) and Wilkinson et al. (2012).

To summarize, the differences obtained in total identification accuracy, identification accuracy in each category, frequency of “no response” elicitation and “inaccurate identification”, as well as supporting literature, were discussed above. The present study found significant findings with possible explanations that are in congruence with previous research. As a result of the field testing, the developed visual scene image dataset can be considered potentially efficient to be utilized in AAC systems for the communication development of Indian AAC users.

Chapter VI

SUMMARY AND CONCLUSIONS

The current study developed and validated the Visual scene image dataset for Indian AAC users. A review of previous research indicated that VSDs are effective in language acquisition, language development, decreasing attention demands and increasing social skills. According to previous studies, incorporating VSD in AAC systems can benefit all AAC users, including children with ASD. Visual scene images should be in meaningful, personally relevant, and realistic contexts to be more effective in communication development. However, there is a lack of availability of such visual scene image datasets in the Indian context. As a result, the present study focuses on developing and validating the Visual scene image dataset that is relevant to the Indian cultural context, as well as determining the efficacy of the developed visual scene image dataset by comparing its identification accuracy with traditional line drawings in ASD children in the age range of 5-12 years.

For developing the Visual scene image dataset, ten categories were selected, which included: fruits, food items, furniture, animals, vehicles, electrical appliances, flowers, vegetables, common objects and daily routines, based on the vocabulary checklist and story books. Visual scene images for all the specified categories were captured in the natural, meaningful, familiar context. Validation of the developed Visual scene image dataset, which included 120 images grouped into ten categories, was done by three Speech-Language Pathologists with at least three years of clinical expertise in AAC and three parents whose children have utilized AAC for at least six months.

The efficacy of the developed visual scene image dataset was field tested. Twelve children with ASD participated in the study. Group I consisted of 6 ASD children (with a mean receptive language performance score of 41.3) who were presented with line drawings, and Group II consisted of other 6 ASD children (with a mean receptive language performance score of 39.5) who were presented with developed visual scene image dataset. All the participants in Group I were instructed to identify a particular line drawing, and participants in Group II were asked to identify the specific visual scene image from the displayed three choices on the laptop screen through online mode.

The analysis of the identification task was done by calculating the total identification accuracy scores, identification accuracy score in each category, frequency of no response elicitation and frequency of inaccurate identification for both Group I and Group II. The responses of the children were subjected to statistical analysis using SPSS version 20.0. The results revealed a statistically significant difference between the two groups, which indicates that Group II, who was presented with the developed visual scene image dataset, performed significantly better than Group I, who was presented with line drawings. The results obtained were consistent with earlier published literature. This demonstrates that the developed visual scene image dataset can be utilized in AAC systems in the Indian context.

6.1 Implications of the study

1. The developed visual scene image dataset can be successfully used in acquiring new vocabulary concepts.

2. The developed visual scene image dataset can be used for the purpose of language expansion as well as for developing social skills like joint attention and turn taking.

3. Using this visual scene image dataset, AAC users can generalize their acquired language easily in daily life due to its resemblance with the natural environment.

4. This image dataset can assist individuals with specific developmental disabilities in attention and minimizing cognitive demands due to the presence of familiar and meaningful Indian cultural contextual cues, especially in ASD children.

5. Finally, in the era of technological revolution, this visual scene image dataset can be easily incorporated into AAC systems for better elicitation of responses in individuals with Complex Communication Needs.

6.2 Limitations of the study

1. The sample size considered for the field testing was less. Greater sample size could have increased the validity of the results obtained. The sample size could not be increased in the present study due to time constraints.

2. The current study selected two groups of participants to participate in the two presentation conditions (line drawings and visual scene images). However, if the same set of participants were selected to perform both the conditions after a specific time interval, the results would have been more reliable. This could not be accomplished in the present study due to the time constraint and difficulty of following up on the same subjects.

6.3 Future directions of the study

1. In the present study, the identification accuracy of responses was measured. Future studies can incorporate measuring reaction time for the responses as it was observed during the field testing that the participants responded rapidly when presented with visual scene images compared to line drawings.

2. More categories can be included in this visual scene image dataset and can also be assessed in individuals with various communication disabilities like Cerebral palsy, Intellectual disability and acquired conditions such as Aphasia to validate the findings.

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APPENDIX A

VISUAL SCENE IMAGE DATASET – VALIDATION FORM

Name: **SLP/ Parent**

Definition of parameters

1. **Clarity:** Whether the overall clarity of the image is appropriate in terms of both focus and contrast?
2. **Relevance:** Whether the image is culturally and ethically acceptable?
3. **Colour:** Is the image appropriate in terms of colour?
4. **Iconicity:** Does the image appear to be recognizable and representational?

Rating Scale:

0- Not satisfactory
1- Satisfactory
2- Good
3- Excellent

Please circle the most appropriate rating.

Sl. No.	Visual scene image	Clarity	Relevance	Colour	Iconicity
1. Fruits					
1.	Apple	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
2.	Banana	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
3.	Chiku	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
4.	Grapes	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
5.	Guava	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
6.	Orange	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
7.	Papaya	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
8.	Pineapple	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
9.	Pomegranate	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
10.	Watermelon	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3

Sl. No.	Visual scene image	Clarity	Relevance	Colour	Iconicity
2. Food items					
1.	Biscuit	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
2.	Chapati	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
3.	Chips	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
4.	Daal	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
5.	Idli	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
6.	Milk	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
7.	Rice	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
8.	Vada	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
9.	Kesari bhaat	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
10.	Gulab jamun	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
11.	Dosa	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
12.	Chocolate	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
13.	Bread	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
14.	Bhajji	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3

Sl. No.	Visual scene image	Clarity	Relevance	Colour	Iconicity
3. Furniture					
1.	Bed	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
2.	Cupboard	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
3.	Chair	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
4.	Mirror	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
5.	Bookshelf	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
6.	Shoe rack	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
7.	Sofa	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
8.	Table	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
9.	Bench	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
10.	Dining table	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3

Sl. No.	Visual scene image	Clarity	Relevance	Colour	Iconicity
4. Animals					
1.	Dog	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
2.	Cat	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
3.	Cow	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
4.	Zebra	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
5.	Horse	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
6.	Turtle	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
7.	Tiger	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
8.	Leopard	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
9.	Squirrel	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
10.	Lion	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
11.	Rhinoceros	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
12.	Monkey	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
13.	Buffalo	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
14.	Bear	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
15.	Deer	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
16.	Fish	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
17.	Elephant	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
18.	Sheep	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3

Sl. No.	Visual scene image	Clarity	Relevance	Colour	Iconicity
5. Vehicles					
1.	Bus	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
2.	Car	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
3.	Scooter	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
4.	Truck	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
5.	Auto	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
6.	Cycle	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
7.	Bike	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
8.	Train	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
9.	Van	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
10.	Aeroplane	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3

Sl. No.	Visual scene image	Clarity	Relevance	Colour	Iconicity
6. Electrical appliances					
1.	Bulb	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
2.	Electric iron	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
3.	Fan	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
4.	Fridge	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
5.	Laptop	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
6.	Mixer	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
7.	Microwave oven	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
8.	Television	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
9.	Tube light	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
10.	Washing machine	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3

Sl. No.	Visual scene image	Clarity	Relevance	Colour	Iconicity
7. Flowers					
1.	Rose	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
2.	Marigold	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
3.	Jasmine	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
4.	Champa	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
5.	Mogra	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
6.	Lotus	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
7.	Hibiscus	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
8.	Periwinkle	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
9.	Lily	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
10.	Sunflower	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3

Sl. No.	Visual scene image	Clarity	Relevance	Colour	Iconicity
8. Vegetables					
1.	Bottle gourd	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
2.	Brinjal	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
3.	Cabbage	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
4.	Capsicum	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
5.	Carrot	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
6.	Cauliflower	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
7.	Cucumber	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
8.	Onion	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
9.	Radish	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
10.	Tomato	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
11.	Potato	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3

Sl. No.	Visual scene image	Clarity	Relevance	Colour	Iconicity
9. Common objects					
1.	Brush	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
2.	Toothpaste	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
3.	Glass	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
4.	Plate	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
5.	Mobile	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
6.	Comb	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
7.	Bucket	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
8.	Mug	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
9.	Tiffin	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
10.	Bottle	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
11.	Book	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
12.	Pen	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
13.	Pencil	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
14.	Spoon	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
15.	School bag	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
16.	Cup	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3

Sl. No.	Visual scene image	Clarity	Relevance	Colour	Iconicity
10. Daily routines					
1.	Sleeping	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
2.	Brushing	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
3.	Writing	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
4.	Washing clothes	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
5.	Reading	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
6.	Cleaning utensils	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
7.	Combing	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
8.	Drinking	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
9.	Climbing	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
10.	Brooming	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
11.	Eating	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3

APPENDIX B

VISUAL SCENE IMAGE DATASET – VALIDATION REPORT

A total of 120 visual scene images subdivided into ten categories were developed. Three Speech-Language Pathologists with at least three years of clinical expertise in the area of AAC and three parents whose children have utilized AAC for at least six months validated the developed visual scene image dataset. All images with good or excellent ratings (0-Not satisfactory, 1-Satisfactory, 2-Good, 3-Excellent) in all four parameters (Clarity, Relevance, Colour, Iconicity) were considered for the final image dataset. The remaining images were updated in accordance with validator suggestions. Suggestions are given below.

Sr. No.	Categories	Suggestions
1.	Fruits	Chiku - Modify depth of field (shallow depth of field is needed to increase the focus) Pineapple - Modify depth of field (shallow depth of field is needed to increase the focus)
2.	Food items	Excellent
3.	Furniture	Bed - Modify depth of field
4.	Animals	Dog – Employ more natural background Leopard – Modify the focus of the image
5.	Vehicles	Excellent
6.	Electrical appliances	Excellent
7.	Flowers	Excellent
8.	Vegetables	Potato – Change the background for better identification
9.	Common objects	Bucket - Modify the focus of the image Comb – Change the background for better identification
10.	Daily routines	Climbing - Employ a more natural background

APPENDIX C

CONSENT FORM

All India Institute of Speech and Hearing, Naimisham Campus, Manasagangothri, Mysore-570006

Dissertation on

“DEVELOPMENT AND VALIDATION OF VISUAL SCENE IMAGE DATASET FOR INDIAN AAC USERS”

You are invited to participate in the study titled “Development and validation of visual scene image dataset for Indian AAC users”. This study is conducted by Ms Kale Ankita Deepakkumar, a postgraduate student of the All India Institute of Speech and Hearing, under the guidance of Dr Reuben Thomas Varghese, Scientist, Department of Speech-Language Sciences and Co-guidance of Dr R. Rajasudhakar, Associate Professor, Department of Speech-Language Sciences, All India Institute of Speech and Hearing, Mysore. The study aims to develop and validate the visual scene image dataset and conduct a pilot study to test the utility of the images by comparing the results with line drawings. Participants and caregivers will be interviewed to obtain demographic details and necessary information prior to confirming eligibility for the study. Once eligible, the Visual Scene Images/ Line drawings will be presented to the participants via tele-mode, and the responses will be recorded for further reference. The identity of the participant will not be revealed at any time, the information and videos will be maintained confidential. The data obtained will not be disclosed, and access will be limited to individuals working on the study. Participation in this study is voluntary. You can refuse to participate or withdraw at any point in the study without penalty or loss of benefits to which you are otherwise entitled. The procedures of the study are non-invasive, and no risks are associated.

Informed Consent

I have read the preceding information or read it to me in the language I understand. I have had the opportunity to ask questions about it, and any questions I have asked have been answered to my satisfaction.

I, ____, give consent on behalf of my child to be a participant of this investigation/study/program.

Name and signature

of the Child/ Parent

Name and signature

of the investigator

APPENDIX D

Sample of Visual scene images

Few Visual scene images captured for the category of Food items are given below.

The entire Developed Visual scene image dataset is provided on CD.

1. Dosa

2. Biscuit

3. Chapati

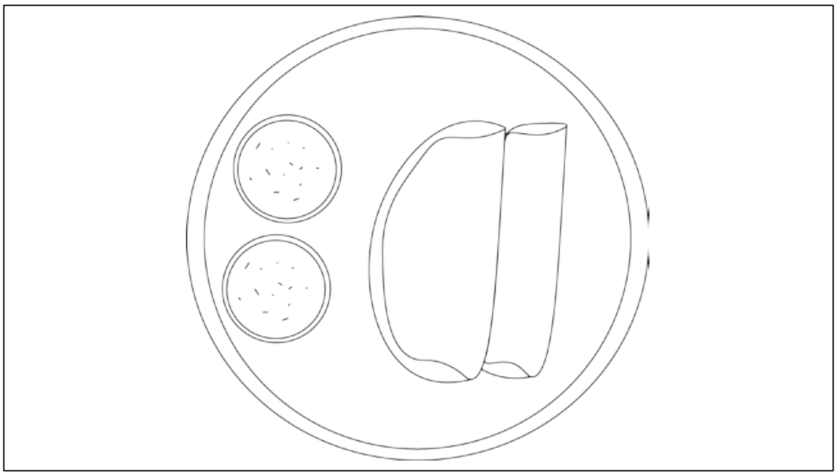
4. Gulab jamun

5. Rice

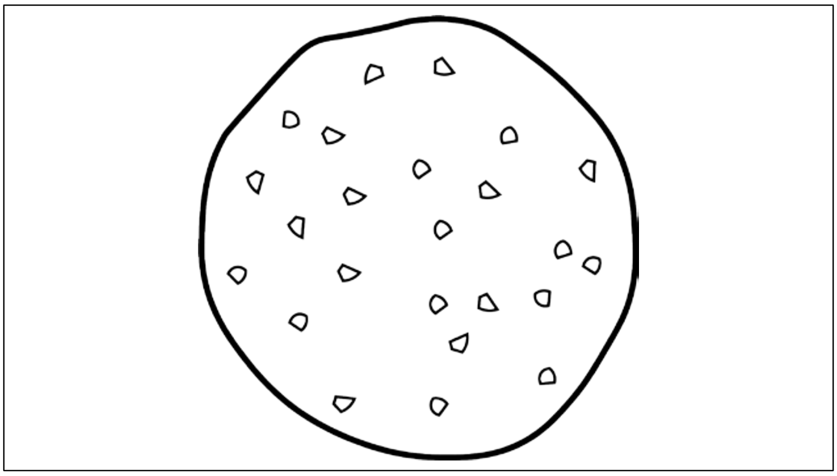
Sample of Line drawings

Few Line drawings for the category of Food items are given below. All the line drawings used as stimuli are provided on CD.

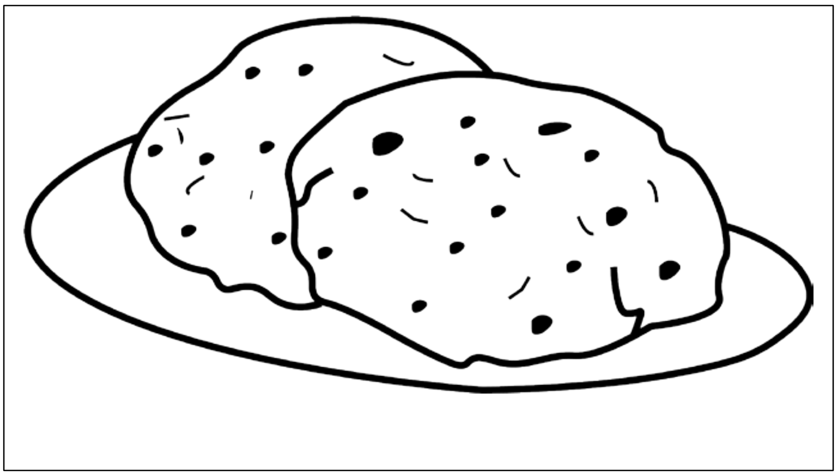
1. Dosa



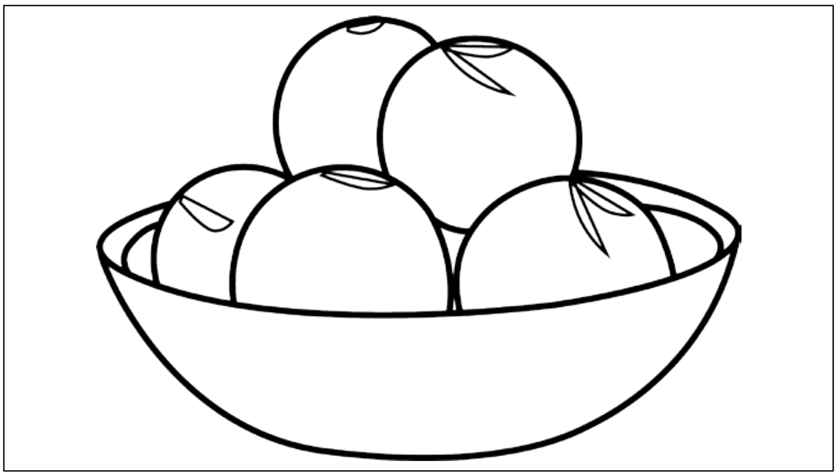
2. Biscuit



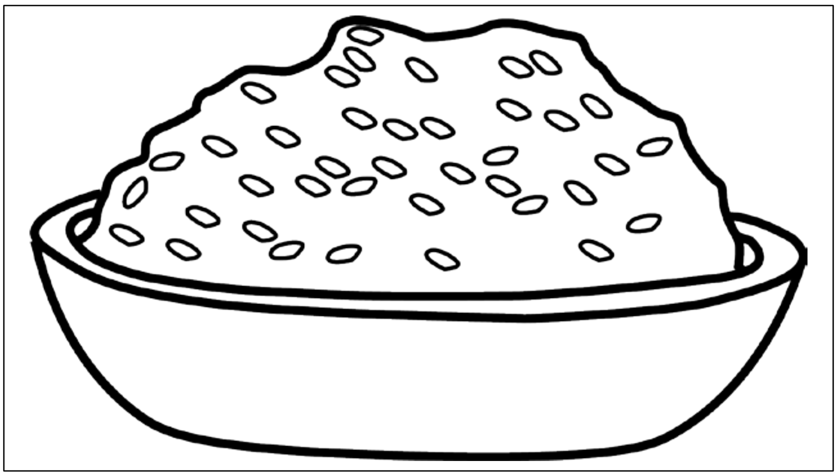
3. Chapati



4. Gulab jamun



5. Rice



Sample of Visual scene images

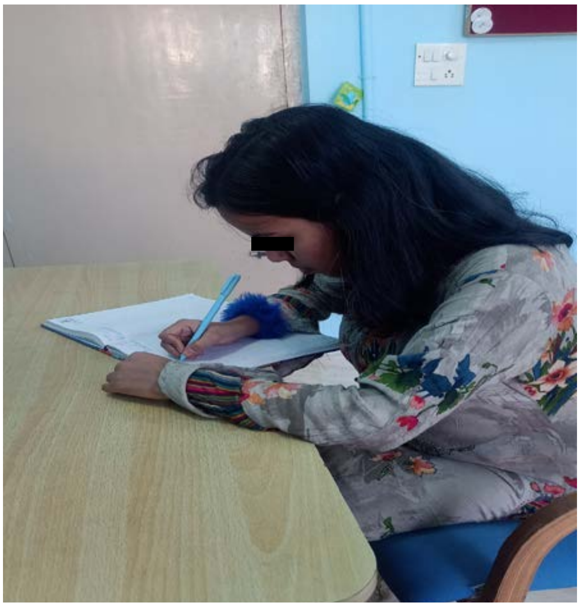
Few Visual scene images captured for the category of Daily routines are given below.

The entire Developed Visual scene image dataset is provided on CD.

1. Sleeping

2. Brushing

3. Writing

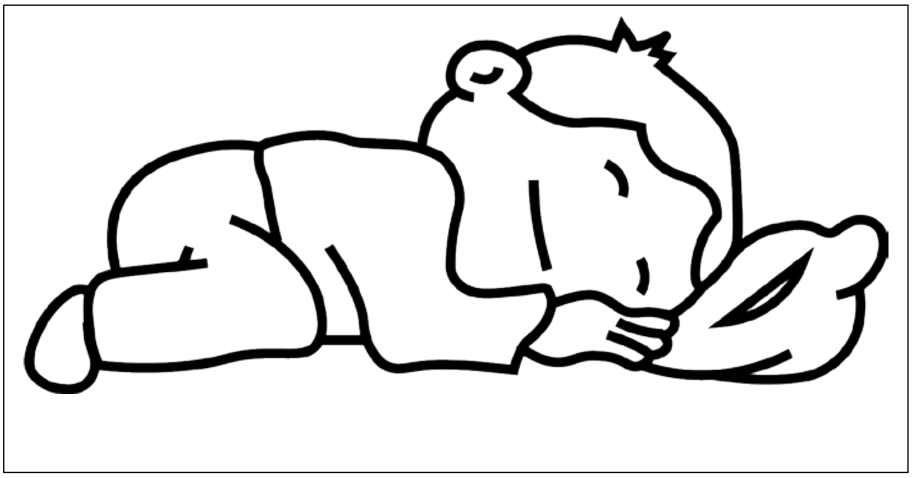


4. Washing clothes

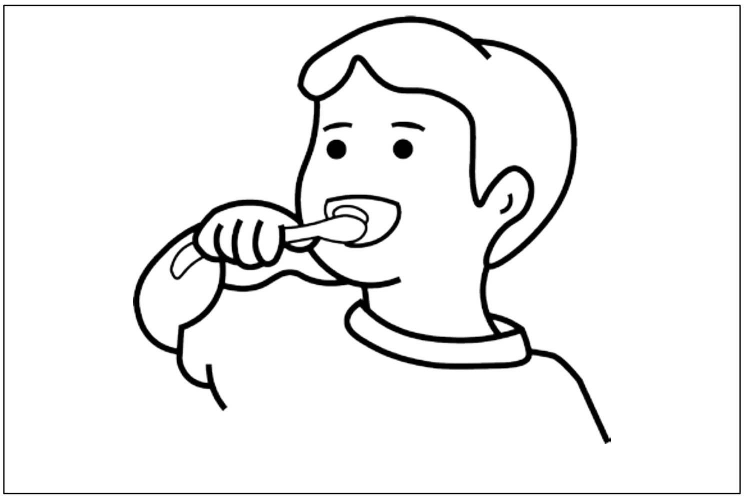
Sample of Line drawings

Few Line drawings for the category of Daily routines are given below. All the line drawings used as stimuli are provided on CD.

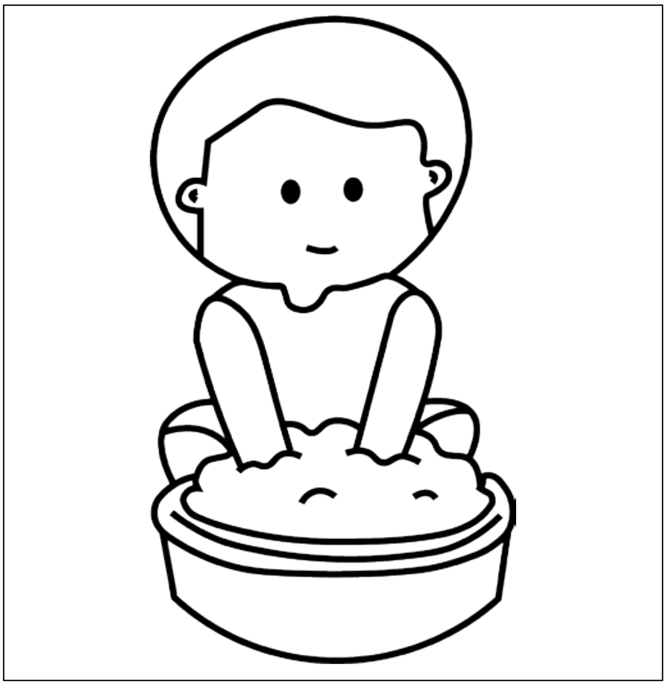
1. Sleeping



2. Brushing



3. Washing clothes



4. Drinking