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The Effectiveness of Augmentative and Alternative
Communication for Developing Requesting Skills in Children with
Autism Spectrum Disorder

運用輔助溝通系統對於自閉症兒童發展請求技巧之成效

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ABSTRACT

Background: Communication is an important factor for independent living. Children with autism spectrum disorder (ASD) fail to communicate with others and express their needs and desires like their other neurotypical peers. Therefore, requesting contributes to the independent life of children with ASD. Augmentative and Alternative Communication (AAC) is a tool which promotes social communication skills such as the requesting skill in children with ASD. The purpose of the study was to evaluate the effectiveness of AAC intervention by using the most to least prompting strategy to develop requesting skills in children with ASD and to generalize this skill to a different setting. Method: Three children with ASD, aged 3 to 10 years and residing in India, participated in this study. A multiple probe experimental design across participants was used to evaluate the effectiveness of AAC on requesting skill of children with ASD. Results: All three participant's requesting skills significantly improved when AAC was implemented along with the most to least prompting strategy. A functional relation was found between the use of the most to least prompting strategy combined with the AAC application and the development of requesting skills, suggesting that this combined method can be an effective intervention for enhancing communication in children. Furthermore, the target behavior was generalized across different settings for all three participants. The effect size of requesting skill across participants was large. Discussion: This study demonstrated that AAC applications combined with most to least prompting, effectively increased independent requesting skills in children with ASD and supported generalization across settings. It further highlights the cultural and practical relevance of mobile-based AAC tools in resource limited contexts with

additional benefits including vocabulary acquisition, increased attention and reduction in problem behaviors. Conclusion: The findings suggest that the most to least prompting strategy in combination with AAC is an effective approach to teaching and promoting functional communication among children with ASD. The integration of this approach offers a practical, cost-effective solution for both educational and home settings.

Keywords: autism spectrum disorder (ASD), augmentative and alternative communication (AAC), communication, requesting skills, speech generating device



摘要

溝通是獨立生活的重要因素之一。自閉症兒童在與他人互動時，往往無法像典型發展的同儕一樣能夠清楚表達其需求與願望。因此，請求行為對於促進自閉症兒童的獨立生活具有關鍵意義。輔助溝通系統為一種有助於增進社交溝通技巧之工具，可有效促進自閉症兒童的請求能力。本研究旨在評估結合最多到最少提示策略之輔助溝通系統介入對自閉症兒童請求行為的成效，並進一步探討在不同情境中的類化情形。本研究採單一受試實驗法之跨受試多探試設計，參與對象為三位居住於印度、年齡介於 3 至 10 歲的自閉症兒童，旨在評估輔助溝通系統對其請求技能之成效。當輔助溝通系統介入與最多到最少提示策略實施時，三位參與者之請求行為均有顯著提升。研究結果顯示，介入與請求行為表現之間具有顯著的功能關係。參與者亦展現出請求行為在不同情境中的類化效果。此外，受試者們請求技能之效應量也達高度效應量。本研究結果支持輔助溝通系統介入與最多到最少提示策略可有效提升自閉症兒童之請求技能，並促進該技能在不同情境中的類化。本研究也顯示在資源有限之情境下，行動裝置為基礎的溝通輔助系統具備文化與實務上的可行性，並可能帶來詞彙學習、專注力提升與減少問題行為等附加益處。本研究結果顯示，輔助溝通系統介入結合

最多到最少提示策略為一有效促進自閉症兒童功能性溝通之介入方式。此整合策略可作為教育及家庭場域中具成本效益且實用的教學方案。

關鍵詞：自閉症類群障礙、輔助溝通系統、溝通、請求技能、語音生成裝置



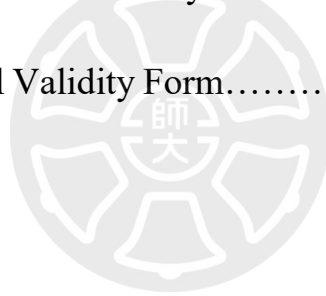
TABLE OF CONTENTS

ABSTRACT	i-iv
TABLE OF CONTENTS	v-viii
LIST OF TABLES	ix
LIST OF FIGURES	x
CHAPTER I INTRODUCTION	1
1.1 Background.....	1
1.2 Objectives of the Research.....	6
1.3 Operational Definition of Key Terms.....	7
1.4 Significance of the Research.....	9
CHAPTER II LITERATURE REVIEW	11
2.1 Functional Communication.....	11
2.2 Autism Spectrum Disorder.....	12
2.3 Augmentative and Alternative Communication.....	15
2.3.1 Types of AAC Modalities.....	16
2.3.2 Application of AAC on ASD.....	19
2.3.3 Advantages of AAC.....	25

2.4 AAC in the Research: Statistics on the use of AAC globally and in India.....	28
2.5 Research Gaps.....	30
CHAPTER III METHOD.....	33
3.1 Structure of Research.....	34
3.2 Research method.....	34
3.2.1 Participants	34
3.2.2 Setting.....	39
3.2.3 Materials.....	40
3.2.4 Response Definition and Measurement and Dependent Variable.....	43
3.3 Research Design and Procedures	45
3.3.1 Preferred Stimuli	45
3.3.2 Baseline	47
3.3.3 Training.....	48
3.3.4 Intervention	53
3.3.5 Maintenance	55
3.3.6 Generalization	55

3.4 Pilot Study.....	56
3.4.1 Background.....	56
3.4.2 Result of the study.....	57
3.4.3 Implications and revisions on the current study.....	58
3.5 Data Collection and Analysis.....	59
3.5.1 Data Collection.....	59
3.5.2 Data Coding.....	60
3.5.3 Data Analysis.....	62
3.6 Interobserver agreement.....	66
3.7 Procedural fidelity.....	69
3.8 Social Validity.....	70
3.9 REC Taiwan.....	72
CHAPTER IV RESULT.....	75
4.1 Visual Analysis.....	75
4.2 Effect Size for children's target behavior.....	82
CHAPTER V DISCUSSION.....	85
5.1 Summary of findings.....	85

5.2 Limitations and Recommendations for Future Research.....	91
5.3 Implications for Practice.....	93
5.4 Conclusion.....	95
REFERENCES.....	97
APPENDIX A: Consent letter	141
APPENDIX B: MSWO Data Preference Sheet.....	142
APPENDIX C: Data Coding Form for Event Recording.....	143
APPENDIX D: Procedural Fidelity Intervention DataSheet	144
APPENDIX E: Social Validity Form.....	145



List of Tables

Table 3.1. Participant's Demographics.....	38
Table 3.2. Definitions of Dependent Variable	44
Table 4.1. Calculations-Visual Analysis.....	78
Table 4.2. Result of Participant's Effect Size.....	84



List of Figures

Figure 2.1 The HAAT Model.....	22
Figure 3.1. Structure of the research.....	34
Figure 3.2. Model of the Classroom setting.....	40
Figure 3.3. Interface of the Application.....	42
Figure 3.4. Visual Support of Training Steps.....	51
Figure 3.5. Prompts listed from most to least intrusive level.....	52
Figure 4.1. Result of the Children’s Requesting Skill.....	77



CHAPTER I

INTRODUCTION

1.1 Background

Communication is a process of exchanging information in various forms with others. Communication is not limited to verbal communication like language but also includes non-verbal communication via gestures, symbols, and technologies (Heflin & Alaimo, 2007). Functional communication is referred to as the basic communication skill (Speech and Language Solutions). The four main functions of communication are to convey one's needs and wants, transfer information from one person to another, maintain social closeness, and to possess social etiquette (Light, 1998). For example, requesting is one of the most necessary skills that an individual should possess. It is an act of calling attention to one's wants or desires (Merriam-webster dictionary). When a child wants his most basic needs to be fulfilled such as "I want to drink water," "I want to go to the bathroom," or "I am hungry." It is essential for enabling individuals to convey essential wants and needs effectively (Hall, 2012; Mirenda, 2003; Thompson & Johnston, 2012).

However, previous research has suggested that about 30% of individuals with autism spectrum disorder (ASD) are non-verbal or have minimal verbal abilities (Kasari et al., 2013). The Diagnostic and Statistical Manual 5 (DSM-5) criteria deficits in social communication include the failure of social-emotional reciprocity. It explains that when an individual fails to converse in a normal back-and-forth technique or an individual's inadequacy to initiate or respond to social interactions. Although requesting and language impairment are not included in the social communication criteria for ASD. It is treated as a descriptor within the diagnosis of ASD (American Psychiatric Association, APA, 2013). These deficits mostly start becoming apparent when children get older, and the social communication needs and expectations start increasing (Tantam, 2003). Impairment of functional communication is quite common among children with ASD (Gengoux et. al., 2021). Some children display maladaptive behaviors such as aggression, self-harm, and tantrums when they cannot articulate what they desire (Reichle & Wacker, 2017). Estimates suggest that 25% to 50% of individuals with ASD never completely acquire functional communication (Brignell et al., 2016; Armstrong & Jokel, 2012). Therefore, learning requesting skills especially for children with ASD is especially important when the children's language skills start increasing. Therefore, children with ASD need intervention

to develop their requesting skill. This provides them with a chance to have greater control of their environment and communicate with others in a socially acceptable form of communication that can be easily understood (Chan & Zoellick, 2011; Howes, 1983; Sigafos & Mirenda, 2002).

Augmentative and alternative communication (AAC) is defined as a research area and a method where technology compensates for the communication impairment of children dealing with communication difficulties (ASHA). This includes speech-language production which can be in written or spoken modalities. AAC refers to a wide span of disciplines which consists of assistive technology, psychology, rehabilitation, special education, and speech-language psychology. Thus, it is deduced that there is a wide range of subject matter which comes under AAC. AAC can be a method to support communication skills (e.g., speaking out or forming particular words or sentences to ask for what they want) and improve communication in children with ASD. Brignell et al., (2016) and International Society for Augmentative and Alternative Communication (ISAAC, 2018) stated that AAC includes tools and strategies that an individual with ASD who has a speech deficit, or a language impairment can use to supplement or replace speech or writing. Furthermore, AAC is also often used to amplify

unintelligible speech. Therefore, the primary function of AAC is to assist people with limited speech to communicate using an alternative to speech.

The use of technological gadgets has effectively contributed to a successful educational experience for both children with and without disabilities (Martin & Crawford, 2004). High tech AAC devices like iPad and other mobile apps are utilized in classrooms to facilitate student learning. This enhances their problem-solving and cognitive thinking ability (Pilgrim et al., 2012). The use of the AAC application will also be useful in a special education classroom where the teachers and students can access the content and control the data by adding the necessary specifications needed by the student. The iPad and various other AAC applications and devices are preferable to other low tech AAC devices considering the accessibility, cost effectiveness, durability, and appearance (Hartnett & Price, 2011). Therefore, in this world of digitization and globalization, the 21st century has reconstructed the form of communication. Each classroom reflects the communicative connectivity, complexity, and conjunction between students from diverse cultures and communities (Lotherington & Jenson, 2011). Since we have noticed that children with ASD have deficits in social communication and the use of AAC can help them provide a means to assist them with these difficulties. Providentially, some of the research indicated that AAC could be an effective

medium for learning and communication for children with ASD (Chiang & Lin, 2007). This technology can be motivating, safe, and emotionally engaging because many children with ASD have a natural affinity with technological devices.

The current study was conducted in India and one of the issues in the society related to the application of AAC in the classroom is the unacceptability of the mobile device inside the classroom. This implies that social disapproval leads to discrimination against an individual and their exclusion from society (APA, 2023). Another issue which contributes to the avoidance of AAC application is the attitudinal barriers of the parents and teachers. It limits the person with a disability to communicate with their peers and participate in daily activities. The worries and anxiety about being denied access to communication devices and support by adults who do not support AAC is one of the prominent attitudinal barriers of AAC (Baggs, 2012). The high-tech AAC device can be catalyst to help an individual with ASD fit in the society with its peer (Conley, 2012; Shinohara & Wobbrock, 2011; Van Laarhoven et al., 2009) as well as raise social awareness and acceptance of the AAC technological device.

In 2017, a study conducted in India which highlighted the trainer's perception that using touch screen technology improves the children's interest to

participate (Sankardas & Rajanahally, 2017). The trainers felt that this technology can be a useful educational tool, and many more educational concepts can be added in picture mode. This will give the children an opportunity to be independent. However, there is a limited amount of evidence-based research studies conducted in India which caters to the communication needs of children with ASD using AAC.

2.5 Objectives of the Research

This research sought to investigate the application of high-tech AAC technology to enhance requesting skills among children with ASD in India. Additionally, this research sought to garner insight into variables like language and vocabulary and the method of most to least prompting to make children with autism functionally independent. The purpose of this study is to explore how effective the use of AAC is for children with ASD to help them to request and spontaneously communicate with another individual. Therefore, in context of functional communication and requesting skill the following hypothesis is proposed: The use of AAC system increase the ability of the child's requesting skill for children with ASD in India.

More specifically, the study aims to answer the research question:

1. Does the use of AAC increase communication in the form of requesting skill in children with ASD by using the most to least prompting method?
2. Do children with ASD generalize requesting skill via the AAC application independently across settings?

2.5 Operational Definition of Key Terms

Children with autism spectrum disorder (ASD)

ASD is defined as a neurodevelopmental disorder (DSM-5) which often affects how children with ASD perceive and socialize with others (Durand, 2014). The primary impairment observed in individuals with ASD is social communication (Howlin et al., 2014; Pickles et al., 2014; Tager-Flusberg & Kasari, 2013).

In this study, individuals with ASD are referred to as children within the age range of 3 to 10, diagnosed with ASD by a professional and those who are unable to effectively communicate verbally and have difficulties to socially communicating with others. MacArthur Bates Communication development Inventory was used to assess the children's early language and communication skills (Fenson et al., 2007).

Augmentative and alternative communication (AAC)

Speech is a mode which an individual utilizes to communicate with one another. Whereas AAC involves the use of non-speech modes as a supplement or a substitute for spoken language (Tetzchner & Jensen, 1996). Minimally verbal children with ASD represent a largely underserved and under-researched within the spectrum (Tager-Flusberg & Kasari, 2013).

In the current study, AAC is defined as the use of mobile technology like android phones, iPhone or tablets which has an application LetMeTalk downloaded. The participants in my study will use the AAC application to effectively communicate with others by touching the icon of the item that they want to request.

Requesting skill

Requesting skill is defined as an ability to functionally communicate with others and independently ask for what they need or want (Skinner, 1957). It is a skill that leads to greater independence for an individual (LeBlanc et al., 2009; Sundberg & Michael, 2001).

In this study the researcher asks the question, “what do you want to play?” or “which toy do you want?” to the participant. The participant is prompted to

select the specific icon by touching the screen of the AAC application to make a request.

1.4 Significance of the Research

India estimates that about eighteen million people have ASD (Economic Times, HealthWorld, 2022). There was a dwindling number of studies related to high-tech AAC technology catering to the communication skills of children with ASD. There were only three studies conducted in India between the years 2001 to 2022. However, only one study was a pretest – posttest control group study design (Lal, 2010), while the other two were pilot study (Srinivasan et al., 2022; Srinivasan et al., 2011) and project report (Sankardas & Rajanahally, 2017). Although these studies have explored the use of AAC to assist children with ASD in their communication skills (Srinivasan et al., 2022; Srinivasan et al., 2011; Lal, 2010; Sankardas & Rajanahally, 2017), there is a route of insight which has not been investigated, in existing literature. Comparatively, previous research has investigated the use of AAC among individuals with ASD. Given the various factors that may influence the usage of AAC, the focus of the study can be further narrowed.

Given the fundamental role of AAC, this study aims to enhance and support the communication abilities of individuals who stand to benefit from its use. It is the priority of the researcher to learn about the preferences, interactions, and capacities of those who use the tools. One way to do so was to gain insight into the perspective of the parents or teachers closest to the user. Every piece of reliable information will help this study further develop and understand the user's individual needs and preferences that impact on the use of AAC and make the device a crucial tool for effective communication in the daily lives of the user.

Various researchers shed some light on how the different modalities of AAC help children with autism to request; however, we notice that there remains a research gap in the neurological and psychological factors that control and contribute to language and communication for individuals with ASD. Considering these factors, it enormously guides the practitioners and teachers to remove the social stigma and attitudinal barriers and select the appropriate assessments and the mode of AAC to help the individual with ASD bring about a positive change in independent communication. Even though there are some studies conducted in India related to AAC and ASD, there is a lack of strong evidence-based study.

CHAPTER II

LITERATURE REVIEW

2.1 Functional Communication

Functional communication represents expressing a person's wants and needs to those around them and socializing with them (Beukelman & Light, 2020). Therefore, functional communication refers to the skills, knowledge and attitude possessed by an individual from which the individual's competence and effectiveness may be inferred (Larson et al., 1978). It can vary in various ways, including words, gestures, sign language, pictures, and assistive devices.

The primary function of communication is to convey information from one person to another. This can be applied to many situations (e.g., asking for help, shopping, requesting something or relaying information). Teaching functional communication promotes active participation in home, school, and community environment (Hendricks & Wehman, 2009; Orsmond et al., 2004). Many children with ASD show negative behavioral problems like aggression, frustration, and tantrums. These characteristics mostly emerge because they cannot relay their message or communicate. Being able to functionally communicate avoids frustration and promotes reinforcement.

2.2 Autism Spectrum Disorder

ASD is characterized as “a developmental disability that causes significant social, communication and behavioral challenges in an individual,” it may also involve myriad aberrant perceptual, cognitive, linguistic, and social behaviors (Hallahan et al., 2020). ASD is a neurodevelopmental disorder described by difficulties related to social communication and restricted, repetitive behavioral patterns (Diagnostic and Statistical Manual -5; American Psychiatry Association, 2013). The term spectrum reflects the continuum in impairments associated with ASD, from mild to severe. The American Psychiatric Association describes this term as a ‘gold standard’ for diagnosing autism (APA, 2013). Therefore, ASD is a developmental disorder which affects the behavior of an individual and their interactions with the world around them.

The DSM-5 recognizes ASD as an umbrella term which includes Asperger’s syndrome in the spectrum. The symptom of ASD encompasses a broad range and are categorized by DSM-5 into two domains: deficits in social communication and restricted, repetitive patterns of behavior. It is also emphasized that the deficits may begin in the early childhood years of children with ASD though it may not be recognized earlier until the children’s communication skills become recognizable (Hallahan et al., 2020).

Students with ASD often demonstrate a lack of speech and language skills (Bondy & Frost, 1994; Sigafoos et al., 2004a; Sturm & Clendon, 2004). They often rely on behaviors such as gestures, eye gazing and facial expressions than verbal communication. Moreover, if their gestures or signs are not understood by their teachers or parents, these students display problem behavior (e.g., aggression, self-injury and tantrums to express their needs and wants) (Sigafoos et al., 2004b; Reichle & Wacker, 2017; Durand, 1993; Durand & Merges, 2001). Consequently, to help children with ASD who need to make advancement beyond their early communicative behavior of language or decrease challenging behaviors through enhanced communication, AAC strategies can be one of the tools which can be used to support their communication development to ensure that the AAC technology facilitates communication (Sevcik et al., 2004; McNaughton & Light, 2013). Research suggests that a considerable number of children with autism have difficulty acquiring speech. It is estimated that one third to one half of children with ASD lack functional communication (National Research Council, 2001).

Regarding social communication characteristics in children with ASD, ASD is recognized as a spectrum, with the type and severity of the impairments differing widely among individuals. Although an area which is frequently and most impacted by autism is communication and language (Beukelman & Mirenda,

2013). Some of the common symptoms of ASD are echolalia, nonverbal, lack of eye contact, and communication difficulties. Therefore, children with ASD find it exceedingly difficult to express themselves. They do not know how to ask for what they want and illustrate their thoughts to another person. The acquisition of expressive functional communication is more complex than acquiring receptive communication (Pelios & Lund, 2001). Therefore, children with ASD experience a lot of difficulties in expressing themselves by using language to communicate effectively (Filipek et al., 1999).

Children with ASD lack communicative intent or the desire to communicate for social purposes. Some children also suffer severe language impairment, they tend to use little or no language (ASHA, n.d.; Scheuerman & Webber, 2002). Some studies have also shown that children with autism are unable to compensate for speech impairments with gestures or facial expressions (Heflin & Alaimo, 2007) These children commonly show deficits in communicating for social purposes, familiarizing themselves with social partners, or sharing affective or emotional states with others (Wetherby et. al., 2000). Using language for the purpose of communication becomes extremely difficult for children with ASD.

Furthermore, if language is not acquired the difficulty in functional communication will increase making children with ASD unable to interact socially. This poor prognosis of children with ASD makes them a suitable candidate for AAC (Alzayer, 2020; Gevarter et al., 2020; Holyfield et al., 2017; Muharib et al., 2019).

2.5 Augmentative and Alternative Communication

AAC can be defined as all forms of communication other than oral speech that are used to express thoughts, needs, wants and ideas (American Speech & Hearing Association ASHA). AAC is a field of study and a wide variety of technology that helps individuals with social communication deficits bridge the gap between communication problems and the individual (Beukelman & Light, 2020). It is a continuum of communication that supports individuals with communication impairments who lack functional speech (Mirenda, 2009). The term Augmentative refers to AAC device's role in enhancing or supporting existing communication such as speech, while the term alternative denotes its function as a substitute communication method when speech is not available (Smith et al., 2014). If an individual is denied the ability to communicate intelligibly and articulate his words effectively then he is deemed to have a life of social and emotional isolation (Prentice, 2022). AAC includes all forms of

communication except for oral speech that is used to express an individual's needs, wants, desires, and thoughts through the device. Therefore, the use of AAC should assist, facilitate, or augment an individual's speech or function as an alternative method for an individual to communicate. Consequently, developing and maintaining a relationship with others and removing the communication gap that persists. It can be either an additive to their existing speech disorder or a substitute method to express themselves. Therefore, due to the commonly affected areas in individuals with ASD, AAC can be employed to address a range of language and communication challenges.

2.3.1 Types of AAC Modalities

Previous studies have examined the diverse modalities of AAC and the influence of technological advancements on achieving communication goals (McNaughton & Light, 2013; Chavers et al., 2021; Van Der Meer et al., 2013). AAC encompasses a range of systems specifically developed to support individuals with communication impairments (Beukelman & Light, 2020). These systems are generally categorized into two primary types: aided AAC, which requires external tools and unaided AAC which relies on the individual's body such as gesture and facial expression.

Unaided AAC

The unaided AAC system does not require any external technology. This type of modality encompasses the “modes that rely on the user’s body to convey the message” (Baxter et al., 2012). Some of the examples of unaided AAC systems are gestures, signs, eye contact, and speech approximation which is also known as non-verbal communication by individual who does not use any technological tools (ASHA, n.d.; Buekelman & Mirenda, 2013). However, this classification excludes sign language as sign languages like American Sign Language (ASL) as they are recognized as complete language (ASHA, n.d.).

Aided AAC

Modalities that incorporate outside devices to cater to the communication needs of the individual with communication deficits are categorized as aided AAC devices (Desch et al., 2008). Within the category of the aided AAC device there is a sub-categorization of three main factors which includes low tech device, mid tech, and high tech device (Baxter et al., 2012). The aided system requires some form of technological device. This system may constitute photographs, pictures, words, symbols, or letters of some vocabulary concepts so that the individual can

apply these during conversing with another individual. These illustrations are organized in diverse ways depending on the application that is being used.

A low technology AAC system may include communication boards, a picture exchange system (PECS) which is a paper based tool that used visual symbols to represent words allowing individuals to point at or physically exchange images (Ganz et al., 2012), and Pragmatic Organization Dynamic Display (PODD) which consists of a wide range of vocabulary for spontaneous, unpredicted messages (ASHA n.d.; Porter & Cafiero, 2009). In addition to this, low-tech devices are inexpensive, simple, and easy to obtain (Cook & Hussey, 1995; Quist & Llyod, 1997, p. 107).

The high technology systems represent some most advanced forms of technology used in the high tech AAC modalities. The Speech-generating devices (SGD) that include a mobile phone, a tablet or an iPad which consists of a variety of AAC applications and digital communication media which can be bought online. SGDs are electronic communication tools that utilize symbols to represent sounds, words, or phrases and deliver messages through digitized voice outputs (Achmadi et al., 2012; Rispoli et al., 2010; Schlosser & Koul, 2015). They are portable electronic devices which can generate a pre-recorded verbal message (Mirenda, & Iacono, 2009). SGDs its divided into two categories: a static display

and a dynamic display. SGDs with static displays adhere to a standard format. When individual symbols are selected, the screen remains unchanged. When a user taps or selects a symbol on a dynamic display SGD, the device may present a new screen display on the device, allowing the user to navigate by scrolling up, down, left or right to find the desired symbol (Achmadi et al., 2015). It can also be accessed by a mouse or a joystick controller (Desch et al., 2008). Both static and dynamic display systems can be accessed either indirectly or directly. Many dynamic display SGDs (e.g., iPad, iPod) are commonly operated using a touchscreen interface. Additionally, the individual using the high technology AAC can access the application like Proloquo2go™ by selecting the picture, word or visual representation within the application that is spoken aloud by the device (AssistiveWare), if it is a touch screen mobile device or by directly selecting the item that is offered to him by the instructor.

2.3.2 Application of AAC on ASD

Considering the various AAC modalities available which significantly benefit individuals with ASD with difficulties in speech by enhancing their communication skills (Light et al., 1999), many researchers have compared the efficacy of the device, their rate of learning and the preferred communication method among students with ASD (Ganz et al., 2013; Hill & Flores, 2014; Lorah

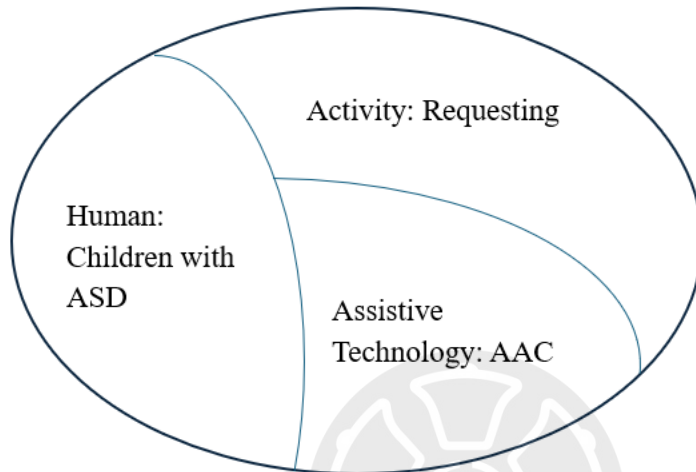
et al., 2013; Lorah et al., 2022; McLay et al., 2015; McLay et al., 2017; Van der Meer et al., 2012). These studies have explored the effectiveness of AAC devices in facilitating communication. A study in 2013 evaluated the preference of three preschoolers with ASD. The result indicated that one of the participants preferred using the AAC application and the other participant preferred using the traditional PECs (Van der Meer et al., 2013). According to the study in 2014, both PECs which is a low tech AAC device and iPad which is a high tech AAC devices were compared which used children with ASD as their subjects. The outcome was that the teaching of low technology picture exchange prior to introducing the iPad may be effective progression in teaching communication reciprocity skills for students with ASD (Hill & Flores, 2014). A systematic review in 2022 selected twenty studies which included a total of 242 students with ASD. The research incorporated SGD, PECs, and Makaton as forms of AAC modalities. The age ranged from 5 to 13 years, and the result of the study indicated that the preference for a specific AAC mode was conducted in only two studies and the author deduced that assessing the preference of children with ASD when using AAC is a very important method because the preference of the mode of AAC can affect the result of the study. This is because an individual's preferences might change

over a period (Syriopoulou-Delli & Eleni, 2022). These studies help us to analyze and understand the better use of AAC with ASD population.

The Human, Activity, Assistive Technology (HAAT) model (Cook & Hussey, 1995) is based on human performance as well as recognizes that assistive technology is an extrinsic enabler and enhances an individual's abilities and includes other social and cultural aspects as well as the environment and physical conditions such as temperature, noise, and lighting. The HAAT model includes a person such as children with ASD, the activity which is developing requesting skill and assistive technology such as a mobile-phone or an iPad with the AAC application. In this study, the functional outcome of assistive technology is defined as the non-verbal children with ASD, developing their requesting skill with the help of an AAC device.

Figure 2.1

The HAAT model



The most common characteristic of the student with autism is the difficulty in functional communication. This should be taken into consideration while selecting an AAC device to facilitate the child with functional communication (Mirenda, 2002) though every student's individual needs determine the tool which is appropriate for them. One study demonstrated a positive correlation between the learning characteristics of students with ASD and the specific features of AAC devices (Cafiero, 2005), supporting the notion that AAC is well suited to address the communication needs of these students (Babb et. al., 2020; Cafiero, 2005;

Chavers et. al., 2021). AAC devices utilize visual representation such as symbols, pictures, and words to communicate an individual's thoughts and ideas. This mode of communication is more accessible to non-verbal learners compared to spoken language or manual signs (Mirenda & Schuler, 1988). Consequently, AAC plays a crucial role in enhancing communication skills for students with ASD within the classroom setting. Therefore, when collaborating with people with complex communication difficulties, the researcher needs to evaluate the person's capacity and provide the right kind of care to support their degree of communication abilities. AAC may become an alternative to communication for people with ASD who cannot speak orally or a means of communication augmentation for people with communication challenges.

When we use the AAC application, there is inconsistency in the interface, structure of the content and the navigation system within the high tech AAC system, which may make it difficult to use the system effectively (Alant et al., 2010; Drager et al., 2004; Schlosser et al., 2012; Still et al., 2014). In a review of existing literature in AAC systems it suggests that there is a considerable variation in the symbols and their visual design which is used to create symbols and their iconography (Basson & Alant, 2005; Gevarter et al., 2014; Lloyd et al., 1997). It was exceedingly difficult for a child to transition from different structures and

functions in the AAC system. A system can evolve alongside the child in aspects of vocabulary and content at the same time keeping some of the same iconography and organizational structure. This continuity may facilitate a faster acquisition of an advanced and complex communication method.

To establish an effective adoption of the AAC system, we need to identify the needs of the population who was administering it. The AAC device should be accessible and easy to learn, cost friendly and affordable and facilitate functional communication and social interaction into the daily life of the individual with ASD (Basson & Alant, 2005; Mandak et al., 2017; Rackensperger, 2012; Sevcik & Ronski, 2007).



2.3.3 Advantages of AAC

The benefits of using AAC outweigh the disadvantages of getting dependent on AAC (Blackstone et al., 2007; Lund & Light, 2007). One of the benefits of AAC is that it supports the individual to produce and generate speech by themselves. Therefore, this reduces the stress that the individual feels while facing a situation alone (Beukelman & Mirenda, 2005). Another reason to support AAC is that individuals with autism can disregard their impairments and concentrate on the goal of communication despite their inability to generate speech (Alzrayer et al., 2014; Ronski & Sevcik, 1996). We are currently in a significant shift in the existing paradigm relating to the fields of AAC for individuals with ASD, driven by the growing use of handheld media applications and devices obtained through a consumer-oriented delivery model that is cost-effective, portable, socially acceptable, and readily available. (Shane et al., 2012). One significant advantage of high tech AAC mobile technology is its increased functionality and interconnectivity. These technological advances are not limited to speech prostheses; they are multi-purpose devices that enable individuals to interact effectively (McNaughton & Light, 2013). The nature of communication has shifted to individuals who need AAC “require a need for and a right to the same range of communication options available to everyone else” (RERC on

Communication Enhancement, 2011, p. 3), which includes access to speech output facilitating face-to-face communication, written outcome supporting academic demands, the Internet access which enables information gathering, multimedia elements (e.g., photos, videos) to enhance presentations and texting which fosters social connections.

However, regardless of the many benefits of AAC many interventionists and parents insist on not using AAC because they apprehend that AAC will come a crutch for their children and negatively affect their speech (Dowden & Marriner, 1995; Gevarter et al., 2020). It can be debated that many children may not be motivated to communicate with speech and choose AAC because it was easier for them than generating speech by using words.

Furthermore, it can be challenging to assess the overall language skills and understanding of children who are using the AAC system (Nelson, 1992; Sutton et al., 2022). It will also be difficult to determine whether children with ASD are visual, auditory, or kinesthetic learners. The use of AAC will therefore help the student with ASD by providing and incorporating words, alphabets, graphic symbols, iconography as well as sounds (Trudeau et al., 2007). But, only using AAC does not make children with ASD proficient communicators. A proficient communicator is “other oriented” where he reaches out to ask questions and

responds to questions that are asked in a social setting (Light et al., 1999). A study in 2014 implemented an intervention using a SGD. The participants included three children diagnosed with ASD who were trained to request using an iPad. The participants were expected to activate the message 'I WANT + preferred items name,' setting the device on the table and directing the attention to the instructor. The result indicated that the SGD based intervention, incorporating a modified PECS protocol was effective in promoting the development of requesting skills among children with ASD (King et. al., 2014). Another study conducted in 2019, assessed an SGD based intervention was implemented to enhance functional communication in older individuals of 14 and 23 years of age diagnosed with ASD. The participants were trained to drag a single picture and position it in the sentence strip (SS) using an iPad. Participants were required to combine two symbols I WANT plus the name of the preferred item on the iPad within 5 s. The researcher applied a constant time delay of 1–2 s after pointing to and reading the phrase I WANT and before receiving the item, encouraging the participants to complete the sentence by naming the chosen item. The authors noted an increase in speech production in one participant following the intervention (Wendt et al., 2019).

2.4 AAC in Research: Statistics on AAC Globally and in India

Some studies analyzing the effectiveness of AAC interventions starts from preschool and extends to adulthood. One of the studies where Olive et al, (2008) utilizes SGDs to increase requesting skill during playtime of three children studying in preschool and to elicit the requesting skill of a four-year-old girl with ASD (Olive et al., 2008). The research implements PECs (Ganz et al., 2008; Ganz & Simpson, 2004; Marckel et al., 2006) as the main AAC system. The author also employed additional picture based systems including aided language modelling (Drager et al., 2006). This increased the communication behavior of the child with ASD such as requesting and symbol comprehension. According to Wong et al., there is a lack of evidence-based SGD protocol for children diagnosed with ASD. Currently most AAC applications facilitating requesting interventions utilize a limited field size (Alzrayer et al., 2014). These studies primarily focused on teaching a single target behavior of requesting skill per session, rather than providing opportunities for individuals to choose among multiple preferred items which would reflect more functional and naturalistic communication.

A review of twenty-three studies established that 78% of these studies provided evidence that the usage of SGD could support the development of communication skills among children with ASD; most of the studies targeted

requesting skill (Van der Meer & Rispoli, 2010). Moreover, using SGD is determined to promote functional speech in children with ASD age 5-8 years (Kasari et al., 2014). In a study by Schlosser and Blischak (2004), two students with ASD, one in elementary and one in secondary school were participants who used SGD that provided auditory, visual or combined feedback to improve spelling accuracy with variations in effectiveness depending on feedback type (Schlosser & Blischak, 2004).

A pilot study conducted whichn a special school whichn Tamil Nadu, Whichndia whichh aimed to improve social interaction in children with ASD. The participants included were eight children aged between 11-14 years attending school for more than one year. The study used an SGD app called AVAZ which was installed in an android device or an iPhone. The authors concluded that relevant sentences were formed through the application of each child from the 1st to 21st session ranging from 28.5% to 40%. There were five children that showed improvements, but three children did not form any sentence neither relevant nor nonrelevant (Sonawane & Varshneya, 2020). Therefore, there is a need of conducting more rigorous studies to assess the effectiveness of communicational skills in the light of requesting for children with ASD in India

because there is a limited amount of literature using High tech AAC technology to develop communication skills in children with ASD.

2.5 Research Gaps

Research suggested that up to 25% of children with ASD do not develop functional speech (Eigsti et al., 2011; Rose, Trembath et al., 2016). Therefore, to get across what they need these children rely on AAC. Many clinicians start with an aided low tech AAC system such as picture exchange communication system and communication boards to give children with ASD an opportunity to communicate and which leads to a potential of success with the AAC system before progressing into high tech AAC system (Alzrayer, 2020; Lynch, 2016). Some researchers recommended that there are no prerequisites to introduce high tech AAC system (Ganz et al., 2017; Gilroy et al., 2017; Still et al., 2014). They were in support of the early intervention of high tech AAC with advanced verbal production that will help develop linguistic and cognitive capacities. According to the study of Srinivasan et al., 2022, this commonly used method implemented in low to middle income developing nations, as low tech AAC tools are both accessible and cost effective, making them suitable for individuals across diverse economic groups (Bhatnagar & Srilverman, 1999; Muttiah et al., 2022). Therefore, a high tech AAC application was useful for children with ASD in India.

There are previous studies that prove that High tech AAC is effective for children with ASD in facilitating communication. This study will further extend the literature about the effectiveness of using high tech AAC technology which is inexpensive and accessible to teach children with ASD requesting skills with most to least prompting strategy. However, there are also no experimental investigations that portray the complexity of communication. Although there are several studies that focus on establishing communication by the aid of the AAC system, these studies fail to show how these systems can increase the student's communication (McNaughton et al., 2008; Ronski & Sevcik, 1996; Ronski & Sevcik, 2005). Therefore, this still needs further investigation especially in a developing country like India where the responsibility about communication for children with ASD lies on the non-governmental organizations and private bodies. Governmental support mostly comes from financial grants but the process to access the grants is lengthy and complex (Barua M., 2014).



Chapter III

Method

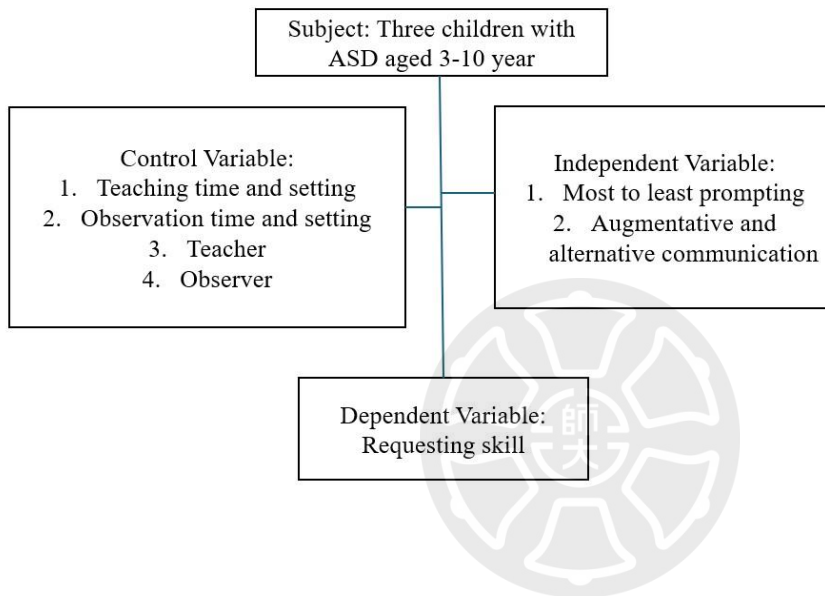
To analyze the effectiveness of AAC in combination with the most to least prompting strategy for developing requesting skills in children with autism spectrum disorder this chapter outlines the structure of the research, the description of the participant, setting and materials, research design and procedures, and data analysis to assess the effectiveness of high tech AAC application to increase requesting skills in children with ASD.



3.1 Structure of Research

Figure 3.1.

Structure of Research



3.2 Research method

3.2.1 Participants

The participants were three children diagnosed with ASD between 3-10 years of age. They were recruited through direct contact with the teachers who collaborated with the individuals with ASD in an inclusive school in West Bengal, Kolkata, India. Kolkata is in the eastern part of India which is a linguistically diverse country. India follows a three-language formula in schools, (i.e., all

children in schools are taught a total of three languages which are English as a compulsory language, a regional or state language (Bengali) and a third language which is Hindi).

After discussing with the participants' teachers, the individuals who met the following criteria were included in the study for the screening procedures to determine the eligibility: (1) School aged children of 3-10 years of age diagnosed with ASD by a professional; (2) Communication skills was inadequate for the daily communicative requirements (i.e., less than 50% intelligible word level); (3) Symbolic communicators (i.e., used at least ten words /signs/ symbols). This was evaluated by using Mac Arthur Bates communicative Development inventories in the second edition. The participants' parents were given the MacArthur Bates CDI (Fenson et al., 2007) to determine their language age; (4) The IQ of the participants needs to be above 80; the previous IQ tests can be provided by the school or the parents; If the IQ results are in between the range of 60-79, then McArthur bates communication development inventory (Fenson et al., 2007) was used to determine their comprehension skill.(5) No hearing or visual impairment should disrupt the application of the AAC application and sufficient motor skills to use the AAC or able to use another alternative method or tool to operate the

AAC device (Sparrow et al., 2005; Sparrow et al., 2016); (6) The participant does not use the AAC before the research.

The exclusion criteria for recruiting the participant are as follows: (1) Any acute or chronic condition that would limit the ability of the children to participate in the study. (2) If the IQ of the participant is less than 60. (3) Not able to communicate in English.

Child 1 was a 10-year-old male diagnosed with mild ASD, with a comorbid disability of developmental delay and ADHD. He could speak only a few words and mostly depended on pointing and gesture as a communicative mode. He displayed repetitive behavior (e.g., wanting to do the same thing) and echolalia (e.g., repeating words that he has heard). He liked to color in a piece of paper as a coping mechanism to calm him down and to focus his attention. Child 2 was a 9-year-old male diagnosed with mild ASD with a comorbid disability of developmental delay and moderate hearing loss. Child 2 was completely nonverbal and communicated through gestures. Though child 2 indicated repetitive behavior (e.g., taking his sister's things whenever he wanted without asking) he was mostly independent (e.g., could perform daily tasks on his own). Child 3 was a 5-year-old female diagnosed with mild ASD and comorbid disability of developmental delay and ADHD. Child 3 was completely nonverbal

and depended on gestures to communicate. She exhibited very low emotional and behavioral control often crying and feeling anxious. She displayed repetitive behavior (e.g., taking others' belongings without permission), echolalia (e.g., making continuous sounds) and aggressive behavior (e.g., throwing objects in front of her).

Prior to the beginning of the research, the parents signed a written consent to allow their children to be a part of the research see Appendix A. The process and the aim of the research study were clearly explained to the parents. All the parents were informed about the intervention and the research.

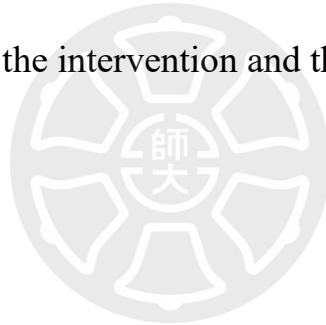


Table 3.1*Participant Demographics*

ID	Child 1	Child 2	Child 3
Age	10Y	9Y	5Y
Gender	M	M	F
Severity of ASD	Mild	Mild	Mild
Symptoms of ASD	Repetitive behavior, Echolalia	Repetitive behavior	Repetitive behavior, Echolalia, Aggressive behavior
Comorbid disability	Developmental Delay, ADHD	Developmental Delay, Moderate hearing loss	Developmental Delay, ADHD
Language	English, Hindi	English, Hindi	English, Bengali
IQ	82	60	83
Communication mode	Speech, Gesture	Gesture	Gesture

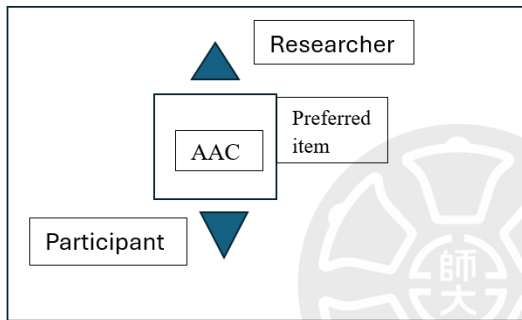
3.2.2 Settings

The research was implemented in Vishesh Special School and Clinic, which is in Kolkata, India. All the assessments, baseline, intervention, and follow-up phases were conducted in a small classroom at the school. The classroom consisted of tables and chairs for the child to sit comfortably. The classroom also consisted of enough space for the children to move around if they so desired and properly ventilated so that the child felt comfortable. The whole treatment was filmed. The researcher sat on the chair on the opposite side of the participant to capture the attention of the child participant. The table was positioned in the middle of the researcher and the child. The AAC device which is the iPad was kept in front of the child. It also included the children's preferred items. Generalization was conducted across phases in an inclusive classroom and outside the classroom. For all the three Children the generalization took place in a different classroom with other children present. For participant 1, one generalization session was conducted at his house since his mother could not bring him to school on that day. The classroom consisted of a table and two chairs, with a video camera that recorded the entire process of the research so that the researcher can confirm and check the full process. This removed the measurement bias faced in the duration of the study and promoted transparency. The instrument

that was used for the study (i.e., iPad), was kept in the classroom so that children can play and get accustomed to it. The play materials of the children's choice were also kept in the classroom.

Figure 3.2

Model of the classroom setting



3.2.3 Materials

Speech generating device (SGD).

An iPad was used to teach targeted communication skills by using the application LetMeTalk software (AppNotize UG, 2014; see Figure 3.3). LetMeTalk software is free software available on iOS and android phones. It was developed in 2014 by AppNotize UG. According to the current statistics, the

current rating given by users in both android and iPhone is 5.0 out of 5.0. The image database in the LetMeTalk application software consists of more than nine thousand easy to understand images. The existing images and pictures can also be added to the vocabulary chart from the device. New pictures can also be taken from the built-in camera, and a caption can be added to describe the picture. The formation of the sentences was taught to the participants for each targeted response like I want – the plane. The LetMeTalk application does not require internet connection or mobile contract. Therefore, the use of the application is easily accessible in any type of environment such as hospital, home, or school. The AAC technology which was used in the study is a high-tech system which included a mobile phone compatible with AAC applications. This will assist the participant to learn to request independently. This study illustrates the relationship between the human that is children with ASD, the activity which is learning the skill of requesting and the assistive technology which includes the LetMeTalk application downloaded on the iPad, through the HAAT model.

Figure 3.3

Interface of the Application



Information and Communication Technologies (ICT)

The ICT used in the study was audio and a video camera which recorded the entire process of the experiment. The camera faced at a forty-degree angle or seventy-degree angle so that the participant does not get conscious or distracted by the camera.

3.2.4 Response Definition and Measurement and Dependent Variable

The intended behavior involved the independent use of the AAC application on a mobile device without any supplementary verbal, gestural, or physical prompts from the interventionist. The participants used the AAC application for requesting food items, specific play, greetings, answering questions asked and etiquettes like thank you and please. For the use of SGD, when the participant touches the screen display to select the item they want to activate the corresponding verbal output, then the response is counted as correct. The definition of the target behavior which was coded is mentioned in Table 3.2.

Table 3.2

Definitions of the Dependent Variable.

Code	Definition	Example	Non-example
Requesting Skill	Non-verbal initiation or response to question ‘what do you want? What would you like to eat? What would you like to play with? What would you like to do? What would you like to drink?’	Pressing the touch screen to request in full sentence. I + WANT + WATER.	The response without the AAC application would not be coded (e.g., gesture, touching the screen anywhere except the symbol of the item to be requested). If the child responds with the AAC application but does not request to the question directed at him (e.g., the child responds “hi” to the question “what you would like to drink?”). Add another non-example.

The dependent variable refers to the number of times the child requests an item what he or she needs with the help of the verbal or non-verbal cues.

1. The verbal cues include the most to least prompting. The participant will request what he needs or wants by saying those words with the help of AAC,

replying to the question asked, ‘What would you like to play with?’ or ask for more.

2. The non-verbal cues include gesturing or pointing at the picture and asking for what they want to obtain, reacting to the gestures or movements made by the researcher.

3. Verbal or non-verbal aids include android phones, photographs of the items, toys, cars, food, or snacks.

3.3 Research Design and Procedures

A multiple-probe experimental design across participants was employed in this study (Cooper et al., 2007; Ledford & Gast, 2018; Richards et al., 1999). This study will investigate the effectiveness of using AAC devices for developing requesting skill on children with ASD. For this investigation, the effectiveness of using AAC to request was calculated in the phases: (1) baseline, (2) intervention, (3) maintenance, and (4) generalization phases across all phases.

3.3.1 Preferred Stimuli

Each parent and teacher were asked to identify five preferred items for the child, such as favorite foods, toys, or games, that would be appropriate for the child to request during intervention. These preferences were assessed using the

Multiple Stimulus Without Replacement (MSWO) method, a systematic preference assessment procedure (DeLeon et al., 1999; Duker et al., 2004; see Appendix B). In the first stage, an indirect assessment was conducted in which the parent or teacher listed toys or snacks the child was known to enjoy and that were suitable for use in intervention. In the direct assessment phase, each child was presented with the selected items and asked to choose one. Once selected, the item was removed from the array and not replaced. This procedure was repeated across five sessions. The preferred items were identified as the three highest-ranked based on frequency of selection. Preference was calculated applying the formula: $(\text{number of selections} \div \text{number of offers}) \times 100\%$. Of the five items suggested by parents and teachers, the three most preferred items for each child were identified. For Child 1, these were a toy car, building blocks, and a snack box. Child 2 showed a preference for kitchen set toys, building blocks, and a notebook with pencil. Similarly, Child 3's preferred items included a red toy car, building blocks, and animal figurines. The pictures of the preferred items were

uploaded to the AAC application and used throughout the baseline, training, intervention and maintenance phase.

3.3.2 Baseline

During the baseline Phase the children were given toys to play in the classroom. Different toys were kept in the classroom for them to play with. The high tech AAC system (iPad) with the LetMeTalk application was provided to the child. This made them comfortable with the new device. The researcher asked, “What do you want to play with or what do you want to drink?” The questions were asked 10 times, and this was considered as one session. The response was marked as a correct response only when the child answers the researcher using the AAC application on the iPad. However, the LetMeTalk application was not introduced prior to the intervention phase. The baseline phase did not include any introduction to the AAC application. The baseline phase consisted of normal interaction and games with the researcher present in the classroom.

For each participant, a multiple probe design (Kahng et al., 2000; Kladopoulos & McComas, 2001; Krantz & McClannahan, 1993) across participants was used. The children were asked questions about what they want to request by the researcher. They were given 50 seconds to answer the question by

using the high tech AAC application (iPad) and were given the toy for 3 minutes after he successfully requested by using the iPad. In this design, control was demonstrated by showing that change has occurred from baseline to treatment for each participant in a successive pattern. Primarily, the data in the baseline should remain stable until intervention has started for each participant (Kratochwill et al., 2013).

During the baseline phase, the researcher was present in the classroom to initiate interaction and asked the question “What do you want?” to the child participant; however, no instruction or training was provided to the child participant on the use of AAC application. To make the baseline stable 3 data points were collected in the baseline phase for the first participant. For the second and third participants, the data points in the baseline will increase respectively according to the multiple probe experimental design.

3.3.3. Training

Each child was given a training session of about 15 minutes, to train them in how to use the LetMeTalk application before the intervention. Within the application, there was a folder created for the children with ASD which includes all the preferred articles that the children would like to use in their daily life after

the McArthur Bates preference test. After the training session the children were given a 10-minute break after which the intervention commenced. This helped them get familiar with the different interfaces of the application so that they can find the picture of the article that they want to request easily.

The training session included: (1) Showing the children how to open the application, (2) selecting the term “I want” from the general section, (3) selecting the preferred item that he wants to request (e.g., water). They were given a break for 10 minutes after the training session. The intervention will begin right after the 10-minute break.

The children were asked the question “what do you want?” or “what would you like to play with?.” If they answered correctly by touching the icon of the requested item then they were presented with a verbal reinforcement of ‘well done’ and presented with the requested item. The training continued until an 80% correct response was achieved.

The participants attended a training period to get familiar with the use of the AAC device at the beginning of the intervention. The total training session was five for all three participants. If the children do not score more than 70% in

the training evaluation, he was given an extra two sessions of training and evaluated again.



Figure 3.4

Visual Support of Training Steps



Identify the LetMeTalk application on the iPad



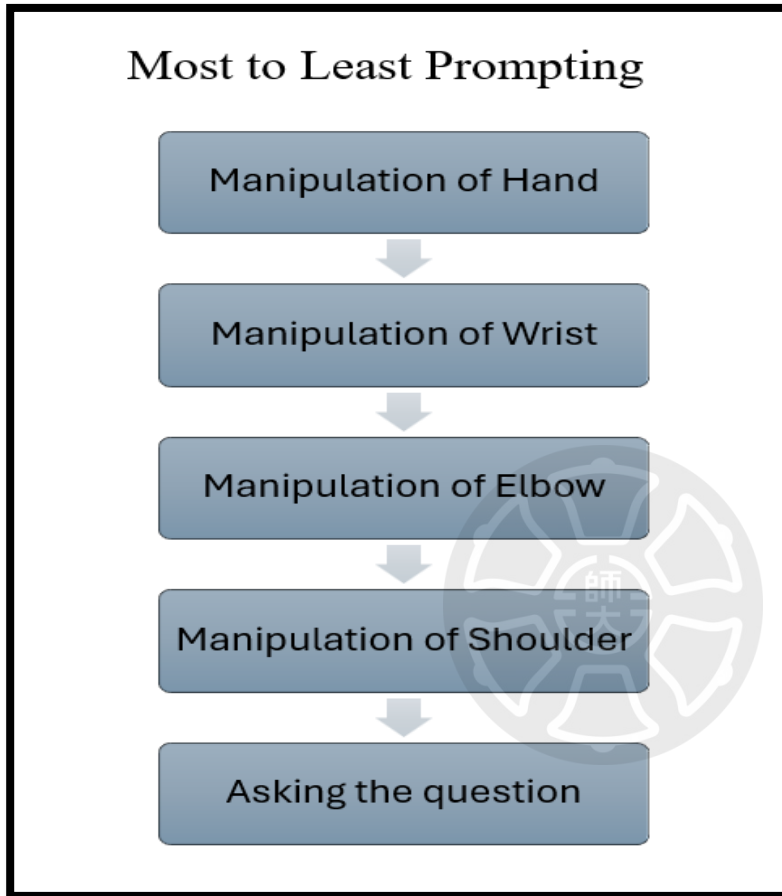
Select the icon 'I WANT'



Select the object to be requested e.g. water

Figure 3.5

Prompts listed from most to least intrusive level



Note. Adapted from “Effective teaching: Principles and procedures of applied behavior analysis with exceptional students,” by Wolery, Bailey & Sugai, 1988, copyright 1988 by Allyn and Bacon, Inc.

3.3.4 Intervention

The intervention demonstrated that the children's communicative behavior was changed when and only when the intervention was implemented (Alberto & Troutman, 2003). The materials or object used were each child's favorite food or toys as a symbolic picture in the LetMeTalk application. Each session began by gaining their attention and initiating a trial. In this study, each child was trained to request successfully using the LetMeTalk application independently. The children sat with the AAC device within their reach. The other items which were to be requested were visible but without their reach.

The instructor gives the participant appropriate instructions by telling the children, "I am going to ask you a question and you will answer me by touching the screen. Only after you answer me by touching the screen will I give you what you want." The researcher then asked the question of the item that is to be requested, (e.g., "what would you like to play with?"). The researcher makes the participant choose one item by selecting an item while touching the screen. The researcher waits about 50 seconds for them to respond. If they make a correct response, the researcher moves the items closer to him and within his reach. They were given 3 minutes to play with the requested item as a reward.

If the child did not correctly respond to the question, the researcher used the most to least prompting strategy. The intervention phase consisted of verbal as well as non-verbal strategies. The non-verbal strategies used in the study was most to least prompting, and the gestures made by the researcher to assist them to complete the task while the verbal strategy was to prompt the participant with words (e.g., “would you like to play with a truck or a ball?”). Most to least prompting involves gradually reducing the level of assistance and offering less intrusive prompts as the child demonstrates the ability to complete the task with higher levels of support (Billingsley & Romer, 1983).

First, the researcher takes the child’s hand and helps them select the symbol on the application. Then, each child selects the icon ‘I WANT’ and the item to be requested. After they can perform this task without any resistance she puts her hands on their wrists for additional trials. Reinforcement was provided to participants after every successful attempt at requesting. After the criterion is met the researcher then uses the participants elbows and shoulders to prompt. Verbal prompt was given by the researcher at the end (e.g., “Do you want to play with a truck or a bear?”). This procedure was used to implement the most to least prompting. The procedure is illustrated in Table 1.3. If a correct response was made, the requested item was bought within the children’s reach, and they played

with the object for about 3 minutes. Verbal re-enforcement was given to the child in the form of praise by saying ‘well done’ and ‘good job.’ This procedure was repeated until 10 offers were made. During the intervention phase, twelve data points were collected for three to four days per week for a total of 3 weeks for each child. In the study the researcher asked all three children about what they wanted. She then prompted them to answer correctly with the help of the teaching device to request (Van der Meer et al., 2013). The goal of the intervention is to establish a functional relationship between the independent variable and the student’s progress in learning the requesting skill to communicate.

3.3.5 Maintenance

The maintenance phase was conducted in the inclusive classroom. Three datapoints were collected in the maintenance phase. The maintenance took place after two weeks of mastery criterion was achieved. It was used to assess generalization to the untrained environment and the maintenance of the skill over a period. No prompt was given during the maintenance phase.

3.3.6 Generalization

The generalization probe was conducted in different settings to evaluate whether the participants can apply what they have learned in a different social

setting. The generalization took place across the baseline, intervention, and maintenance phases in a different setting (e.g., playground, playroom, or lunchroom). Generalization was conducted once in every three datapoint. The generalization process was the same as the baseline, intervention, or maintenance phases.

3.4 Pilot Study

A pilot study was conducted with one research participant to test the feasibility of the method and procedure that was used in the large-scale study.

3.4.1 Background

The study assessed the efficacy of AAC system in teaching children with ASD requesting skills in Kolkata, India. LetMeTalk application is a system which can be downloaded on the iPad or any other android devices. It is a high tech AAC application which aims to increase communication in children with ASD by increasing their requesting skills. The most to least prompting strategy was utilized to increase the requesting skill and make children with ASD independent.

A 10-year-old female child was recruited for the pilot study. The participant was recruited from a special school known as Visesh Special School and Therapy Center in Kolkata, India. A single case multiple probe across participants research

design assessed the effectiveness of the study. The pilot study aimed to prove whether the method and procedure of the large-scale study is feasible for children with ASD.

3.4.2 Results of Pilot Study

The data supports a functional relation between the implementation of the intervention and the increase of requesting skills of children with ASD following the visual analysis. There was a functional relation between the baseline and the implementation of the intervention (i.e., most to least prompting and the children's behavior).

An increase in level was observed following the introduction of the intervention, evident when comparing the baseline and intervention phases. Additionally, the generalization data for the intervention closely resembled the data collected during the baseline, intervention and maintenance phases. There is an accelerating trend which can be seen in the intervention data. In addition, a stable intervention data was noted.

For K001, the baseline data for requesting by using the iPad lies on the x-axis (0%). A positive shift in level from the baseline to the intervention, along with a stable trend, is evident in the intervention data. The data show an increase

in level from the baseline to the intervention phase, which remains consistent through the maintenance phase. The generalization phase data are similar to those observed in the baseline, intervention and maintenance phases. The baseline data exhibits a stable trend.

The effect size of the participants target behavior was calculated using the Tau-U online calculator for single case research design. The Tau-U results reflected the magnitude of the effect between the baseline and intervention phases. The participant's Tau-U score was strong ($ES=1$), indicating a very strong effect size.

3.4.3 Implications and Revision on Current Study

The data from this study suggests that the intervention to increase communication in the form of requesting skill in children with ASD by using most to least prompting had a positive impact on the children's outcome. The visual analysis indicated the child participant's requesting behavior increased considerably. Furthermore, we can see that the child participant with ASD generalized the requesting skill successfully via the AAC application in a different setting. The maintenance data indicated that they were able to maintain the skill over time.

After the study was conducted, some revisions were found to be necessary. First, during the intervention procedure, it was observed that the sitting position of the child should be in the opposite direction of the teacher. This position is significantly easier to capture the attention of children with ASD since the child does not make eye contact. Second, when the probing question is asked what do you want? The child only chooses a drawing book in almost all the sessions. Therefore, to break the flow of repetitiveness another question was added for example: “what do you want to play with?” or “Do you want to drink water or eat something?” Third, the data points collected per week would be 3-4 instead of 3 data points. This would be because school would break for winter vacations and the parents sometime the child does not come to school due to personal reasons and miss the session.

3.5 Data Collection and Analysis

3.5.1 Data Collection

The data was collected by using the event recording system. The observer marks an event which has occurred (i.e., the act of requesting by touching the screen of the AAC application). The observer marks every occurring target behavior by making a tally mark on the data coding sheet. An advantage of event

recording is that it is an accurate method to collect data, and the process of data collection is simple (Alberto & Troutman, 2006). Each participant was video recorded during all phases of the study; the video camera captured the child's face, their upper body and the vocalization or speech of the AAC device. During the intervention, the participants were seated so that the camera captured the AAC device and participant. The use of the video recording increases the feasibility of the research, it results in improved analysis, automatic calculations, and social acceptability of the study. Before the video recording of the whole intervention, the written consent of the parents was taken. After the 15-minute training session, data for intervention was collected for one session per day. Each session consisted of ten offers per day.

3.5.2 Data Coding

In this study, data was collected using event recording to calculate the percentage of opportunities. Event recording is a simple method for tracking the frequency of a specific behavior, indicating how many times a behavior has occurred (Tawney & Gast, 1984; see Appendix C). Event recording is usually used to record an increase in appropriate behavior (i.e., counting the number of times the student shared in class) or a decrease in an inappropriate behavior (i.e., counting the number of times a student throws a tantrum in class). An occurrence

was recorded if the target behavior (i.e., requesting through touching the symbol on the AAC device) occurs at any point of the interval. If there is no emergence of the target behavior then it is counted as a non-occurrence. Therefore, a behavior was recorded as occurring only when the participant touches the screen of the AAC application to make a request.

Each child participant was allotted 50 seconds to request an item followed by a 3-minute playtime in which they were permitted to play with the requested item. The target behavior was recorded in tally marks. The target behavior was recorded only when the response occurred in an interval of 50 seconds. If the response was correct the researcher made a tally mark on the coding sheet. The number of counts in which the behavior occurred is divided by the total number of trials to get the percentage of intervals in which the behavior occurred.

This method used a percentage to analyze the behavioral outcome; The event recording form is attached in Appendix C. Only those utterances were coded which was completely intelligible. Unintelligible or partially intelligible utterances were excluded or not coded.

A response was marked correctly if the children correctly stated the requesting word to the researcher. If the response was incorrect or if there was no

response, then it was marked as incorrect. The total number of cues given to each participant was ten per day. The task was assessed in each session and the percentage of correct responses was calculated in each session.

Each baseline, intervention and maintenance phases were videotaped and analyzed by the researcher. Each child's response was coded as an independent verbal, verbal modeled or prompted. Each code indicates utterances produced with the AAC device or both oral language and AAC device. To reduce the biases in the study, the entire process was video recorded for the researcher and the assistant.

3.5.3 Data Analysis

3.5.3.1 Visual Analysis

Visual inspection of graphed data is the most employed technique in single case experimental design to assess whether experimental control has been established (Spaulding et al., 2010; Kratochwill et al., 2013). Visual analyses involve systematic procedures which evaluates specific characteristics of data patterns and the functional relationship between the dependent and independent variable. It also examines data over time and across phases which facilitate formative evaluation of intervention effectiveness (Ledford & Gast, 2018).

In a single case research design, the data are continuously graphed and analyzed as they are gathered throughout the study (Parsonson & Baer, 1978). Within phase visual analyses are performed to identify patterns in level, trend and stability or variability. Visual analysis is a method to analyze the data in this study in addition to calculating the effect size of the data using Tau U. The mastery criterion was established as three consecutive data points demonstrating stability at 70%. This indicates that a stable performance of at least 80% unprompted correct responses is required for progressing from the intervention to the maintenance phase. Three crucial factors were considered during visual analyses. The level of the dependent variable (i.e., the requesting skill of the child) from phase to phase. If the requesting skill is much higher or lower in one phase compared to another phase, then it suggests that the treatment is effective. The second factor refers to trend. It is a gradual increase or decrease in the requesting skill across observation. The third factor consists of latency which is the time taken for the requesting skill to begin changing after a change of phase (e.g., if a change in the dependent variable occurs soon after a phase change) indicates that the treatment likely caused the observed effect.

3.5.3.1.1 Level

Level is described as the magnitude of behavior represented by the value on the ordinate scale (Kennedy, 2005). It is typically categorized as low, moderate, or high and can also be defined by the range of dependent variable values in a phase.

3.5.3.1.2 Trend

Trend refers to the slope and the direction of data series or the direction data are moving over time (Kennedy, 2005). It is characterized by trend direction, trend magnitude and trend stability. The trend direction is indicated as accelerating, decelerating or zero-celerating. Trend can further be characterized by magnitude and is described as steep or gradual and then paired with direction (Ledford & Gast, 2018). To measure the trend, split method technique was applied (Kazdin, 1982; Riley-Tillman et al., 2020; White & Hering, 1980). This technique is used to graph the phase change from the baseline to the intervention phase. First, the baseline and the intervention were divided into halves and quarters. The median was calculated for each half or quarter. Then, the datapoints were placed at the intersections of the median scores and quarter lines. The lines were drawn by connecting the dots. These lines represented the trend in the baseline and

treatment phase. Lastly, the lines were compared to determine if there was any significant change in the trend of the graph.

3.5.3.1.3 Stability and Variability

Stability refers to the consistency and predictability of data points within a phase (Hersen & Barlow, 1985). It is characterized by minimal fluctuations between consecutive data points. Data stability assumes that in the absence of environmental changes, the existing data patterns will remain consistent. The most effective method for quantifying stability is through calculating the stability envelope.

Variability is known as the fluctuation of one data point to the next. It is the opposite of stability. The data which is zero-celerating (i.e., it has no trend) can be described as variable (Franklin et al., 2014). Whereas, in data with trends can be calculated via a stability envelope around a split middle trend line (Lane & Gast, 2014). Variability in the data is reported using the categories: stable, variable or highly variable.

3.5.3.2 Effect Size

The effect size was calculated using the free online Tau- U effect size statistics calculator (Vannest et al., 2016). Tau-U is a nonparametric rank order

correlation statistic. Tau-U, a set of related coefficients, separates the variance associated with changes in both trend and level. By analyzing within-phase and between-phase differences separately using Tau-U, investigators conducting single-case research can gather valuable descriptive and inferential insights about their data (Brossart et al., 2018). The interpretive guideline of Tau-U values is interpreted as 0.98-1 very strong values, 0.93-0.97 strong, 0.80-0.97 moderate, 0.65-0.79 as low and 0.00- 0.64 as very low (Ganz et al., 2017). This synthesis helps in calculating the range of non-parametric effect sizes.

3.6 Interobserver Agreement

Interobserver agreement (IOA) was taken for all sessions to ensure reliability of the test. Each session was measured by calculating the frequency of the target behavior which was recorded during data collection; this is defined as event recording (Tawney & Gast, 1984). Event Recording was used to code the data throughout the study. The time of observation was noted down by the researchers. Each behavior and occurrence were recorded. This was done by making a tally mark in the data sheet for each occurrence of the behavior.

The researcher conducted all interventions. Another observer was a graduate student from the University of Calcutta who had prior experience and

had taken a course in special education. She has experience of conducting research and working with children with disabilities in a special school. She assisted the researcher to code the Interobserver Agreement data independently. The assistant was trained prior to working with the children. The researcher was also trained in how to code the data during analysis. The observer was recruited from the University of Calcutta (CU).

The observer was trained in the following step:

- (1) The target behavior definition was explained to the observers with examples and non-examples. She was familiarized with the data collection forms and procedures for recording her observations. The use of measurements was explained to the observers (e.g., video camera, stopwatch).
- (2) The observers practiced recording behavioral vignettes until they obtain 100% accuracy.
- (3) The training continued until the pre-established criterion agreement of 80% was reached between the observers.

An independent observer collected identical data for each session. A percentage agreement was calculated between the observed data of the researcher

and the independent observer. The two observers sat on opposite sides while filling out the interobserver agreement data collection Form. This ensured that the observations of the two observers were truly independent. The observer was trained by reviewing the operational definitions of each target response and practice recording IOA until 80% reliability was achieved. The study used a percentage agreement to calculate the IOA. IOA is calculated by calculating the number of agreements (both observers) divided by the number of agreements plus disagreements (a difference in scoring by both authors) and multiplied by 100 (Ledford & Gast, 2018). The secondary observer then coded the videos independently until she achieved at least 80% agreement. The assigned videos were coded by the two observers and the results were compared. Randomly selected numbers were chosen online, and the videos were coded every week according to the number. The observers agreed when they coded the same answer for each trial. IOA was calculated for each student as a point-by-point agreement by counting the number of agreements divided by the number of agreements plus disagreements, multiplied by 100. The primary and secondary observers were in 100% agreement for each participant. After plotting the data, any differences between the first and second observer were discussed, and a consensus was agreed upon in a discrepancy discussion. It was seen that the primary and secondary

observers were in total 100% agreement because only one target behavior (i.e., requesting by touching the iPad) was observed and there was no need for a discussion for consensus.

3.7 Procedural Fidelity

Procedural fidelity was measured by watching 25% of the sessions video recording in each phase. The independent observer used a checklist which outlined the procedural steps and recorded whether the researcher had correctly marked each procedural step for the intervention (Ledford & Gast, 2013). The steps for each intervention session were: (1) AAC device is kept on the table where the child is sitting and the other items also visible but without reach; (2) the instructor gives the participant appropriate instructions; (3) ask the question about the item to be requested (e.g., what would you like to play with?); (4) make the child choose one item after in about 50 seconds for the child to respond; (5) if the child makes a correct response, the researcher moves the items closer to him within his reach and let the child play for about 3 minutes; (6) if the child does not make a correct response, the researcher uses most to least prompting; (7) repeat the steps until 10 offers have been made. Procedural integrity was determined by the “number of steps correctly implemented) / (number of steps correctly implemented + number of steps incorrectly implemented) × 100%.” See

Appendix D. To test the reliability of the fidelity measure, the second observer observed 38.89% of the sessions while marking the absence and presence of the fidelity checklists. From the seven sessions evaluated for each participant, the observer reached a score of 100%. The agreement between the two observers was 100%.

3.8 Social Validity

One important dimension of behavioral research is that the dependent variable that is targeted for change should be socially important. Therefore, the targeted behavior that is teaching requesting skill should help children with ASD with in other social settings (Baer et al., 1968). Social validity is defined as the presence of changes in behavior that are clinically significant or effective in the client's life (Kazdin, 1977). Social validity is also one of the quality indicators for single case research design (Horner et al. 2005). The evaluation of the social significance was completed by a variety of key participants. These key participants include individuals who may be indirectly influenced by the intervention, even though they are not directly involved (e.g., teachers of the participants) (Schwartz & Baer, 1991; Ledford & Gast, 2018).

The social validity of the study was assessed to determine its social acceptability. Three teachers working with children with ASD were requested to provide their perspective on the use of teaching requesting skills in classroom setting by completing a modified version of the Treatment acceptability questionnaire (TARF-R; Reimers et al., 1992; Martens et al., 1985). The TARF-R included a total of 6 items on a 5-point Likert-scale that acknowledged the teacher's perspective on the intervention that was conducted. The teachers were requested to observe an intervention session for their feedback. The social validity forms were given to the teachers post intervention see Appendix E.

The teachers of the participants evaluated the social significance, acceptability and feasibility of the most to least prompting intervention to teach requesting skill via the AAC application by using a questionnaire. The social validity was measured by a modified TARF-R. The teachers of the participants rated items on a five-point Likert scale. The average scores out of 5 were calculated (e.g., 5=strongly agree, 4=agree, 3=slightly agree, 2=disagree, 1=strongly disagree). Each teacher ranked the intervention positively. An average score with a mean range of 5 (range=4.3-5) for the intervention session, for all six questions. The feedback from the teachers indicated that they liked the use of AAC device to teach communication during class. They find that children with

ASD can be motivated to learn new vocabulary with the use of AAC, since they find that the sound it generates is a motivating factor. They also find the challenging behavior of children with ASD in the classroom has also improved. The habit of sitting and waiting for their turn or waiting for something that children with ASD have requested has also improved.

3.9 REC Taiwan

Prior to the data collection, approval of the REC was obtained. The personal details of the child had remained confidential and were not disclosed. A confidentiality agreement was signed by the researcher and the parents. The parents were informed that ethical approval involving the data collection was taken from the institutional review board (IRB) which is the REC the Centre for Taiwan Academic Research Ethics Education. Only after the approval of the board, data collection took place for this research.

Participation in this research was voluntary, and the participants were free to drop out of the study at any point in time. In the informed consent that was provided the participant's parents were informed about the purpose, benefits, and risks behind the study before they agree or decline the offer to participate in the study. The involvement of the researcher and her assistant was clearly stated to

the parents. The researcher conducted the study herself with the help of a second assistant. The parents of the participants will also be informed that the data of the study was used for the master's dissertation, and it may be used for future publications, but the identification of the participants was kept confidential. This study did not contain any physical or psychological harm, and no human rights were violated.





Chapter IV

Results

4.1. Visual Analysis

Data provides evidence of a functional relationship between the development of requesting skills and the use of AAC applications combined with the most to least prompting strategy, as demonstrated through visual analysis. This suggests that the implementation of the intervention (independent variable) AAC application and most to least prompting strategy was positively associated with improvements in the target behavior (dependent variable) of requesting skill. A noticeable positive change in level and trend was observed from the baseline to the intervention phase of all three participants. The overall trend for Child 1 and Child 2 showed a consistent increase in requesting skill when comparing the baseline and intervention phase. Comparatively, Child 2 displayed an abrupt increase in the change of behavior from the baseline to the intervention phase. Refer to Figure 4.1 for the percentage of correct responses related to requesting skills across all participants.

In the baseline phase, all three participants scored low requesting skill while using the iPad via the AAC application. Upon the introduction of the training, an

immediate increase in level was seen in Child1 and Child 2 whereas the increase in behavior was found to be slower for Child 3. Child 1 and Child 2 met the mastery criterion of 70% correct of five out of five training sessions. Comparatively, Child 3 reached the mastery criterion on three out of five training sessions.



Figure 4.1

Results of Requesting Skills

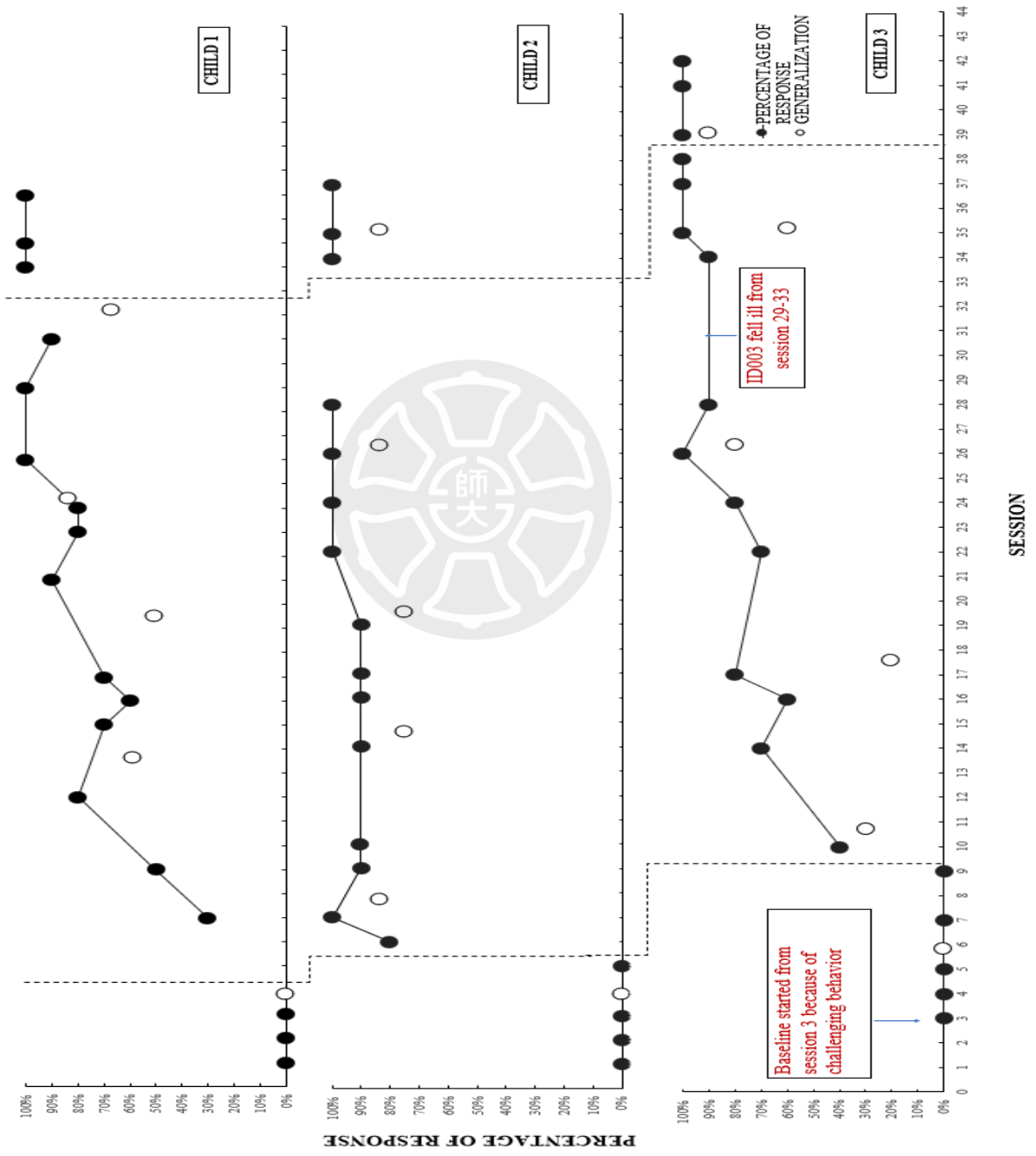


Table 4.1*Calculations- Visual Analysis*

3	Child 1			Child 2			Child	
	BL	INT	Maint.	BL	INT	Maint	BL	INT
Maint.								
Mean	0	73.33	100	0	93.33	100	0	80
100								
Stability Envelope	77.4- 94.6			82.2-107.8			82.8-	
101.2								
PND	100			100			100	
P Value	0.001			0.000			0.000	

Note. BL=Baseline; INT=Intervention; Maint.=Maintenance.

Child 1

Evaluation of each phase indicated that the data was stable during the baseline and intervention phase. The evaluation of level change within condition indicated that the performance of the child in requesting the item was at a very low level at the baseline (M=0) but gradually increased during the intervention phase (M=73.33) (Refer to Figure 4.1). Split middle method of trend estimation was conducted and indicated a zero-celerating trend at the baseline and an

increasing trend at the intervention phase. The data was stable following the stability envelope to the trend lines (Refer to Table 4.1).

The evaluation of behavior changes across conditions indicated that only one variable was introduced across both phases. Therefore, in consideration of the within phase analysis of trend, a change in performance across conditions displayed an accelerating and improving trend, where the requesting skill for Child 1 consistently remained at 0% at the baseline and gradually increased from 30% to 90% at the intervention phase. The level change data indicated a positive change across conditions. Finally, calculation of the PND indicated there was 100% non-overlap of behavior during the baseline and the intervention phase (Refer to Table 4.1). During the maintenance phase, the child's requesting behavior remained consistent at 100%. The data for the generalization demonstrated that while the requesting behavior remained at 0% at the baseline there was an increase in level and trend at the intervention phase.

Child 2

Visual inspection of the data for Child 2 indicated stable data during the baseline and intervention phase. Evaluation of the level change exhibited no requesting behavior at the baseline phase ($M=0$) and a high increase of level

(M=93.33) in the targeted requesting behavior at the intervention phase (Refer to Figure 4.1). The split middle method of the trend estimation was calculated and indicated a zero-celerating trend at the baseline phase and a steep accelerating trend at the intervention phase. Following the stability envelope to the trend line, the data appeared to be stable (Refer to Table 4.1).

Considering between phase analysis of trend, a change in performance across conditions indicated a steep accelerating trend with stable data. The requested behavior of Child 2 remained at 0% at the baseline phase and demonstrated an abrupt increase of behavior at 80% and consistently remained high during the intervention phase. The level change data indicated a positive data change across conditions. The calculations of the PND indicated a 100% non-overlap of behavior during the baseline and the intervention phase (Refer to Table 4.1). The data remained consistent at 100% for the requesting behavior of the child at the maintenance phase. The generalization data for child 2 exhibited no requesting behavior using the AAC application at the baseline. A high increase in level was demonstrated between the baseline and intervention. However, there was no discernable trend at the intervention phase. The data consistently remained at 100% in the maintenance phase.

Child 3

The evaluation of each phase indicated that the data was stable during the baseline and intervention phase. The level change of the targeted behavior of requesting skill exhibited a moderate increase in level from the baseline which remain very low at 0% (M=0) and increased to 40% at the initiation of intervention and remained at 100% towards the end of the intervention (M=80) (Refer to Figure 4.1). The split middle method to estimate trend was conducted which indicated a zero-accelerating trend at the baseline and a gradual increasing trend at the intervention phase. The data was considered stable as they remained within the stability envelope relative to the trend line (Refer to Table 4.1).

The evaluation of the behavior changes between phases indicated that only one behavior which was requesting skill was introduced at the intervention. Therefore, considering within-phase analysis of trend, a change in performance across condition went from zero-accelerating at the baseline to an increasing trend at the intervention phase. The level change at the baseline remained low and they indicated a positive change across phases. Calculations of the PND indicated that there was a 100% non-overlap of behavior observed during the baseline and the intervention phases (Refer to Table 4.1). The requesting behavior of the child was maintained at 100% during the maintenance phase. The generalization data for

Child 3 indicated no behavior at the baseline. A moderate increase in level and a gradual and accelerating increase in trend was noticeable at the intervention phase. The behavior at the maintenance remained consistently at 100%.

4.2. Effect sizes for Child's Target Behavior

The effect size was evaluated to support the visual inspection of the behavior of the three participants with ASD. A single case research design free online Tau-U calculator was used to calculate the effect Size (Vannest et al., 2016). The participant's target behavior was requesting skill using the AAC application on the iPad. A detailed evaluation of the effect size showed that at all three participants target behavior was strong (ES=1). The overall effects demonstrated a strong effect size (ES=1) indicating that the most to least prompting intervention had a significant impact on the requested behavior of the child. All three participants demonstrated a strong effect size individually for the requested behavior using an AAC application. Specifically, the effect size of Child 1 for the target behavior of requesting skill was strong (ES=1; $p=0.008$), the effect size of Child 2 for requesting skill was strong (ES=1; $p=0.003$) and the effect size for the target behavior of requesting skill of Child 3 was also strong (ES=1; $p=0.003$) indicating that all three participant has a strong effect size for the target behavior of requesting. These findings suggested that the most to least prompting method

using the AAC application was effective in developing requesting skill when used alongside the AAC application (Refer to Table 4.2). The effect size across three participants is compatible with the results of the visual analysis Providing further evidence that the most to least prompting strategy was effective in teaching the child to develop requesting skill via using the AAC application.



Table 4.2*Effect Size Results of Participants*

Participants ID	Tau-U	P Value	LL CI 90%	UL CI 90%
Child 1	1	0.008**	0.383	1
Child 2	1	0.003**	0.452	1
Child 3	1	0.003**	0.497	1
All Children	1	0.000***	0.678	1

Note. LL= lower limit; UL= upper limit; CI= confidence level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Chapter V

Discussion

5.1. Summary of Findings

The findings of this study suggest that the use of AAC devices in combination with the most to least prompting strategy effectively increased requesting skills in children with ASD. The multiple probe design across participants allows for cautious inference of a functional relationship between the intervention and the observed improvements in communication behavior. Visual analysis of the data showed that all three participants demonstrated increased independence in making requests using the AAC application as the session progressed.

Child 1, who was also diagnosed with comorbid attention-deficit/hyperactivity disorder (ADHD), initially exhibited restlessness and difficulty maintaining seated attention. However, following the intervention, the child showed improved ability to remain seated and engaged in instructional sessions for a longer period. This change appeared to be influenced by the auditory feedback produced by the AAC device, which may have functioned as a reinforcing stimulus, enhancing the child's motivation to participate.

Child 2 also demonstrated notable progress, including the emergence of verbalization during AAC use. When prompted with the question “What do you want?”, the child engaged in reciting the alphabet through the AAC application and attempted to imitate the corresponding phonemes. This suggests that the AAC tool served not only as a communication aid but also as an engaging and educational resource. Additionally, for Child 3, both tangible reinforcement (e.g., food items and auditory feedback) appeared to support motivation and sustained the use of the device.

Overall, these observations support the conclusion that AAC applications, when combined with evidence-based prompting strategies, can serve as effective tools for teaching functional communication to children with ASD. The interactive and multisensory features of AAC technology contribute to increased engagement, making it a valuable addition to both instructional and therapeutic settings.

The results of this study indicate that children with ASD can generalize requesting skills acquired through an AAC application across different settings, through outcomes varied across participants. Previous systematic reviews and meta-analysis (Gardner & Wolfe, 2015; Hong et al., 2016; Hong et al., 2017) have shown that most AAC interventions are conducted in a controlled school

environment where the researcher often acts as interventionist. In contrast, the current study demonstrates the potential for skill generalization beyond the instructional setting, highlighting the practical application of AAC supported communication in naturalistic contexts.

Within the framework of single-case research design, generalization is defined as the extension of behavior change across different environments, people or stimuli (Ledford et al., 2023; Shepley et al., 2025; Stokes & Baer, 1977). In this study, Child 1 demonstrated a low generalization score at baseline, which increased to 100% by the third generalization session and slightly declined to 80% in the fourth session. Child 2 also showed limited generalization at baseline but achieved 100% generalization during the intervention phase, maintaining this performance through the maintenance phase. In contrast, Child 3 initially demonstrated low generalization, with the first generalization session at 30%, followed by gradual improvement to 80% and 60% in subsequent sessions. During the maintenance phase, Child 3 reached a generalization score of 90%.

These results suggest that Child 1 and Child 2 were able to generalize the use of AAC to independently request items across settings beyond the initial instructional context. Their consistent performance across generalization and maintenance phases indicates that the intervention was effective not only in

promoting skill acquisition but also in facilitating independent skill use in different environments, thereby supporting social validity. Additionally, parental feedback confirmed observable improvements in the child's ability to communicate needs appropriately outside the home and school, alongside a reduction in challenging behavior.

However, child 3 exhibited greater difficulty generalizing the requesting skill contexts, possibly due to attentional difficulties, behavioral regulations challenges or unfamiliarity with the new environment. This underscores the importance of tailoring interventions to individual needs and providing additional support to ensure successful skill transfer. These findings are consistent with prior literature, which emphasizes that AAC interventions, when reinforced consistently and paired with meaningful stimuli, can support the generalization of communication skills among children with ASD (Flores et al., 2012; Lorah et al., 2013).

Beyond the primary research questions, this study revealed several noteworthy findings that contribute to the broader understanding of AAC use in children with ASD. The results align with previous literature suggesting that AAC tools, when paired with consistent reinforcement and evidence-based strategies such as most to least prompting, can support skill generalization across

environments (Flores et al., 2012; Lorah et al., 2013). However, participant differences were observed. While Child 1 and Child 2 demonstrated strong generalization outcomes, Child 3 faced challenges with attention and regulation in unfamiliar environments. These individual differences emphasize the need for tailored support and gradual exposure to new settings to ensure successful skill transfer.

An important outcome of this study is the positive reception and high usability of the AAC application by both parents and teachers. Feedback indicated that the mobile-based AAC tool was easy to use, engaging for children, and convenient for caregivers and educators to incorporate into daily routines. Teachers reported that the application supported consistent communication opportunities in the classroom, while parents noted improved interactions at home. These findings are especially relevant in the Indian context, where access to costly assistive technologies is limited. The application used in this study was freely available and operable without internet access, which alleviated parental concerns about potential screen addiction or exposure to inappropriate online content.

Moreover, several emergent benefits were observed beyond requesting skills. Teachers and parents reported noticeable improvements in vocabulary acquisition, increased attention span and a reduction in challenging behavior. The

interactive and auditory feedback provided by the AAC tool appeared to foster engagement and motivation among children with ASD, making communication not only functional but enjoyable. These secondary outcomes underscore the educational and behavioral value of AAC applications beyond their primary communicative function.

From a cultural standpoint, AAC remains a relatively new concept in many parts of Asia, including India (Rosa-Lugo & Kent-Walsh, 2008). Despite this, the study highlights growing acceptance of AAC technology among Indian families and educators, particularly when the tools are affordable, simple to operate and demonstrate tangible benefits. Parents expressed motivation to learn how to use the application after witnessing their children's progress, which suggests that positive behavioral changes can drive caregiver engagement and uptake of new technologies.

Given the limited research on AAC interventions in India with only two studies to date addressing this topic (Sonawane & Varshneya, 2020; Srinivasan et al., 2022) this study contributes valuable data to the field. It demonstrates that mobile-based AAC applications, when implemented with systematic prompting strategies, can be both effective and culturally appropriate in teaching communication skills to children with ASD. The most to least prompting method

facilitated independent requesting behavior, with Child 2 achieving independence by the third intervention, Child 1 by the sixth and Child 3 by the eighth. These findings provide a strong case for expanding the use of AAC technology in educational and home settings across diverse and resource limited contexts.

5.2. Limitations and Recommendations for Future Research

The current study was designed to assess the effectiveness of AAC application across three participants. While the findings suggested that there was a positive impact of AAC application pertaining to the development of requesting skill among children with ASD, exploring its effectiveness in various settings may yield valuable insights. India is a culturally and linguistically diverse. India incorporates Indian languages in their curriculum rather than only relying on English. While this study was found to be effective in helping children with ASD develop requesting skill using the AAC applications, future research should focus on utilizing the AAC tools as more linguistic options. Using the AAC application in their own language may give rise to a new perspective towards using the AAC system.

In addition to ASD, participants in the research study were diagnosed with various comorbid disabilities. Child 1 and Child 3 were diagnosed with ADHD.

Both children showed positive results during intervention which was conducted in the classroom. But when they were in a different setting like the playroom and a different classroom, they would be distracted and focus their attention on other things kept in the classroom. Comparatively, for Child 2 he was diagnosed with moderate hearing loss on the left ear. The child did not reveal any novel behavior due to the hearing deficiency. Interestingly, Child 2, having an IQ of 60 and a moderate hearing loss which was supported with the use of a hearing aid, demonstrated stronger performance in the intervention compared to both Child 1 and Child 3. Therefore, comorbid disabilities should be carefully considered and controlled by future researchers to ensure a controlled and accurate outcome.

A single case multiple probe research design was used in this study. Multiple probe design is an appropriate design to demonstrate functional relationship (Ledford & Gast, 2018) between the AAC application in the iPad using most to least prompting and development of requesting skill for children with ASD. However, a key limitation of the design can be its inherently small sample size. Therefore, future research can focus on expanding the sample size to explore whether the outcome observed can be generalized or yield a different result.

5.3. Implications for Practice

The current study suggests that teaching the use of AAC application by using the method of most to least prompting strategy can be successfully used as an intervention to develop requesting skill in children with ASD. The most to least prompting strategy are an effective approach for teaching requesting skills to children with ASD using AAC applications. The increase in the requesting behavior observed in the study allowed the children to interact freely in the classroom environment. Therefore, the teacher and parents can use this device to communicate with the children in a fun and interactive manner (Finke et al., 2017). Moreover, researchers working with children with ASD should consider providing training and ongoing feedback to both the parents and teachers as well as opportunities for reflective practice. This support can enhance their ability to effectively learn and implement strategies within their daily routines, thereby promoting better outcomes for the children. Additionally, given the diverse socio-economic backgrounds of parents, it is crucial to provide them with appropriate knowledge and skills to independently operate AAC applications at home, thereby enabling them to actively support their children's development.

After conducting the study, it can be deduced that Most to least prompting strategy is simple to implement with the children with ASD. Prompt fading led to

a higher percentage of independent correct responses (Leaf et al., 2017). The teachers as well as parents could utilize this approach with different students, to teach different skills. This could be beneficial for children with ASD who use AAC and rely on routine.



5.4. Conclusion

The findings of the study revealed positive outcomes, establishing a functional relation between the AAC application in combination with the most to least prompting strategy and promoting requesting skill among children with ASD. The results suggest the integration of AAC technology, in conjunction with the evidence based instructional method of the most to least prompting strategy can successfully enhance communication among children with ASD. Educators are encouraged to incorporate AAC applications into daily classroom activities to facilitate functional communication. Since the study demonstrated positive outcome at the generalized setting, the parents can also utilize the AAC application in the home environment to successfully communicate with the child. AAC technology represents a cost-effective and stable intervention, hence providing an accessible means to foster functional communication. AAC technology is a valuable resource for enhancing developmental outcomes in a developing country like India. This alleviates communicative burdens which are experienced by both the individual with ASD and their caregivers.



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Appendix A: Consent Letter

Consent form to participate in research.

Dear Parents,

I am Chen Mew Ling, a graduate student at the Department of Special Education at National Taiwan Normal University. I am currently conducting research” The Effectiveness of Augmentative and Alternative Communication for Developing Requesting Skill in Children with Autism Spectrum Disorder.”

I hope that the parents and teachers can understand the importance of requesting skill in the child’s daily life.

The collection of data when the child participates in the activities will be at the convenience of the parents and teachers. The personal information in the research will be kept confidential. Only my supervisor and I will have access to the files and video tapes. The name of the child will be anonymized and not be used in any reports or publications resulting from the study. During the process, the participant has a right to withdraw from the research at any point of time. Any hard copies of research information will be kept digitally and always stored under encryption.

Your participation is of great significance in this research and will be of great help and contribution to the field of autism spectrum disorder. If you understand the above instruction and agree to participate in the research on behalf of your child please check and sign below to confirm your agreement. If you have any questions please contact me via email mewling81@gmail.com. I would like to express my sincere gratitude for your enthusiastic participation and support. Thank you!

Best wishes.

Department of Special Education,
National Taiwan Normal University

Supervising Professor: Ching-Yi Liao

Graduate student: Mew Ling Chen

Appendix B: MSWO Data Preference Assessment Sheet

Item A: _____

Sum of trial #s for A: _____

Item B: _____

Sum of trial #s for B: _____

Item C: _____

Sum of trial #s for C: _____

Date		
Child name		
Teacher name		
Trials	Items selected	Placement of items selected
1		
2		
3		
4		
5		
6		
7		

Date		
Child name		
Teacher name		
Trials	Items selected	Placement of items selected
1		
2		
3		
4		
5		
6		
7		

Date		
Child name		
Teacher name		
Trials	Items selected	Placement of items selected
1		
2		
3		
4		
5		
6		
7		

Highest preferred items (lowest summed trial #s):

Moderately preferred items (moderate summed trial #s):

Lowest preferred items (highest summed trial #s):

Appendix D: Procedural Fidelity Intervention Data Sheet

Intervention for requesting procedural fidelity

Participant sits with AAC device in front of them	Yes <input type="checkbox"/> No <input type="checkbox"/> NA <input type="checkbox"/>	Move the correct item to the student when response is correct and let them play for 2 minutes	Yes <input type="checkbox"/> No <input type="checkbox"/> NA <input type="checkbox"/>
Instructions given to the student that the study is going to start and question is asked	Yes <input type="checkbox"/> No <input type="checkbox"/> NA <input type="checkbox"/>	If no response, then prompt is added	Yes <input type="checkbox"/> No <input type="checkbox"/> NA <input type="checkbox"/>
Ask the question for the item to be requested.	Yes <input type="checkbox"/> No <input type="checkbox"/> NA <input type="checkbox"/>	Same steps repeated until 10 offers are made	Yes <input type="checkbox"/> No <input type="checkbox"/> NA <input type="checkbox"/>
Wait about 30 seconds for response	Yes <input type="checkbox"/> No <input type="checkbox"/> NA <input type="checkbox"/>		

Turn	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Mark C (correct) or IN (incorrect) for implementation of steps for each participant.

Turn refers to each question asked to the child where he is expected to request using the AAC device.

Score: (number of steps correctly implemented) / (number of steps correctly implemented + number of steps incorrectly implemented) × 100%.

Appendix E: Social Validity

The Social Validity Form

	Strongly Disagree	Disagree	Slightly Agree	Agree	Strongly Agree
Did this intervention target an important goal?	1	2	3	4	5
The child's behavioral concerns warranted the use of this intervention.	1	2	3	4	5
The intervention procedures were reasonable for the classroom.	1	2	3	4	5
The intervention procedures were put in place as designed.	1	2	3	4	5
The intervention improved the concern.	1	2	3	4	5
The intervention achieved the targeted goal.	1	2	3	4	5

Note. Adapted from modified version of the Treatment Acceptability Rating Form–Revised (TARF-R); “Clinical evaluation of the variables associated with treatment acceptability and their relation to compliance.” T. M. Reimers, D. P. Wacker, L. J., Cooper, & A. O. DeRaad, (1992). *Behavioral Disorders*, 18(1), 67-76.