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CASE REPORT

# Capitalizing on technology for developing communication skills in autism spectrum disorder: a single case study

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**ABSTRACT**

**Purpose:** In this case study, we discuss the application of a patient-centred clinical approach that led to the use of an assisted communication platform to combat severe communicative deficit in a child with autism spectrum disorder (ASD).

**Methods:** Initial assessment at four years of age revealed that the patient had rudimentary communication skills, with significant sensory integration dysfunction manifested as oral, olfactory, and tactile seeking behaviours; self-stimulatory behaviour; and complete dependence on caregiver for activities of daily living. Intensive, multi-disciplinary intervention resulted in minimal improvement in communicative skills and sensory seeking over six months. Subsequently, a tailor-made picture-assisted communication training with the mother as the communication facilitator was adopted. This approach was abandoned due to the patient's poor response and mother's low acceptance of picture-based interaction. A preference for printed material was observed in the patient. Accordingly, further management was focused on employing a computer-based interactive platform that the patient was taught to use over the course of a few months as a part of augmentative and alternative communication (AAC) intervention program. This resulted in a remarkable improvement in the child's skills that now allowed for a better intentional communication of his thoughts and needs.

**Conclusions:** This study highlights the importance of revisiting conventional rehabilitation strategies for communicative deficits and tailoring them according to the patient's needs and preferences. It also emphasises that besides excellent observation skills, clinicians must be willing to consider technology based approaches in patients responding poorly to traditional approaches in order to develop effective interventional programmes.

**➤ IMPLICATION FOR REHABILITATION**

- The current study highlights the importance of exploring the application of technology based intervention for building communication skills in the early stages of rehabilitation for persons with communicative deficit.
- It also emphasises the need for excellent observation skills among clinicians so that the peculiar interests of children with ASD may be applied in designing training programmes to overcome communication barriers.
- Additionally, clinicians should familiarise themselves with the latest assistive technology-based rehabilitation approaches and be willing to explore newer approaches if traditional ones fail to yield satisfactory outcomes.
- Use of technology-based interventions to reduce dependence among persons with disability would be beneficial, both socially and economically, in developing countries with limited resources.

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Technology; autism spectrum disorder; communication; intervention; reading and writing; augmentative and alternative communication



## Introduction

The discriminating attribute of a human from other living being is his ability for social communication and the integration of various sensory information to accommodate the changing needs of the society. Autism spectrum disorders (ASD) are a group of neurodevelopmental disorders where the affected person fails to develop adequate skills for communication, social interaction and ability to integrate the information from all senses [1]. They might exhibit a minimal disturbance to severe impairment in social communication and restricted repetitive behaviours [1]. Intervention for children with ASD mainly targets on the core challenges of these individuals such as social communication [2–4], sensory dysregulation and behavioural skills. Conventional intervention is based on specific approaches determined by the therapist depending on nature and severity of problem. With the upheaval in the field of technology a large portion of the people with ASD has been moving from the conventional way of intervention towards more dynamic strategies involving technology [5].

The positive impact of technological advancement on almost all walks of life is well documented in children with ASD.

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Technology based intervention has been found to be useful in improving social interaction [6,7], enabling communication [8,9], augmenting language [10,11], developing literacy skills [12,13].

Computer assisted technology appears to provide a predictable platform for individuals with ASD by reducing the communication challenges; sensory overload [14,15] and thereby motivating them to engage in various learning activities [16]. The use of computer to augment language and literacy skills among children with ASD have been reported extensively [10,11]. Reading and writing skills have found to enable them to express their inclination and thoughts in a more suitable way and thereby reducing the chances of communication breakdown with the partner [17].

Technology based instructional delivery has been accepted as a learning tool globally. Even in developing countries like India, computer literacy has been gaining momentum because poor resource mobilization to implement effective one to one intervention for the overall development of children with ASD, especially in rural living condition. Therefore, effective implementation of technology-based intervention services requires to be explored country wide due to its potential to bridge communication breakdown, and enhance literacy skills. The present study is thus an attempt to provide addition to the existing knowledge base on the successful use of technology-based intervention to promote the development of language skills in a non-verbal child with ASD and enable communication with technological assistance.

## Case study

The subject under consideration for this study is discussed under the pseudonym Rayan to maintain anonymity. Rayan was four-year-old, when he was brought to department of Neurodevelopmental Sciences, NISH, India, for a detailed evaluation for his delay in communication development. It was noted that he received a diagnosis of ASD at the age of three years. He had been attending speech language therapy and occupational therapy since then at a frequency of 45 min session per week in a developmental centre at a nearby town. A fresh evaluation was done at NISH by a team of professionals including Neurologist, Speech language pathologist, Psychologist and Occupational therapist. The specific difficulties exhibited by Rayan was coded using International Classification of Functioning, Disability and Health-Children and Youth (ICF-CY) developed by World Health Organization (WHO), 2007. The core areas of body function such as lack of speech language skills, socialization and presence of stereotyped behaviours were present in Rayan for receiving the diagnosis of ASDs. This limited his participation in various social activities such as play, communication and interpersonal relationships. He could not attend school independently and his activities of self-care and daily living were affected. Profile of the subject based on ICF-CY is provided in Figure 1.

Autism severity scoring was done by Childhood Autism Rating Scale-2 [18] and Indian Scale for Autism Assessment [19]. Rayan obtained a CARS-2 score of 37 and ISAA score of 156 that signified the presence of severe symptoms of ASD. After the detailed assessment and counselling the parents regarding the baseline status, Rayan was enrolled into an early intervention program which followed the basic principle of intensive intervention with active engagement of the child for at least 15–20 h/week for six months, in systematically planned, developmentally appropriate activities designed to address social, cognitive and linguistic objectives. An informed consent was taken from the mother before enrolling into the intervention program to conform to the ethical guidelines of the institution. A multidisciplinary team involving speech language pathologist and occupational therapist carried out the intervention program. Parental involvement in the therapeutic intervention was ensured during this period. Tables 1–3 show the profile on communication, sensory profile, and activities of daily living (ADL) on baseline, six months post intervention of speech language and sensory integration and six months post technology-based intervention, respectively.

The baseline profile of Rayan's social communication skill was at very rudimentary level of pre intentional behaviours such as crying and some unconventional intentional behaviours such as pushing, grabbing, pulling etc. were noticed. There were no signs of conventional intentional communication during the initial assessment session. The profile of social communication after six months of speech and language intervention revealed marked difference from the baseline. The ability of the child to observe the subtle changes in the world around him and regulate his behaviour became evident during this period of intervention. The social awareness of Rayan showed significant improvement. He began to respond to gross cues from the environment like a person approaching him from an opposite direction. He started to recognize emotions in speech such as anger, displeasure approval etc. The child was showing significant improvement in terms of prelinguistic skills. He started to use unconventional communication to reject, greet and request for attention. Rayan started to use a few simple words as a part of referential communication. He was able to engage in functional play with minimal prompts. In social communication, the child was able to understand the concept of self and large group and communicate with intention upon prompts nearly 50% of the time.

Assessment of sensory regulation and motor coordination at the baseline showed significant sensory integration dysfunction as compared to typically developing peers. . The major domains in which these dysregulations became evident were visual, auditory, tactile, olfactory and vestibular-proprioception. The child was seeking sensory information at a higher rate than typically developing children. He exhibited olfactory seeking which was manifested by smelling strong odour objects like glue stick, body odours, fevicol, etc. The oral seeking was the next concern for Rayan and was manifested as mouthing and licking of non-edible objects. Tactile sensory integration dysfunction was observed during the initial assessment sessions and repeated unusual touch were directed towards others .He liked to experience different textures especially rough surfaces, rub the body on the walls and floor and liked to play with viscous and sticky objects. He explicitly had self-stimulatory behaviours such as self-rocking, self-spinning, and fidgeting. He failed to sit erect and bumped on other people all the time. All these sensory dysregulations interfered with Rayan's attempts to attend towards information from the external environment. During the period of speech, language and sensory intervention Rayan cooperated for most of the sensory integration activities which focused on the tactile/proprioceptive senses. He was interested in whole body movements and cooperated for physical activities, which was focused on motor coordination and bilateral integration. After sensory integration therapy the olfactory, gustatory, tactile and proprioceptive dysfunction were regulated to an extent to which the child was able to attend and act upon the instruction provided. However he had to be physically prompted for activities such as rhythmic tapping, colouring and paper craft. Sensory regulation was evident in auditory and visual sensory skills with a marked reduction in attention towards bright light and reduction in the frequency of vacant stares. The child also began to respond to name call by familiar people and family members. Though the parental reports revealed a reduction in

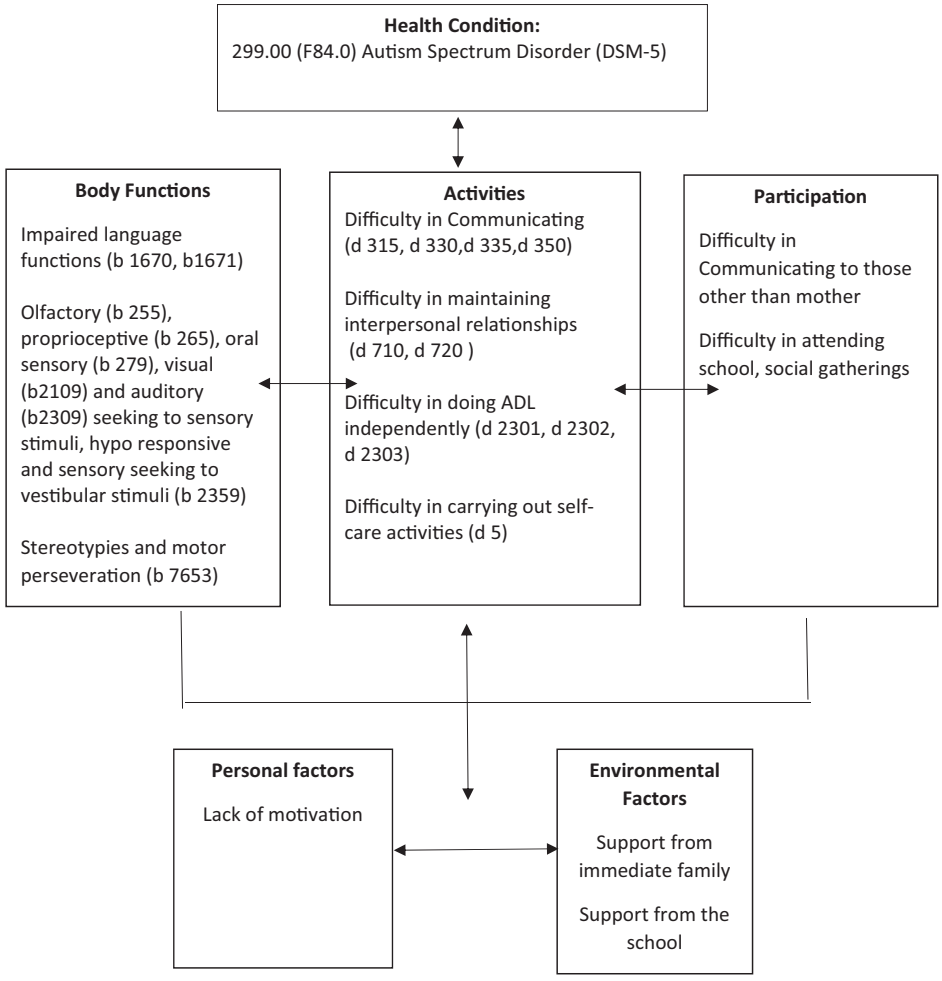


**Figure 1.** Profile of the subject based on ICF-CY classification.

**Table 1.** Baseline profile and progress after 12 months of intervention in communication.

| Communication matrix | Baseline | Six months post speech language intervention | Six months post technology based intervention |
|---|---|---|---|
| Refuse | Level-2 mastered | Level-3 mastered | Level-7 mastered |
| Obtain | Level-2 emerging | Level-3 mastered | Level-7 mastered |
| Social | Level-1 not emerging | Level-3 emerging | Level-7 emerging |
| Information | Level-1 not emerging | Level-1 not emerging | Level-7 emerging |

The levels (1–7) are as described in communication matrix profile for parents [35].

mouthing behaviour of Rayan, a significant sensory regulation in oral as well as olfactory sense was not evident.

Rayan was completely dependent on caregiver for all his ADL's and was evident in the baseline profile. The major domain in which the child require maximal assistance were eating, grooming, dressing, bathing, toileting and bowel and bladder management at the beginning of intervention. The child relied on caregiver even for the timing of each activity. Rayan's mother fed him each time as he found it difficult to take food by himself with hand and was not trained to have his food using spoon. Dressing was another domain which was challenging to Rayan as he was reluctant to wear clothes of particular texture, because of his sensory dysregulation. Even though, he was able to lift his hands while donning and doffing clothes, no attempts were made by the child to dress up independently. Toileting required maximal assistance. Mother had to take him to toilet on a timely basis as he didn't indicate his toileting needs. Washing and managing clothes after toileting also required complete assistance. However, at the end of 6 months of intervention, the child was able to achieve partial independence in activities of daily living. Self-feeding using hand and spoon was the main area where Rayan showed marked progress, though he required moderate assistance as measured using WeeFIM in most of the ADL such as, bathing, toileting, grooming and dressing.

**Table 2.** Baseline sensory profile and progress after 12 months of intervention.

| Sensory profile | Baseline | Six months post speech language intervention | Six months post technology based intervention |
|---|---|---|---|
| Auditory | 19 | 12 | 9 |
| Visual | 18 | 15 | 11 |
| Vestibular | 22 | 20 | 12 |
| Tactile | 21 | 21 | 16 |
| Proprioception | 12 | 10 | 9 |
| Oral | 23 | 21 | 18 |

The scoring of each sensory domain was done as per sensory profile 2 child [36].

Table 3. Baseline profile on activities of daily living and progress after 12 months of intervention.

| Activities of daily living | Baseline | Six months post speech language intervention | Six months post technology based intervention |
|---|---|---|---|
| | | Level of assistance | |
| Eating | Maximal | Moderate | Minimal |
| Grooming | Maximal | Moderate | Minimal |
| Bathing | Maximal | Maximal | Moderate |
| Dressing | Maximal | Moderate | Moderate |
| Toileting | Maximal | Maximal | Moderate |
| Bowel and bladder management | Maximal | Moderate | Moderate |

The scoring of each ADL was done as per Functional Independence Measure for Children [37].

Since the child's social communication was not showing expected prognosis the child was then referred for augmentative and alternative communication (AAC) assessment with a view that it might be a more appropriate solution for him. AAC assessment was rooted in Participation Model [20] to identify Rayan's communication needs and participation barriers. Rayan's motor, cognitive/linguistic, sensory/perceptual profile suggested the use of an AAC system. His mother's attitude and willingness to act as communication facilitator further resulted in enrolling him into a Picture assisted communication training programme. These training sessions were tailor made where in the child and the clinician engaged in a communication process through picture exchange. AAC reassessment was done to review the child's performance for picture assisted communication after a catch trial period of three months. During the review, it was found that the child was not able to maintain the expected prognosis. His communication development through picture exchanges was assumed to be unsuccessful due to lack of practice at home. Rayan often chewed picture cards or threw them away, making it difficult for the mother to carry out home training. From the perspective of the mother, she believed only in oral communication and was hesitant to use picture exchange as an alternate and augmentative communication. The mother was fearful about society rejecting picture exchange as an alternate mode of communication. At this point, the clinician and parent further explored his interest towards print which was evidenced through peculiar interest in seeing printed matter in books, notice boards, and commercial labels during observation sessions. His reading and writing skills were informally assessed at both word level and sentence level. A decision to shift from no technology AAC system (Picture assisted Communication Training) to high technology AAC system was considered due to the lack of development of communication skills through the initial AAC system, progression of child's age and mother's low acceptance to the given AAC system. The idea of using high technology AAC system was acceptable and hence a consensus was reached between clinician and parent. At this juncture mother was advised to slowly transit from a developmental model to an educational model of intervention. He was enrolled to an inclusive education classroom. However, his sensory difficulties prevented all means of classroom engagement. He was introduced to a partial home-schooling program where the child attended classroom for few hours and rest of the time he was coached at home. The speech language therapy and occupational therapy continued once in a week. Speech and Language intervention then focused on AAC intervention with a redefined objective of using high technology to improve communication through reading and writing.

### Technology based intervention

At this stage of intervention, technological devices were introduced as a means of communication as well as training tools for enhancing the communication skills of Rayan.

### Selection of technology

In light of the Rayan's interest towards alphabets, efforts were undertaken to capitalize this interest into using written letters as a full-fledged medium of communication. Since writing on paper turned out to be laborious and undecipherable, he was introduced to an on screen touch QWERTY keyboard with word prediction feature in an iOS based AAC application; Avaz. He found touch keyboard to be difficult as he had difficulty in digit control while selecting the keys and always used to swipe the screen without focusing on the alphabets. Hence, he was provided with a desktop PC along with Clevy keyboard. The coloured adapted Clevy keyboard with large keys enabled him to type letters better. The key repeat switch on the keyboard was disabled which prevented the letters from appearing more than once no matter how long he pressed a single key. This was discontinued after few sessions as he became highly distracted by the coloured keys and also since it could be used only during therapy sessions and not at home due to non-availability of the device.

Rayan was then referred for AAC follow up assessment to feature match his skills to the available AAC system options. Text was selected over pictures or symbols, direct selection using physical keyboard was selected over virtual on screen keyboard. Considering portability, availability and presence of physical keyboard, a portable Personal Computer was selected as the AAC system for Rayan. The progression of communicative development using technology is listed below

### Initial phase of technology based intervention (three months)

He was introduced to a personal computer was taught function of different keys by engaging him in simple copying activities in Microsoft Word. The child was made to read and write in English though his mother tongue was Malayalam, an Indian language. This was because of his ability to recognize English alphabets, use of English as preferred medium of instruction at school, increased demand on cognitive resource allocation by the alpha syllabic Malayalam language and lack of availability of physical keyboard in Malayalam.

He was enrolled for individual sessions of 45 min duration per week. Adequate home training activities were also provided. The progress was monitored through analysis of daily progress monitoring sheets which was marked during each session of Rayan, parent perspective in social skills, literacy, adaptive skills and sensory symptoms were also taken into account.

### Intermediate phase of Technology based intervention (second three months)

The technology based intervention helped the child to express his needs with ease and less distraction. During the second month the communication skill witnessed a tremendous growth both in

terms of quantity and quality. The child began to communicate his needs intentionally, began to make appropriate choices and request for object which he needs. By the end of the second month the child also began to answer correctly polar questions directed towards him by the clinician and caretaker. The typing speed of Rayan also showed significant improvement and began to use correct punctuation while communicating. The literacy and adaptive skills also showed significant improvement. The progress continued to be monitored using evaluation sheets and the parent's observations.

### *Final phase of Technology based intervention (last three month)*

The progression of technology based intervention to the third month witnessed a tremendous progress in the areas of communication where Rayan began to use question forms. He began to ask questions about people and object which are not present in the immediate environment. The usage of polite forms while communicating with the partner was yet another milestone in social interaction. Academic performance was reported to meet expected prognosis. The severity of ASD symptoms exhibited by the child showed mild to moderate symptoms of ASD with a total score of 33 in CARS-2 in comparison to an earlier score of 37. But sensory dysfunction showed fluctuations depending on the amount of home training. Though the technology helped him to communicate his needs through a new medium the child remained partially dependent on caregiver for his activities of daily living. The child remained at a level where he required a moderate assistance for all activities of daily living including eating, bathing, dressing toileting and grooming. The sensory regulation which was exhibited by Rayan was also commendable and it aided in enhancing communication skills and ADL.

## Discussion

### *Clinician's skill is a deciding factor*

A key factor contributing to the development of an effective intervention programme in this case was close observation of the child's behaviour. The planning of the treatment programme was mainly depended on the observation made by the clinician. In the present study, during the course of therapeutic intervention the clinician utilized three important methods namely observation, assessment and planning. Clinical observation was an active process that the clinician engages in to understand the unique profile of the child. In the present study, a close observation on the specific interest of the child in printed matter promoted the use of reading and writing as a medium to develop communication. Alongside with the observations, continuous informal and formal assessments provided clear picture on the progress of the child. Another strength was the involvement of a multidisciplinary team in developing deeper insights while planning intervention goals.

### *Other intervention*

Rayan had been attending traditional approaches before the introduction of technology based intervention. Rayan had been enrolled into an early intervention program which follows the basic principle of intensive intervention with active engagement of the child for at least 15–20 h/week for six months, in systematically planned, developmentally appropriate activities designed to address social, cognitive and linguistic objectives. A multidisciplinary team involving speech language pathologist and occupational therapist carried out the intervention program. Parental involvement in the therapeutic intervention was ensured during this period. The formal assessments and observation done at the end of six months intervention revealed that he had improved in the use of communicative intentions. He achieved a level three performance in communication matrix (parent version). He started to use unconventional communication to reject, greet and request attention. But Rayan found it difficult to generalize and maintain functional use of these skills outside the intervention setting primarily because the mother was stressed with the responsibilities of another sibling and constant travel. Lack of generalization resulted in no further improvement in functional communication.

### *Transition*

Upon reviewing the prognosis obtained after a catch trial period revealed that the child was not able to maintain the expected prognosis. He was introduced to a partial home-schooling program where the child attended classroom for few hours and rest of the time he was coached at home. The speech language therapy and occupational therapy continued once in a week and during this time his specific interest towards print was identified. With the support of the parent an objective to use technology to develop communication was initiated. The provision of technology as a supportive intervention strategy for individuals with autism spectrum has been accepted by many researchers. Studies done by Bellini & Akullian [21], Cafiero [22], Mirenda [23,24], Mirenda et al. [5] mainly addressed the intervention for core challenges by using technology.

### *Technology*

With the introduction of technology Rayan began to generalize the strategies for communication and social interaction. The fact that individuals with ASD enjoy technology is because it makes them secure and motivated [25]. Multifariousness in the symptomatology of autism can become a hurdle for service providers [26] but the technology has the ability to provide customised intervention for each individual depending upon their changing needs. Moore and Calvert [27] found that retention of taught words was better for computer-presented words than for those taught in a behavioural treatment drill. The present scenario should focus on the ways in which the individual with autism can express their feelings to the world like self-reporting rather than trying to solve the puzzle by teaching them declarative knowledge.

### *Other domains through technology*

The individuals with ASD has sensory dysfunction which prevents them from understanding a complex/multiple cues in the environment and act accordingly. Technology has the capability to streamline the information needed for the individual thereby reducing the sensory overload. The affective and social learning in individuals with ASD has shown significant prognosis when technology driven intervention is used [21]. Technology plays the role of an adaptive filter and a bridge that connects between communication partner and it prevents all the ambient sensory stimuli which hinders the proper functioning of the individual. Literacy is another area which is closely associated with technological advancement. The keyboarding has been considered as a viable option for written communication in the case of Rayan and it helped him to overcome the motor in-coordination. This was supported by Cafiero [28] in his article "Technology in Action". Another prominent area which requires close monitoring and

timely intervention is activities of daily living and technology has crucial role in assisting individuals with ASD to improve quality of life. The provision of visual scheduling in this regard can be considered. The utilization of easily available technology like mobiles apps and iPad apps for scheduling their day to day activities can be done effectively. The validated research has been done in using visual cues in enhancing the functioning of individuals with autism [29]. Visual scheduling helps the individual to bring about noteworthy change in the self-monitoring skills and thereby improving the overall quality of life.

### *Guideline and candidacy*

Technology provides a platform for systematic exploration. It is learner paced and learner centred. Computers become a best medium for learning because it is predictable and is less distractible. There is no documented evidence to show who would benefit and who would not benefit learning based on technology. However, subjective evaluation on interest to explore the technology can be considered during the subsequent client contact hours. The clinician's observation on child's interest, the acceptability of the parent to use the technology and the progress that the child makes over session would be predicting the success of using technology in children with ASD. Further, it offered learner paced and child centred activities making it interesting for Rayan. When assessing an individual for the candidacy of technology based intervention, issues such as usability, integration, discontinuance, technology compatibility, context, and sensory and cognitive demands need to be considered [30].

### *Positive and negative aspects of technology based intervention*

Any intervention is said to be an effective intervention when the skill acquired through that intervention is generalized and maintained outside the intervention setting. In that respect the maintenance of skills acquired with the technological interface is firmly proved. There are several detrimental factors which support this notion of successful technology based intervention. One of the most important factor is the accessibility of technological assistance in the present scenario. Governing bodies are ready to supply the assistive devices at a concession rate and this would lead result in availability of the devices time boundary to the needy time boundary. Second contributing factor which enhances the maintenance of technology as medium of communication is the capability of technology to provide focused attention on well-defined task and reduced distractions from the unnecessary sensory stimuli [31].

The innovative technologies which are usually free from the social demands which are challenging and confusing for ASD can also be the third detrimental factor that influences the success rate. In the case of Rayan, the distraction from the unnecessary sensory stimuli enhanced his communication and the restrictions of the social rules were dissolved by his mode of intervention. The responses from the Rayan have also become spontaneous. The fourth and the most important factor which helps in this journey is the portability of device involved in the intervention most of the traditional picture assisted intervention are cumbersome and is found to be less appealing for the individual to present in the social setting. The fifth detrimental factor which has strong impact on the use of technology as a source of communication is the reduced societal stigma. The invisible barrier created by the societal stigma is hindering the expected prognosis of individual with disability. But the wide spread usage of mobile, tab, and iPad has provided a new platform for these individuals.

Technology based interventions act as a boon to many individuals with difficulty in fine motor skills like handwriting issues. This intervention strategy has been evolved out of the difficulty of Rayan with writing. The usage of keyboard for communication made learning more enjoyable as it was less strenuous than writing. The pace of technological advancement is high and the availability of technology holds promises for individuals with ASD.

There are certain negative concerns too in the practice of technology based intervention. The major concern is regarding the possibility to isolate individual with ASD from the social life [12,32]. Majority of the researchers in the field of Neurodevelopmental sciences were of the opinion that social motivation is affected than their typically developing peers [33,34]. Thus their interaction through the technology acts as an alternative to conventional face to face relationship. The utilisation of technology based intervention has opened a new arena of development in the overall quality of life of individuals with ASDs.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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