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*Original Article*

# Augmentative and Alternative Communication for Children with Autism Spectrum Disorder: A Randomised Study of Awareness and Developmental Language Interventions

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**Abstract** Using a computer-based voice output communication aid (VOCA) device, the present study aimed to evaluate the effectiveness of augmentative and alternative communication systems for autistic symptoms, language features and emotion regulation of children diagnosed with autism spectrum disorders (ASD's). The child and adolescent psychiatrist (an experienced clinician) diagnosed the children as ASD according to Diagnostic and Statistical Manual of Mental Disorders fifth edition (DSM 5) and clinical observation and follow up. Forty-two children (36-72 months old) diagnosed with ASD participated in the study. Subjects were randomised into two groups (Twenty-one children were in the intervention group and 21 children were in the control group) and the first group received the augmentative and alternative communication systems treatment while the second received routine treatment. The socio-demographic features of groups were similar and children who were part of the experimental group showed improvements in receptive and expressive language skills, had better emotion regulation skills and their autistic symptoms decreased. Furthermore, the experimental group's mean length of utterance and language sample size increased. This study provided preliminary evidence that augmentative and alternative communication systems using computer-based voice output communication aids, which are portable and simple, may help children diagnosed with ASD develop communication and language skills.

**Key words** Augmentative and alternative communication; Autism spectrum disorder; Emotion regulation; Voice output communication aid

## Introduction

One of the core features of autism spectrum disorder (ASD) is the impairment in social-communication skills. Such impairments may manifest themselves in a limited range of communication functions such as; reduced use of communication acts to share interests and emotions, and problems with appropriately initiating and responding to communication with others.[1] Children with ASD have impaired communication – both verbal and non-verbal communication – and the impairment in communication affects the children's ability to request for objects and actions as well and the use of such acts have been limited in terms of social interaction (e.g. requests for social routines and permission, showing off, greetings, calling, and acknowledgements) or acknowledging a joint effort (e.g. comments, requests for information, and clarifications).[2,3] These findings have been replicated in succeeding studies.[4] Comparison of this pattern indicates a contrast between children with ASD and children who follow typical development since a range of communication functions develop at the same time for the

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latter even before they start speaking.[2] Findings of research studies in which researchers utilised augmentative and alternative communication (AAC) interventions to target communicative acts for behavioural regulation support the idea that children with ASD who are taught how to use AAC increase their attempts to regulate behaviour of another person through, for example, requesting needs and wants.[5-7] In fact, systematic reviews conducted by Ganz et al (2010) and Meer and Ripsoli (2010) presented strong empirical evidence that such interventions can be successful when conducted for children with ASD.[8,9]

In ASD, one of the important reasons for maladaptive emotional and behavioural responses is considered to be emotion dysregulation.[10,11] Maladaptive emotional and behavioural responses may result in temper tantrums, difficulties in anger control, self-injurious behaviour, aggressive behaviours, and mood dysregulation.[12-14] In addition, children with ASD have been found to make frequent uses of non-appropriate or idiosyncratic strategies like breath holding, crying and avoidance.[14,15] On the other hand, Jahromi and colleagues showed that impaired functioning may become worse with maladaptive emotional responses and difficulties in emotion regulation.[16] In a different study, Jahromi and colleagues also found that children with ASD use less frequent and less effective adaptive emotion regulation in comparison to children who follow typical development.[15] Samson and colleagues found an association between emotion dysregulation and the core symptoms of ASD.[17] Current studies report high rates of emotion dysregulation in individuals with ASD,[18,19] but the associations between AAC, language profiles and emotion dysregulation have not been investigated before. Considering the fact the positive effects of AAC treatments with voice output communication aids (VOCA) on children with ASD (i.e. teaching single-step requesting), it can be interpreted that AAC treatments that utilise VOCAs might help children' development of receptive and expressive language development.[8,9]

Recent research suggests that there has been a notable increase in the use of computer-based AAC systems, with advanced input systems such as touch screens or eye tracking sensors.[20] It is argued that such systems, regardless of the technology level, are positive for children who have social and communication needs and this is because such systems promote linguistic, cognitive, and social development.[21,22]

AAC with aided interaction may help simplify the communication with peers. For example, in their studies, Clarke and Wilkinson reported on the process in which children operate and orient towards a VOCA while interacting with peers.[23-25] Their results revealed the positive effects of the sound output (bleep sounds during word construction) in negotiating meaning in relation to peers' immediate sequential context. On a different note, parents, unlike teachers and/or therapists who spend a limited amount of time with children, have the unique capacity to be able to impact on their children's lives. The recognition of this role resulted in the development of parent-mediated intervention and training programmes.[26] Training parents is a crucial component of intervention programmes since such training helps children with ASD receive consistent and daily support.[27] In Patterson and colleagues' review, it is reported that parents of children with ASD can become effective language facilitators after attending appropriate training.[28] In addition, parental well-being and behaviours may be positively affected as a result of parents being included in the treatment process (e.g. a decrease in depression levels, better communication skills, and knowledge of ASD); furthermore, this can positively impact on children's language and behavioural development.[28,29] Programmes, in which parents take active roles with therapists, have more positive effects on children's early social communication skills,[30] language development,[31] and augmented communication.[32] AAC may promote linguistic, cognitive, and social development in ASD and parents' active roles with therapists, might provide positive effects on ASD symptoms and emotional dysregulation.

The aim of the present study was to evaluate the effectiveness of AAC using a computer-based VOCA device with a touch-sensitive screen-input system for autistic symptoms, language features, and emotion regulation of children diagnosed with ASD.

## Method

### *Setting and Protocols*

Firstly the children were screened for hearing problems and only children whose audiological evaluations were normal with normal bilateral hearing thresholds were included in the study. Families of children with ASD worked for 55 minutes a day for 5 days a week over the course of eight weeks (i.e., a total of 40 days). Each session focused on a 40-minute AAC condition. During the treatment, the VOCA was either placed within reach or outside the reach of children with ASD. The parents participated in the therapy process by playing an active role in the regulation

of the home environment and providing the verbal cues that signalled the start of a requesting opportunity. In addition, opportunities emerged for parents to teach children communication skills during their daily routines in the therapy (e.g. rounding and reinforcing social and physical environment). The parents were shown different sizes and types of graphic representations (e.g. line drawings, photographs) and were asked to provide their opinions about the visual features as well as number and content of messages that would be most useful for teaching each child how to use a VOCA during their daily routine. We also included an element of book reading, in which a speech and language therapist (SLT) read from a storybook, into the process of using VOCAs. This activity primarily focused on receptive vocabulary gains for children. The parents became part of the therapy process by playing an active role in the regulation of home environment for the children involved. In the VOCA therapy, the role of the family was using remarkable expressions or the selected vocabulary for simple talk (small talk). This is because the core word category increases the interest of the children and stimulates them to give more natural answers, talk more about the story or topic, interact, initiate a joke, or complete a sentence.[25] If a child stops at one point, then, the parents provide hints for interpretation and encourage the child in a natural way to tell the rest of the story. The children are in constant dialogue with their parents during their use of the VOCA devices without interruptions.

Parents' use of remarkable expressions or the selected vocabulary for simple talk is intended to increase the interest of the children and stimulate the children to give more natural answers by encouraging them to talk more about the story or topic, interact, and initiate a joke or complete a sentence. The VOCA devices used included picture or word representations of one to eight pieces of the food and/or drink that a child preferred to eat and/or drink. When a child pressed one of the symbols, the VOCA device produced a verbal request which was then fulfilled. A VOCA device with an active panel was provided and given to parents of children with ASD. This VOCA device had a micro switch with a picture. The picture represented "WANT" and was connected to a verbal recording of "I want more" which was used to request (and obtain) any of several preferred food/drink and activity items. The parent provides hints for interpretation and encourages the child in a natural way to tell the rest of the story. Through the use the VOCA, the children with ASD in children are enabled to turn the interaction into a conversation without stops. During this process, verbal and physical prompts were provided by the SLT to complete work-related tasks such as sorting items when necessary. Clinical evaluation was conducted twice a week by investigating and controlling the child and family relationships. The computer-assisted methods of transcript analyses[33,34] were utilised for analysing spontaneous language, the production of non-targeted actions on either a target or non-target focus, and phonological awareness on the recordings of treatment sessions. Systematic Analysis of Language Transcripts (SALT) software was used as a language reference point and this software was used to calculate mean length of utterances (MLU) and language sample size (LSS) in utterances. These procedures were performed by an audiology and language speech therapist.

#### *Data Collection Tools*

Autism Behaviour Checklist (ABC): The ABC contains 57 items in five areas: Sensory, Relating, Body and Object Use, Language, and Social and Self-help Skills. Each item is scored from 1 to 4 and the total score is obtained by adding the weight of the different areas. The minimum score that can be achieved is 0 while the maximum is 159.[35] The validity and reliability study of the scale for the Turkish version was conducted by Irmak and colleagues.[36] The procedures in relation to the administration of the ABC checklist were performed by a child psychiatrist.

Denver II Developmental Screening Test (DDST): The test was developed by Frankenburg and colleagues and was adapted and standardised by many countries for their own communities.[37] This is the first and only available developmental test standardised for Turkish children. It was revised and adapted into the Turkish context in 1990s. The Turkish validity and reliability study was conducted by Anlar and Yalaz.[38] Being an easily applicable test for children between the ages of 0 and 6 years, DDST is important for following children's development and early identification of developmental deviations within this time period. DDST evaluates four areas; a) personal-social (the ability to get along with people and meet one's personal needs), b) fine motor (the ability of having hand-eye coordination, using small objects and solving problems), c) language (the skills of hearing, comprehending, and using both receptive and expressive language), and d) gross motor (the ability of using large muscles to complete actions such as sitting, walking, and jumping). These procedures were performed by the SLT.

Test of Early Language Development-Third Edition (TELD-3): This is a norm-based assessment instrument developed by Hresko, Reid and Hammill for measuring the skills of receptive and expressive language in children aged

between 24 months (2 years) and 95 months (just under 8 years).[39] It is commonly used for purposes such as diagnosing children with early-period language disorders, showing the weak and strong aspects of their language development, and understanding their language development process.[40] The test was adapted in Turkey with the title of Turkish Test of Early Language Development (TELD). Including three of the five basic components of language; TELD assesses the semantics, syntax and morphemes through the test items. TELD contains two subtests as receptive language and expressive language. There are 24 items assessing the semantics in Form A (the Subtest of Receptive language); 25 items assessing the semantics in Form B (the Subtest of Receptive language); 13 items assessing the syntax in Form A (the Subtest of Receptive language), and 12 items assessing the syntax in Form B (the Subtest of Receptive language). There are 22 items assessing the semantics in Form A (the Subtest of Expressive language); 24 items assessing the semantics in Form B (the Subtest of Expressive language); 17 items assessing the syntax in Form A (the Subtest of Expressive language); and 15 items assessing the syntax in Form B (the Subtest of Expressive language). In case of meeting the pass criteria specified besides the enumerated items in the form, one point is obtained for a correct answer and in case of failing to meet the pass criteria, zero points is obtained for a wrong answer (or 'did not pass'). Raw scores are converted into standard scores from the tables at the end of the Handbook for Users. Both Form A and Form B of TELD was used in the study and the forms were administered by the SLT.

Emotion Regulation Checklist (ERC): ERC is used for assessing the emotion regulation in children.[41] The scale consists of 24 items which assesses the regulation and expression of emotional reactivity and emotions of preschool and school-age children according to the conditions of environment under two subscales; a) "Emotion Regulation" and b) "Emotional Lability – Negativity". The former subscale consists of 15 items and the latter of nine items. Items are responded on a Likert scale with four anchors (1= never, 2= rarely, 3= frequently, 4= always). If a child scores high in the first factor that means that s/he cannot regulate his/her emotions. On the other hand, if a child scores high in the second factor then this suggests that the child can regulate his emotions very well. Not only parents and teachers, but also an adult who knows the child well enough can fill the questionnaire. The studies show that the Turkish adaptation of the scale has high reliability and distinctive validity.[42,43] The validity and reliability study of the scale was also conducted by Kapci and colleagues.[44] In the present study, the ERC scales were filled by the mothers with the guidance of a child psychiatrist.

### *Participants*

The participants in the present study were 42 children (36-72 months old) who were diagnosed with ASD and who had limited expressive vocabulary at the onset of the study. Those children met the following criteria for minimal expressive vocabulary: less than 14 spoken words produced spontaneously according to; a) a teacher report, b) a parent report, and c) a language sample collected during our assessment process. Children who had chronic organic diseases, epilepsy or genetic diseases were excluded from study. Also children who had language problems due otolaryngologic problems (cleft palate or lip) were excluded. The intervention took place in Nevşehir State Hospital within the department that specialises in AAC assessment and intervention for children with complex communication needs. Subjects were randomised into two groups according to the order of applying to outpatient clinic; odd numbers were included to the intervention group. (Twenty one children were in intervention group and 21 children were in control group). The first group attended the experimental AAC treatment and speech sound practice using a computer-based voice output communication aid (VOCA) device with a touch-sensitive screen-input system was used to teach children individualised words that were selected on the basis of initial speech sound repertoires and principles of phonotactic probability and neighbourhood density. The second group was the control group and received only routine treatment. Routine treatment consisted of monthly psychiatric session and weekly special education lessons (two lessons in a week). Both intervention and control group received routine treatment during current study. We have examined the impact of using VOCAs on children's organisation of communicative activities. Visual schedules utilising VOCAs were used with children with ASD during the speech therapy sessions. The assessor was blind to whether the child had participated in the VOCA programme. Test of Early Language Development (TELD) was used to evaluate language profiles, autistic symptoms were evaluated with Autism Behaviour Checklist (ABC) and children's emotion regulation skills were evaluated with Emotion Regulation Checklist (ERC). TELD was administered in the child's native tongue. A communication profile was obtained through informal analysis of a 20-

minute video-recorded session in both play and snack-time contexts prior to baseline. This profile was then combined with parents' reports of their children's expressive communication skills. The MLU was calculated for each instance of spontaneous speech that occurred at a spontaneous speech opportunity using SALT. The evaluation was conducted by applying the DDST. Lastly, the ABC was used to investigate autistic symptoms just before and after sessions. Those children receiving only routine treatment were assessed again in the time that children finished VOCA sessions.

### *Ethical Considerations*

Since the participants in the present study were children who had limited language skills, parents were asked if they would allow their children to participate in this research. As such, parents of the 42 children described above signed the informed consent form prior to the collection of any data. The consent form that was filled by parents was in accordance with the Declaration of Helsinki as amended by the World Medical Association Declaration of Helsinki (World Medical Association, 2013) and received ethical clearance from the Non-Invasive Clinical Trials Ethics Committee at Nevþehir Hacý Bektaþ Veli University.

### *Statistical Analysis*

Some socio-demographic and clinical categorical variables of the case group and the control group were assessed through descriptive statistics. Chi-square test was used for comparing the classified categorical variables (e.g. gender). Distribution of the data was primarily assessed by using the Kolmogorov-Smirnov test and since the data did not meet the requirements of a normal distribution, the binary groups were assessed using Mann-Whitney U test. In addition, the Wilcoxon analysis was used to evaluate changes in the same group. The p value was accepted to be statistically significant at <0.05.

## Results

The average age was determined as 52.19 (±6.91) months for children diagnosed with ASD in the intervention group while it was 53.76 (±6.59) months for children in the control group. The difference between the groups was not statistically significant (p=0.307). The comparison of the children in terms of their mental age using the data acquired from the DDST suggested that children in the intervention group had a mental age of 38.81 (±8.92) months and children in the control group had a mental age of 38.40 (±7.69; p=0.907). The assessment of children's speech levels showed that the experimental group's average speech level was 36.66 (±10.55) and the control group's was 36.57 (±9.22; p=0.798). The groups were similar in terms of sex distribution, maternal age, education and working condition. The socio-demographic characteristics of the groups are displayed in Table 1.

Prior to the intervention, Mann Whitney U test was used to compare the experimental and control group members' skills by analysing their ABC scores in terms of receptive

**Table 1** Comparison of groups' age, mental age, language levels, and sociodemographic data

| | Intervention | Control | p |
|---|---|---|---|
| Age (months) | 37.48±7.38 | 38.55±9.59 | 0.307 |
| Mental age (months) | 38.81±8.92 | 38.40±7.69 | 0.907 |
| Speech level (months) | 36.66±10.55 | 36.66±10.55 | 0.798 |
| Sex | | | 0.484 |
| Male | 14 | 17 | |
| Female | 7 | 4 | |
| Mothers' age (year) | 32.80±3.59 | 2.26±4.99 | 0.526 |
| Mothers' education (year) | | | 0.757 |
| Over 8 | 9 | 10 | |
| Under 8 | 12 | 11 | |
| Mother's social status | | | 1 |
| House wife | 14 | 14 | |
| Works | 7 | 7 | |

and expressive language use. No significant difference was found between the groups. Table 2 shows the values obtained from language skills and all subscales of ABC before the intervention. As can be seen from the table none of the test results were significant which supports the idea that both the control and the intervention groups were similar.

Post-intervention comparison of the intervention and control group's scores, however, showed that children who were in the intervention group scored significantly better than those in the control group in terms of receptive and expressive language and all subscales of ABC (see Table 3). Test results indicated that there was a significant increase in the intervention group's emotion regulation but also they experienced a decrease in emotional lability. The results of the remaining tests were also significant in favour of the intervention group (see Table 3).

The calculation of MLU requires sufficient numbers of intelligible utterances per sample. Table 4 reports on the MLU and LSS results of both groups for pre and post-treatment. It can be seen that, with AAC, children increased the number of utterances and there was a significant difference between pre and post treatment in MLU and LSS. The correlations remained significant in both groups under both partner conditions. Overall, LSS was a close parallel to MLU within the same language samples after controlling for language sample size in post treatment groups. This indicates that there is a statistically significant relationship between using AAC treatment with VOCA and the children with ASD's language development.

## Discussion

Our findings showed that AAC can be effective in improving language development, autistic symptoms and emotion regulation in individuals with ASD. There were 3 main findings.

First of all, to the best of our knowledge, this is the first study to provide preliminary evidence supporting effectiveness of AAC in emotion dysregulation of autistic children. As explained at the beginning of this paper, recent

**Table 2** The scores of Denver Developmental Screening Test II, Test of Early Language Development, Emotion Regulation Checklist, and Autism Behaviour Checklist prior to the intervention

| | Group | N | Mean rank | Sum of ranks | p | z | U |
|---|---|---|---|---|---|---|---|
| Denver total | Int. | 21 | 21.71 | 456.00 | 0.907 | -0.117 | 216 |
| | Cont. | 21 | 21.29 | 447.00 | | | |
| Denver language | Int. | 21 | 21.02 | 441.50 | 0.798 | -0.256 | 210.5 |
| | Cont. | 21 | 21.98 | 461.50 | | | |
| Receptive language | Int. | 21 | 24.24 | 509.00 | 0.144 | -1.460 | 163 |
| | Cont. | 21 | 18.76 | 394.00 | | | |
| Expressive language | Int. | 21 | 23.00 | 483.00 | 0.426 | -0.796 | 189 |
| | Cont. | 21 | 20.00 | 420.00 | | | |
| Emotional lability | Int. | 21 | 19.86 | 417.00 | 0.384 | -0.871 | 186 |
| | Cont. | 21 | 23.14 | 486.00 | | | |
| Emotional regulation | Int. | 21 | 24.60 | 516.50 | 0.100 | -1.643 | 155.5 |
| | Cont. | 21 | 18.40 | 386.50 | | | |
| ABC sensory | Int. | 21 | 18.76 | 394.00 | 0.144 | -1.461 | 163 |
| | Cont. | 21 | 24.24 | 509.00 | | | |
| ABC relating | Int. | 21 | 18.21 | 382.50 | 0.077 | -1.769 | 151.5 |
| | Cont. | 21 | 24.79 | 520.50 | | | |
| ABC body and object use | Int. | 21 | 19.00 | 399.00 | 0.183 | -1.331 | 168 |
| | Cont. | 21 | 24.00 | 504.00 | | | |
| ABC language | Int. | 21 | 18.55 | 389.50 | 0.113 | -1.586 | 158.5 |
| | Cont. | 21 | 24.45 | 513.50 | | | |
| ABC social and self-help skills | Int. | 21 | 18.69 | 392.50 | 0.134 | -1.499 | 161.5 |
| | Cont. | 21 | 24.31 | 510.50 | | | |

ABC=Autism Behaviour Checklist; Int.=Intervention; Cont.=Control

studies have reported high rates of emotion dysregulation in children with ASD.[18,19] Emotion dysregulation may be explained as failing in regulating emotions appropriately and effectively. Parents and clinicians have long emphasized the important role that maladaptive emotional responses in ASD[11] which might be a result of dysregulated emotions. In Samson and colleagues' study, all core features (including deficits in social and communication functioning, repetitive behaviours, and sensory abnormalities) of autism were found to be related to emotion dysregulation.[17] These findings, especially the association between emotion dysregulation and social and communication deficits, were in accordance with previous reports of an association between poor social abilities (i.e., theory of mind, perspective taking abilities) and emotion dysregulation.[16,17] Considering these, our results are significant in the development of efficient treatment for emotion dysregulation which could be used to improve the social communication and interaction of children with ASD. These effects may be reciprocal, thus it is possible that development in linguistic and social areas might provide positive effects on emotional dysregulation. It is a known fact that disruptive behaviours related to emotion dysregulation, such as irritability, temper tantrums, aggression, or self-injurious behaviour are the basic reasons for pharmacological treatment.[45] In light of the evidence presented so far, it could be, tentatively, interpreted that the availability of training programmes such

**Table 3** The scores of test of Early Language Development, Emotion Regulation Checklist, and Autism Behaviour Checklist post intervention

| | Group | N | Mean rank | Sum of ranks | p | z | U |
|---|---|---|---|---|---|---|---|
| Receptive language | Int. | 21 | 30.76 | 646.00 | 0.001* | -4.928 | 26 |
| | Cont. | 21 | 23.00 | 483.00 | | | |
| Expressive language | Int. | 21 | 28.40 | 596.50 | 0.001* | -3.666 | 75.5 |
| | Cont. | 21 | 23.14 | 486.00 | | | |
| Emotional lability | Int. | 21 | 16.48 | 346.00 | 0.008* | -2.662 | 115 |
| | Cont. | 21 | 26.52 | 557.00 | | | |
| Emotional regulation | Int. | 21 | 29.67 | 623.00 | 0.001* | -4.349 | 49 |
| | Cont. | 21 | 13.33 | 280.00 | | | |
| ABC sensory | Int. | 21 | 17.79 | 373.50 | 0.046* | -1.992 | 142.5 |
| | Cont. | 21 | 25.21 | 529.50 | | | |
| ABC relating | Int. | 21 | 16.71 | 351.00 | 0.010* | -2.593 | 120 |
| | Cont. | 21 | 26.29 | 552.00 | | | |
| ABC body and object use | Int. | 21 | 16.81 | 353.00 | 0.012* | -2.516 | 122 |
| | Cont. | 21 | 26.19 | 550.00 | | | |
| ABC language | Int. | 21 | 14.74 | 309.50 | 0.001* | -3.599 | 78.5 |
| | Cont. | 21 | 28.26 | 593.50 | | | |
| ABC social and self-help skills | Int. | 21 | 15.81 | 332.00 | 0.002* | -3.038 | 101 |
| | Cont. | 21 | 27.19 | 571.00 | | | |

*p is significant at <0.050

ABC=Autism Behaviour Checklist; Int.=Intervention; Cont.=Control

**Table 4** Mean length of utterance (MLU) and language sample size (LSS) before and after intervention

| | Pre-intervention | | Post-intervention | |
|---|---|---|---|---|
| | MLU | LSS | MLU | LSS |
| Intervention | 3.01± 0.33 | 117.46±31.82 | 4.28±0.34* | 133.57±31.83* |
| Control | 3.11±0.64 | 107.32±24.33 | 3.88±0.94 | 127.14±33.16 |

*p is significant at <0.001, the number of utterances used to calculate MLU was used for LSS.

as the one employed in this study might decrease the use of pharmacological agents associated with severe side effects (e.g., antipsychotic medications). Thus, AAC can be considered as an option to supplement or augment an individual's speech and facilitate emotional regulation.[46] AAC, with increasing verbalisation, may provide expressing feelings and that cause better emotion regulation skills.

Secondly, this is one of the first studies to show increases in minimally verbal children's spontaneous communication including parental intervention. Involvement of parents may positively influence the development of language skills and emotional regulation. Treating the social exchanges between the child and caregiver as a crucial component of learning is a milestone for development.[47] In their research, Adamson and colleagues found that the amount of time young children with ASD spend with caregivers is 20 to 30 per cent lower than the typically developing children.[48] Having a child with developmental difficulties, indisputably, means that a parent needs to spend more effort; however, having a child with ASD makes this situation even more difficult. Thus, teaching parents how to facilitate joint interactions with their children with ASD becomes an important and necessary consideration.

In a study by Shire and colleagues', 61 children with ASD, who were between five- and eight-years old and who had minimal spontaneous communication, received a six-month social communication intervention including parent training which resulted in positive outcomes for the children.[27] Adamson and colleagues recorded parent–child play interactions and coded them for parents' strategy implementation and the time they spend together with their children.[48] They found that parents mastered an average of 70% of the strategies and children's joint engagement was associated with parents' implementation success of the strategies across time, which demonstrated that parents' implementation of those strategies was relevant to children's social engagement.[48] Thus, it can be interpreted that emotion regulation skills may be gained with reciprocal parent-child relations and availability.

Thirdly, autistic symptoms decreased after the AAC intervention. Due to previous studies' effectiveness of treatment packages involving speech output, the vast majority included a dedicated speech generated device (SGD). It is, however, reported in a recent study that, given the revolution in mobile technologies, AAC-specific apps that can be installed on mobile devices can also be used during the treatment process. A review of 23 studies which used an SGD included a total of 51 children with ASD whose ages ranged between three and 16.[9] All studies were single-subject designs, and most focused on teaching, requesting, or responding to questions using the SGD. Few studies assessed maintenance and generalisation. While it appears that using an SGD increases children's communicative abilities, particularly in terms of requests,[6-9] there has not been any rigorous group designs which have replicated those findings, and few studies have demonstrated different communicative functions than requests (e.g., commenting) or an increase in spoken language.

Our study was one of the first studies to use the TELD-3-T as a tool for assessing language development in children with ASD in AAC. Additionally, there were statistically significant relationships between AAC with VOCA and the children with ASD's language development and linguistic skills. The speed of learning for children with ASD might be enhanced through the use of SGD and applications in VOCA which delivers a graphic illustration for communication and integrates visual discriminations as part of the interaction. Many communication training programmes initially teach labelling, a process which involves teaching the child to identify an object with a symbol, a hand gesture, or a vocal response.[49,50] Such programmes may contribute to the initiation of verbal behaviours. Thus, it is considered using AAC with VOCA can be an advantage for children' receptive and expressive language development. In particular, children start to acquire expressive vocabulary. In our study, the correlations between language sample size and MLU reached statistical significance after the AAC intervention. The language sample size is not necessarily a confounding variable in our results; it is, nevertheless, a useful component that should be included in an attempt to predict language development. Additionally, there were statistically significant relationships between AAC with VOCA and the children with ASD's language development with MLU-TELD scores. MLU is not a language malfunction indicator but supports language disorder recognition.

To conclude, children showed significant improvements in emotion regulation and social communication in a low intensity, parent attributed, behaviourally based intervention in a short time. Potential advantages and the pragmatic features of AAC have been adopted in the autism treatment community. Unfortunately verbal comprehension of children were not evaluated in current study and long term effects of AAC in children were not

evaluated in current study as important limitations. Our sample size and duration of the intervention are not sufficient to generalise results but our study provides preliminary evidence to support the use of AAC for promoting emotional regulation, social communication & interaction for children with ASD. Thus, further research in this area is encouraged.

## Declaration of Interest

None

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