**Using a Video Visual Scene Display Application to Improve Communication for Individuals with Autism Disorder**

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**Abstract**

Augmentative and Alternative Communication (AAC) describes different ways to communicate that supplement or compensate for the impairment of individuals with complex communication needs. AAC includes high-tech aids, e.g., tablet-sized devices and dedicated computers. Visual scene display (VSD) is a standard communication display on those devices. Video visual scene display (VVSD) is an advanced version of VSD. Recent literature insufficiently tackles the differences between the two modes of presentation. To address this issue, we have developed a user-friendly application (“Spot&Spot”) that can display both video clips and photographs with embedded hotspots. We evaluated the application by measuring end-user perceptions and performance, then, compared the efficiency of VSD vs. VSD on the conversation skills of the ASD adult population.

We conclude that there is evidence that VVSD has advantages over VSD in improving communication for people with complex communication needs. However, further research with a larger sample size is required.

*Keywords:* augmentative and alternative communication; video visual scene display; complex communication need; autism spectrum disorder

**Using a Video Visual Scene Display Application to Improve Communication for Individuals with Autism Spectrum Disorder**

Autism spectrum disorder (ASD) is a neurodevelopmental disorder. The Diagnostic and Statistical Manual of Mental Disorders, DSM-5, (American Psychiatric Association, 2013) defines ASD as a complex condition involving persistent challenges in social communication and behavior, like difficulties in expressing needs and avoiding direct eye contact, restricted interests, repetitive behavior, difficulties in adapting to changes and unconventional reactions to tastes, smell, sound, or touch. There is a variation in the degree of impairment in functioning between individuals. Individuals with moderate to severe ASD tend to experience social interaction and communication problems, as well as language delay and cognitive challenges. According to Silvera-Tawil et al. (2018), almost 50% of children on the autism spectrum do not possess sufficient spoken language for effective communication, with many never developing functional speech. Some use non-verbal means to express their needs, while others speak in phrases or sentences with little to no meaning. These challenges impact various facets of the person's life, including education, leisure, employment, relationships, and beyond, influencing the overall quality of life (Jensen & Spannagel, 2011).

AAC supports and enhances communication for people who have complex communication needs, meaning, they have no speech at all or they do not have enough functional speech to fulfill their communication needs (Ganz, 2015, Trembath & Iacono, 2016).

There are two common AAC display methods in high-tech aids: (a) a grid, and (b) a visual scene (Light et al, 2019b). It is possible to combine both grids and visual scenes to create a hybrid presentation. While the grid presentation displays isolated symbols arranged in rows and columns, visual scene display (VSD) contains scenes (mostly photographs) of motivating or meaningful events from the individual's life (Beukelman & Light, 2020). There are several potential advantages for beginning communicators when using this type of display (Babb et al., 2021b, Light et al. 2019a; Light et al., 2019b): it reduces joint attention demands (by infusing the shared activity into AAC technology), cognitive demands (by removing the need to navigate through vocabulary pages and giving contextual cues that enhance understanding), and promotes linguistic learning (by supporting a wide range of language concepts). Beyond these cognitive/linguistic advantages, VSDs also exploit the human capacity for rapid visual processing of naturalistic scenes.

When using VSD presentation, the relevant vocabulary for the scene is pre-programmed using hotspots. As soon as a hotspot is touched, a recorded speech output is produced (Babb et al., 2020). VSDs can be used with low-tech devices (where the hotspots are drawn by hand) or with high-tech devices (computers/tablets) (Blackstone et al., 2004).

To further support the more cognitively and communicatively impaired population, an advanced version of VSD, called visual video scene display (VVSD), has been suggested (Beukelman &Light, 2020). The VVSD technique involves individualized video clips that the individual (actively) watches together with his communication partner. The video is paused automatically at some pre-programmed key moments (moments of interest). When the video pauses, a still image is displayed (thus creating a VSD display with hotspots on it), allowing the person to communicate. There are some powerful advantages of VVSD display (Light, McNaughton, & Caron 2019a, Light, Wilkinson, Thiessen, Beukelman & Fager, 2019b): it reduces joint attention demands (because the AAC supports are integrated automatically into the video) and cognitive demands (since the dynamic relationships and spatial\temporal cues found in the real world are preserved). Moreover, the display uses movement that has been found to engage children with complex communication needs. Lastly, the automatic pausing of the video at key points explicitly marks the exact opportunity to communicate.

Recent studies demonstrated that a VVSD display increases social interaction: the number of communicative turns and the amount of vocabulary used is larger than in a grid display. It also improves independent participation in community activities and allows the AAC user to engage in a displaced talk about past events (Babb et al., 2021a; Babb et al., 2021b; Caron et al, 2018; Edger and LaValley, 2023; Chapin et al., 2022, Laubscher et al., 2022). The research population in VVSD studies includes both children and adolescents with complex communication needs and developmental disabilities (mostly ASD or Down syndrome). The communication partners in those interventions are peers or skilled adults.

Over the years, several VSD applications have been released, such as Scene Speak2, Social Adventures3, and Mental Imagery Therapy for Autism Spectrum Disorder (MITA)4. Scene Speak allows editing an image with multiple different-sized sound areas and pop-up text. In addition, the editing process enables linking hotspots to the image. Social Adventures allows users to apply VSD to promote social interactions using games. The MITA application uses visual puzzles to help children mentally learn how to integrate multiple features of an object. In Hebrew, there are two applications, TouchChat5 and Tinytap6, that can produce VSD but not VVSD. To the best of our knowledge, no application exists that combines the following essential elements and provides: (1) both VSD and VVSD, (2) compatibility with both iOS7 and Android8, (3) history usage records for analysis of interaction and evaluation, (4) audio feedback to the user, (5) an option to edit audio accompaniment, (6) usage free of charge (7) supporting Hebrew language.

This study examines how VVSD presentation affects communication among individuals with autism spectrum disorder compared to VSD displays. Six adults with ASD and complex communication needs (from non-speaking individuals to those who use one-word sentences) were evaluated and compared for their communication performance via VSD and VVSD. To conduct the research, we developed an application called Spot&Spot that supports both English and Hebrew. Both video clips (VVSD) and static images (VSD) can be added to the Spot&Spot application.

We devised hypotheses to investigate the effects of VVSD on adults with moderate-severe ASD as compared to the impact of VSD on their communication skills.

Using VVSD will improve the quality of the interaction compared to VSD in the following aspects:

1. The response time of the participant will be shortened.
2. Involvement of the participant in the communication process will increase. This participant involvement is expressed by more frequent eye contact with the mediator and less stereotypical movement.
3. Quantity and quality level of mediation will decrease (as defined in the Section ‘Variables’).
4. The number of unaided initiatives and responses will increase.
5. The total number of responses will increase.
6. The number of wrong answers will decrease, and the number of correct answers will increase.

The importance of this study lies in expanding the knowledge regarding optimal communication strategies and techniques for individuals with complex communication needs. The results show that there is evidence that VVSD is a more helpful tool in improving communication among people with ASD in comparison to VSD.

**Method**

This section describes the experimental sample and the experimental settings (location and the course of the meetings). In addition, we will describe the experimental design and procedure, the application's characteristics, and the data collecting and analysis methods.

**Participants**

Six participants took part in the experiment: one female and five male adults (shown in Table 1). All participants live or study in a group home for individuals with autism.

There was no obligation to participate in the study, and each participant had the right to withdraw from the experiment at any stage. The session included visual materials that contained only positive experiences. The experimenter scheduled breaks according to the needs of the participants at each step in the process, and participants could stop the session if they wished. The participants were not trained to operate the application before the experiments.

**Materials** **and Measures**

The research tools used in the experiment are tablets with iOS operating systems. The tablet computer used for the session was a 10.2-inch iPad that contained the developed Spot&Spot10 application. Spot&Spot is a dedicated VVSD application developed by our team to assist communication. The application's main functionality is to play video clips with predefined embedded hotspots.

In the current study, the speech therapist defined hotspots for each participant. To initiate a dialog, the speech therapist asked questions which answers referred to the hotspots in the static pictures of either VVSD or VSD. The pictures filled almost the entire screen of the tablet, except for the programming icons and several additional static symbols positioned vertically on the left and right sides of the screen.

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To increase the user experience and the usability of the application, three special education teachers received the application for a test period and submitted comments that were used to enhance the performance of the software. The development used agile methodology, where a team cycles through planning, executing, and evaluating.

***Videos Clips with Integrated VSDs***

Research suggests that using individuals as their self-models may promote attention, increase self-efficacy, and reinforce learning (Cihak & Schrader, 2008). Therefore, in our experiment, we used personal video clips and photos of the participants themselves. Although the Spot&Spot application supported capturing video clips, video files used for the intervention were captured using various cell phones. To support video trimming, Windows Video Maker12 was used to edit the video clips before they were uploaded to the Spot&Spot application.

***Embedding the VSDs***

Before the intervention, the speech therapist collected the VVSDs for each participant.. The video was paused at the end of each meaningful step in the task. The pause triggered the app to create a VSD at these junctures. Each video clip averaged approximately one to two minutes.

Three pauses were created for each video clip. At each pause, a WH-type question was asked. The same questions were asked for both kinds of presentation modes, VSD and VVSD.

Two hotspots were embedded at each pause; one was a targeted message (the correct answer), and the other was a distraction. The outline of the hot spot was displayed in red to indicate the opportunity for communication. Four general symbols, representing happy, sad, yes, and no, were placed in a grid-like presentation at the left and right sides outside the VSD. Because the participants could click on them, they could provide another important way to communicate. It should be noted, however, that none of the participants initiated the use of those symbols. During the experiments, the speech therapist noted that the participant did not fully understand those abstract concepts.

**Research Design**

The experiment used single-subject experimental designs (Cook et al., 2014). The single-subject experimental design method uses participants (individuals or groups) as their own control and collects repeated measures of dependent variables over time to test the effects of a practice manipulated by the researcher. To validate the effects of the intervention, we conducted AABB/reversal by comparing baseline [A] and intervention [B] situations using a set of variables. The baseline in this study is a static scene display (VSD), and the intervention is the VVSD. The baseline and intervention were reversed when participants were presented with the VVSD first and then with the VSD. Group 1: [A] − VSD, [B] − VVSD; group 2: [A] − VVSD, [B] − VSD. This research followed a single-subject study because a single-subject study is a suitable design for small samples and short experimental sessions. While an individual single-case design study provides limited evidence of efficacy, multiple replication studies by different research groups build the strength of evidence (Hume et al., 2021).

The experiment was approved by the college's ethical committee (see Appendix A in Supplementary Material). We also met with the director of the group home for individuals with autism, who approved this pilot research. Written consent was obtained from the parents of all the participants.

***Variables***

The following is a list of the dependent and independent variables used in the study. Independent variables encompass demographic factors - age and gender, and the usage of VVSD vs. VSD. Dependent variables included response time (measured automatically from the moment the video stopped until the moment the participant clicked on the screen), the number of correct and incorrect answers, the number of unaided initiatives and responses (involving voice, eye contact, or body language), duration of the conversation (seconds), level of mediation, and usability of the application. The response time was assessed through automatic application measurements and manual observation of session recordings. The usability of the application was evaluated in terms of simplicity, intuitiveness, effectiveness, and participant involvement. The degree of the participant's involvement was expressed through how the participant focused on the screen, cooperated, and the extent of the participant's interaction with the speech therapist and the tablet. Mediation requirements displayed by the participant were ranked as follows: 1 - no mediation; 2 - visual mediation (pointing); 3 - verbal mediation (giving verbal hints); 4 - physical mediation (holding and directing the hand of the participant); and 5 - physical and verbal mediation.

Table 2 defines and summarizes the collected data, including the related variables.

***Experimenters***

As part of a multidisciplinary research team, software engineers reviewed the products, technologies, and available tools and developed a dedicated application that fulfilled the experiment's needs. A speech therapist was responsible for choosing and preparing the video clips, choosing hotspots and symbols, managing the meetings, and writing feedback. Experts in autism disorders were responsible for filming the participants to prepare the database for the experiment, defining static and VVSDs for each participant, and adjusting the questions for each participant.

**Procedures**

The experimental preparations and the sessions took place in the group home. Four participants lived and worked at the ALUT1 home, while two worked only in the occupation center. The session was held in the main office. Each meeting with a participant took approximately 5 minutes.

The speech therapist guided the participants in each session while the first author recorded the session. After each experimental session, the speech therapist completed a specially designed questionnaire. The experiments were recorded with a Samsung S9+10 phone for transcription and analysis to accompany the data that the application collects during use.

Data collection was used for research analyses and followed privacy regulations and ethical rules. The application collected data automatically; the experimenter (as specified in the “Collected By” column in Table 2 above) manually collected additional data. Each session was performed once a week. Group A started with VSD, followed by VVSD. Group B followed the reverse order. Each session was performed once a week. Because the images and video clips are short, we decided to present both instances during the same session, i.e., on a day when the participant worked with VVSD, both instances of the video were shown to the participant that day. Then, on a day when VSD was shown, both instances of the images were shown to the participant. The experiment lasted approximately a month and a half (as illustrated in Figure 2).

**Results**

The results are divided into three subsections. The first two demonstrate the experimental findings, while the third, explaining the system usability score (SUS), focuses on the application's usability.

**Experiment Results**

The speech therapist reported the results of observations by filling out questionnaires after each session. Overall, questionnaire data yielded results that favored VVSD regarding participants' interest level, level of mediation, and level of improvement (see Table 3).

Detailed data about each participant and the content of the questionnaires appear in Appendix B and C. Table 3 summarizes the results of the speech therapist questionnaires regarding the participants' level of interest, the level of mediation, and the level of performance improvement compared to previous times. Descriptive analysis shows that the average level of interest was higher for VVSD (4.67) than VSD (3.16). Similarly, the results for the “viewing the tablet” parameter were higher among all participants in the VVSD. However, the eye contact, correct clicks, physical and pointing mediations, body language, and smiles parameters did not yield clear results. For some participants, it was possible to see more repetitions in the VSD compared to the VVSD; the opposite was true for others. Generally, verbal mediation was higher in the VSD environment.

Upon examining the transcripts and observations related to each parameter, we summarize whether the responses noted in the VVSD were greater or smaller compared to those in the VSD (see Appendix E Table S1). The findings indicate that four of six participants exhibited a higher level of engagement with the tablet during VVSD. Three of the six participants made more correct clicks during VSD, however, they needed more verbal mediation during static VSD. During VVSD, three of the six participants (two of whom were among those needing more verbal mediation) needed more physical mediation.

**Data from the Spot&Spot Application**

The application measured objective performance by using the three variables: number of clicks, accuracy, and response time. The Number of Clicks was higher for VVSD (VVSD: *M* = 19.67, *SD* = 8.02; VSD: *M* = 17.67, *SD* = 6.8, see Appendix D, Figure S1 in ), Accuracy was higher for VSD (VVSD: *M* = 0.57, *SD* = 0.21; VSD: *M* = 0.74, *SD* = 0.19, see Appendix D, Figure S2), and Response Time was much shorter for VVSD ( VVSD: *M* = 58.66, *SD* = 24.07; VSD: *M* = 119.77, *SD* =68.93, see Appendix D, Figure S3).

**System Usability Scale**

The two experimenters filled out the SUS questionnaire. In general, the outcomes showed average grades on the SUS scale (see Appendix E Table S2). The results of the questionnaires show that the system is still complicated to use (see Appendix B, answers to questions 7-9), it requires some preparations, and there is a need for technical support and assistance in using it. Average answer: 3. Currently, we are working on improving the usability of the application according to the feedback provided by the two experimenters.

**Discussion**

The results of this study provide preliminary evidence that AAC technology using VVSD may be a powerful tool to support communication among people with ASD. The results are outcomes of fruitful collaboration between researchers, teachers, and parents. A collaboration between different stakeholders throughout the research process is recommended in several reviews (Crowe et al., 2022). Data analysis revealed that the VVSD captured a greater level of interest from participants than the VSD display. For some participants, VVSD also drew more correct clicks and more body language expressions. Although the values obtained did not present an unequivocal result, we learned that the participants who started with VSD and then moved to VVSD presented a more significant improvement than the other group.

These results are consistent with other studies (Chapin et al., 2022a; Babb et al., 2021b), which showed that a VVSD intervention among people with ASD may increase the number of interactions generated compared to standard speech.

Regarding mediation, in VSD, more verbal mediation was required, but there was no absolute conclusion regarding the other types of mediation (pointing mediation, physical mediation). These results suggest that each participant responds to technology differently.

An important contribution of this study lies in the functionality of the application. The simple and quick way of importing new videos or photos to the app and integrating hotspots on them by parents and caregivers enhances language learning since new vocabulary can be immediately programmed as required (Light, McNaughton, & Caron 2019a). The application is free, available for download at any moment in the application store, and supports both Android and iOS operating systems. The application also supports English and Hebrew languages. Although not used in this study, Spot&Spot also supports the transparency of hotspots. In addition, Spot&Spot enables personal customization for each participant in several parameters – VSD/VVSD scenes and symbol types. These research findings suggest that the diversity of configurations available in the Spot&Spot application increases participants' motivation, interest, and achievements.

**Implications**

Communication is an essential life skill and a fundamental human right. We suggest a promising tool for AAC users, primarily beginners' communicators. While our subjects were autistic, this new application is expected to have a positive impact on a wider range of individuals (i.e., other developmental disabilities). Equally important is the relatively simple way to manipulate the app, making it possible to be largely used by carers and teachers. Previous studies indicated that families are the most valuable AAC implementers, especially because they can maintain and generalize communication skills in natural and authentic settings (Wattanawongwan et al., 2022). The simple operated Spot&Spot app will make it possible for parents and other relatives to impact their loved ones' quality of life by enhancing their language and social communication skills. In addition, the quality of life of all family members will also be enhanced as the VVSD will strengthen social closeness between them and the AAC user.

**Limitations and Future Research Directions**

Although the results of this case study suggest that VVSD technology may positively impact the communication of people with ASD, there are several limitations: the small number of participants and sessions, and the differences between the ASD communication profiles. Even though the order of the sessions was counterbalanced among participants, the small sample size and the differences between subjects limited the generalization of results. In addition, because two images or video clips were presented in each session, this may have affected the participants' concentration and interest levels.

The study was limited in duration, so intrinsic variables like health issues, mood, and motivation likely influenced the results. Our intervention took place in highly structured interactions with a skilled, familiar communication partner as a mediator. It would be interesting to replicate the study in a more natural situation and with peers and unfamiliar communication partners.

Improving communication among people with ASD can have social and emotional consequences (Oono et al., 2013). Therefore, further research on the subject is needed. The research directions for future studies could be using multiple participants with different diagnoses and other age ranges, different communication and language profiles, and diverse histories of AAC use. We should also explore how an instruction phase to the application, before intervention, would impact the efficiency of communication. Another suggestion for further research is to address literacy by adding written text to the voice output.

Additional research directions related to the application could test the effect of changes in the transparency and color of the hotspots on the results. It is also interesting to investigate the differences between specially created personal video clips vs. general video clips (where the AAC user is not present) in communication.

**Conclusions**

Engaging in social interactions is a crucial element of life and is linked to the overall quality of life (Light et al., 2002). For beginning communicators with ASD, participation in such interactions provides opportunities to develop social communication skills and to become an integral part of society.

A video VSD is a powerful presentation of messages because it is engaging and reduces memory demands by recounting events that dynamically preserve the spatial and temporal contexts of events. This study provided preliminary evidence that AAC featuring VVSD has the potential to support people with ASD communication difficulties. Our findings show that VVSD performance was varied by variables. The total number of clicks on VVSD was higher than on VSD, and similarly, the response time was much shorter for VVSD. However, the accuracy of the answers was better for VSD. These findings might indicate that participants’ interest increased for video with sound and motion compared to static pictures. The tendency to click more and faster in VVSD might decrease the level of accuracy.

Given the potential of this advanced technology, further research on various aspects is highly required to better understand VVSD efficacy. Such research could promote AAC intervention toward supporting all individuals in sharing their life experiences with others.

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**Footnotes**

1Israeli Society for Autistic Children (ALUT) association. <https://alut.org.il/>

<https://www.autismspeaks.org/autism-diagnosis-criteria-dsm-5>

2Scene Speak: A versatile application available for the iPad to create interactive visual scenes and social stories. [www.goodkarmaapplications.com/scene-speak1.html](http://www.goodkarmaapplications.com/scene-speak1.html)

3Social Adventures: An application that is intended for speech therapists, teachers, and parents of children with ASD and includes a variety of activities designed to teach social skills. [www.all4mychild.com](http://www.all4mychild.com/)

4MITA: An application that provides mental health care to children with ASD through pictures. [www.imagiration.com/autism/](http://www.imagiration.com/autism/)

5 <https://touchchatapp.com/>

6 <https://blog.tinytap.com/hebrew_welcome/>

7Apple website. [www.apple.com](http://www.apple.com/)

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9Samsung website. [www.samsung.com](http://www.samsung.com/)

10Spot&Spot application. <https://apps.apple.com/il/app/spot-spot/id1570948189?l=iw>

11Windows Video Maker. <https://apps.microsoft.com/store/detail/movie-maker-video-editor/9MVFQ4LMZ6C9?hl=en-il&gl=il&rtc=1>