Visual Schedule System in Dental Care for Patients with Autism: A Pilot Study

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***Objectives**: A pilot study to test whether a visual schedule system using picture communication symbols can help children with autism have successful routine dental cleaning visits. **Study Design:** 14 boys with autism between three- to eight-years-old presented to the dental clinic for four weekly consecutive dental appointments. Patients were randomly assigned to either the control group who received the tell-show-do method (i.e., standard of care), or the test group who received the tell-show-do method plus the visual schedule system. **Results:** Patients in the test group completed an average of 1.38 more steps, at 35.52 seconds per step faster, and with 18.7% lower levels of behavioral distress than those in the control group. **Conclusion:** The use of a visual schedule system, along with repeated weekly visits, showed some promise in helping children with autism successfully complete more steps, progress at a quicker rate, and exhibit lower levels of behavioral distress within a dental appointment, compared to a traditional tell-show-do approach.*

***Key words:** Autism, Visual Pedagogy, Dentistry, Electrodermal Activity.*

INTRODUCTION

Encountering patients with autism in a dental office is very common these days as the prevalence of autism has been increasing (1 in 165 Canadian children) in the last decade. Among children with autism, impairments in social interaction and communication, as well as low cognitive functioning, aggression, anxiety, and sensory sensitivities contribute to their greater aversions to dental care[1,2]. Parents frequently are reluctant to take their children with autism for routine dental examinations because of the children's fear of dental procedures[3, 4]. As a result, children with autism are often prone to preventable dental problems[5,6,7,8]. The associated health, social and financial repercussions on these children and families are exacerbated by the lack of adequate means to meet their oral health care needs[9]. Families have greater difficulties finding dentists who are trained, willing, or able to provide appropriate care for children with autism[10] and often, dental treatment is performed under general anaesthesia[9]. Despite these challenges, there is very little research about dental treatment for children with autism.

The paucity of evidence-based methods to facilitate positive dental visits for children with autism remains one of the obstacles for them to obtain optimal oral care[11,12]. More generally, the application of basic behavioral principles is known to be effective to improve the lives of persons with autism[13]. In addition, research has indicated that people with autism share certain neuropsychological characteristics that are often targeted by behavioral approaches, including preference for processing visual information and attachment to routines[14]. For instance, graduated exposure, or the systematic contact of the participant to variations of a feared stimulus, is an evidence-based technique to treat anxiety, and has been used to help anxious individuals with autism[15]. Furthermore, current research supports the use of visual aids or picture cues as being an effective technique to teach children with autism at home and at school[16]. To our knowledge, only a limited few studies have investigated this visual approach for dental-related procedures among children with autism. One study reported that the use of a series of pictures (e.g., showing steps of brushing teeth) helped children with autism maintain good oral hygiene at home[17]. It was also found that cooperation improved when children with autism reviewed a book showing pictures of all steps of the dental visit[18], or watched a video of other children undergoing a dental visit[19]. However, the studies were limited by the lack of objective outcome measures and no control comparisons. Therefore, we sought to expand on this approach of using picture cues for children with autism during dental visits, and to objectively evaluate the children's successful completion of dental visits.

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MATERIALS AND METHOD

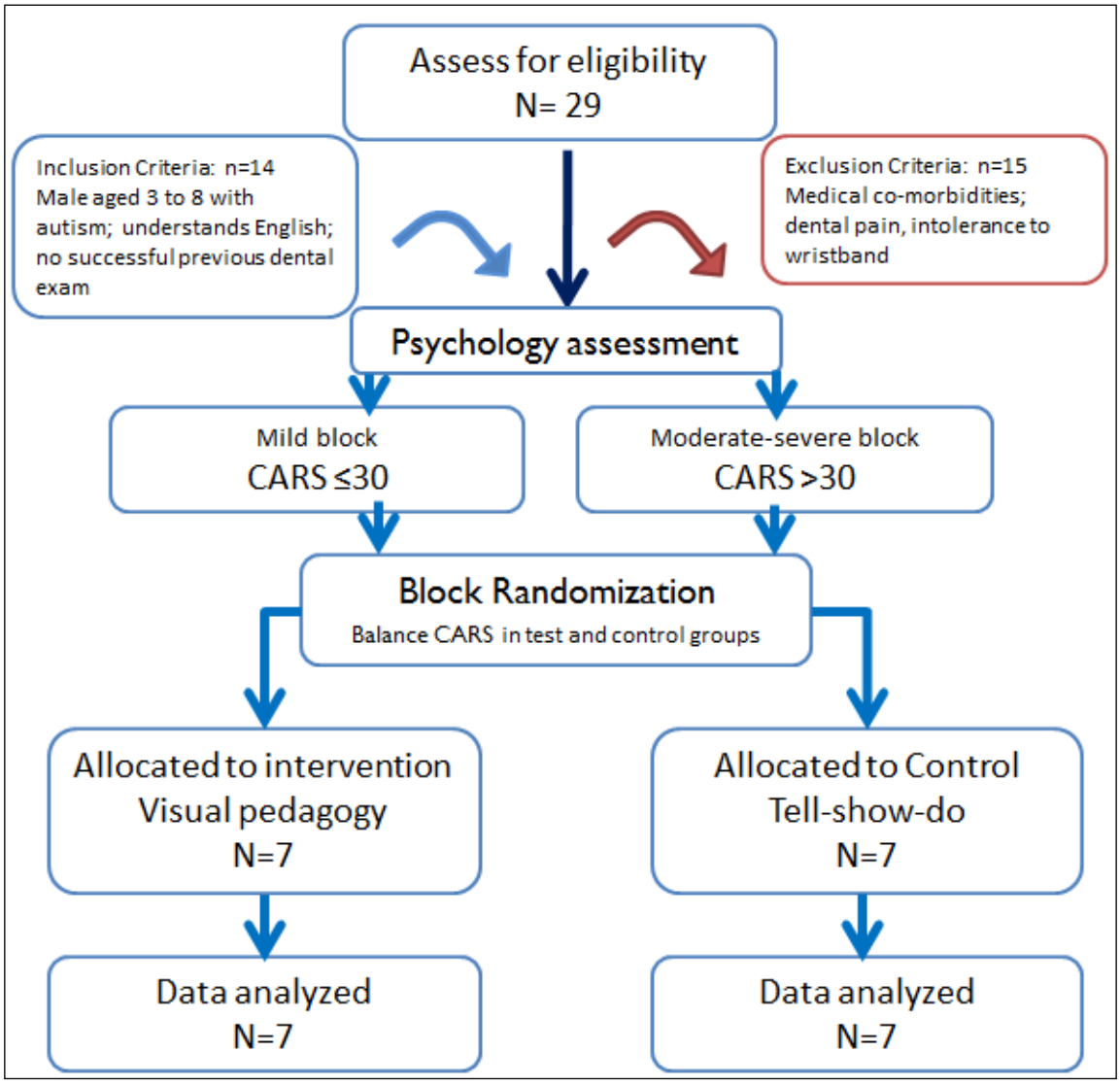
The study protocols were reviewed and approved by the University of British Columbia and Children's & Women's Health Centre of BC Research Ethics Review Board.

Participants included boys between the ages of four to eight years of age, who have been previously diagnosed with an Autism Spectrum Disorder (ASD) by their physicians, and have not successfully completed a dental exam. This reflects the sample of children with autism who likely have greater aversions to dental care and may require additional behavioral intervention beyond the current standard of care provided in the communities. These subjects were referred by physicians or health workers of local autism support networks to the department of dentistry at BC Children's Hospital (BCCH). Only boys with ASD were included because the prevalence rates of autism are four to five times higher in males than in females, and females with autism are more likely to exhibit more severe intellectual disability[20]. Children with other concurrent medical conditions (e.g., uncontrolled epilepsy), have painful visual dental caries requiring general anesthetics, or who cannot tolerate wearing the wristband required to measure physiological arousal were excluded from the study.

Fourteen individuals were eligible to participate in the study, and consent was obtained from the parents/legal guardians and assent was given by the children. Then, children and their parents met with a registered psychologist for a one-hour interview. A review of the autism diagnostic report was completed to confirm ASD diagnosis. In addition, a brief screening of the child's current severity of autism symptoms was also conducted using The Childhood Autism Rating Scale- 2nd Edition (CARS-2)[21]. The CARS-2 score was used as the basis of the block randomization protocol to maintain balanced groups. This method helps to evenly distribute subjects and diffuse significant confounding variables, particularly given the small sample size of this pilot project (Figure 1).

Participants of the study presented with their parents to four dental appointments at consecutive 1-week intervals scheduled around the same time of day. The experimental team comprised of three dentists and one hygienist who performed all the dental procedures in a typical dental setting with a ceiling mounted lamp at BCCH. The same dentist/hygienist was assigned to conduct the four consecutive dental appointments for each participant. To reduce the chance of inter-operative bias, a verbal script was used to maintain consistency with the subjects, and each dentist/hygienist

Figure 1. Recruitment and Randomization Flowchart



was equally assigned subjects from the experimental and control conditions. Upon arrival to the dental clinic, the subjects and their parents were invited to a waiting room to measure their baseline level of physiological arousal for 15 minutes prior to the start of any dental procedure (see Figure 2a). A small prize was also chosen as motivation for the subject if he was successful in completing all the steps in the dental visit. Next, the child and parent were brought into the dental clinic by the dentist/hygienist to start the 12 procedural steps involved in a dental exam and cleaning appointment (see Figure 2b). A maximum of five attempts were made at each step; if cooperation was not achieved after five attempts at a given step, the appointment ended without giving the reward to the subject.

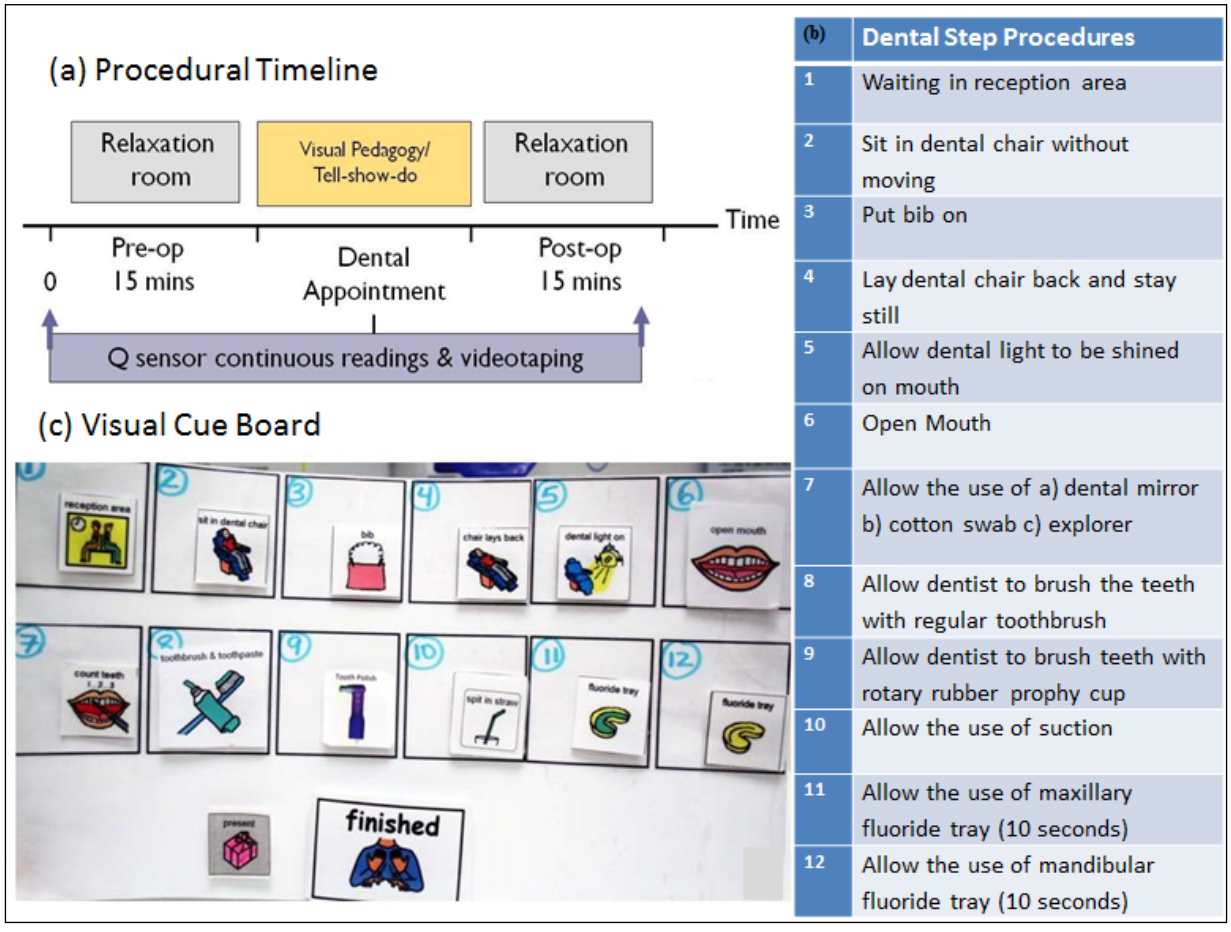
When attempting the dental procedures, the control group received the current standard of care, the tell-show-do method (TSD). The visual pedagogy (VP) test group, in addition to the TSD method, received a visual schedule, which was a pictorial cue board (Figure 2c) designed to show the steps involved with a dental visit. The pictorial cues used on the board were created based on the Picture Exchange Communication System (PECS) that has been widely-used for the childhood autism population. When a step was completed, the picture was detached from the cue board. This technique visually set a timeline for the dental procedures, and outlined the expectations for the children during the appointment.

After the dental procedures, the subject returned to the initial waiting room to relax for another 15 minutes when their post-operative physiological arousal levels were recorded, before they left BCCH.

Outcome Measures

The primary outcomes measured in this study were the number of dental steps attempted, completion time for the dental procedures, and child behavioral distress. The number of steps attempted and total completion time was recorded by a research assistant during each dental appointment. Because patients varied in the number of steps achieved during each dental visit, the total completion time was divided by the number of steps attempted to obtain a score for the time required to complete each step. Child behavioral distress was measured using a standardized observational coding system: the Child-Adult Medical Procedure Interaction Scale-Short Form (CAMPIS-SF)[22]. Ratings of each patient's level of behavioral distress (e.g., anxiety, screaming, resistance, level of crying, discomfort, and desire to escape) were made on a 5-point Likert scale. A rating was made for each step of the dental procedure that was attempted, and the ratings were averaged to produce a total score of child behavioral distress for each of the four dental appointments. Ratings were made retrospectively from videotapes of the child's behaviour during the dental appointments. There were a total of three raters who were randomly assigned to independently code videotapes across different subjects and different dental appointments. Twenty percent of the videotapes were randomly selected to be independently coded by two of the three raters, and intraclass correlation was 0.95, indicating a very high level of inter-rater reliability. To assess the exploratory objective of child physiological arousal, we used electrodermal activity (EDA), that is, subtle changes in electrical

Figure 2. Procedural Timeline, Dental Steps, and Visual Cue Board



(b)	Dental Step Procedures
1	Waiting in reception area
2	Sit in dental chair without moving
3	Put bib on
4	Lay dental chair back and stay still
5	Allow dental light to be shined on mouth
6	Open Mouth
7	Allow the use of a) dental mirror b) cotton swab c) explorer
8	Allow dentist to brush the teeth with regular toothbrush
9	Allow dentist to brush teeth with rotary rubber prophy cup
10	Allow the use of suction
11	Allow the use of maxillary fluoride tray (10 seconds)
12	Allow the use of mandibular fluoride tray (10 seconds)

conductance on the skin when people experience stress[23,24]. EDA in our study was measured by placing the *Q-sensor (by Affectiva Inc.*), a device embedded in a velcro wristband similar to a watch, on each patient's right wrist for the duration of each appointment.

RESULTS

Preliminary analyses

Data were analyzed using SPSS. However, given the small sample size in this pilot study, there was not enough power to examine statistical significance in results. Rather, we placed emphasis on practical or clinical significance; that is, we examined the magnitude of benefit between the test and control group.

First, we examined group differences in descriptive characteristics (presented in Table 1).

Table 1. Participant Descriptive Characteristics

Group	Child age in months Mean (*SD*)	Age range	CARS-2 score Mean (*SD*)	CARS-2 score range
Test	72.86 (*11.94*)	39 - 81	29.64 (*6.36*)	25.0 - 43.0
Control	55.86 (*13.40*)	55 - 89	31.79 (*6.34*)	20.5 - 38.0

The average severity of autism symptoms in patients in both the test and control groups was in the mild range. There was no significant difference in severity of autism symptoms between groups, t =-0.63, p>0.05, 95% CI [-9.53, 5.25], which reflects that the randomization procedure was effective in balancing the groups in this regard. However, the groups differed in child age, with the test group significantly older than the control group, t=2.51, p<0.05, 95% CI [2.22, 31.78]. Thus, child age was used as a covariate in subsequent analyses.

Primary analyses

To address the primary objective of examining the effectiveness of a visual pedagogy on dental visits, a two-way mixed multivariate analysis of covariance (MANCOVA) was used to compare the number of dental steps attempted, the completion time per step, and the level of behavioral distress, with one between-subjects factor: group (test vs control), and one within-subjects factor: appointment (dental visit 1, 2, 3, 4), with child age as a covariate. Refer to Table 2 for the means and standard deviations of the primary outcomes for both groups.

Across both groups of participants, the average number of steps completed during dental visits increased with repeated weekly appointments. Over all appointments, patients in the test group that received the visual pedagogy were able to complete 1.38 more steps than patients in the control group who received standard of care. By the final fourth appointment, all seven patients in the test group successfully completed all 12 dental steps, whereas only five patients in the control group completed all 12 steps.

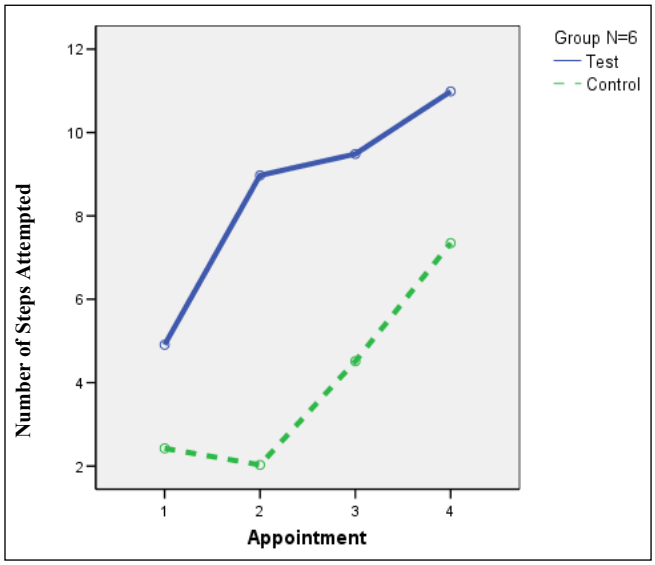
However, it was noted that many subjects in both groups were able to successfully complete all 12 dental steps in the first appointment. Thus, we specifically examined the effectiveness of the visual pedagogy approach for the six patients (three in test group, three in control group) who did not complete the dental appointment within their first visit. As expected, all subjects completed more dental steps over time, and by the fourth appointment, all three subjects

Table 2. Primary Outcome Results

Outcome	Appointment	Test Group		Control Group	
		Mean	*SD*	Mean	*SD*
Steps Attempted	1	8.91	*2.04*	7.95	*2.04*
	2	10.12	*1.81*	8.31	*1.81*
	3	10.54	*1.68*	9.17	*1.68*
	4	11.48	*1.28*	10.09	*1.28*
Completion Time per Step (minutes)	1	1.41	*0.47*	1.80	*0.47*
	2	1.04	*0.35*	1.63	*0.35*
	3	1.00	*0.43*	1.57	*0.43*
	4	0.98	*0.45*	1.34	*0.45*
Behavioral Distress Level	1	1.55	*0.48*	2.48	*0.48*
	2	1.62	*0.45*	2.14	*0.45*
	3	1.77	*0.57*	2.15	*0.57*
	4	1.65	*0.54*	2.08	*0.54*

in the visual pedagogy group, but only one subject in the control group, completed all 12 steps (Figure 3). Clinically, patients using the visual pedagogy approach were able to fully complete the dental exam and cleaning by the fourth appointment, whereas patients without the visual pedagogy were only able to complete half of the procedures (i.e., successfully opening mouth, but not allowing the use of dental mirror/cotton swab/explorer to examine patients' teeth).

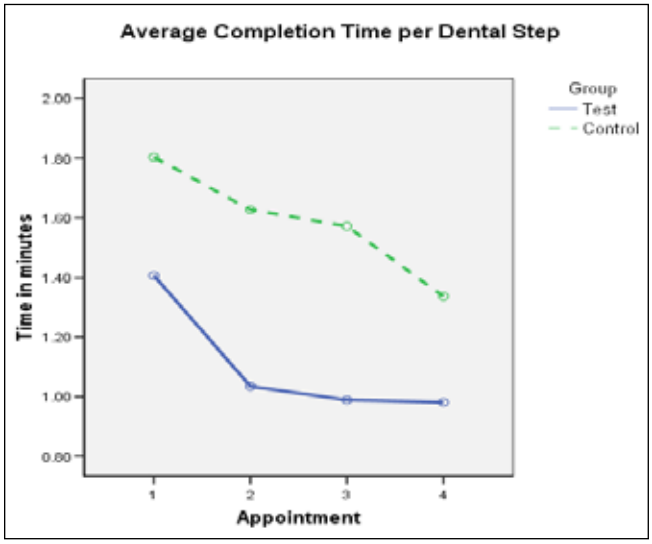
Figure 3. Number of Dental Steps Attempted in Each Group across Appointments



With regards to completion time per dental step, as predicted, patients using the visual pedagogy approach was able to complete each step in less time than those in the control group (Figure 4). The greatest magnitude difference between groups was on the second appointment when patients in the test group completed an average of 35.52 seconds per step faster than those in the control group. In the context of a dental appointment requiring the full 12 procedural steps, the results suggest that using a visual pedagogy for children with autism could potentially reduce appointment time

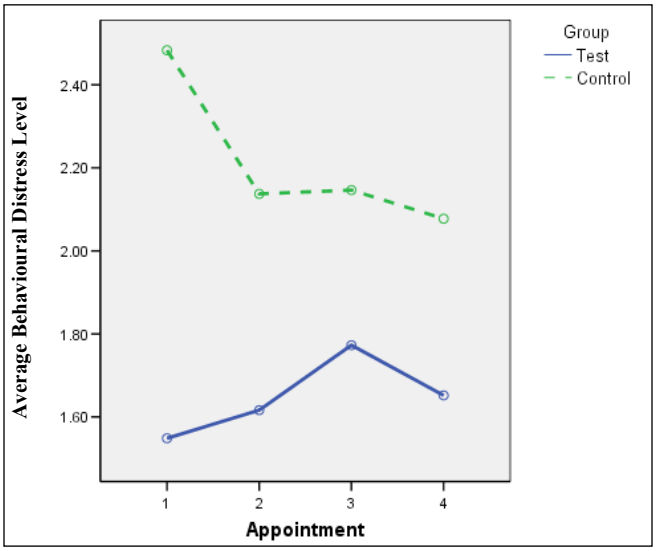
by up to seven minutes. This is particularly meaningful given that the average completion time for patients in our study who were able to complete all 12 steps at the second appointment was only 9.92 minutes.

Figure 4. Average Completion Time per Dental Step in Each Group across Appointments



As expected, the levels of behavioral distress exhibited by all patients were significantly correlated with the number of dental steps completed and the time required to complete each step. That is, the lower levels of behavioral distress exhibited, the greater number of steps completed at each dental visit (r= -0.97, p <0.001), and the less time required to complete each time (r=0.94, p <0.001). Overall, across appointments, subjects in the test group exhibited lower levels of behavioral distress compared to those in the control group (Figure 5). In particular, the greatest magnitude of benefit in using the visual pedagogy occurred in the very first appointment, when patients in the test group displayed 18.7% lower levels of behavioral distress (i.e., 0.94 point difference on a 5-point scale), compared to patients in the control group.

Figure 5. Behavioural Distress Level in Each Group across Appointments



Exploratory data

The EDA data was helpful in tracking progress of some, but not all, individuals throughout the series of four dental appointments. It was difficult to accurately compare across groups given the high variability in each subject's EDA data, as elevated EDA levels could reflect physiological arousal not only as a product of stress or negative emotion, but also as a product of excitement or positive emotion (e.g., when receiving a reward at the end of the appointment), or even as a product of excessive movement from the wristband that the child was wearing. Thus, EDA data was best interpreted within the context of behavioral events for each individual. For example, the EDA data for one of the subjects is shown in Figure 6. The EDA levels exhibited by this subject showed a downward trend from appointment one to appointment four. This coincided with this individual's diminishing behavioral distress scores and increasing number of dental steps that subject could completed. The results from this subject show the interrelations between a child's physiological arousal, behavioral distress, and progress through dental procedures.

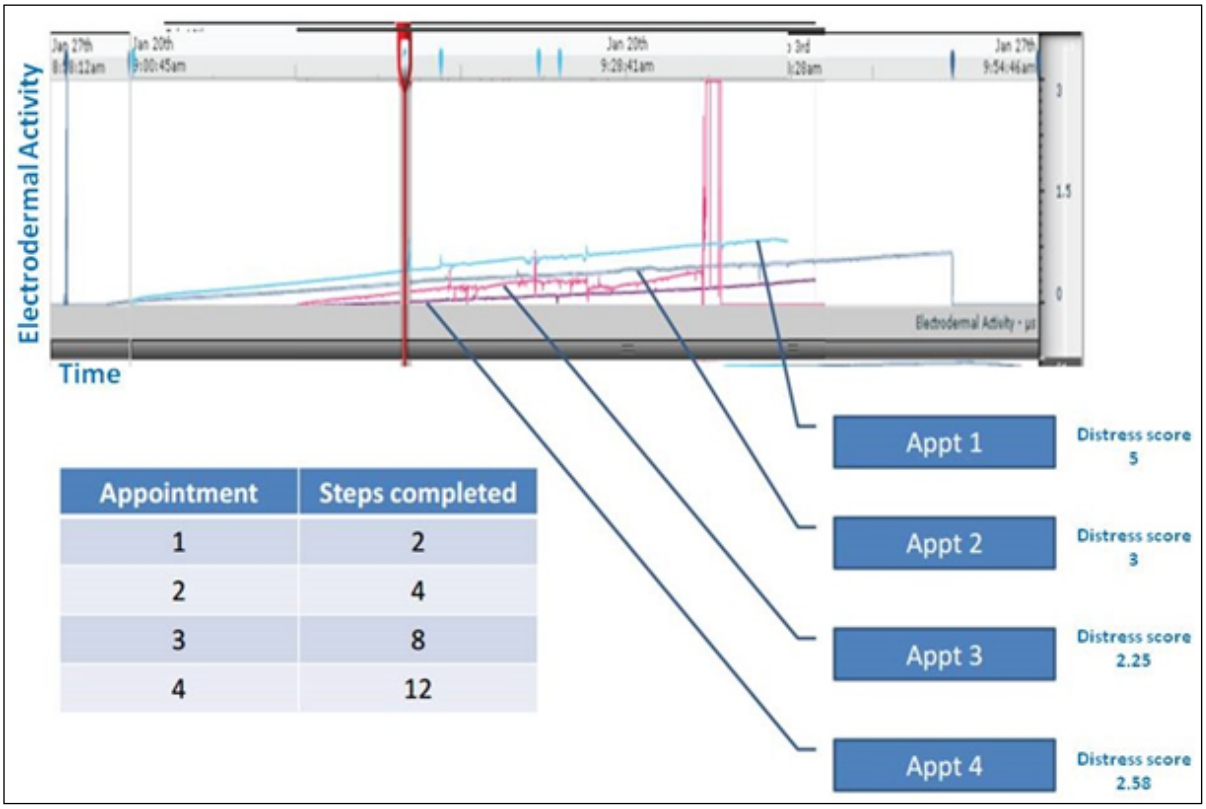
DISCUSSION

Within this pilot study, the use of a visual pedagogy approach, along with repeated weekly visits, showed some promise in helping children with autism successfully complete more steps, progress at a quicker rate, and exhibit lower levels of behavioral distress within a dental exam and cleaning appointment, compared to a tell-show-do approach as part of standard care. In some cases, physiological arousal in the form of electrodermal activity was related to levels of behavioral distress and dental procedural progress. These initial results correspond well with previous research in the fields of anxiety and autism that highlight repeated exposure to a feared stimulus, and use of visual aids and routines, are helpful strategies for children with autism.

This project has several key strengths. First, it has direct and valuable practical application to benefit a population of children with significant oral health challenges, as well as their families and dental care providers. Second, this project targeted objective outcome data, using multiple methods (e.g., behavioral and physiological) and across multiple time points (e.g., four dental appointments). Finally, the project included an interdisciplinary team consisting of both dentistry and psychology clinical and research expertise.

This project also has several limitations. First, this project is a pilot study with a small sample size. A much larger sample size is required to have enough statistical power to detect significant differences between interventions. Second, only one intervention (i.e., the visual pedagogy) was compared to standard of care. However, the combination of comforting strategies (e.g., dimmed lighting, soft music, deep pressure, vibration, security object), rather than just one method, is likely more effective in helping a child with autism progress through a dental visit[25]. Another limitation of this study is that the dentist/hygienist and raters of behavioral distress outcomes were not blind to intervention allocation because the presence or absence of the visual pedagogy (which distinguishes the intervention groups) was clearly noticeable during each dental appointment. However, rater bias for the interaction between intervention group and time was minimized for the behavioral distress outcomes since the same rater did not code all four videotapes of the same child,

Figure 6. Sample Results from One Subject



Appointment	Steps completed
1	2
2	4
3	8
4	12

and raters were blind to which of the four dental appointments the child was attending.

Children in this study were not informed in advance about their upcoming dental appointments in hopes of reducing their level of anticipatory anxiety; however, some children with autism may respond conversely by increasing distress and anxiety with the lack of transitional warning or preparation. Moreover, for children who did not successfully complete all 12 procedural steps, the dentist/hygienist following study protocol ended the dental appointment without giving the reward to the subject; however, research indicates that it is often better to end a teaching/training session on a positive success which allows for maintenance of confidence to try again the next time[26].

Although the CARS-2 assessment was attempted in this study to stratify participants according to the severity of their autism symptoms, it did not account for their dissimilarities in the areas of oral sensitivity, preferences for verbal vs. visual communication, cognitive levels and acceptance of novel stimuli and environment. Variation in the expression of the symptoms of ASD make individualization of treatment protocol necessary, yet this presents problems for standardizing and comparing protocols in a research setting. This challenge is ubiquitous in examining other behavioral interventions for autism.[13] Finally, as aforementioned, the interpretation and between-group comparison of EDA data was limited by multiple extraneous factors contributing to fluctuations in EDA levels (e.g., movement artifacts). Other physiological indicators, such as salivary cortisol level, may be a better alternative objective measurement for stress during an dental appointment[27].

The results of our study offer preliminary evidence that repeated exposure to weekly dental visits and using picture cues can help children with autism to have better experiences at the dentist to improve their dental care and oral health. The advantages of a visual system for children with autism include a) utilizing the child's visual strengths and providing a receptive communication system to increase understanding; b) informing the child about upcoming tasks to better prepare the child for transitions; and c) decreasing the child's anxiety by having predictable expectations of what's to come. In addition, the visual system can be easily implemented with benefits even within one appointment. This study also informs the development of an effective treatment protocol which could help increase the confidence and effectiveness of dental professionals in the care of young patients with autism. Furthermore, we hope that the current practice of repeated dental treatment under general anesthesia and the time required for routine dental visits may be reduced. Thus, the associated health costs can be lower when children with autism can receive routine dental care through this behavioral desensitization and visual pedagogy approach.

Future Research Directions

More research into matching treatment approaches to individual characteristics is needed, such that clinicians can classify and select appropriate behavior guidance methods for patients with autism based on their unique symptoms, learning styles and preferences. It is important that future directions should consider extending our project to include the study of girls with autism as well as individuals with autism at different ages and developmental stages. Future studies may also benefit from obtaining reports from patients, their parents, and the dental clinicians regarding their experiences during each dental appointment. Finally, more research is also needed to further explore the clinical utility and a more sensitive and accurate

method of measuring physiological arousal or stress levels that can be used for comparisons between different groups of subjects.

CONCLUSIONS

Repetitive dental visits and visual pedagogy can help patients with autism successfully complete more steps, progress at a quicker rate, and exhibit lower levels of behavioral distress during dental visits. More research effort is needed to validate this protocol for a larger population of children with autism. Thus, we hope that successful routine dental care can be made possible for these patients without relying predominantly on pharmacological operating room procedures, resulting in improved satisfaction and efficiency in dental care for children, their families, and dental professionals.

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