Dental Journal
Majalah Kedokteran Gigi

Dental Journal
(Majalah Kedokteran Gigi)
2019 September; 52(3): 117–121

Research Report

Effectiveness of Applied Behavior Analysis (ABA) with regard to tooth brushing in autistic children

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ABSTRACT

Background: *Children demonstrating autistic spectrum disorders tend to be uncooperative when receiving dental treatment. Actions as simple as brushing the teeth with a prophylactic brush can constitute complex processes for children with such conditions. Applied behavior analysis (ABA) can train children in new positive behavior and it is, therefore, anticipated that an ABA-based approach is capable of influencing the behavior of individuals with autistic spectrum disorder.* ***Purpose:*** *This study aimed to assess the effectiveness of the ABA-based approach for autistic children during dental brushing procedures.* ***Methods:*** *The research constituted a quasi-experimental single subject investigation of children presenting autistic spectrum disorders who attended the Lembaga Pendidikan Autisma Prananda, Bandung. Potential changes in the behavior of subjects were monitored four times during treatment with a one-week interval between consultations. Those subjects satisfying the inclusion criteria consisted of 11 boys and 4 girls. The data analysis used in this study consisted of an ANOVA test and a non-parametric Kruskal-Wallis test with a p–value < 0.005.* ***Results:*** *Changes in scores between the initial and final consultations were statistically significant with a p-value (0.269) <0.05. Statistically significant differences existed between changes in the behavior of level 1 and level 2 autistic subjects.* ***Conclusion:*** *An ABA-based approach effectively changes the behavior of autistic children with regard to prophylactic brushing. Children with level 1 autistic spectrum disorder demonstrate greater capacity to follow instructions and consistently implement a prophylactic brushing technique.*

Keywords: *applied behavior analysis; autistic spectrum disorders; prophylaxis brush; picture cards*

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INTRODUCTION

Children with Autism Spectrum Disorder (ASD) tend to demonstrate limited ability to maintain their oral hygiene. Activities such as brushing and flossing teeth can prove challenging for such individuals, while caregivers also usually experience a certain degree of difficulty in brushing their teeth.[1–3] Research conducted on 196 families by Chan, *et al*. indicated that 42.3% of the population reported problems brushing their children's teeth and that, consequently, they only attempted to do so once a day.[4] Individuals with ASD enjoy eating sweets and soft foods, while also tending to pouch food inside their mouths (particularly in the vestibule, interdental and occlusal regions).[1,5] Oral hygiene levels in children with ASD compared to those who do not present the condition contrast sharply. Indeed, 59% of non-ASD children demonstrated a high level of oral hygiene, whereas only 3% of their ASD counterparts recorded a similar level.[3] Poor oral hygiene is responsible for caries and periodontal diseases among children afflicted with ASD. The prevalence of dental caries among such individuals is as high as 77%, but only 46% in non-ASD children. 97% of ASD children suffer from gingivitis, whilst only 41% of their non-ASD counterparts do so. Given their dental condition, ASD children require preventive action but, generally, prove uncooperative when receiving dental treatment. [3,6–8]

One of the routine treatments administered during a dental consultation is that of prophylactic brushing. This procedure involves the use of a prophylactic brush

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.

DOI: 10.20473/j.djmkg.v52.i3.p117–121

and toothpaste to remove plaque from dental surfaces. Such cleaning can be performed manually, but dentists prefer motor-driven prophylactic brushes for reasons of efficiency. A prophylactic brush is attached to a straight or angled hand-piece or a prophy angle. Brushing should be performed at a recommended speed of 1500-3500 rpm, although it is difficult to measure the exact speed during actual brushing. A buzzing or high-pitched squeaking sound will be heard when the prophylactic brush is rotating at an excessive speed. The dental surface should brushed for 2-5 seconds at a moderate but consistent speed.[9,10]

This tooth cleaning procedure not only facilitates clinical observation but also introduces children to dental procedures. ASD children who have learned dental cleaning techniques involving the use of prophylactic brushes are likely to become competent in other procedures. Dentists can teach ASD children such procedures by adopting a method-based behavioral approach known as Applied Behavior Analysis (ABA).[10] ABA is an instructional method commonly used with ASD children which has also been employed within other disciplines to manage ASD child behavior problems.[1–3] An ABA-based teaching approach involving the use of picture cards is one that can be adopted to amend the behaviour of ASD children. The basic ABA procedure consists of prompting, fading, shaping, and chaining which are employed repeatedly and consistently in combination with positive reinforcement.

The effectiveness of the ABA-based behavioral approach is evident from the change in the ability of children suffering from the condition to follow instructional steps. During each consultation, the subjects were rated in terms of their compliance with dental cleaning instructions. Their scores, in addition to any indications of behavioral change, were observed and recorded. Any increase in scores recorded between the initial and final meetings would indicate the effectiveness of the ABA-based approach. The use of a prophylactic brush and dental micromotor constitutes a cleaning procedure for labial and buccal surfaces. The prophylactic brush employed during the research was of a pink-colored, soft-textured, nylon, latch flat type. This research aimed to measure the effectiveness of the ABA approach in dental cleaning with a prophylactic brush with ASD children.

MATERIALS AND METHODS

Approval for this research was granted by the Research Ethics Commission of Universitas Padjadjaran in a letter numbered 374/UN6.C1.3.2/KEPK/PN/2016. The research subjects consisted of 15 ASD children attending Lembaga Pendidikan Autisma Prananda who satisfied the inclusion criteria of the research project. Subjects were selected on the basis of the following criteria: males and females diagnosed with level 1 and level 2 ASD based on DSM-5 diagnostic criteria. Children with specific limitations other than ASD such as systemic diseases or physical disabilities were excluded. The research adopted a quasi-experimental single-subject design to assess the effectiveness of an ABA-based approach in shaping dental cleaning behavior with a prophylactic brush among children with level 1 and level 2 ASD.

Treatment was administered four times at intervals of one week. One day prior to treatment, the teacher prepared the subjects by introducing them to a set of picture cards that would be employed the following day (Figure 1). The activities were completed in a room with only the teacher, children and researcher present. Treatment was administered to six areas of the subjects' oral cavities, commenced with region 2, continued with regions 5, 1, 3, and 4 and terminated with region 6. Posterior region brushing was initiated with the most anterior tooth and culminated with the most posterior tooth. At each instruction step, the subjects were shown a picture depicting the respective treatment. Subjects who were able to follow the instructions received verbal praise and a reward based on their preference indicated by a previously-administered questionnaire. Any change in behavior was measured on the basis of the ability of subjects to follow instructions. Scores of 1 and 0 were respectively awarded to those subjects who were able or unable to follow instructions as shown in Table 1.

No score would be awarded if the subject proved unable to follow an instruction. Under such circumstances, the instruction would be repeated until the subject was able to perform the action as required. Failure on the part of the subject to obey the instruction meant that the process would not continue to the subsequent step. The maximum

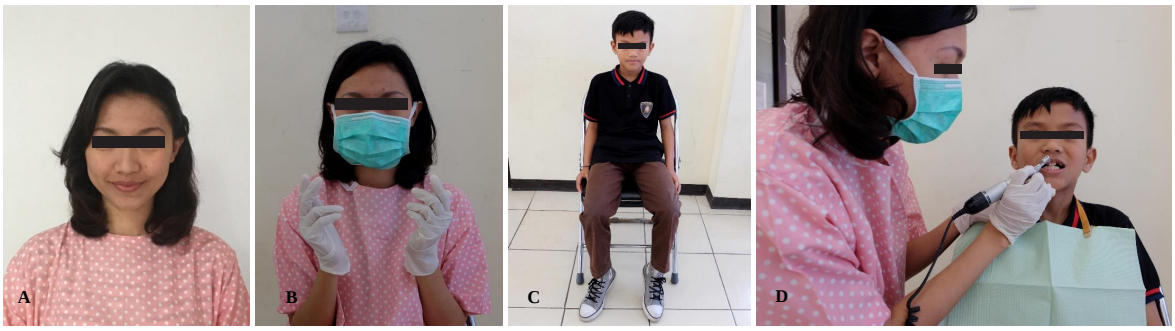

Figure 1. Materials in Picture Cards: (A) Researcher without face mask; (B) Researcher wearing face mask; (C) Subject seated during examination; (D) Subject receiving dental cleaning treatment.

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.
 Available at http://e-journal.unair.ac.id/index.php/MKG
DOI: 10.20473/j.djmkg.v52.i3.p117–121

treatment time was one of 15 minutes per consultation. In cases where the attention of the subject was distracted during treatment, his/her focus would be reoriented by eliminating the source of distraction and repeating the instruction.

Any step completed during one consultation would be repeated during the subsequent one before the subject was allowed to proceed to the next step. During each consultation, a record was made of the extent to which each subject was able to follow instructions and whether he/she demonstrated progress, retrogression, or no change. The data selected was then analysed through the administering of a Kruskal-Wallis test with a p-*value* <0.005 in order to address the research problem and test the hypothesis.

RESULTS

Changes in the behavior of subjects between the initial and fourth meetings are presented in Table 2. During the research, all subjects demonstrated varying degrees of behavioral change. Subjects with level 1 ASD proved capable of following all instructions, while of those with level 2 ASD only two completed all the required steps.

During the initial meeting, the subjects undertook different levels of tasks. One individual required more time before he/she was finally able to enter the observation room in a composed manner, while another sat calmly in the chair provided. Three subjects were willing to wear a bib and one opened his/her mouth to allow the tool to be inserted, although with the power off. As for the remaining nine subjects, all were able to proceed to the prophylactic brushing stage.

In general, positive behavioral change was identified during the second consultation with the exception of five subjects who demonstrated no change of any description. Two subjects failed to present any behavioural change after transitioning from the second to the third consultation. The number of subjects capable of fully implementing the instructions increased from two to five during the third consultation.

During the final consultation, eight subjects were able to complete their task effectively. Overall, 12 subjects underwent dental cleaning with a prophylactic brush, although four underwent partial cleaning of specific areas of the oral cavity. As shown in Table 2, only one subject failed to show any behavioral change after the third consultation.

Table 1. Subject responses to instructions as assessment of behaviour

No.	Instruction	Score
1	Subject unwilling to enter treatment room	0
2	Subject willing to enter room	1
3	Subject willing to remain seated	1
4	Subject willing to wear a bib	1
5	Deactivated tool inserted in mouth	1
6	Activated tool inserted in mouth, but brushing process cannot be performed	1
7	Operator able to clean region 2	1
8	Operator able to clean region 5	1
9	Operator able to clean region 1	1
10	Operator able to clean region 3	1
11	Operator able to clean region 4	1
12	Operator able to clean region 6	1

Table 2. Subjects' behavioural change scores between 1st and 4th meeting

ASD Level	Subject Code	1st Meeting Score	2nd Meeting Score	3rd Meeting Score	4th Meeting Score
Level 1 (Easy)	A	8	11	11	11
	B	7	7	9	11
	C	7	11	11	11
	D	7	9	11	11
	E	7	9	11	11
	F	8	9	11	11
Level 2 (Moderate)	G	4	5	6	8
	H	6	6	7	9
	I	3	3	4	4
	J	2	2	3	4
	K	7	9	10	11
	L	8	8	10	11
	M	3	3	3	6
	N	3	5	6	7
	O	1	2	2	3

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Based on the progression between the initial and final consultations, all subjects demonstrated varying degrees of positive behavioral change, while none showed behavioral retrogression. However, one subject was able to progress only one step further after the initial consultation.

Table 2 also contains the contrasting behavioral change of subjects with level 1 ASD and those with level 2 ASD. During the preliminary meeting, the subjects with level 2 ASD proved capable of executing fewer instructions than their level 2 ASD peers. All level 1 ASD subjects were willing to open their mouths, thereby enabling the operator to perform dental cleaning, while only a trio of level 2 subjects accomplished this task. During the second meeting, two of the six level 1 ASD subjects proved capable of performing the required steps. In the final meeting, however, all level 1 ASD subjects accomplished these. Unlike level 1 ASD subjects, only two of their nine level 2 ASD counterparts successfully followed the instructions.

The statistical test results indicated a change in scores between the initial and the fourth consultations, with a p-value of <0.05 (0.026). As indicated by the scores achieved (p-value < 0.05), there was a statistically significant difference in behavioral change between level 1 and level 2 ASD subjects of <0.05 (7.67E-06).

DISCUSSION

The initial ABA procedure consisted of prompting which involved the use of picture cards to facilitate communication. This was followed by fading the objective of which was to reduce subject dependence on pictorial prompts. During the subsequent stage, referred to as shaping, instructions were repeated from the outset and the subjects were rewarded with complements or gifts.

Prophylactic brushing is a simple procedure appropriate for non-ASD children. In contrast, for those with ASD, the process can prove extremely complex. For this reason, the researcher adopted a chaining procedure. The prophylactic brushing procedure was broken down into several simpler instructional steps to facilitate subject comprehension and compliance. The researcher did not proceed to the next step until the subject were able to accomplish the current one.

Research has revealed that ABA represents a potential approach to changing the behavior of children suffering from ASD with regard to the use of prophylactic brushes for dental cleaning. All of the research respondents underwent contrasting degrees of behavioral change as indicated by the scores they achieved. The research findings were consistent with those of studies conducted by Mochamant *et al*., and Hidayatullah *et al*.[11,12] Foxx *et al.,* (2016) even argued that ABA technique represented the optimum approach whose effectiveness in changing the behavior of children with ASD has been proven scientifically.[13]

The chaining process of breaking down dental procedures into several instructional steps was intended to facilitate the learning of new information and skills by ASD children. Chaining was employed because the human brain can more readily encode repeated short inputs in the synapses than process longer pieces of information that are provided only once. In addition to chaining, repetition is another important aspect of ABA, while also constituting a basic learning principle.[14,15]

An ABA approach is suitable for brain rewiring because it basically promotes continuous and consistent repetition of positive behaviour. Behavioral change occurs because of the formation of new links between neurons during rewiring in the brain. which undergoes change by adapting to a novel activity or a repeated experience. Behavioral change among children with ASD varies because such individuals possess different levels of ability, intelligence, and performance.[16–18]

During the research, behavioral change occurred between the initial and fourth meetings, although not every subject presented this during every meeting. The number of subjects not experiencing behavioral change decreased with each consultation, but the number appeared to increase between the third and fourth consultation. This was because there were those who were able to complete the instructions in the course of that third meeting. In this case, non-occurrence of behavioral change was viewed in a positive light.

Generally, children with ASD value stability and routine. Altering the latter, therefore, requires careful preparation. Individuals with level 2 ASD tend to experience discomfort regarding any change to their daily routine. The situation differs in the case of children with level 1 ASD who demonstrate greater flexibility in the face of change.[19]

One day prior to the consultation, the teacher was instructed to inform the subjects of a change in the following day's schedule. He/she showed several picture cards and provided a brief explanation regarding the planned events of the subsequent day. The effective preparations of the teacher at LPA Prananda rendered the subjects more tolerant of changes to their schedules.

Within the context of this research, the ABA method applied involved the use of picture cards to facilitate communication. Children with ASD are generally good at processing visual information, but experience problems processing and interpreting verbal input. Effective visual aids can, therefore, help to focus their attention on the task or instruction issued. Pictures can both attract and retain the attention of such individuals. Visual aids can also provide ASD children with visually concrete tasks and instructions which support their processing of information. Studies have proven the effectiveness of picture cards in introducing children to a new activity that is useful for their daily lives.[10,19,20] Picture cards can prove an effective tool in changing the behavior of children with ASD .

Individuals with ASD are capable of performing a task more effectively when provided with a visual cue rather than a verbal instruction. Pictures support an improvement in their understanding by reducing dependence on abstract concepts and words. The researcher postulates that

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individuals with ASD tend to conceptualise visually owing to the intense level of activities in the parietal and occipital regions of their brain. The detailed and well-structured visual memory that they frequently demonstrate facilitates their adaptation to the environment.[21]

Through the use of picture cards, the researcher was able to communicate instructions more effectively to the subjects. The majority failed to follow the verbal instructions issued during the initial meeting. However, when shown a set of cards with accompanying instructions, the subjects became more focused and were capable of following instructions. The length of time required to process information contained in a picture card varied from one subject to another. Those with level 1 ASD required less time to respond to and understand the content of a picture card. During the final meeting, only one of the subjects suffering from level 1 ASD still required the use of visual aids. The others were able to follow verbal instructions effectively. In contrast to the subjects with level 1 ASD, most of those suffering from level 2 ASD needed to use visual aids up to and including the final meeting, the exception being respondent L. According to the teacher, this individual demonstrated a high level of compliance and extreme passivity in his/her daily life.

The researcher used one picture card for each instruction step because, based on the findings of a study conducted by Hidyatullah, subjects with ASD would become confused when presented with two different picture cards for the same instruction. Another difference from the picture cards used by Hidayatullah was that, in this study, the picture operator donned a mask and gloves.[12] This approach was adopted as a means of rendering the subjects more familiar with the researcher and understanding fully that he/she would clean their teeth with a prophylactic brush. One factor influencing the success of care is the level of recognition of the operator demonstrated by the subject.[11] Consequently, it is recommended that each subject is handled by a single operator. Exposure to a photograph of the researcher proved effective because the subjects, particularly those with level 2 ASD, became more cooperative when shown the photograph again and informed that this individual would perform the dental cleaning. The use of a photograph of the researcher as a form of introduction is an approach also adopted in other studies.[1,22,23] It was concluded that ABA has been proven to be an effective approach to changing its sufferers' behaviour with regard to prophylactic brushing. The research found that subjects with level 1 ASD experienced different degrees of change compared to those with level 2 ASD.

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Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.
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