

RESEARCH ARTICLE

Efficacy of differential reinforcement of alternative behavior on the on-task behaviors of deaf and hard of hearing students: a single subject study

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Abstract

Background and Aim: Function-based intervention have been shown to have positive increase in social skills of children with behavioral problems. The same findings can be potentially applied to the deaf and hard of hearing (D/HH) children. The present study examined the efficacy of differential reinforcement of alternative behavior (DRA) on the on-task behaviors of deaf and hard of hearing students in school.

Methods: Three subjects from one education center were selected. Multiple baseline design across subjects was utilized. Baseline data were collected through frequent observation of behaviors for each subject. In the intervention phase, three subjects were assigned to DRA programs.

Results: The data from the present study were analyzed by visual inspection and effect size index indicating that DRA was effective on the improvement of on-task behavior of these students.

Conclusion: The results showed that DRA was effective on improvement of academic task

behavior of D/HH students.

Keywords: Differential reinforcement of alternative behavior; deaf and hard of hearing; on-task behaviors

Introduction

According to the data gathered by Gallaudet Research Institute, almost 40% of deaf and hard of hearing (D/HH) students in the United State have multiple disabilities. Almost 30% of this population has behavioral problems which are the result of conditions such as developmental delay, attention deficiency-hyperactivity disorder, traumatic brain injury, mental retardation, autism and etc. [1].

Recent researches showed a high rate of behavioral problems in children with hearing problems compared to their peers [2]. Students that are deaf or have hearing problems do not have environmental hearing experiences, so they try to adjust themselves to the hearing world. Delay in speech and language skills limits their ability to communicate with others; so the necessary skills for understanding social language do not develop; such children are socially less accepted and have depression more social problems at school [3]. Also, D/HH students are less interested in school compared to their

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peers and teachers indicate that they have more off-task behaviors [4].

The behavioral problems of children are common; these disabling problems cause a lot of difficulties for children and their families and decrease individual and educational effectiveness. These children are rejected by relatives and there are a lot of complaints at school about them [5]. Due to the lack of training and knowledge, teachers of deaf students need research-based strategies to understand the effects of deaf disability and behavioral problems of these students [6].

In order to decrease the behavioral problems of children with deaf disability, different methods are used (medication, psychotherapy or combined therapies). One of the well-known interventions in this field is medication interventions. Although we have evidence supporting the existence of biological factors which cause behavioral problems for individuals with developmental disability, the results of basic and applied studies showed that most behavioral problems have immediate antecedents and consequences which function in the environment [7].

Based on the behavioral model, abnormal behaviors are learned; environmental factors not only begin the abnormal behaviors, but also make them continue by reinforcing abnormal behaviors. For behavioral problems, stimuli (events related to behaviors), responses (reaction for such stimuli) and outcomes for behavior change are the main focus [7].

Behavioral approach received a wide empirical support in the field of behavioral problems [8]. There is a substantial body of literature demonstrating the effectiveness of behavioral interventions for decreasing the problem behavior of individuals with developmental disabilities. The widest behavioral interventions used for behavioral problem is the differential reinforcement technique [9]. The differential reinforcement (DR) methods include systematic remove of behavioral problem reinforcement (i.e. extinction), while reinforcement is provided when behavioral problem is absent or when alternative suitable behavior is provided. Two

common methods of differential reinforcement include differential reinforcement of other behavior (DRO) and differential reinforcement of alternative behavior (DRA) [9].

DRO includes providing reinforce stimuli when there is no special behavior at a given time [9]. Some researchers investigated the effectiveness of DRO for decreasing a series of behavioral problems such as stereotypic behaviors, self-injurious behaviors and aggression [10]. While DRO affects the decrease of aggression and self-injurious behavior, the main failure of this method is replacing suitable behaviors and its low social validity. As a result, DRA that includes extinction for undesired behavior and at the same time reinforces a special alternative response behavior which is considered for educational opportunities such as classroom is suitable for school education [9].

Numerous studies have demonstrated the effectiveness of DRA for decreasing problem behaviors and increasing occurrence of appropriate replacement behaviors [11]. Posture et al. investigated the empirical background of DRA of researches during the last 30 years. Findings showed that 91.5% of the participants have autism and other developmental disability diagnosis. Moreover, the overwhelming majority of behaviors selected for reduction in those studies included stereotypy, aggression, self-injury, and destruction. So, while much is known about the effectiveness of DRA with low-incidence disabilities and presenting problems, much less is known about the effectiveness of DRA with individuals of typical development engaging in common problem behaviors [12].

One likely reason for the success of DRA is that most DRA treatments are based directly on the results of a functional analysis [13,14]. Identifying the function of problem behavior permits researchers to disrupt the response-reinforcer relations for problem behavior (e.g. via extinction) and to contingently provide the identified functional reinforcers for appropriate behaviors.

DRA interventions have been shown to effectively decrease problem behaviors and to

Table 1. Demographic characteristics of participants

Case	Age	Behavior topography	Behaviors function
1	7	Aggression, distraction	Access to attention
2	8	Destruction, inappropriate movement	Access to attention
3	7	Aggression, destruction	Escape

maintain over time [15-21]. Generally, history shows that in the last 30 years a significant number of studies conducted in other countries was confirmed the effectiveness of DRA in the field of developmental disabilities but the effectiveness of the results in Iran due to cultural differences and different educational styles students with hearing impairment are discussed. Therefore, the purpose of the study was to examine this question that, does the implementation of DRA increase On-task behaviors in students with deafness or hard of hearing? In efficacy analysis of psychological and behavioral treatments, psycho-social and cultural factors play an important role. Although effectiveness of differential reinforcement of alternative behaviors has been investigated in European Western culture as well as the United State and Canada, it has been studied in Iran rarely. Therefore, In this study the researcher decided to fill the gap and observe the result.

Methods

A multiple baseline design across participants was used to evaluate the effectiveness of DRA on increasing the on-task behaviors. When data for the first participant demonstrates a stable pattern, the intervention is introduced to the next participant and continues until the intervention is implemented across all participants. Since ethical considerations are of utmost importance, multiple baseline designs, along with alternating treatment designs, can be very useful when withdrawals and reversals are inappropriate [22].

The study was conducted in a special school of deaf students in the province of Kurdistan. Three 7-8 years old children participated in the

study. For the selection process of participants teachers were asked to introduce students with the most behavior problems in school. Demographic characteristics of subjects are shown in Table 1.

Case-1: Subject was a seven-year-old boy with a bilateral, moderate to moderately severe sensorineural hearing loss (SNHL). He used two behind-the-ear style hearing aids and his speech reception thresholds were 70 dBHL for the right ear and 75 dBHL for the left ear. His teacher reported that problem behaviors occurred daily, especially during group activities. He felt subject liked attention and wanted to impress people with his intelligence. He had tried ignoring the behavior, redirecting, prompting the correct behavior, and removing him from the group activity.

Case-2: Subject was an eight-year-old boy with a profound, rising to moderate, hearing loss in both ears. He had been fit for behind-the-ear style hearing aids but rarely wore them, choosing instead to play with them in class. His speech awareness thresholds were 65 dBHL for the right ear and 60 dBHL for the left ear. His teacher reported that problem behaviors occurred daily, especially in the afternoon or if he was less motivated by the activity. She described him as fun, hands-on, and very social. He enjoyed socializing with the teacher, the classroom aid, and his peers. According to teacher, she had tried redirecting and prompting him to return to the task as well as punitive strategies such as providing a countdown to losing recess.

Case-3: Subject was a seven-year-old boy with a bilateral, moderate to severe SNHL. He had

been fit for behind-the-ear style hearing aids but no longer used them after losing two pairs. His speech detection thresholds were 40 dBHL bilaterally. His teacher reported that problem behaviors occurred daily and throughout the day. She described him as impulsive and hyper and said he became frustrated when something did not go as planned. He enjoyed socializing with the teacher, the classroom aid, and his peers. According to teacher, she had tried moving him off to the side and asking him to explain his behavior and what he needed to do to improve it. He did better with short, structured activities that required movement or hands-on activities.

The motivation assessment scale (MAS) is a rating scale designed to determine a teacher's perspective on the factor reinforcing a child's challenging behavior [23]. It contains 16 questions, each relating to one of four possible classes of reinforcement. The four types of reinforcement include: Sensory, escape, attention and tangible. The MAS test-retest reliability values reported by the original authors [23] were high (0.92-0.98) and the interrater reliability values for the MAS were ranging from 0.80 to 0.90.

Functional assessment interview (FAI) follows a structured interview format, and is used to assist in the formation of a hypothesis about the function of challenging behavior [24]. The interviewer asks informants to identify specific behaviors of concern, when and under what classroom circumstances the behaviors typically occur, and what the typical responses of teachers and other students are to each specific behavior. The inter-rater reliability and the test-retest reliability of this tool were obtained 0.71 and 0.81, respectively. The predictive validity of this tool is also an acceptable value [25]. In this study, the values of inter-rater reliability MAS and FAI were 0.76 and 0.69, respectively.

Antecedent-behavior-consequence (A-B-C) data were collected individually for each participant [26]. Each observation was conducted within each participant's elementary classroom setting during naturally occurring activities for a minimum of 30-min. During A-B-C data

collection, an observer recorded the specific antecedent and consequent conditions that preceded and followed the occurrences of the identified target behavior. A-B-C data were collected until there was a clear pattern of antecedents and consequences related to the behavior.

A checklist was prepared based on visual observations of on-task behaviors. The checklist was mostly descriptive and its inter-rater reliability was 0.85.

Interobserver agreement (IOA) is the extent to which two observers agree that behavior occurred [27]. For frequency measures, the percentage of IOA is calculated by dividing the number of agreements by the total number of agreements plus disagreements and then multiplying by 100. Reliability was calculated on approximately 50%-60% of baseline and intervention sessions across all children. Agreement on on-task behaviors for Case-1 ranged from 68%-97% (mean=74%). Agreement for Case-2 ranged from 65%-90% (mean=76%), and for Case-3, agreement ranged from 69%-93% (mean=78%).

The intervention rating profile (IRP-15) was used to assess levels of satisfaction [28]. The IRP-15 consists of 15 items and utilizes a Likert scale ratings system. The scores on the IRP-15 can range from 15 to 90, higher scores indicating a greater acceptance level of the intervention. Reliability of the instrument is 0.98 [28]. Scores above 52.50 are considered to be acceptable [29].

The researcher, the behavior specialist, and teacher of student observed treatment sessions implemented with the participants. A checklist was used to record whether the procedures were implemented with fidelity according to the experimental procedures of the study. Treatment integrity was calculated by dividing the number of times the intervention was implemented correctly by the number of sessions (trials) of implementation. This number was multiplied by 100 and expressed as percentages across the study. Although there is not a consensus on what constitutes a criterion level for treatment integrity [27].

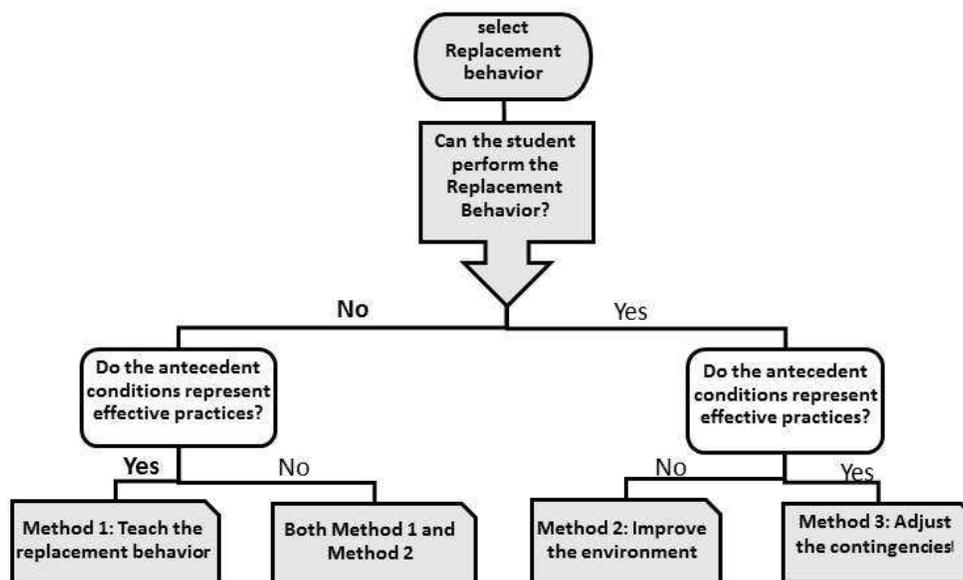


Fig. 1. Function-based intervention decision model [30].

In the present study the function-based intervention decision model was used [30]. Fig. 1 presents this model. After a functional behavior assessment is conducted, two questions are posed related to the student's behavior and the classroom environment: (a) "Can the student perform the replacement behavior?" and (b) "Do the antecedent conditions represent effective practices?" These questions lead to four possible outcomes. Each outcome identifies which of the three intervention methods, individually or combined, is appropriate for a given situation. If the student cannot perform the replacement behavior but the antecedent conditions represent effective practice, then method 1 "Teach the replacement behavior" is used. If the student can perform the replacement behavior but the antecedent conditions do not represent effective practice, then method 2 "Improve the environment" is used. Both method 1 and method 2 are applied if the answer to both questions regarding the student and the environment are answered no. Finally, if the answer to both questions is yes, then method 3 "Adjust the contingencies" is used. This study is generally divided into four phases including functional behavioral assessment,

choose replacement behaviors, baseline and Implementation of DRA. In the phase 1, for each participant, the function(s) of the target behavior were identified through the motivation assessment scale and functional assessment interview. During phase 2 based on information obtained from indirect assessments and the function-based intervention decision model [30] and structured observations replacement behaviors were determined. In baseline phase 3 direct observations were conducted in the classroom to determine the percentage of on-task behaviors identified for each child and in phase 4 the intervention was implemented. During phases 3 and 4 systematic observation data of participant's behavior were collected.

During each session, data were collected and recorded by the primary experimenter. Data on the percentage of intervals of on-task behaviors were collected. In order to obtain the percentage, the number of intervals in which the on-task behavior occurred was divided by the number of intervals in a session.

Visual inspection is the most common method of evaluating the data. A second option is to use a statistical technique such as the two standard deviation-band, chi-square analysis, or

proportion test (see 31-33). In the present study, visual inspection and effects size index were conducted to determine the impact of the independent variable. Chi-square test, test of proportions and 2-standard deviation test were also used.

Results

The results of the baseline and intervention are shown in Figs. 2A-C. As shown in Fig. 2A, Case-1 mean for on-task behavior in baseline was 56% range (20%-38%) over six sessions. During the intervention, Case-1 mean on-task behavior increased to 77.59% in the intervention phase. The percentage of non-overlapping data (PND) was calculated to be 100% as all data points (22/22) in the intervention exceeded 38%.

The Fig. 2B presents Case-2 on-task behavior. During baseline, Case-2 mean for on-task behavior was 27.30% with a range of 18%-37% over ten sessions. With the presentation of the intervention, on-task behavior increased to 64.27%. PND was calculated to be 100% as all data points in the intervention (18/18) exceeded the highest point (i.e., 37%) in baseline. The data during intervention for Case-2 ranged from 45%-75%.

When three consecutive data points were above 50% for Case-2, the intervention was implemented with Case-3. Case-3 mean for on-task behavior was 39.57% in baseline, with the presentation of the DRA intervention was reached to mean of 53.71%. PND was calculated to be 92% as 13/14 of the data points in the intervention phase were above the highest data point of the baseline phase (Fig. 2C).

Treatment integrity data were collected on 50% of baseline and intervention sessions. Treatment integrity data revealed that the intervention was implemented with a high level of fidelity across the participants in the study (mean=88%, range=74.2-90.3%). Social validity data indicated the intervention was considered to be a highly acceptable intervention to address the on-task behaviors of the participants (total score were 75).

In order to examine the effectiveness of the

treatment plan, statistical tests such as chi-square, test of proportions, and two standard deviations tests were used to examine the significance levels of data. All three statistical tests showed that baseline data were significantly different from the intervention phase. The results are shown in Table 2. As indicated in this table, based on three statistical tests including chi-square, test of proportions (p), and two standard deviation tests baseline data and intervention phase were significantly different.

Discussion

The research question was designed to determine the effects of DRA on the on-task behaviors of students with D/HH. Results indicated that all participants acquire the alternative behavior during the intervention phase. In this study, multiple- baseline designs were used to control contaminating variables more than AB designs which cause an increase in validity and precision and accuracy of the results and therefore, they do not require reversals, and some of the ethical issues inherent in other single subject designs are avoided.

The findings reflect the positive impact of the intervention program in on-task behaviors. PND was very effective to all participants. These findings are consistent with previous researches [16,19] which demonstrated that DRA could be successfully increase on-task behaviors of children with developmental disability. Also this study is consistent with previous researches in which DRA could reduce off-task behavior in children with ADHD [15]. This study in the field of reducing behavioral problems in children with developmental disability is consistent with previous researches [17,18,34] conducted on nonclinical population [35,36].

High acceptance of intervention by the teachers can be mentioned as other findings of this study. Teachers' points of view showed that significant changes were made. Social validity data indicated the intervention was considered to be a highly acceptable intervention to address the problem behaviors of the participants. These

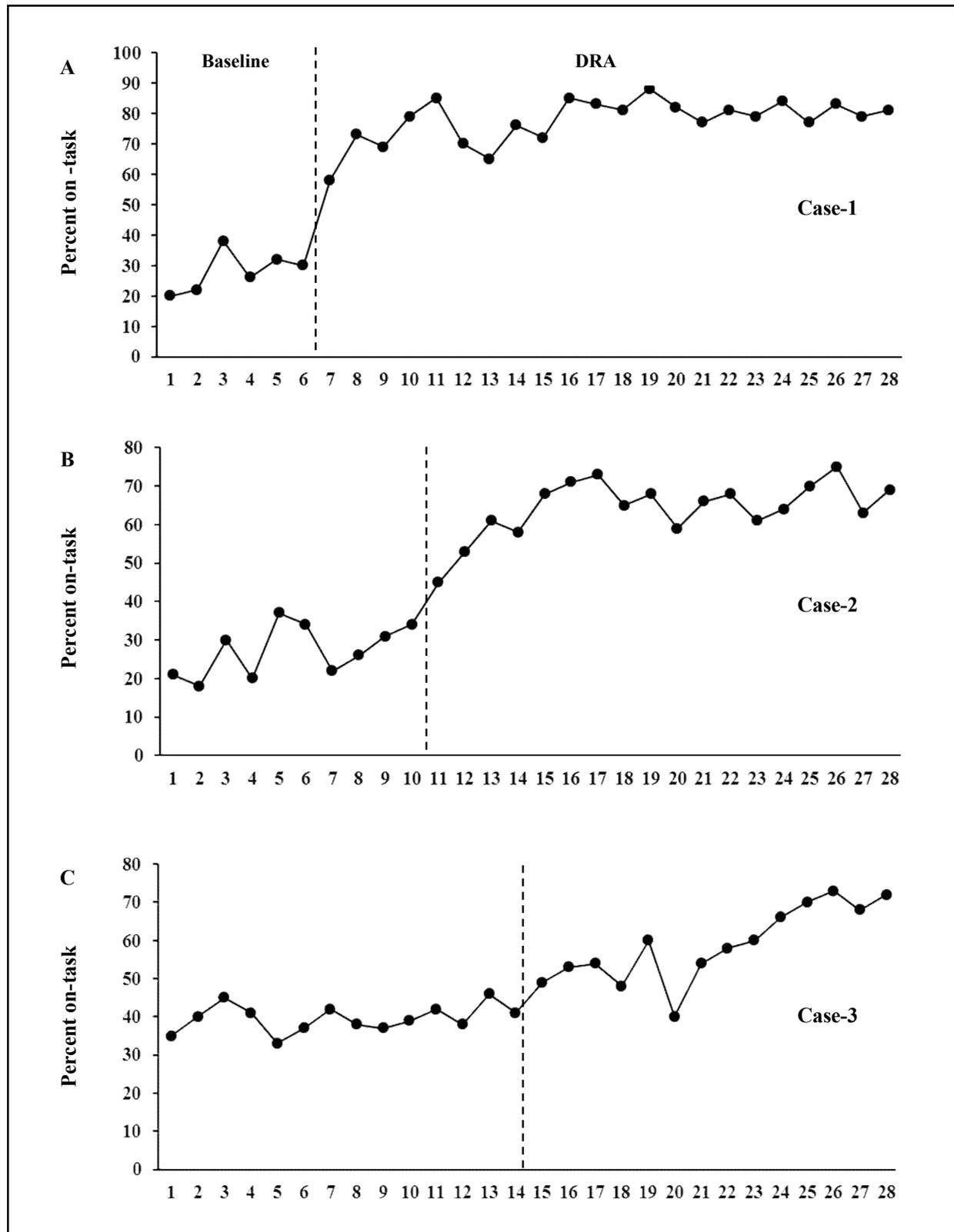


Fig. 2. Percentage of intervals occurrence for on-task behaviors in A) Case 1, B) Case 2, and C) Case 3.

Table 2. Results of chi-square, proportions, and two standard deviation differences between baseline and intervention data

Case	Tests	Score* (χ^2 , Z and SD)	p
1	Chi Square	13.11	0.001
	proportion	3.65	0.001
	2-Standard Deviation	6 sd<	✓
2	Chi Square	13.03	0.001
	proportion	3.63	0.001
	2-Standard Deviation	4 sd<	✓
3	Chi Square	3.88	0.049
	proportion	1.99	0.047
	2-standard Deviation	2 sd<	✓

Scores of χ^2 (Chi-Squared), Z (test of proportions) and the number of non-overlapping standard deviations between baseline and intervention (2-Standard Deviation test).

findings indicated the views of teachers on the possibility of using this technique in the future. Several factors have been identified that may influence the success of outcomes of DRA. Such elements may be necessary to cause increase in on-task behavior. First factor that influences the success of DRA is identifying the reinforcer. The procedure involves reinforcing a desirable behavior and withholding reinforcement for undesirable behaviors. In this study, for all students one or more reinforcers according to their conditions were selected. Reinforcer or function of undesirable behaviors was extinguished as well. These findings are consistent with previous researches [37,38] which demonstrated that a function-based intervention could be successfully implemented in a school setting.

Second factor is reinforcement of the desirable behavior immediately and consistently in the beginning of intervention. A behavior that is reinforced on a continuous reinforcement schedule, at least initially, is more likely to increase the desirable level and to replace the undesirable behaviors that are not being reinforced [39].

Another factor that is important to maintain the target behavior is using the intermittent reinforcement in the late intervention. We started to thin the schedule of reinforcement and reinforce the desirable behavior intermittently.

Environmental conditions were also improved. These conditions which were used in intervention program are consists of two parts: 1) eliminating discriminative stimulus for the off-task behaviors, and 2) providing discriminative stimulus for desirable alternative behaviors.

In the present study, among changes in the environment to increase the likelihood of desired behavior following actions can be pointed: identifying access rules to reward in the classroom, displaying the number of received tokens for desired behavior, relegating students with behavioral problems, sitting students with behavioral problems in classroom separately, explaining the rules to reinforce access, preventing discontinuity in the educational process in the classroom, sitting the student with behavioral problems in front of the classroom, adjusting the amount of task difficulty assigned to students and asking other students not to regard the behavior problem of the student.

Conclusion

The present study revealed that DRA was successful for students with D/HH in a school setting. Key point in this method is regarding all components of intervention that guarantee a successful intervention. This study utilized the functional behavior assessment (FBA) process as a method to derive function-based data to be used for the development of function based intervention strategies within the differential reinforcement paradigm. DRA could be effective to decrease behavioral problems of students with D/HH if it implements based on the functional analysis and participant's language skills. Although the intervention was successful to increase the on-task behaviors of all three participants, there are a few limitations in this the study. First, the small sample size limits generality across subjects. All three participants were diagnosed with hard of hearing, but each participant displayed different characteristics. It is difficult to determine if similar results would be achieved with other students with hard of hearing because the diagnosis of hard of hearing is not necessarily related to likelihood success of a specific intervention. Secondly, since this study was conducted on children with hard of hearing, we must be cautious to generalize results to other groups. Thirdly, we did not implement generalization sessions, due to school schedules. The extent to which these results can be extended to other settings (i.e. home) and other times is limited. It is suggested that future researches select alternative behaviors which are used by speech-language pathologists. It is suggested that future researches use videotape to calculate the IOA.

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