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Abstract

Skill acquisition can be particularly difficult when prerequisites are lacking (e.g., attending to learning materials) that are necessary to expand academic abilities. However, behavioral technologies exist that can help individuals overcome, or at least improve their quality of life despite these difficulties. The current case study used a quasi-changing-criterions-design to examine the effectiveness of a Teaching with Acoustical Guidance (TAGteach) technique to increase attending to learning materials in an eight-year-old participant with Down syndrome. The TAGteach technique was effective in increasing the percentage of trials in which the participant looked at materials and the duration of looking at presented materials during learning trials. Furthermore, results generalized to a leisure task, showing that the intervention was not only academic, but also has the ability to improve on quality of life.

Introduction

Clinically significant gains are arguably best when achieved efficiently; that is, gains achieved with the greatest return on investment. One means of efficient programming lies in targeting behavioral cusps, which creates and provides access to long-lasting new and significant reinforcers beyond the behavior directly targeted (see Bosch & Fuqua, 2001). For example, teaching an individual to manipulate a door handle not only allows them to open a door, but also grants access to new environments (e.g., rooms) and reinforcers (e.g., events, stimuli behind closed doors). Similarly, teaching independent play skills can lead to greater independence, expanded interests, and can set the stage for other social skills should other individuals take an interest in the activity (e.g., a parent playing with or parallel playing to the child).

One precursor skill common to many behaviors, and thus serving as a behavioral cusp, is attending to stimuli. There are many ways to program for improvements in attending. For example, previous research for children diagnosed with various disorders has found token reinforcement to be a successful intervention to increase attending skills (e.g., Tarbox et al., 2006). However, token reinforcement requires participants to tolerate delays to reinforcement. For example, in the study by Tarbox and colleagues, the participant showed increases in attending during a token reinforcement intervention when compared to baseline when the schedule of reinforcement was thinned from 10 to 50 tokens. Additionally, the participant in this study had fine and gross motor

skills, independent play skills, self-help skills, and pre-academic skills. For children with fewer skills and more significant developmental disabilities, interventions other than a token reinforcement system may need to be considered.

Research using Teaching with Acoustical Guidance (TAGteach) has found success with populations with significant language or intellectual deficits (LaMarca et al., 2018). TAGteach has been used with dancers (Quinn et al., 2015), golfers (Fogel et al., 2010), and medical residents studying to become surgeons (Levy et al., 2016). More recently, TAGteach has been used in behavior-analytic clinics.

In TAGteaching, an auditory stimulus (tag) is established as a conditioned reinforcer. Once established, the auditory stimulus can be delivered almost immediately after a successful behavioral execution. Additional putative reinforcement can follow, but the important point is the tag is salient, immediate, and the first reinforcing stimulus following behavior. For some individuals, whose disabilities might accompany greater social and language deficits, the use of an auditory marker removes the complexities of language used with praise. Additionally, individuals with significant delays may benefit from the inclusion of an auditory marker to precisely mark and reinforce the desired behavior (LaMarca et al., 2018). For example, TAGteach has been found to decrease the number of prompts and increase independence with imitation and requesting (i.e., manding) in individuals diagnosed with autism (Pineda et al., 2014) and to reduce problematic toe-walking (Persicke & Jackson, 2013).

Despite the success of TAGteach procedures in teaching skills to individuals diagnosed with developmental disabilities, TAGteach has not yet been implemented to increase attending skills. The advantage of implementing TAGteach to increase attending skills is the ability to precisely mark and immediately reinforce the target behavior, a benefit that has been recognized by previous research (LaMarca et al., 2018). Precisely marking and reinforcing the target behavior may be especially beneficial when developing an intervention aimed at increasing skills in an individual with a significant deficit in social and communicative skills (Pineda et al., 2014). Indeed, the preliminary demonstrations of success of this procedure among individuals with varying disorders and significant disabilities who struggle to learn through traditional applied behavior analysis (ABA) strategies suggests that the use of TAGteach can and should be expanded beyond the populations it has proven effective with in the past. The present case study extends the developing ABA literature on TAGteaching and examines the effectiveness of a TAGteach-inspired procedure in increasing attending to learning materials for a child with Down syndrome during learning trials.

Method

Participant

Lee, an eight-year-old boy diagnosed with Down syndrome, autism spectrum disorder, and a moderate intellectual disability, participated in this study. Lee was asked to participate based on his skill deficit in attending to stimuli and his slow rate of acquisition. His skill deficit in attending interfered with engaging in independent play and other learning trials that required the physical manipulation of materials. This skill deficit was of concern to his parents, the board-certified behavior analyst (BCBA), and the behavior technicians on his team. A goal Lee's parents had for him was to increase his opportunities to engage in independent play, which is why additional efforts were given to develop this skill. At the time of the study, Lee was receiving 18 weekly

hours of ABA services at a clinic that delivers ABA behavioral health services for children diagnosed with autism spectrum disorder and related disorders.

At the time of the study, Lee could follow five separate instructions with gestures (e.g., extending a hand toward Lee accompanied with the vocal instruction "give it to me" to request an object Lee was holding, holding a hand up accompanied with the vocal instruction "give me five" to request a high-five). Lee's imitative repertoire was limited, as was his vocal-verbal behavior. Lee was able to non-vocally request for help, request "no", and request for preferred items by moving the therapist's hand on the object in question or pushing the unwanted object away. At the time of the case study, Lee was working to expand his requesting repertoire by focusing on gesture-based requesting and requesting through object selection (e.g., presenting three actual stimuli affixed to poster board for Lee to choose), increasing his listener repertoire (e.g., following directions or instruction) through following gesture-based instructions, and developing independent living skills, such as handwashing, dressing, and working toward independent feeding. Lee also had limited physical mobility, as he had learned to walk and sit up approximately two years prior to the time of the study. Finally, Lee was working on increasing his independent play skills.

When presented with independent play materials, Lee would look up at the ceiling. If material manipulation was required, Lee would either attempt to manipulate the materials or accept physical prompts while looking at the ceiling. When physical prompts were faded, Lee would either disengage from the trial (i.e., let go of materials and slump over in the chair) or engage in stereotypy with the materials (e.g., tap a block against his mouth). A previous successful intervention to increase attending involved Lee tracking reinforcers from left to right, right to left, and up and down. Staff that worked with Lee reported challenges related to identifying additional reinforcers to use during therapy sessions. At the time of the study, three consistent reinforcers had been identified: staff singing to Lee, tablet time, and hearing the vacuum.

Informed consent from caregivers was received prior to Lee participating in the study. Due to the number of sessions that may have been performed each day, caregivers were informed that the implementation of the intervention might interfere with other skill development programs. The caregivers consented to this potential intervention cost, as the focus of the intervention was to increase attending to learning materials, which might serve as a behavioral cusp to engage correctly with independent play materials.

Setting and Materials

Baseline and intervention phases were conducted in the center in which Lee received ABA services. The center is in the Midwest and provides ABA services for 10 to 20 young children diagnosed with autism spectrum disorder and related disorders. All sessions were conducted in private therapy rooms at this center.

Materials used included a handheld device that produced a sharp and short auditory stimulus (tag), a timer, a table, two chairs, and several different independent play materials. Independent play materials used included a shape sorter, a ring stacker, a peg shape stacker, a pegboard, colored bears and cups, blocks, a piggy bank toy, and several different puzzles. Additionally, several materials were used as reinforcers, including a vacuum, a tablet, an electronic dancing sock monkey, a fan with ribbons tied to it, and light up toys.

Measures

Measurement

For each session, the individual implementing the procedure collected data using a data collection application (i.e., Catalyst) and by hand using paper data sheets and a pencil. Two measures were collected during each condition for Lee. The two measures included initiation of looking at presented materials within 3 s of material presentation and duration of looking at presented materials. Duration of looking at presented materials was measured using a timer.

Percentage of correct trials was calculated by dividing the number of trials in which the current criterion was met by the total number of trials during that session and multiplying by 100. Although percentage correct was used to determine whether to advance across phases, each trial is shown individually in Figure 1 to aid in data interpretation. Duration of looking was calculated for each trial by totaling the number of consecutive seconds that the participant looked at the presented materials.

Interobserver Agreement and Treatment Integrity

Interobserver agreement (IOA) data were collected by having a second observer independently collect and score data on the percentage of trials in which the current criterion was met. These data were collected by hand using paper data sheets and a pencil. Exact agreement was calculated by comparing the session data for each interval (i.e., each trial). The number of intervals in which both observers agreed on the criterion being met or not being met were divided by the total number of intervals and multiplied by 100. IOA data were collected on 33% of trials during baseline and 27% of trials during intervention. During baseline, IOA agreement was 100%. During intervention, IOA agreement was 99%.

Treatment integrity data were collected on a task analysis sheet that staff completed after each session. Self-reported treatment integrity data were collected on 100% of sessions across baseline and intervention. During baseline, treatment integrity was 100%. During intervention, treatment integrity was 99%.

Response Definitions

The target behavior, looking, was defined as Lee turning his head and body to orient towards the presented stimuli and directing his gaze at the presented stimuli for the designated duration of time.

Design

This study followed a criterion-based shaping procedure with modified baseline design. This design is modeled after the changing criterion design, but as responding during intervention—but not baseline—could be terminated prematurely when correct performance was produced (in an effort to capitalize on immediacy of reinforcement), this approach violated a fundamental requirement of the changing criterion design (see Ledford & Gast, 2018). However, the design still enjoys many of the control features of the changing criterion design.

The criterion that changed was the duration of time that Lee spent looking at presented materials. The initial criterion began by having Lee briefly (i.e., <1 s) look at the presented materials, preferably within 3 s of instruction presentation. The terminal criterion was for Lee to continuously look at the presented materials for 3 s, again preferably within 3 s of instruction presentation. The criterion increased by 1 s following Lee meeting mastery criteria (i.e., 80% of trials or more at criterion across three consecutive sessions).

Procedure

Preference Assessment

Prior to baseline, two preference assessments were conducted. The *Reinforcement Inventory for Children* (Willis et al., 1993) was completed by Lee's mother and another therapist. The results of the inventory were used to inform the free-operant preference assessment, which included tablet, vacuum, light up toys, and water toys.

Baseline

During baseline, the trial began when the clinician presented the independent play material, pointed to the material, and gave the vocal instruction, "look". The trial ended after 5 s, regardless of the client's response. Each baseline session consisted of five consecutive trials.

During baseline, the clinician paused the tablet Lee was watching, presented the independent play material, pointed to the material, and gave the vocal instruction, "look." The trial continued for 5 s and the duration in which Lee looked at the presented materials (i.e., consecutive seconds of looking without looking away) was recorded. Praise (e.g., "Good job trying!") and tablet time (i.e., 10 s of watching tablet) were provided as reinforcers for participating in baseline trials, regardless of performance.

Pre-Intervention Pairing

A TAGteach-inspired procedure was used to reinforce longer durations of looking at a variety of materials presented to Lee. First, highly preferred items and reinforcers were paired with the auditory stimulus produced by the tag through reinforcer pairing trials. Each pairing trial began when the clinician produced the tag, which was immediately followed by 10 s of one highly preferred item identified by the reinforcer inventory and preference assessment. This process also took place with four other items found to be reinforcers through an in-the-moment reinforcer assessment with the clinician. The clinician waited approximately 15 to 20 s between pairing trials. Twenty pairing trials were completed consecutively as a pairing session. Pairing trials were arranged to continue for 120 trials or until Lee oriented to the reinforcer 85% of the time when the tag sounded during one pairing session. Once the tag had been conditioned as a reinforcer through reinforcer pairing, intervention sessions began.

Intervention

Five trials of this program were conducted consecutively without intermixing other acquisition trials. To promote adherence to the procedure and high treatment integrity, staff

completed a treatment integrity checklist following each session. Between one and four sessions were performed each day during the intervention. During intervention sessions, approach responses and physical interaction with objects (i.e., touching the object) were used to identify the reinforcer to be used during the session.

During intervention, the trial began when the clinician presented the independent play material, pointed to the material, and gave the vocal instruction, "look". The trial ended when either the participant met the criterion in effect or 10 s had passed without meeting the criterion. Unlike baseline, 10 s was permitted to pass so we could work to shape up shorter latencies, and to do so we wanted to make sure we caught all correct responses, even if slow. Reinforcers were provided on a differentiated reinforcement schedule (van Haaren, 2017) wherein when Lee met the current tag point (i.e., looked at the materials within 3 s for the designated duration), the clinician immediately produced the tag and delivered vocal praise (e.g., "good looking!") and 10 s of the reinforcer. If Lee did not meet the current tag point but looked for the designated duration before 10 s elapsed, 3 s of the reinforcer was delivered. If Lee did not look at the presented materials for the designated duration within 10 s, no reinforcer was delivered, the response was marked as an error, and the clinician attempted to establish a different reinforcer.

The first tag point was for Lee to look at the presented independent play materials momentarily. Mastery criteria for each tag point was three consecutive sessions at 80% accuracy (i.e., meeting the tag point within 10 s) or greater per session. The tag point increased by 1 s until Lee was looking at presented materials for 3 consecutive seconds.

The intervention consisted of two different phases. During the first phase, materials were presented to Lee while he was sitting on the floor. After meeting mastery criteria at the terminal tag point during the first phase, the second phase began in which Lee was moved up to the table to look at presented items. The purpose of the second phase was to perform the procedure in a more natural location, as independent play tasks are often done during table time learning.

Generalization

Generalization was programmed into the procedure by having two different therapists conduct the intervention sessions (up to session 35, at which time only the first author remained; see Figure 1). Staff were trained in conducting the procedure using behavior skills training. Staff training continued until staff correctly implemented the procedure at 100% fidelity across three in-vivo sessions. Additionally, generalization across stimuli was programmed into the procedure by presenting a variety of different independent play materials for Lee to look at in an effort to follow Stokes and Baer's (1977) recommendation to train loosely. Furthermore, generalization to a more natural learning location was completed with the second phase of the intervention, as learning with independent play materials is more likely to be completed during table time learning.

Social Validity

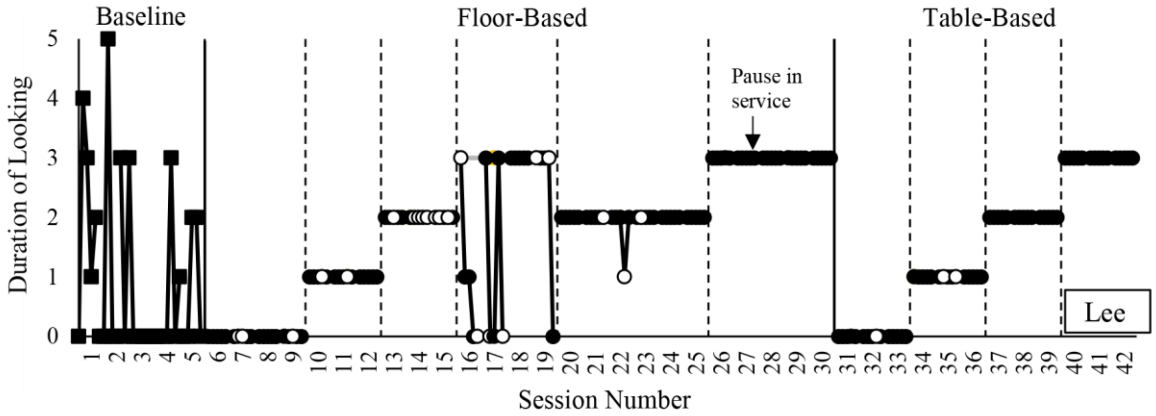
Social validity rested on parental requests to provide Lee with independent play skills. Prior to beginning the study, data were collected across three trials on Lee's ability to correctly put shapes into their corresponding slots in a shape sorter when all incorrect slots were blocked (i.e., taped closed with duct tape; tape position moved for each trial). Following the intervention, data were again collected using the same stimuli and procedure.

Results and Discussion

The results from this intervention support the use of TAGteaching techniques to improve attending skills in a young boy with Down syndrome. Trial-by-trial data for looking at materials across baseline and intervention are depicted in Figure 1. Five sessions or five trials each were run during baseline, and the time spent looking at materials ranged from 0 s to 5 s, with 19 of the 30 baseline trials resulting in no looking at materials for 1 s or more.

Figure 1

Duration of and Timing of Initiation of Looking Across Response Requirements



Note: Squares are in baseline, circles are during intervention. Closed circles indicate Lee initiated looking within 3 s of the instruction; open circles indicate Lee initiated looking after 3 s of the instruction's delivery. Baseline trials ended based on the passage of time whereas Phase 1 and Phase 2 trials ended when Lee successfully performed the response (or time elapsed with no response). Each session consisted of five trials.

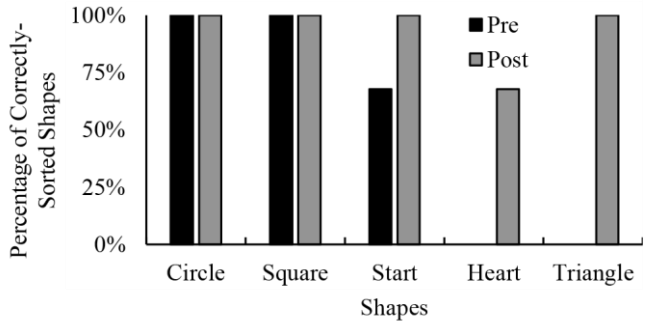
During the first phase, where Lee was situated on the floor, the first three duration criteria produced successful sessions, with an additional session run in the first criterion (<1 s) due to a data collection software issue. During the fourth criterion (3 s), variability increased. This variability prompted us to inspect staff behavior, helping us discover staff using a praise tone of voice when giving the instruction and failing to establish items as reinforcers prior to each session. As Lee did not have many language skills, failure to use an instructional tone when giving the instruction likely resulted in reduced stimulus control of the instruction. As the original reinforcer assessment identified only three putative reinforcers, Lee might have become habituated to the preferred items being used during the intervention, and therefore fault might not lie completely with staff. The clinic team reacted to this variability and its associated issues in 3 ways: 1) increase staff training on the procedures, 2) identify new highly preferred items, and 3) revert to the 2 s criteria to build back success. Given the variability seen in the 3 s criteria, additional sessions were run at 2 s. After session 27, an unexpected pause in services took place for approximately one month. After returning, Lee remained at the 3 s criteria, but was required to start over with the requirement for three consecutive successful sessions before advancing.

Session 31 marked the phase of the intervention where Lee was moved from the floor, which was more comfortable for him given his limited mobility, to a more challenging location at the table. From here Lee was successful in moving through the requirements.

Social validity data are shown in Figure 2, which depicts the percentage of trials in a block of three trials in which Lee correctly put shapes into their corresponding slots in a shape sorter when all incorrect slots were blocked. Taken together, these data are correlated with a greater degree of independent play skills following a TAGteach procedure to increase looking at presented play materials.

Figure 2

Percentage of shapes Lee sorted correctly across three trials before and after the TAGteaching intervention



Another unplanned benefit of the intervention was revealed when the clinician analyzed the rate at which Lee mastered other goals in his treatment plan. For example, Lee had been working on the modeled play skill of stacking blocks since he began receiving ABA services approximately one year prior. As the TAGteach procedure progressed, Lee mastered stacking blocks and maintained the skill after the intervention concluded. At one month prior to the TAGteaching procedure, Lee was mastering skills at a rate of 0.5 goals per week. At one month after TAGteaching, Lee was mastering approximately 4.0 skills each week, and anecdotally these skills were of a more complex nature. The intervention, then, likely served as a behavioral cusp for Lee.

Experimentally, one limitation of this intervention is that the procedure does not represent a true TAGteach procedure, as the response was not conditioned first without a vocal instruction. The decision to move straight into conditioning the response with an instruction was made following baseline data collection, as the response with an instruction (i.e., “look” with a gesture to the materials) was a response that Lee could perform. The intervention was needed to get the response under stimulus control and to shape the response, so that the response occurred at an increased duration. Thus, while an experimental limitation, clinically it is a strength of the TAGteach procedure; one need not necessarily wait for prerequisite training to start making progress.

Another limitation to this procedure is the difference between baseline and intervention durations. During baseline, the duration of looking at presented materials was measured up to 5 s. During intervention, the duration of looking at presented materials was measured up to 3 s, but Lee was given up to 10 s to complete the response. Due to the difference between baseline and intervention, the results may not be fully comparable. The decision to reduce the duration of looking from 5 s to 3 s was made due to clinical judgement, as looking at a stimulus for 5 s without

engaging in other actions was deemed excessive by the BCBA. This decision should have been made prior to collecting baseline data so that baseline and intervention phases were similar.

TAGteach is a technique that is not commonly used with children diagnosed with autism or other developmental disabilities. The present study is one of few studies to examine the use of a TAGteach procedure with a child with developmental disabilities. TAGteach has the potential to help build skills in children with developmental disabilities that struggle to learn through traditional behavioral techniques. Although TAGteach has been used to teach children various skills (Fogel et al., 2010; LaMarca et al., 2018; Pineda et al., 2014), more research on the effectiveness of TAGteach procedures with children with developmental disabilities is needed.

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