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A Functional Analysis of Physical Activity in Children with Intellectual and Developmental Disabilities

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A Functional Analysis of Physical Activity in Children with Intellectual and Developmental Disabilities

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Abstract

The U.S. Department of Health and Human Services recommends children get 60 min of moderate-to-vigorous physical activity each day, but few children with intellectual and developmental disabilities meet these guidelines. Determining the function of physical activity may lead to more effective interventions for increasing physical activity levels in these children. The present study adapted the methods of Larson, Normand, Morley, and Miller (2014) to conduct a functional analysis of physical activity in children with intellectual and developmental disabilities. For two subjects, rates of physical activity were measured using pedometers in five conditions: Verbal attention, adult interaction, music, ignore, and control. This multi-element functional analysis was embedded within a treatment analysis in an attempt to increase the child's rate of physical activity during their typical playground time. An automatic function was found in one subject, and a successful treatment was implemented and generalized to the subject's teacher. In the second subject, an interaction function was found but an intervention analysis was unable to be conducted due to lack of baseline stability. This study begins to shed light on automatically reinforced physical activity and variations in physical activity functions across populations.

Introduction

According to the National Center for Health Statistics, 18.5% of children in the United States were obese as of the 2015-2016 survey, a number that has increased from 13.9% at the time of the 1999-2000 survey (Hales, Carroll, Fryar, & Ogden, 2017). This number is believed to be greater in children with intellectual and developmental disabilities (IDD). Although exact numbers vary between studies, in a study by Levy et al. (2019) the overweight and obesity prevalence among 2-5-year-old children was found to be 1.38x greater in children with IDD and 1.57x greater in children with Autism Spectrum Disorder (ASD). One possible contributing factor of obesity is a lack of physical activity. The U.S Department of Health and Human Services (DHHS, 2018) currently recommends children get 60 min of moderate-to-vigorous physical activity (MVPA) each day. However, it is estimated that 0 to 42% of children with IDD meet these guidelines (Must et al., 2014). Specifically for children with ASD, physical activity levels are hypothesized to be lower than those of their typically-developing peers due to motor impairments, restricted interests, difficulties with social communication, behavioral problems, or sensory processing issues (Srinivasan, Pescatello, & Bhat, 2014).

The majority of behavioral physical activity research has focused on interventions to increase physical activity. These include contingency management for typically-developing adults (Donlin Washington, Banna, & Gibson, 2014; Kurti & Dallery, 2013), self-management treatment packages for typically-developing adults and children (Normand, 2008; Hustyi, Normand, & Larson, 2011; Hayes & Van Camp, 2015), exergaming for typically-developing children (Fogel, Miltenberger, Graves, & Koehler, 2010; Shayne, Fogel, Miltenberger, & Koehler, 2012), a modified Good Behavior Game for typically-developing children (Galbraith & Normand, 2017), token systems for adults with IDD (Krentz, Miltenberger, & Valbuena, 2016),

and a team-based physical activity program for children with IDD (Collins & Staples, 2017). Despite the positive outcomes found in these studies, these interventions tend to rely on arbitrary or generalized reinforcers instead of functional reinforcers to promote or maintain physical activity levels. As noted by Iwata et al. (1994), function-based interventions are more likely to be effective than interventions that are not derived from behavioral functions. The current best practice for determining the function of a behavior is the functional analysis (FA), as developed by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994). Although multiple variations of FAs have been developed, many procedures include test conditions for maintenance by attention, tangible items, escape from aversive stimuli, and automatic reinforcement. These conditions are often alternated along with a control condition in a multielement design until a function can be determined by visual inspection.

Although FAs are most often conducted to assess problem behavior, FAs have also been used to identify the function(s) of appropriate behavior, including physical activity. The first of the physical activity FAs was initially investigated by Larson, Normand, Morley, and Miller with two preschool children in 2013. In accordance with the DHHS guidelines, the authors chose to focus on MVPA as the primary dependent variable. Larson and colleagues used a 5-point observational rating scale to determine the physical activity levels of the subjects, with MVPA defined as a level 4 or 5 on the scale and generally consisting of running, jumping, or climbing. Though observers recorded the occurrence of all levels of activity, these data were converted to 1-s intervals and presented as percentage of intervals in which MVPA occurred (i.e., 1-s partial-interval recording). This observational method is thorough yet labor-intensive, with a heavy observer burden limiting its utility for practitioners wishing to assess an individual's physical activity in the natural environment.

MVPA levels were assessed during verbal attention, adult interaction, escape from task demands, alone, control, and naturalistic baseline conditions. These conditions were similar to those conducted in a problem behavior FA except each of the tested reinforcers was delivered contingent on MVPA instead of problem behavior. In the verbal attention condition, descriptive praise and eye contact were provided approximately every 10 s during periods of MVPA. In the adult interaction condition, the researcher engaged in the activity with the subject for the duration of the MVPA, as well as providing descriptive praise every 10 s during MVPA. In the escape condition, the researcher prompted the child through a worksheet while sitting at a table on the playground and terminated the demands for 30 s if MVPA occurred. As a test for automatic reinforcement, the subject was allowed to play on the playground with the researcher out of sight and no other people present during the alone condition. In the control condition, the researcher and subject sat together at a picnic table on the playground and colored, and the researcher provided descriptive praise every 30 s and stayed within 3 m of the subject at all times. The naturalistic baseline condition, conducted for three sessions before and three sessions after the multielement FA, involved observing the subject during their normal playground time with peers with no programmed consequences. For both subjects, the authors found the highest levels of MVPA occurred during the verbal attention and adult interaction conditions, indicating that both verbal praise from adults and interactive play with adults maintained the highest levels of MVPA for these subjects.

Larson, Normand, Morley, and Miller (2014) expanded on this approach by conducting similar procedures with four additional preschool children. The authors embedded the functional analysis within a reversal design to assess the extent to which the maintaining consequence identified in the FA would increase MVPA in the natural setting. The authors used the same

observational rating system and 1-s partial-interval recording method as the previous study. The procedure began with a naturalistic baseline, followed by a multielement functional analysis. Then, a single-session reversal to baseline conditions was conducted, followed by a return to the condition under which the most MVPA occurred for three sessions. For all four subjects, the highest level of MVPA occurred during the adult interaction condition, although there were also elevated levels of MVPA observed in the verbal attention condition relative to the control for two of the subjects (Grace and Gretta). The authors concluded that adult interaction increased MVPA in the treatment evaluation, however, elevated levels of MVPA were observed in second baseline for two of the four participants (Greta and Vivien). This increase may be attributable to variability, but the short duration of the reversal (i.e., a single data point) makes it difficult to make this determination. Thus, the effectiveness of functional reinforcers for physical activity in treatment contexts could benefit from a more rigorous demonstration of experimental control (i.e., a longer reversal-to-baseline condition).

Zerger, Normand, Boga, and Patel (2016) further investigated the potential for the maintaining variable of MVPA as determined by the FA to function as an effective reinforcer for increasing MVPA. The authors conducted a functional analysis of MVPA followed by an intervention analysis with seven preschool children. The authors omitted the escape condition from the functional analysis, but otherwise used the same conditions used in the previously discussed studies. It was found that MVPA was maintained by verbal attention for two subjects, interactive play for one subject, both verbal attention and interactive play for two subjects, and results were undifferentiated for two subjects. The authors then compared contingent and noncontingent delivery of the functional reinforcer and found moderately higher levels of MVPA when reinforcement was delivered contingent on MVPA as opposed to noncontingently. This

suggests that contingent delivery of the maintaining reinforcer is the most effective way to increase physical activity.

Taken together, the emerging FA of physical activity literature suggests the prevalence of some form of adult attention as a functional reinforcer for MVPA. For 11 of the 13 subjects in the three aforementioned studies, MVPA was maintained by verbal attention, interactive play, or both. However, all three studies were conducted with typically-developing preschool children. It is unknown if these findings would generalize to other populations, specifically children with intellectual and developmental disabilities. Prior research has demonstrated different effects of attention stimuli for typically-developing children and children with ASD (e.g., Dube, Macdonald, Mansfield, Holcomb, & Ahearn, 2004); thus, it is reasonable to assume that these reinforcers may function differently in the context of physical activity as well.

If verbal attention or interactive play do not serve as functional reinforcers for physical activity for some individuals (regardless of population), there is a question of what other consequences might maintain this behavior. Tangible items are often included in FAs as potential functional reinforcers; however, delivery of tangible items during an FA of physical activity might interfere with the ongoing physical activity. Thus, other reinforcers that may be effective for increasing physical activity would likely need to be other forms of auditory or visual stimuli that do not interfere with the activity. One possible such stimulus is music. Nakamura, Pereira, Papini, Nakamura, & Kokubun (2010) demonstrated that physical activity performance was greater when subjects were listening to preferred music, as opposed to non-preferred music or no music. This finding illustrates the potential for preferred music to function as a reinforcer for physical activity.

All of the aforementioned physical activity FA studies focused specifically on MVPA as a dependent variable, instead of physical activity in general. Although the Physical Activity Guidelines specifically recommend 6o min of MVPA (U.S Department of Health and Human Services, 2018), this may be unrealistic or unsafe for children with motor impairments. Furthermore, any increase in general physical activity level may lead to health benefits (U.S Department of Health and Human Services, 2018), so it may be beneficial to understand the conditions that evoke even less vigorous physical activity. One way to capture small variations in physical activity may be to use a device-based measurement method, such as a pedometer. Pedometers are an objective measurement approach that may allow experimenters to capture a wide range of physical activity, with reduced observer burden relative to the rating-scale approach employed by previous studies.

The purpose of this study was to conduct a partial replication and extension of Larson et al. (2014) with children of a variety of ages with IDD. Physical activity was analyzed as a rate measure using a pedometer, and the effectiveness of the identified functional reinforcer was evaluated. Furthermore, the functional analysis included a music condition to assess the effects of preferred auditory stimuli on physical activity.

Method

Subjects

Subjects were two children recruited from a local clinic providing behavior analytic and academic services. Jean was an 8-year-old female with a diagnosis of Autism Spectrum Disorder and a speech language delay. She had no reported motor impairments. At the start of the study she was approximately 1.27 m tall and 30.84 kg, according to parental report. Molly was a 10-year-old female with a diagnosis of MECP2-Related Disorder. Molly had also been diagnosed

with Dyspraxia and Hypotonia, and wore Supra-Malleolar Orthosis on both feet to assist with her motor impairments. At the start of the study she was approximately 1.40 m tall and 52.16 kg, according to parental report. Both subjects communicated vocally using full sentences and had picture-to-object and object-to-picture matching repertoires, as reported by their teachers. A third subject (male, 10 years old) completed the preference assessments and baseline sessions, but did not assent to further sessions and was excluded from the study.

Setting and Materials

All sessions were conducted on the playground of the clinic, a fenced-in area measuring approximately 14 m by 14 m with an outcropping measuring approximately 12 m by 3 m. Playground equipment included a play structure with an elevated "treehouse," stairs, a rock wall, a rope ladder, a slide, three swings, and a tire swing; an "airplane" see-saw with seven seats; a hopscotch area; a multi-hoop basketball hoop with various balls; and a chalkboard wall with chalk. A beach blanket measuring approximately .89 m by 1.86 m was also on the playground for every functional analysis session. The blanket was primarily used to provide the subject and researcher a place to sit during the control condition, but was present in all sessions to control for the availability of non-physical activity options across conditions. Additional materials included a 3DTriSport pedometer, a phone and speaker for playing music in the music condition, 7.8 cm by 7.3 cm pictures of YouTube thumbnails of songs with the song title listed below for the preference assessment, various toys, a timer, stopwatches, colored t-shirts for each functional analysis condition, clipboards, pens, and data sheets.

Response Measurement, Interobserver Agreement, and Treatment Integrity

Physical activity was measured as steps per minute as recorded by a pedometer worn on the subject's shoe. Prior to the start of the study, the validity of the pedometer was assessed by

attaching the pedometer to a researcher's shoe, counting the steps taken during a variety of activities (e.g., walking, running, swinging, climbing), and comparing the observed count to the step count on the pedometer. The overall mean accuracy of the pedometer was found to be 90.5%. Because the pedometer appeared to overestimate physical activity during swinging and see-saw activities, the researcher also measured the duration of swinging and see-saw use in each session using the Countee app. Immediately prior to the start of each block of sessions, the researcher clipped the pedometer onto the laces or strap of the subject's shoe. The number of steps was recorded and the pedometer was reset after each session, but the pedometer remained on the subject's shoe until the end of the session block. Session duration was be measured using a stopwatch, starting the moment the researcher stopped touching the pedometer attached to the child's shoe and ending the moment the researcher touched the pedometer at the end of the session For the purpose of implementing session contingencies (described below) and the duration measures, physical activity was operationally defined as translocation of the subject's feet, resulting in the subject's body moving at least 1 ft from its previous position. Examples included but were not limited to walking, running, hop scotch, climbing, and swinging while pumping the legs.

Interobserver agreement (IOA) was assessed for 37.2% of sessions. A second observer independently recorded the number of steps displayed on the pedometer after each session. The second observer also independently timed the duration of the session using a second stopwatch. IOA was calculated using total count IOA for number of steps and duration of the session in seconds. Step count IOA was 99.7% (range, 90.6% to 100%), and session duration IOA was 98.8% (range, 94.5% to 100%). To assess the reliability of the independent variables, a second observer assessed the researcher's implementation of the data collection methods and delivery of

the target antecedents and consequences (data sheets in appendix). Treatment integrity data was collected for 34.0% of sessions and was 100% for all assessed sessions.

Procedure

The general procedure was adapted from Larson et al. (2014). A multielement design (FA) embedded in a reversal design (intervention analysis) was used to demonstrate experimental control. A demographic survey to confirm the subject's age, height, weight, and diagnosis was sent to parents who returned signed informed consent forms. Preference assessments were then conducted to select toys and songs for use in the functional analysis. Next, a naturalistic baseline condition was conducted, followed by a functional analysis. Upon conclusion of the functional analysis, a return to baseline was conducted for both subjects, followed by a treatment phase for Jean. Each session lasted approximately 5 min, with one to four sessions conducted per day.

Prior to each block of sessions, verbal assent was gained by asking each subject if they would like to go play. If the subject (a) refused to come with the researcher, (b) made negative statements, or (c) attempted to leave the session area, it would have been interpreted as a lack of assent and a session would not have been conducted. Both subjects assented prior to each session block, but in session 37 Molly requested to go back to her class and the session was immediately terminated. During all sessions, a minimum of two adults were present to ensure the safety of the subject. With the exception of the ignore condition, peers and other adults were sometimes present on the playground during sessions. Other adults were asked not to interact with the subject, and peer interactions were not intervened upon. If unsafe behavior occurred at any point during a session (e.g., elopement, unsafe climbing on playground equipment, aggression), the

researcher would have blocked the behavior, terminated the session, and terminated the subject's participation in the study. However, unsafe behavior never occurred.

Preference assessments. Two multiple stimulus without replacement (MSWO; DeLeon & Iwata, 1996) preference assessments were conducted, one with toys and one with songs. The song MSWO was based on a pictorial preference assessment procedure similar to Hoffmann, Brady, Paskins, and Sellers (2019). Items included in each preference assessment were selected based on parent, therapist, and/or teacher report. Five stimuli were used in each assessment. Prior to each assessment, the researcher provided the subject with 10 s of access to each stimulus. Then, each of the five stimuli (physical toys in the toy preference assessment or pictures of the YouTube thumbnail for each song in the song preference assessment) were placed in front of the subject and the subject was instructed to "pick one." Upon selecting a stimulus, the researcher provided 30 s of access to the selected toy or song. Then the stimulus was removed from the array, the remaining stimuli reshuffled, and the process repeated. Each subject selected a single stimulus at each presentation and instructions did not have to be repeated. Each preference assessment was conducted two times with the exception of Jean's song assessment which was conducted a third time due to large fluctuations in preferences between the first and second assessment. For Molly, a single paired-choice trial was conducted to break a tie for her second-highest preferred song.

Naturalistic baseline. The naturalistic baseline condition was conducted during the subject's typical playground time with their class. Their teachers and other students were present. The researcher attached the pedometer to the subject's shoe, and allowed the subject to play as they typically would without interaction from the researcher. After 5 min, the researcher reset or removed the pedometer and recorded the number of steps and the exact duration of the session.

Baseline was continued until stability was achieved as determined by visual inspection of the graph and a minimum of three sessions had been conducted.

Functional analysis. The functional analysis was based on the procedures developed by Iwata and colleagues (1982/1994). With the exception of the extended ignore conditions (described below) five conditions were semi-randomly alternated in a multielement design so that each condition was conducted before the cycle repeated and no condition occurred twice in a row. To increase the discriminability of the conditions, the researcher wore a different colored t-shirt in each condition, and every session of that type was conducted wearing the same colored t-shirt. The conditions assessed included verbal attention, adult interaction, music, ignore, and toy play. In Molly's functional analysis, a sixth condition was included that combined the consequences of the interaction and music conditions. These conditions were based on those used by Larson et al. (2014) with the following exceptions. First, the escape condition was omitted, because (a) low levels of physical activity were observed during escape conditions in previous studies, and (b) the reinforcement of physical activity with escape from task demands may inadvertently differentially reinforce elopement. Second, a music condition was included. Third, in the positive reinforcement test conditions (i.e., verbal attention, adult interaction, music, and music+interaction), a 3 s onset/offset criterion was used. The putative reinforcer was delivered once the subject took a minimum of three steps within 3 s, and terminated once 3 s passed in which the subject took fewer than three steps.

Verbal attention. The purpose of this condition was to test for maintenance by social positive reinforcement is the form of verbal praise from adults. Immediately prior to the start of the session, the researcher said to the subject, "If you move around and play, I'll watch you and talk to you." Contingent on physical activity, the researcher looked at the subject and provided

statements of praise or engaged in subject-led conversation. Visual attention was provided continuously. Verbal attention was provided with a maximum of 5 s between statements unless the subject was speaking in a conversation with the researcher. If physical activity was not occurring, the researcher angled away from the subject and pretended to be busy with paperwork while covertly watching the subject. If the subject attempted to recruit the researcher's attention, the researcher did not make eye contact and said, "I'm busy," to the first bid for attention and ignored all subsequent bids in the session.

Adult interaction. The purpose of this condition was to test for maintenance by social positive reinforcement in the form of interactive play with adults. Immediately prior to the start of the session, the researcher said to the subject, "If you move around and play, I'll play with you." Contingent on physical activity, the researcher played with the subject, engaging in the same activities in which the subject was engaging (e.g., climbing on the treehouse, playing tag). If physical activity was not occurring, the researcher left the area/equipment where the subject was and pretended to be busy with paperwork while covertly watching the subject. Regardless of whether or not physical activity was occurring, brief verbal attention was delivered on a variable time 30-s schedule in this condition, the music condition, and the combined (music+interaction) condition to control for the effects of adult attention across conditions.

Music. The purpose of this condition was to test for maintenance by social positive reinforcement in the form of access to music (i.e., access to tangibles). Immediately prior to the start of the session the researcher asked the subject to choose between their two highest preferred songs as determined by the preference assessment. The researcher then played 10 s of the selected song and said to the subject, "If you move around and play, we can listen to music." Contingent on physical activity, the researcher played the song through a speaker. If physical

activity was not occurring, the researcher paused the song until physical activity occurred. If physical activity continued for longer than the duration of the selected song, the researcher again asked the subject to choose between their two highest preferred songs during a scheduled delivery of attention and played the subject's selected song once the first song ended.

Music+Interaction. A combined interaction and music condition was included in Molly's second functional analysis to determine if the combination of the two conditions could be sufficient to serve as a treatment to increase Molly's physical activity. Immediately prior to the start of the session, the researcher asked the Molly choose between her two highest preferred songs as determined by the preference assessment. The researcher then played 10 s the selected song and said to the subject, "If you move around and play, I'll play with you and we can listen to music." Contingent on physical activity, the researcher played with Molly while playing the song through a speaker. If physical activity was not occurring, the researcher paused the song and left the area until physical activity occurred. If physical activity continued for longer than the duration of the selected song, the researcher again asked Molly to choose between her two highest preferred songs during a scheduled delivery of attention and played the selected song once the first song ended.

Ignore. The purpose of this condition was to test for maintenance by automatic reinforcement. This condition was conducted without any peers on the playground. Immediately prior to the start of the session, the researcher said to the subject, "I have some work to do, but you can play." The researcher angled away from the subject and pretend to be busy with paperwork while covertly watching the subject. The researcher ignored all bids for attention. For both subjects, an extended block of ignore sessions was conducted in which up to four ignore sessions were conducted back to back. Additional blocks were conducted on subsequent days.

Toy Play. The purpose of this condition was to control for the researcher's attention and interaction, as well as the presence of music. Prior to the start of the session, the researcher offered the subject a choice between the two highest preferred toys and two highest preferred songs for use in the session. Immediately prior to the start of the session, the researcher sat on the beach blanked and said to the subject, "Let's play with (name of toy)." The researcher then played preferred songs for the duration of the session. Near the end of the selected song, the researcher again asked the subject to choose between their two highest preferred songs to play next, and the selected song was played after the first song, but no other demands were given. The researcher provided continuous attention and responded to interactive play requests from the subject.

Intervention analysis. After the completion of the functional analysis, a second naturalistic baseline condition was conducted as described above. For Jean, once baseline stability was achieved (as determined by visual inspection of the graph), the condition in which the highest level of physical activity was observed in the functional analysis was implemented during the subject's typical playground time, first by the researcher, then by the subject's teacher. An intervention analysis was unable to be conducted for Molly due to lack of baseline stability.

Results

Preference assessment results for Jean are displayed in Figure 1. Her two highest preferred songs were "Try Everything" and "Pop See Ko." Her two highest preferred toys were a toy pizza kit and a coloring book with crayons. Molly's preference assessment results are displayed in Figure 2. Her two highest preferred songs were "Venus" and "Ex's and Oh's,"

which was selected over “Betty Boop” in a single choice tie breaker. Her two highest preferred toys were a talking Foofa doll and puppets.

Figure 3 shows Jean’s rate of physical activity across sessions. Baseline levels of physical activity for Jean were low at around 10 steps per min. During the functional analysis, high levels of physical activity were consistently observed in the interaction condition (approximately 50 steps per min), and an increasing trend occurred in the ignore condition. Physical activity levels in the Attention and Music conditions were variable. No physical activity occurred in the control condition. Based on the increasing trend in the ignore condition, an extended ignore condition was conducted, in which sessions were conducted in 4-session block(s), with the exception of the first session for Jean. In this instance a single session was conducted before the block was terminated due to weather conditions. Throughout the extended ignore condition, physical activity rates maintained stable and elevated at approximately 55 steps per min. For Jean, rate of physical activity was correlated to the percent of the session spent swinging (means of 2% in baseline, 8% in attention, 90% in interaction, 23% in music, 75% in ignore, and 0% in control), indicating that swinging was automatically reinforcing. Upon reversal to baseline, physical activity levels again dropped to approximately 10 steps per min. Because social contingencies in the baseline and extended ignore conditions were essentially identical, it was hypothesized that decreased access to swings (as a result of peers occupying all available swings) could account for the difference in physical activity in these two conditions. Thus, treatment for Jean consisted of ensuring a swing was available for her during playground time and providing a general prompt (e.g., “You can swing if you want.”). Higher levels of physical activity (around 55 steps per min) maintained when this treatment was implemented by the researcher in the treatment phase. Subsequently, the treatment was generalized to the teacher by providing verbal instructions and

modeling the session set up for the teacher. Training on consequence delivery was not required for Jean's treatment. During teacher-implemented treatment, physical activity remained at around 55 steps per minute.

Figure 2 shows Molly's rate of physical activity across sessions. Baseline levels of physical activity for Molly were low and variable at around 15 steps per min. During the functional analysis, physical activity levels remained at around 5 steps per min during the attention and music conditions. Physical activity was slightly higher in the interaction and ignore conditions at approximately 25 steps per min in the last two sessions of each of these conditions. No physical activity occurred during the control condition. Three blocks of extended ignore sessions were conducted. Physical activity exhibited an increasing trend in the first block, but decreased during the second and third blocks, indicating that physical activity was not maintained by automatic reinforcement. Additional functional analysis sessions were then conducted without the ignore condition. A music+interaction condition was included in this phase, as Molly's highest level of physical activity was seen in the interaction condition and she repeatedly manded for music during non-music conditions. This condition was not included to assess a combined function, but rather to assess a potential treatment package. Physical activity was variable in all test conditions with the highest rates of physical activity observed in the second and third interaction sessions (83 and 62 steps per minute, respectively). No physical activity occurred during the control condition; thus, Molly's functional analysis indicated an interaction function of physical activity. However, upon re-implementation of baseline, physical activity remained high and variable. At this point, Molly's participation in the study was terminated due to failure to demonstrate a reversal to baseline levels of the target behavior.

Discussion

Functional analyses of physical activity were conducted for two children diagnosed with IDD. For one subject, an automatic reinforcement function of physical activity was identified, and the treatment was effective in increasing physical activity even when implemented by a teacher in the generalization phase. For the other subject, an interaction function was identified, but a treatment analysis was unable to be conducted due to elevated responding in the second baseline phase. Thus, the present study partially replicated Larson and colleagues' 2014 study assessing functional reinforcers of physical activity in children and extended this line of research in several ways. Previous FAs of physical activity (Larson et al., 2013; Larson et al., 2014; Zerger et al., 2016) were all conducted with typically developing preschool children. This is the first known study to assess functional reinforcers for physical activity in older children and in children with IDD. Additionally, this study included a generalization component and, in Jean's case, successfully demonstrated that a function-based intervention for increasing physical activity (i.e., noncontingent access to preferred play equipment) could be generalized from the research setting to Jean's typical playground environment and teachers.

This study was also the first to assess a positive reinforcement condition other than adult interaction and attention. While prior studies (Larson et al., 2013; Larson et al., 2014; Zerger et al., 2016) only evaluated adult attention and adult interaction as forms of positive reinforcement, this study included preferred auditory stimuli. This condition was included because previous research (e.g., Nakamura et al., 2010) has demonstrated that access to preferred music can increase physical activity. Although a music function was not found for either subject, this study provides a framework to assess potential tangible reinforcers for use during intervention.

This study was also novel in that physical activity was measured using mechanical measurement (i.e., a pedometer), rather than the rating scale used in prior literature (Larson et al.,

2013; Larson et al., 2014; Zerger et al., 2016). Use of a pedometer enabled the FA to be conducted by a single individual. Without the pedometer, the procedures used in the present study would have required a) at least one other experimenter (i.e., one data collector and one individual to implement session contingencies), and/or b) video recording of sessions, which may be difficult when physical activity occurs over a large area or clients of behavior analytic services may be present. The present study, however, allowed the functional analysis to be conducted in a "one-to-one" format, similar to the subjects' typical therapy sessions (with the exception of sessions in which a second experimenter was required to collect IOA and treatment integrity data). The pedometer method might therefore make functional analyses of physical activity more accessible to practitioners by decreasing barriers to implementation of this assessment.

It is somewhat unclear the extent to which the observed changes in physical activity are comparable to changes in physical activity, and specifically MVPA, observed in prior research. This is due to both the change in the target behavior on which data was collected (overall physical activity vs MVPA), and the means by which those data were collected (pedometer vs observational recording system). Although pedometer validity data were collected, it is possible that the pedometer had some degree of measurement error. For example, the pedometer could have counted small non-step movements, such as jiggling a leg, as steps. Some degree of measurement error is expected with all forms of mechanical measurement. Unless a mechanical failure occurred partway through the study, such measurement error would likely be consistently distributed across conditions and therefore unlikely to affect the interpretation of the results. Future research could address this limitation by evaluating correspondence between mechanical (i.e., pedometer) and the observational measures of physical activity used in prior studies.

In Molly's case, an effective treatment was not able to be identified as experimental control was not demonstrated during the treatment evaluation. Although an interaction function was concluded following the FA, high and variable levels of physical activity occurred in the second baseline. This may be indicative of a potential automatic function of physical activity; however, an automatic function was ruled out based on the pattern of responding in the extended ignore phase. It is also possible that other extraneous variables (e.g., the presence of specific peers) may have led to the variability in responding, but it is unclear which of these may have been responsible for the observed behavior change.

Although an effective treatment was identified for Jean, it is unclear how socially significant this behavior change is. The mean increase in rate of steps from baseline to treatment was around 45 steps per minute, which equates to a total daily increase of 1,350 steps across the two 15-min playground times provided in a typical school day. One way to assess the meaningfulness of this behavior change would be to collect social validity data. Another method would be to compare pedometer data to observational data, as suggested above, to determine how the behavior change observed in the present study compares with that of previous studies. Even so, small changes in physical activity may have large cumulative effects. The U.S. Department of Health and Human Services (2018) notes that any increase in physical activity may lead to health benefits, so it is possible that this level of increase may be beneficial.

This was the first study to use an extended ignore condition to conclusively demonstrate the presence of an automatic reinforcement function of physical activity. Of the 13 subjects included in previous studies (Larson et al., 2013; Larson et al., 2014; Zerger et al., 2016), attention or interaction functions were found for 11 (84%) of subjects. For two of the subjects in Zerger et al. (2016), Debbie and Steve, physical activity remained relatively low and

undifferentiated across conditions. The authors did not conclude that this was indicative of an automatic function; nevertheless, this conclusion could have been strengthened by an extended ignore condition. The maintenance of high levels of physical activity in the extended ignore condition for Jean shows a conclusive automatic function for physical activity.

Further assessment of automatically reinforced physical activity is warranted. As previously discussed, this is the first known study to assess the function of physical activity in subjects with intellectual and developmental disabilities. Perhaps due to extending to this population, automatically reinforced physical activity was observed. Notably for Jean, physical activity levels were specifically tied to time spent swinging. It is possible that repetitive motor movements like swinging may be automatically reinforcing, especially in individuals with ASD for whom repetitive movement is a core symptom (American Psychiatric Association, 2013). Future research could further investigate this by assessing the functions of physical activity in children with a variety of intellectual and developmental disabilities (e.g., ASD, ADHD) to better understand automatically-reinforced physical activity and how functions may vary across populations.

Regardless of population, the present study provides evidence that functions of physical activity are likely idiosyncratic across subjects. More effective interventions for increasing physical activity can be developed by assessing functions for each individual subject and developing a function-based intervention. Future research must continue to refine assessment methods, and this study contributes to this goal. The use of the pedometer rather than observational methods with high observer burden may make this assessment methodology more accessible to practitioners wishing to assess and increase physical activity in clinical settings.

Through the use of similar methodology, more effective function-based treatments for increasing physical activity may be developed.

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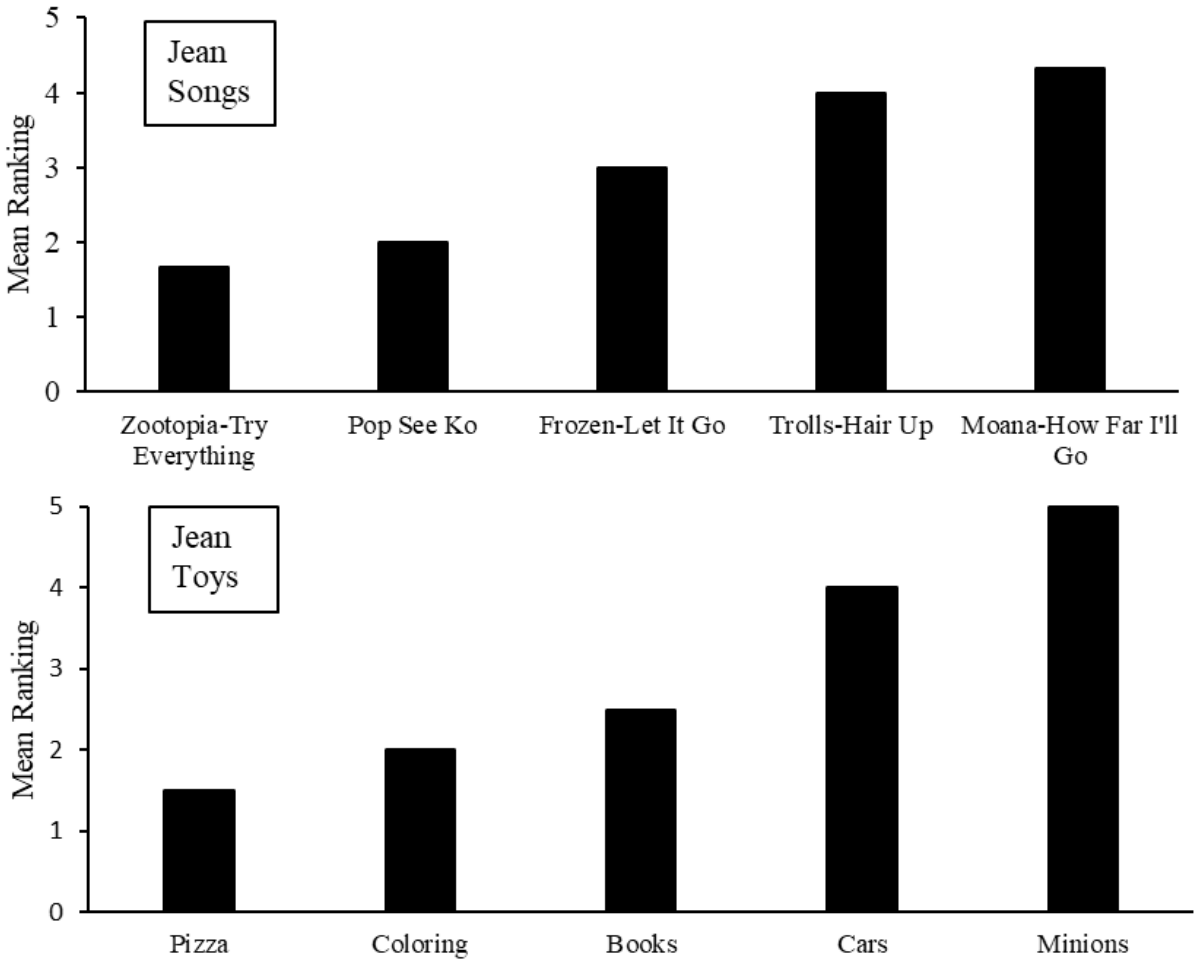

Figure 1. Preference assessment results for Jean for songs (top) and toys (bottom). Stimuli are listed in order of highest preferred to lowest preferred.

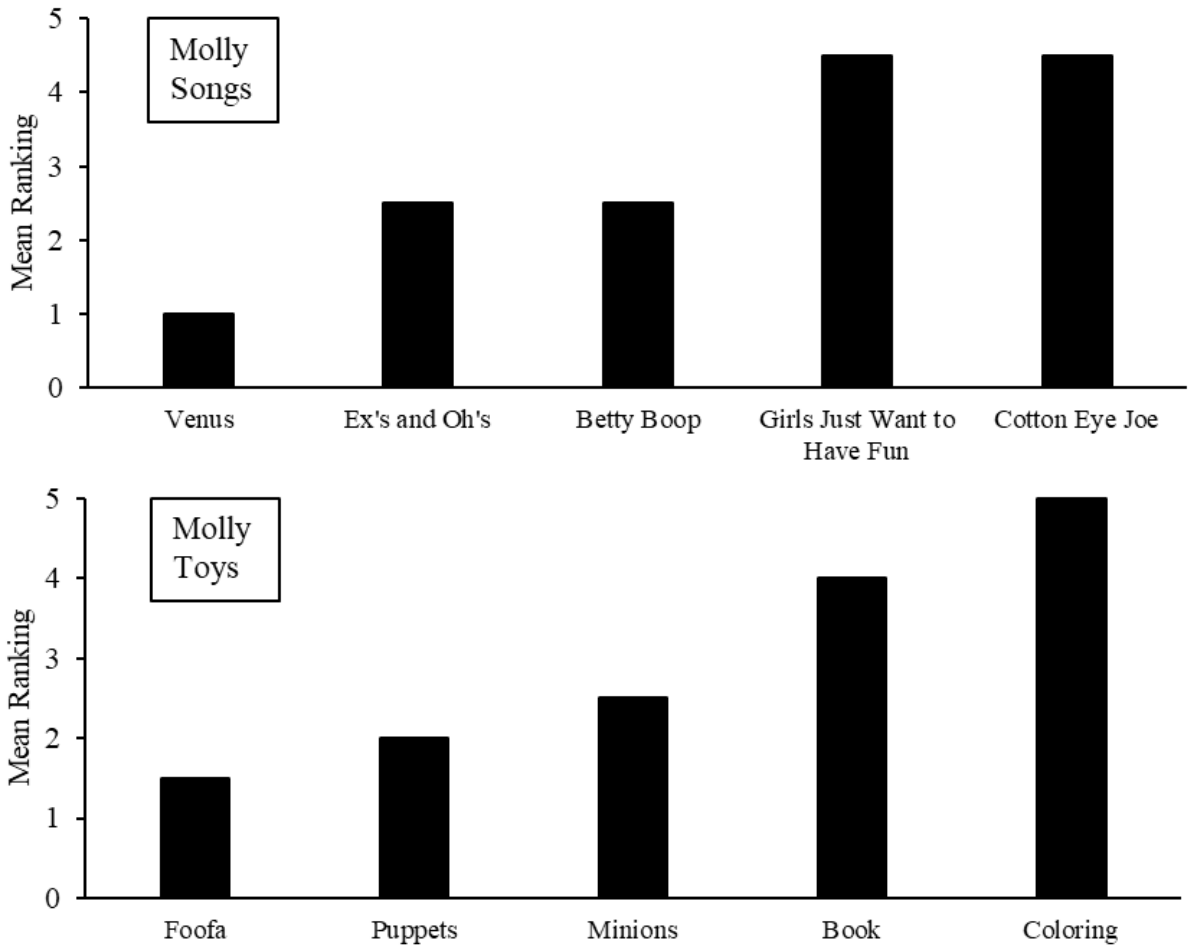

Figure 2. Preference assessment results for Molly for songs (top) and toys (bottom). Stimuli are listed in order of highest preferred to lowest preferred.

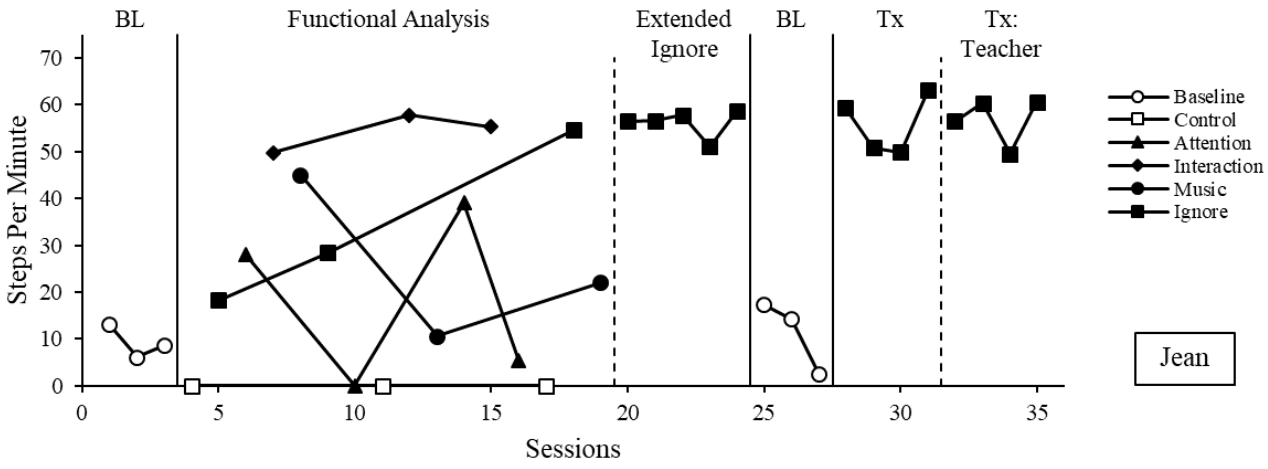

Figure 3. Results for Jean displaying steps per minute across sessions during baseline, the FA with extended ignore, a return to baseline, the implementation of the treatment by the researcher, and the implementation of the treatment by Jean's teacher.

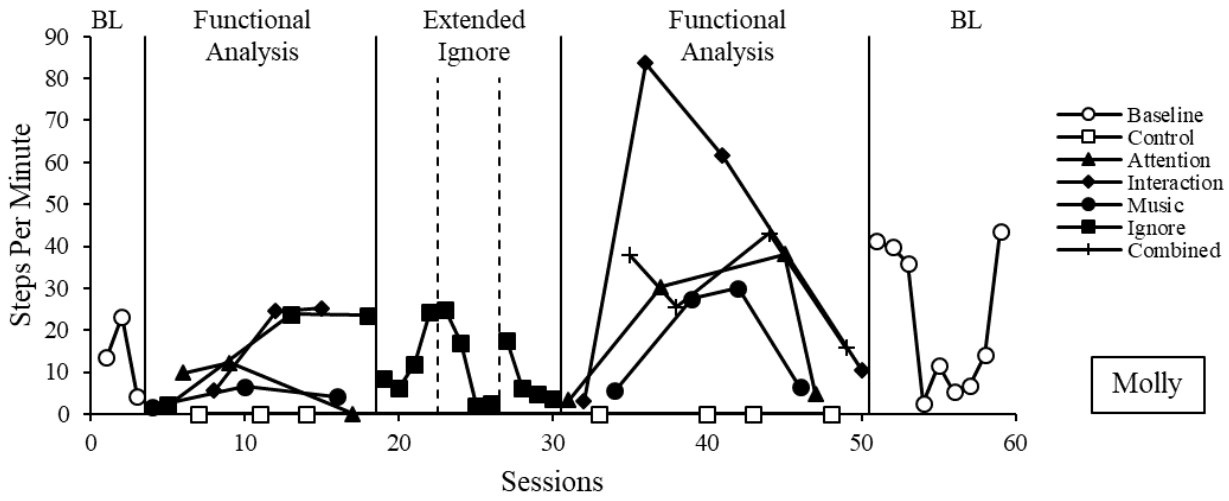

Figure 4. Results for Molly displaying steps per minute across sessions during baseline, FA, three extended ignore blocks, a second functional analysis, and a return to baseline.

Appendix: Treatment Integrity Data Sheets

Subject: _____

Session Date:_____ **Session Time:_____**

Therapist:_____ **Tx Int Assessor:_____**

Incorrect delivery = any form of attention or interaction with the subject with the exception of "I'm busy" or removing the pedometer

Baseline	**Yes**	**No**
Session takes place during subject's normal playground time		
Pedometer attached to subject's shoe with step count of 0		
Session duration timed with stopwatch & data recorded		
Pedometer removed at end of session & data recorded		

Incorrect Delivery of Antecedents/Consequences							
0:15	0:30	0:45	1:00	1:15	1:30	1:45	2:00
2:15	2:30	2:45	3:00	3:15	3:30	3:45	4:00
4:15	4:30	4:45	5:00				

Subject: _____

Session Date:_____ **Session Time:_____**

Therapist:_____ **Tx Int Assessor:_____**

Incorrect delivery = delivery of verbal attention (except "I'm busy") when subject is not engaging in PA or failure to deliver attention within 10 s of PA

Verbal Attention	**Yes**	**No**
Pedometer attached to subject's shoe with step count of 0		
Session duration timed with stopwatch & data recorded		
Pedometer removed at end of session & data recorded		

Incorrect Delivery of Antecedents/Consequences							
0:15	0:30	0:45	1:00	1:15	1:30	1:45	2:00
2:15	2:30	2:45	3:00	3:15	3:30	3:45	4:00
4:15	4:30	4:45	5:00				

Subject: _____

Session Date:_____ **Session Time:_____**

Therapist:_____ **Tx Int Assessor:_____**

Incorrect delivery = interacting with subject (except "I'm busy") when subject is not engaging in PA or failure to interact with subject within 10 s of PA

Adult Interaction	Yes	No
Pedometer attached to subject's shoe with step count of 0		
Session duration timed with stopwatch & data recorded		
Pedometer removed at end of session & data recorded		

Incorrect Delivery of Antecedents/Consequences

0:15	0:30	0:45	1:00	1:15	1:30	1:45	2:00
2:15	2:30	2:45	3:00	3:15	3:30	3:45	4:00
4:15	4:30	4:45	5:00				

Subject: _____

Session Date:_____ **Session Time:_____**

Therapist:_____ **Tx Int Assessor:_____**

Incorrect Delivery = delivery of music when client is not engaging in PA or failure to deliver music within 10 s of subject engaging in PA.

Music	Yes	No
Pedometer attached to subject's shoe with step count of 0		
Session duration timed with stopwatch & data recorded		
Pedometer removed at end of session & data recorded		

Incorrect Delivery of Antecedents/Consequences

0:15	0:30	0:45	1:00	1:15	1:30	1:45	2:00
2:15	2:30	2:45	3:00	3:15	3:30	3:45	4:00
4:15	4:30	4:45	5:00				

Subject: _____

Session Date:_____ **Session Time:_____**

Therapist:_____ **Tx Int Assessor:_____**

Incorrect delivery = any form of attention on interaction with the subject with the exception of "I'm busy" or removing the pedometer

Ignore	Yes	No
Pedometer attached to subject's shoe with step count of 0		
Session duration timed with stopwatch & data recorded		
Pedometer removed at end of session & data recorded		

Incorrect Delivery of Antecedents/Consequences

0:15	0:30	0:45	1:00	1:15	1:30	1:45	2:00
2:15	2:30	2:45	3:00	3:15	3:30	3:45	4:00
4:15	4:30	4:45	5:00				

Subject: _____

Session Date:_____ **Session Time:_____**

Therapist:_____ **Tx Int Assessor:_____**

Incorrect delivery = full 15 s interval passess without the delivery of attention, interaction, or music

Control	Yes	No
Prefered toy available near blanket at start of session		
Pedometer attached to subject's shoe with step count of 0		
Session duration timed with stopwatch & data recorded		
Pedometer removed at end of session & data recorded		

Incorrect Delivery of Antecedents/Consequences

0:15	0:30	0:45	1:00	1:15	1:30	1:45	2:00
2:15	2:30	2:45	3:00	3:15	3:30	3:45	4:00
4:15	4:30	4:45	5:00				