Increasing Treadmill Walking Duration of an Adolescent with Autism Spectrum Disorder
with Token Reinforcement

by

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Submitted in Partial Fulfillment of the Requirements

for the Degree of

Master of Science

in the

Applied Behavior Analysis

Program

YOUNGSTOWN STATE UNIVERSITY

May 2021

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Disorder Using Token Reinforcement

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Dr. Stephen Flora, Thesis Advisor   Date

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Dr. Salvatore A. Sanders, Dean of Graduate Studies   Date

ABSTRACT

Autism spectrum disorder (ASD) refers to a group of neurological disorders that can be characterized by repetitive behaviors and difficulties in social interaction and communication (NINDS, 2019). Children and adolescents with ASD have barriers such as social impairments and deficits in motor development and motor skills that can increase sedentary behaviors and limit the opportunities for them to engage in physical activities (McCoy, et al, 2020). Research on youth with autism and similar types of disorders find that these children often fall short of reaching physical activity guideline levels (Jones et al., 2017). Additionally, there is limited research about overweight and obesity prevalence in children and adolescents with autism. Therefore, the purpose of this study was to increase the treadmill walking duration using token reinforcement and a changing criterion design for an obese, sedentary adolescent with ASD. Results indicated the token economy demonstrated experimental control for the participant by increasing her duration of walking by 500%.

Contents

Increasing the Treadmill Walking Duration for an Adolescent with Autism Spectrum Disorder

Using Token Reinforcement

Autism spectrum disorder (ASD) refers to a group of neurological disorders that can be characterized by repetitive behaviors and difficulties in social interaction and communication (NINDS, 2019). These symptoms can occur in early childhood and can affect daily functioning. Children with ASD can exhibit repetitive behaviors, deficits in social and communication skills, and motor development delays (American Psychological Association, 2013). Some children and adults are fully able to perform activities of daily living while others require a great deal of support to perform basic activities. The latest analysis from the Centers and Disease Control Prevention estimates that 1 in every 68 children has ASD (NINDS, 2019). Autism is now recognized as the most common neurological disorder affecting children (Petrus et al, 2007). People with autism can be dependent on routines and are extremely sensitive to changes in their environment (Pastor et al, 2018).

Obesity in ASD population

Inactivity is often a concern for an individual with ASD because they may have fewer opportunities to participate in exercise and physical activity programs, exposing them to risk of developing other health problems (Pastor et al., 2018). Individuals with ASD have been shown to have delays in motor development as well as deficits in engagement of activities and decreased motivation to engage in physical activities (Pastor et al, 2018). Additionally, there is limited research on the prevalence of overweight and obesity in children and adolescents with autism, making this issue an increased public health concern (Presmanes et al, 2015). In a multisite clinical sample of 5053 children with ASD that identified variables as risk factors for unhealthy weight in the general population, Presmanes and colleagues (2016) found 33.6% of children with

ASD aged 2 to 17 years were overweight and 18% were obese. Results indicated that the prevalence of unhealthy weight is significantly greater among children with ASD compared with the general population. Many of the risk factors for unhealthy weight are most likely the same in children with ASD compared to their typical peers, but children and adolescents with autism can be vulnerable to additional risks (Presmanes et al, 2015). The consequences of obesity may not manifest immediately, but could lead to type 2 diabetes, hypertension, cardiovascular disease, gallbladder disease, postmenopausal breast cancer, colon and other cancers, and physical and mental disabilities (Presmanes et al, 2015).

Problematic eating behaviors such as food selectivity are also common among adolescents with autism, which can lead to preferences for a narrow range of low-nutrition foods and rejection of fruits, vegetables, and whole grains (Presmanes et al, 2015). The physical and psychosocial impairments in children with ASD likely contributes to their higher obesity prevalence (Srinivasan et al, 2014). Development of obesity in a child with autism negatively impacts their quality of life, increase the cost of management, and cause a greater burden to caregivers. Obesity among children with ASD may be particularly problematic because of its potential for further negative impact on limited social motivation or motivation to participate in structured physical activities with other children (Toscano et al, 2018).

Sedentary Behaviors

Physical inactivity is problematic for all children (McCoy et al, 2020). Increased physical inactivity and sedentary behaviors, such as TV/ iPad viewing time, has been associated with increased weight gain in children and adolescents (Sisson, et al. 2010). The American Academy of Pediatrics recommended that children and adolescents should limit their screen time to less than two hours per day (2001). In the US, only 37.2% of US children and adolescents (between

the ages of 2-19 years old) have met this recommendation (McCoy et al, 2020). Children and

adolescents with ASD may have barriers, such as social impairments and deficits in motor

development and motor skills, that further limits the opportunities to engage in physical activities

and promotes unhealthy increases in sedentary behaviors (McCoy et al, 2020). Many physical

activities, especially sports, require social interaction and turn taking which can be difficult for

children and adolescents with ASD (Pan and Frey, 2006). The preferred activities of children and

adolescents with ASD are usually solitary activities that require less physicality and involve

screen time (Memari et al, 2015).

Physical Activity

Physical activity is defined as a multi-dimensional construct that includes intensity,

mode, duration, and frequency (Todd & Reid, 2006). Identifying physical activity as a behavior

allows one to consider factors that can help to shape the behavior of physical activity to

encourage increased levels of physical activity. Physical activity is beneficial to people of all

ages, backgrounds, and abilities (U.S. Department of Health and Human Services, 2017), but is

often overlooked in people with disabilities, including those with ASD (Todd & Reid, 2006).

When compared to individuals without ASD, individuals with ASD are more likely to have

difficulties with postural stability, balance, gait, joint flexibility, and movement speed (Lang et

al, 2010). Moderate to vigorous physical activity may be especially beneficial to children with

ASD and has been shown to decrease rates of stereotypical and repetitive behaviors and improve

cognitive performance, self-regulation, classroom performance, attention and compliance and

social and emotional functioning (Sorenson & Zarrett, 2014). Adolescence (10-19 years of age)

has been recognized as a critical period of development which individuals can set behavioral

patterns which may last into adulthood which makes adolescence a critical intervention point for

physical activities change because there is documented increased rates of overweight and declines in physical activity during adolescence. (Sorenson & Zarrett, 2014).

Although physical exercise is included in many education curricula, it is not consistently or systematically encouraged for children with autism. Recent data suggests that adding exercise programs and other physical activities to intervention programs for children with ASD may be beneficial. Walking and running programs have been the most common modes of delivering physical activity interventions (Toscano et al, 2018). It is recommended that children and adolescents (between the ages of 6-17 years old) in the United States participate in 60 minutes or more of physical activity each day, which should include moderate-to- vigorous physical activity (MVPA). Given the aforementioned limitation, encouraging individuals with autism to be physically active for even thirty minutes may prove to be challenging (Todd & Reid, 2016).

Children with disabilities are less likely to engage in sustained and vigorous exercise compared to children without disabilities (Srinivasan et al, 2014). Subjective measurements reported by parents of children with ASD suggest that children and adolescents with ASD are less likely to participate in physical activity behaviors compared with their typically developing peers (McCoy et al, 2019). Using the *2011-2012 US National Survey of Children's Health,* McCoy, Jackicic and Gribbs (2016) found that children and adolescents (between the ages of 6-17) with ASD were less likely to engage in regular physical activity compared with their peers of typical development (McCoy et al., 2019). The same survey was used by Gillete et al, in 2015 and they found that adolescents (between the ages of 10-17) with ASD were statistically more likely than their developing peers to have 0 days per week when they engaged in at least 20 min of physical activity that made them sweat or breathe hard (Gillette et al, 2015). Using objective measurement of physical activity, Bandindi et al., (2013) found that typically developing

children and adolescents (between the ages of 3-11) accumulated more time spent on MVPA daily compared with children and adolescents with ASD, with only 23% of those with ASD engaging in the federal recommendations compared with 43% of those with typical development.

Token Reinforcement

Several studies have used token reinforcement to increase exercise for individuals with intellectual disabilities (Krentz et al., 2016). In 1989, Eisenman, Bennett, French, Henderson, and Schultz administered tokens later exchanged for back-up reinforcers for pedaling a set number of rotations on a stationary bike. Pedaling increased with the intervention and decreased when the token economy was withdrawn. Krentz et al, studied the effectiveness of a token economy system for increasing distance walked for adults with intellectual disabilities who attended an adult day-training center and found using a token-reinforcement system (consisting of tokens, praise, and back-up reinforcers) increased walking duration. The first token-reinforcement phase resulted in a noticeable increase in walking laps for four out of five participants. After the return to baseline phase, the laps decreased for all participants to levels at or below baseline. When token reinforcement was implemented again, all five participants increased their laps substantially. There was some overlap in data between phases, but the treatment effect was clear as experimental control was demonstrated with the replication of these effects with four out of five participants. The four participants reported that they would continue to walk after the intervention, but during the return to baseline their physical activity did not maintain in the absence of the token reinforcement. The results of the Krentz et al (2016) study was consistent with results from the Bennet et al (1989), Croce and Horvat (1992) and Todd and Reid (2006) studies which found that providing reinforcement contingent on exercising increases physical activity for individuals with intellectual disabilities (Krentz, et al, 2016).

Statement of the Problem

There is significant research available about the importance of physical activity for typically developing children and adolescents, but there is limited research about the importance of physical activity for their peers with ASD. There is also limited research about the effectiveness of token reinforcement to increase physical activity specifically for adolescents with ASD. Although several studies have shown that token reinforcement can increase physical activity in participants with disabilities, only two studies have demonstrated experimental control. Therefore the purpose of this study was to increase the treadmill walking duration of an adolescent with ASD using token reinforcement and changing criterion design.

Method

Participant and Setting

The participant was a 16-year-old female adolescent diagnosed with ASD identified by her physician as obese. The participant's lifestyle consisted of sedentary behaviors (e.g.- sitting on couch, watching iPad and drawing) and did not engage in any physical activities at home or at the clinic where she received therapy services. The participant received one-on-one therapy at an ABA clinic for thirty hours a week. The participant was chosen for this study because of her sedentary behaviors, lack of a physical activity intervention in her treatment plan, and for the parent's request for her to increase physical activity. The participant previously had walked on a treadmill as a regularly scheduled activity, but this had not occurred regularly over the past year. The intervention took place in a room located near the participant's therapy room where she received one-on-one ABA therapy at a clinic. The treadmill was the only item in the room during baseline, but a table and chair were added for the intervention phase for the participant to draw after walking on the treadmill.

Materials

A token board that was used for the intervention phase was the same one that the participant used during her daily discrete trial training. The token board had two parts: a first/then section where the client chose an activity to do after working from her choice board and four circles that were checked after the participant walked the set criterion time divided into four sections (see Figure 1). For example, if the set criterion time was four minutes, a circle was checked each minute after walking. There was a picture of the participant on the treadmill, and this was placed in the "first" section of the board. This token board was chosen as a way for the participant to gauge her progress and see how much time she had left. Other materials included a timer that was preset to the predetermined set criterion duration and paper and markers that were novel to the participant.

Preference Assessment

A multiple stimulus without replacement preference assessment was completed with the participant to identify effective reinforcers for the client to walk on the treadmill. The items in the preference assessment included: paper, the participant's iPad, activity books and sticker books. These are all items that the participant has shown interest in during her therapy. The preference assessment was completed on three separate occasions. The participant chose paper to draw first on every assessment, followed by her iPad, a sticker book, and an activity book. Drawing had been shown to be a reinforcing activity with the participant and the participant frequently chose it from her choice board during her regular therapy as well.

Experimental Design

A changing criterion design was used to judge the effectiveness of the token economy intervention to increase the duration of treadmill walking for the participant. Changing criterion

designs are appropriate for answering questions about the effects of a single intervention or

independent variable on one or more of the dependent variables (Byiers et al, 2012). The

changing criterion design consisted of an initial baseline phase followed by a series of treatment

phases that consisted of gradually changing the criteria required for reinforcement. This design

was chosen for this participant so the duration of walking could be increased gradually and

demonstrate experimental control.

Baseline

Baseline data was collected for two sessions per day for a morning and afternoon session

for three consecutive days. The treadmill and a timer were the only items present in the room for

the baseline phases. The investigator did not provide any praise or prompts during the baseline

phases and the token reinforcement was not provided to the participant. Total duration walked

was collected per session to determine a starting criterion time.

Intervention

The participant and the investigator met in the room where the treadmill was located. A

table and chair, markers, paper, and the token economy board were present in the room during

the intervention phase. The speed on the treadmill could be set at speeds of 1 to 6 and was set at

level two for the entire intervention. There were two intervention sessions completed each day: a

morning and afternoon session. The set criterion time was divided up into four equal increments

of time (e.g. a minute was divided up into four 15s increments) and the timer was set for each

designated second increment. When the timer beeped after the set criterion increment time, a

checkmark was placed in a circle on the token board and the timer was reset for the next

increment. The experimenter showed the participant that a circle was checked and let her know

how many circles she had left on the board to receive reinforcement. The experimenter held up

the paper and markers as a visual for what she was walking for. The experimenter also delivered

prompts and praise during the intervention phase. Praise statements included "You're going to

walk for paper", "great job walking", "I'm so proud of how you are walking" and "keep going".

When the participant met the set criterion level, the participant was told "we are all done

walking-great job!", and paper and markers were made available. The participant was free to

shut off the treadmill at any time while she was walking. If the participant stopped the treadmill,

the session ended, and she returned to her regular therapy room without drawing. If the

participant met the set criterion level, she was able to draw one picture with no set time limit

with the markers that were only available in the intervention room. The experimenter continued

to deliver praise to the participant when she was drawing. Once the participant met the set

criterion for two consecutive session, the next criterion level increased by 15 seconds. If the

participant did not meet the set criterion time for two consecutive sessions, the time would stay

at the same level until she reached the criterion level for two consecutive sessions. If the

participant became ill or displayed problematic behavior, the session ended, and the client left

the room without receiving any reinforcement.

Due to an increase of problem behavior while the participant was walking on the

treadmill, an additional antecedent intervention was added while walking occurred. Previously,

the participant had shown interest in looking at/gazing at pictures she drew after finishing them.

Therefore, the participant was allowed to tape pictures on the wall after drawing them that were

visible during walking. The pictures then served as preferred stimulus that functioned as a

reinforcer for walking. The intervention room at the end of the intervention is shown in figure 2.

Interobserver Agreement

Interobserver agreement (IOA) data was collected with a fellow graduate student and 2 Board Certified Behavior Analysts (BCBA) on site during the intervention. Data was either collected with in-person observation of the participant walking on the treadmill or with a permanent product of a video of the participant walking on the treadmill. For the in-person observation, the duration of time walked was taken from the digital readout on the treadmill and was documented by both observers. For the videotaped sessions, the second observer noted the time recorded on the treadmill at the end of the video. IOA data for the intervention was 100%.

<p align="center">**Results**</p>

In baseline, the client walked 39s, 65s, 60s, 48s and 70s. An average of the six sessions in baseline was taken to determine the starting criterion level and a starting criterion of 60s was established. After the start of the intervention, the client's duration of walking met the initial first criterion change in three session. In the next criterion, problem behavior occurred but the client met the requirement after 4 sessions. At this point, the antecedent intervention in which pictures were added to the room occurred. After this, the client only had one episode of problem behavior with the antecedent intervention in place. The client reached her set criterion time for most sessions within two consecutive sessions.

The criterion walking levels, and the results of the study are presented in Figure 3. The ending criterion time of 6 miuntes and 15 was used in this study as an ending point due cardiovascular limits of the participant's current health status.

After the 71st intervention session, the participant began to request walking on the treadmill during her discrete trial training as her reinforcement form her token board. The treadmill walking card was left on the back of her first/then board during therapy and the

participant chose it as her reinforcement for learning. After session 79, a withdrawal of the

intervention occurred to increase internal validity and examine whether or not the intervention

was responsible for the changes in walking duration. During this time, the participant would look

at the table where the token board was placed in the intervention phase, and then stop the

treadmill when the token board was not present. Without the token board, the participant's

duration of walking immediately returned to levels lower than baseline of 40s, 41s, 32s and 38s.

A fourteen day follow up probe was completed with the participant. In the fourteen day follow

up probes, the participant walked for three sessions of seven minutes each. This accumulated

time of twenty-one minutes is close to the parent requested daily walking duration for the

participant. A treadmill walking intervention was added to her daily therapy after the

intervention ended.

Discussion

The primary purpose of this study was to determine the efficacy of a token reinforcement

intervention to increase the walking duration on a treadmill for an adolescent with autism. A

changing criterion design was used to gradually increase requirements for receiving

reinforcement and demonstrate experimental control. This study resulted in a meaningful 500%

increase in the participant's duration of walking on the treadmill. A return to baseline phase

demonstrated that the intervention itself was responsible for the increases in the duration of

walking. The intervention appeared to be socially valid as indicated by the participants requests

to engage in walking during free time and duration of walking during follow up.

Results of this study are similar to previous research. In a similar study, Pitetti et al.,

(2006) performed a 9-month treadmill walking program for ten adolescents with autism living in

a residential treatment facility. Even though there were several differences in methodology

between these studies, such as number of participants and length of study, they both showed a

significant increase of the duration of walking on the treadmill for the participants. The Pitetti et

al study also used a progression in frequency while walking on the treadmill. The current study

similarly demonstrated the that the token economy reinforcement was effective to increase the

participant's duration of walking on the treadmill. When the token economy was removed in

follow-up probes, the participant would stop the treadmill in less time than was found in

baseline, demonstrating experimental control.

The results of this study are also consistent with the findings from the Krentz et al study

(2016) indicating that using token reinforcement contingent on increasing walking increased the

duration of walking for an individual with a disability. The participants in the Krentz et al study

also decreased their walking laps in their return to baseline without the use of the token

reinforcement. Taken with previous research, results from this study demonstrate that

reinforcement contingencies are often necessary to maintain physical activity duration for

individuals with developmental disabilities.

Limitations and Directions for Future Research

A limitation of this study was the time involved to implement the intervention. The

participant's mother had requested a 30-minute per day goal for the treadmill walking program.

Due to restrictions in time for the study and the scheduling conflicts of the experimenter, this

was not feasible in the allotted time for the intervention. Instead the changing criterion was used

to gradually increase the walking time for the participant and gradually increased the time by 15

seconds after two consecutive sessions of reaching criterion time. Before the intervention, the

participant did not have a physical activity intervention in place at the clinic where she receives

services but since the intervention a treadmill walking program has been added to her daily ABA therapy.

The token economy reinforcement was shown to be an effective and easy to implement intervention to increase the participant's duration of walking. Token economies are commonly used in ABA facilities for working on academic or developmental skill building, but also have the potential to be used in various contexts such as during large motor activities and physical activity interventions. Future research should examine whether or not this intervention can be used with other individuals with and without disabilities to increase physical activity.

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Figure 1

Token Economy Used in the Current Study
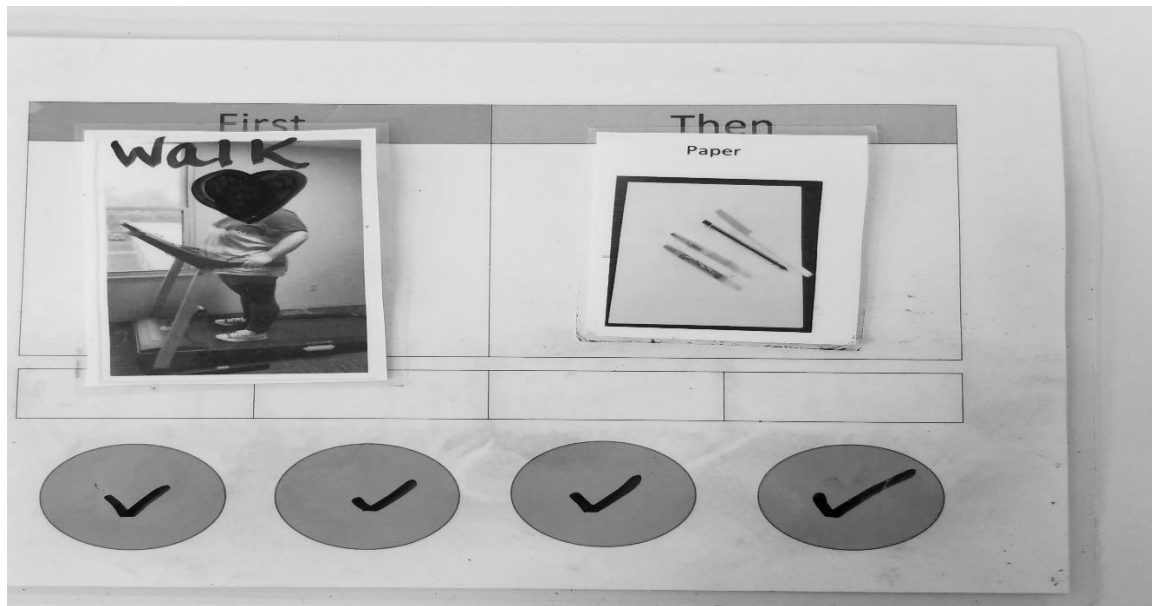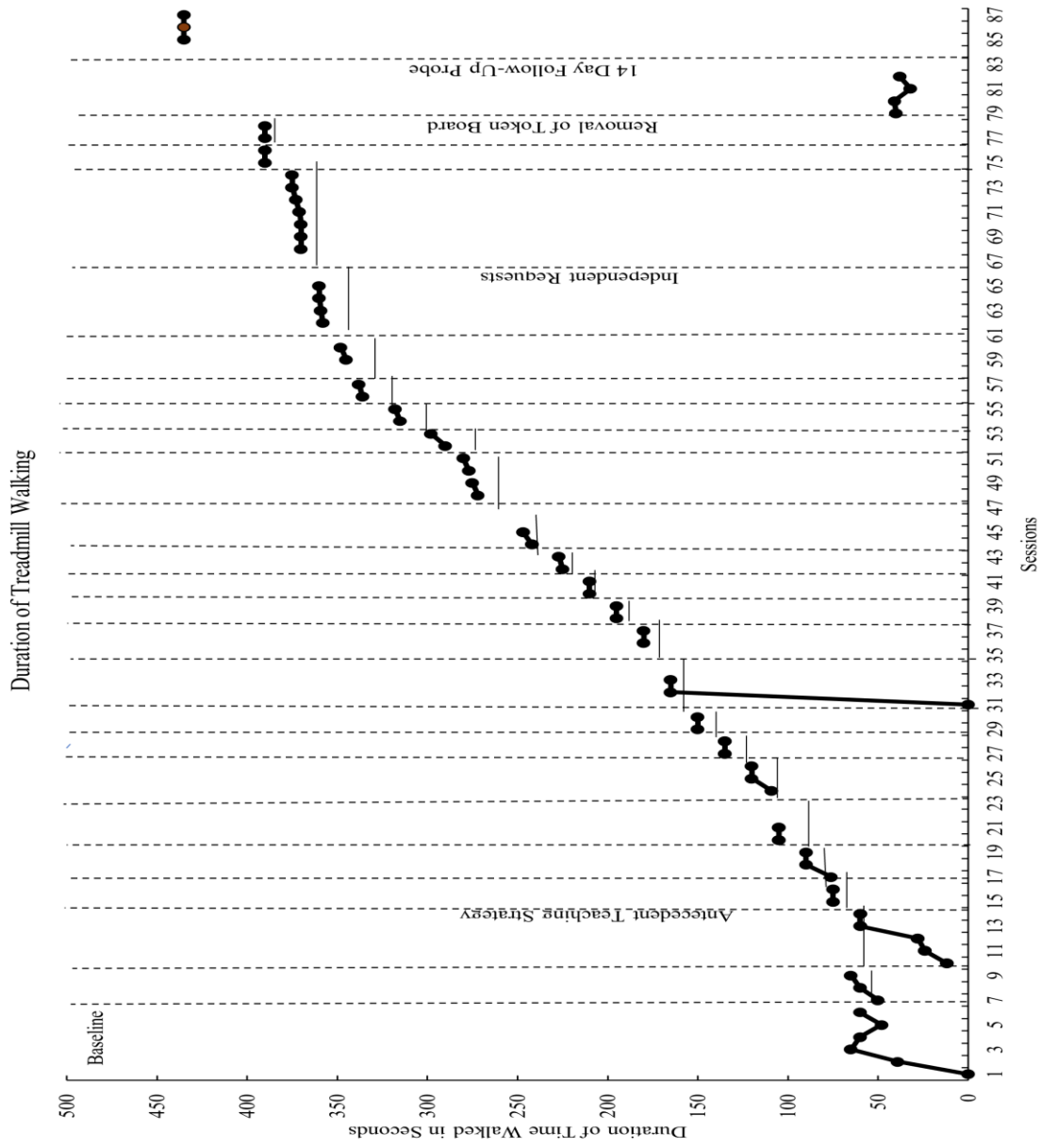

Figure 2

Setting in Which the Intervention Took Place

Figure 3

Duration of Walking in All Phases of the Current Study

APPENDIX I

From: Karen H Larwin <khlarwin@ysu.edu>
Sent: Wednesday, November 18, 2020 9:12 AM
To: Stephen R Flora <srflora@ysu.edu>; Christina M Cole <cmcole02@student.ysu.edu>
Cc: ckcoy@ysu.edu <ckcoy@ysu.edu>
Subject: Re: Christina Cole Thesis Paperwork #045-21 (ltr)

Dear Investigators,

Your protocol entitled Increasing Treadmill Walking Distance for Adolescent with Autism Spectrum Disorder Using Token Reinforcement and Changing Criterion Design has been reviewed and is deemed to meet the criteria of an expedited protocol. You will be working with on student who has autism to assess if a token reinforcement will encourage the student to spend more time walking on the tread mill. The student is already using the treadmill as part of her daily educational plan six days every week. This token activity will take place during three treadmill sessions. The parent will provide consent; the student must supply assent.

Your project is approved. This protocol meets the expectations of an expedited study, category 7. You may begin the investigation immediately. Please note that it is the responsibility of the principal investigator to report immediately to the YSU IRB any deviations from the protocol and/or any adverse events that occur. Please reference your protocol number 045-21 in all correspondence about the research associated with this protocol.

Good luck with your research.
Karen

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