

SELF-DETERMINATION THEORY AND EXERCISE PERFORMANCE FOR
INDIVIDUALS WITH AUTISM.

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A Thesis Presented to

The Faculty of California State Polytechnic University, Humboldt

In Partial Fulfillment of the Requirements for the Degree

Master of Science in Kinesiology

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July 2023

ABSTRACT

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Individuals with Autism Spectrum Disorder (ASD) tend to demonstrate low levels of physical activity and exercise when compared to their developing peers. Low physical activity levels are associated with multiple factors, including lack of understanding of how to perform exercise movements and low intrinsic motivation. Token economy reward systems have shown to be practical in behavior analysis for changing behaviors however, there is limited research on the effects of token economy reward systems in an exercise setting. The purpose of this study was to determine the impact of a token economy board combined with self-determination theory (SDT) on the exercise performance of two individuals with ASD. Methods: Two participants with ASD between the ages of 13 and 17 were enrolled in a 6-week weight-lifting exercise program. Participants' muscular endurance was measured using the DXP Deluxe Chest Press Machine and the Leg Extension Machine, following the pre-established Holten Curve formula, and cardiovascular endurance was monitored using the IHT Spirit Classroom Reader heart monitors. A token-economy board was used to indicate the number of repetitions completed. A single case changing-criterion design was used to guide data collection by obtaining initial baseline observations on target behaviors and

implementing stepwise changes in target behaviors during each treatment phase. Both participants successfully completed each established exercise goal during each criterion phase and showed a marked improvement in muscular endurance when compared to baseline. Results suggest a positive association between participants' completion of established exercise goals and the implementation of SDT.

ACKNOWLEDGEMENTS

I would like to thank my committee members who provided guidance throughout my graduate studies and the writing of this thesis. I would like to thank Dr. David Adams for his continuous support and expertise. His constant feedback and guidance have impacted my academic writing and development as a researcher. Each of you have provided me with an invaluable opportunity to learn and grow in this field and contribute as a member of the Kinesiology Department at California Polytechnic State University, Humboldt. I would also like to thank my research partners, Nicholas Velazquez and Ruben Diaz, for their contributions and collaboration.

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INTRODUCTION

The National Center for Educational Statistics (2022) reported that 63 percent or more of students with disabilities complete 80 percent or more of their classwork within the general education setting. For teachers working with students with disabilities, there is a strong need to understand specific evidence-based practices (EBP) that can support each of their students' needs (Wong et al., 2015). Autism spectrum disorder (ASD) is a developmental disability caused by differences in the brain that may cause people to interact, behave, communicate, and learn in different ways (e.g., visual supports) from most people (Centers for Disease Control and Prevention, 2022). Researchers have reported that individuals demonstrate low levels of physical activity and exercise when compared to their typically developing peers (Hartman et al., 2015; Melville et al., 2018; Nichols et al., 2019; Pitetti et al., 2007; Stanish et al., 2017). These low levels of exercise may be due to existing barriers, such as parent perception (Nichols et al., 2019), transportation (Sherman and Sherman 2013), exclusion or lack of peers to exercise with (Nichols et al., 2019), as well as a lack of understanding of how to perform the exercise movements (Nichols et al., 2019). Exercise is a form of structured physical activity consisting of repetitive body movements to maintain or improve one or more components of physical fitness (CDC, 2017; World Health Organization, 2022). For individuals with ASD, exercise is an established EBP that has improved the performances in a variety of areas, such as improved physical fitness levels (Chanias et al., 1998), academic engagement (Kern et al., 1982), skill acquisition (Lang et al., 2010) and decreasing

challenging behaviors (Pan et al., 2022; Celiberti et al., 1997, Dillon et al., 2017; National Professional Development Center on ASD, 2017; Oriel et al., 201; Pan, 2011). While exercise is considered a valuable EBP, educators are still tasked with motivating students to participate in activities and ensuring students understand the requirements. The token economy board is a reward system that includes visual representations of progress to promote a desired behavioral outcome (Diamond et al., 2016; Pan et al., 2022).

Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a neurological and developmental disorder affecting social communication, interaction, and repetitive behaviors (Aksoy, 2018, Brodski-Guerniero et al., 2018, Ferreira et al., 2018). ASD is categorized into three separate categories: level one, “Requiring support,” level two, “Requiring substantial support,” and level three, “Requiring very substantial support” (Aksoy, 2018). According to the National Center for Educational Statistics (2022), 7.2 million or 15 percent of all public-school students ages 3 to 21 received special education services under the Individuals with Disabilities Education Act (IDEA) from 2020 to 2021.

Within the k-12 grade levels, ASD is one of the leading disabilities serviced by special educators and accounts for 12 percent of students served under the IDEA (National Center for Educational Statistics, 2022). The rise in the prevalence of students with ASD in public schools has resulted in an increased focus on teacher training for students on the autism spectrum (Morrier et al., 2011). Teacher training and support need

to incorporate multiple approaches and emphasize strong EBPs to ensure success for students with ASD (Morrier et al., 2011). Established and effective strategies and EBPs for students with ASD include positive behavior reinforcement, visual supports, and self-monitoring (Odom et al., 2003).

US Physical activity-based programs became a priority after ASD was declared a national health emergency by Congress in 2002 due to increases in the amount of annual ASD cases (Autism Society of America, 2002). Due to existing barriers, individuals with ASD often experience difficulty participating in regular physical activity or exercise (Lang et al., 2010; Todd et al., 2019; Todd, n.d.). Physical exercise has shown increased physical fitness levels in individuals with ASD (Lang et al., 2010). A range of motor skills deficits has also been identified in individuals with ASD, including gross and fine motor skills (Bhat et al., 2011).

Exercise

Regular physical activity reduces the risk of high blood pressure, diabetes, and colon cancer and can improve general well-being (American College of Sports Medicine [ACSM], 2000). Physical activity is any bodily movement produced by the contraction of skeletal muscle that substantially increases energy expenditure and could include activities such as walking, running, or swimming (WHO, 2020). Exercise is planned and structured physical activity used to condition the body and includes activities such as weight training, soccer, and basketball (*NHIS - Adult Physical Activity - Glossary*, 2019) (CDC; 2019). Physical activity is categorized into two different categories: moderate

intensity (heart rate between 64-76% of maximum heart rate) and vigorous intensity (heart rate between 77-93% of maximum heart rate) (*Target Heart Rate and Estimated Maximum Heart Rate / Physical Activity / CDC, 2022*) (CDC; 2022). The Centers for Disease Control and Prevention recommends that children, including those with ASD, between the ages of 6-17 years of age engage in a minimum of 60 minutes of moderate-to-vigorous physical activity or exercise daily.

Token Economy Reward System

Reward systems intend to influence participants to meet a desired outcome through reinforcement and have been shown to be valuable for correcting behaviors in individuals with disabilities, including ASD (Amelia, 2012; Pan et al., 2022). In token economy reward systems, participants can earn tokens (e.g., stickers or visual cues) when they complete the desired behavior. Following this type of reward system can motivate individuals by providing clear expectations (Pan et al., 2022). Token economy reward systems can be used in both individual and group settings and can be tailored according to each participant's individual needs (Pan et al., 2022). Token economy reward systems have shown to be practical and valuable in behavior analysis (Alstot, 2012.; Diamond et al., 2016) for changing behaviors, such as increasing motivation and participation, decreasing problem behaviors, and improving skill acquisition however, there is limited research on the effectiveness of the token economy reward system in an exercise setting (Alstot, 2012.; Diamond et al., 2016). The purpose of this study was to determine the

impact of a token economy board combined with self-determination theory (SDT) on the exercise performance of two individuals with ASD.

METHODS

Participants

The participants for this study included two individuals with ASD between 13 and 17 years of age. Participants were recruited from local high schools in Northern California. Recruitment consisted of speaking directly with each participant and parent/caregiver about the opportunity to be part of the study and receiving parental permission and participant assent to participate. Each participant had no previous injury that impacted their ability to participate in a full-body exercise program using weights and cardio equipment.

Setting

The study was conducted at a student recreation center at a University in Northern California. The student recreation center is divided into two areas (open turf field and weight room). The open turf field allowed participants to warm up, stretch, and for the researchers to explain the goals for the day. The weight room consisted of free weights, weight machines, treadmills, stationary bicycles, elliptical machines, and other resources. All sessions took place during open gym time, where other individuals were present and exercising within the facility.

Instrumentation

Exercise equipment

Each participant's muscular endurance was measured using the DXP Deluxe Chest Press Machine and the Leg Extension Machine, following the pre-established Holten Curve formula. The chest press (CP) machine required weight to be manually loaded and had safety features to ensure safety. Cardiovascular endurance was measured using treadmills. Each treadmill could reach a speed of 12 mph and 15% incline and had 60 inches of running surface. Participants could stop the treadmill using the red stop button or simply get off the treadmill.

Token economy board

A token-economy board was used to indicate the number of repetitions completed during CP, and leg extension (LE). The token board was held by the researcher, and the researcher placed an “X” after each repetition or minute (min) had been completed and circled the number once the participant had reached the established goal.

Heart-rate monitors

The IHT zone wrist heart rate monitor was used to track the participant's heart rates (HR) and determine HR levels. Resting HR, average HR, peak HR. The IHT zone wrist HR monitor provided Average HR and peak HR through the IHT Spirit Classroom Reader.

Assessment

Participants were asked to complete all assessments before, and at the study's conclusion (Baseline, Intervention, and Follow Up). A full description of each assessment for this study is provided below.

Upper and lower body strength and endurance assessment

The Holten Curve (Figure 1) is a scale of the number of repetitions completed associated with the percentage of intensity (Lorenz et al., 2010). A 1 repetition max (RM) was determined by having the participant conduct a series of repetitions at a moderate weight until fatigue and correlating the number of repetitions completed by the participant with the estimated intensity level (Lorenz et al., 2010). For example, if a participant lifts 20 lbs for 11 repetitions (80%), then 20 is divided by 0.80 for a 1 RM of 25 lbs (Lorenz et al., 2010).

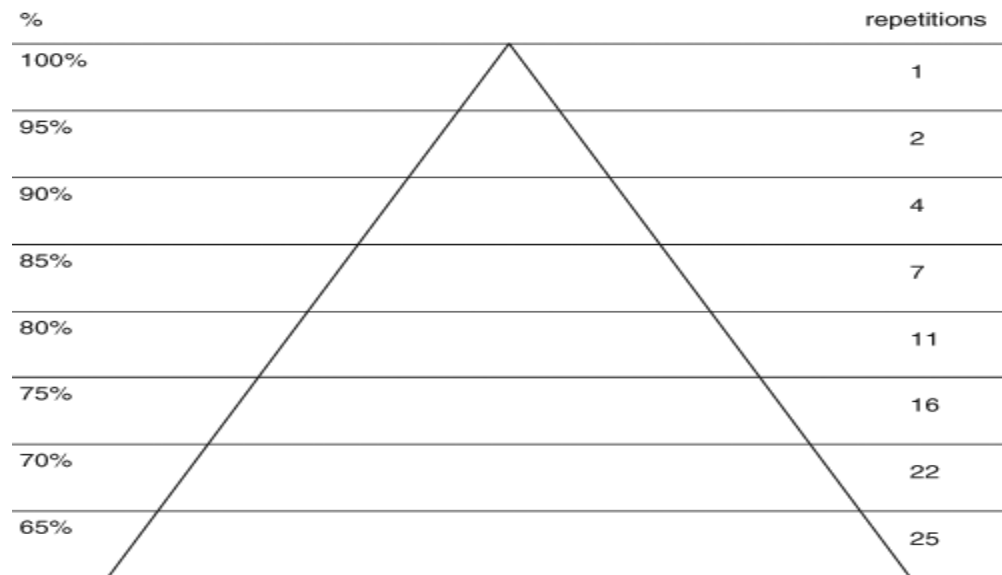


Figure 1. The Holten Curve Scale

Exercise Program

A 6-week exercise program included each participant completing various exercises to improve muscular endurance and cardiovascular endurance. Each exercise session lasted a total of 90 minutes.

Performance Criteria

Each participant's CP and LE performance criteria were determined by the 1 RM using the Holten Curve Scale (e.g., Baseline was 15 pounds (lbs) for 7 repetitions (85%), then 15 will be divided by 0.85 for a 1 RM of 17 lbs). For example, if the participant's 1 RM CP baseline was 17 lbs and they established a goal of wanting to lift 30 lbs by the end of the 6-week program, the participant performance criteria would be set at a 20% increase within each sub-phase to reach the goal duration of 1 RM CP at the end of the 6-week program. Participants had to meet the established performance criteria within each sub-phase in a minimum of 2 out of 3 consecutive sessions to progress to the next sub-phase. The Holten Curve Scale has been determined to be safe and reliable when testing for the 1 RM in children (Lloyd et al., 2012).

Research Design

A single case changing-criterion design guided the data collection and analysis, as well as the performance criteria of this study. The changing-criterion design was performed by obtaining initial baseline observations on a single target behavior and

implementing a treatment program in each treatment phase (Hartmann & Hall, 1976). Each treatment phase contains a stepwise change in the target behavior's criterion rate, allowing a new baseline to be set for the following phase (Hartmann & Hall, 1976). Experimental control is demonstrated when the rate of the target behavior changes with each stepwise change in the criterion (Hartmann & Hall, 1976). The researchers will evaluate the design's effectiveness based on the changing-criterion design.

Structured program

The structured program included a visually numbered token board indicating the agreed-upon number of repetitions (e.g., 1-10) and minutes walking. Numbers were marked over with an "X" after each repetition or minute when completed. Weight was increased each week based on the previous week's number of repetitions (not exceeding 10).

Dependent variables and data collection

Continuous data was collected each session. Specifically, the researchers recorded the amount of weight lifted during the CP and LE for each participant as well as total time walking on the treadmill. Table 1 below provides an illustration of the token economy board that was used for both the CP and LE. Data collection on the treadmill consisted of total time of walking and distance as well as HR.

Table 1. Total Repetitions of CP and LE for Each Session

1	2	3	4	5
6	7	8	9	10

Procedures

The participants provided written consent prior to beginning data collection. Additionally, the participant's parents were provided with a complete description of the study, which contained the time commitments. They were asked to provide written consent for their child before the study. Each participant was also asked to give a verbal assent to participate in the study.

Pre-baseline training

Prior to each participant beginning the baseline phase, the researchers provided a full overview of how to correctly use the CP and LE machines as well as the treadmill. The overview consisted of a verbal description accompanied by visual cues of those movements. To ensure understanding, each participant was told to complete one full movement or 1-minute of walking prior to beginning the baseline phase.

Baseline phase

Within the baseline phase, each participant completed the maximum number of repetitions for both the CP and LE machines. Participants were also told to walk on the treadmill. Before the CP and LE testing began, the participants completed two warm-up

sets of 5-10 repetitions with no weight and had two minutes of rest in between each warm-up set (Parrino et al., 2021). During each of the above exercises, participants were told “try your best” and no other instruction was provided. After each participant completed the CP, LE, and treadmill walking, they were told “great job.” Participants' data across each session was collected and the average number of repetitions was determined and total walking time was established.

Pre-intervention phase

Prior to beginning the intervention phase, each participant was provided a visual representation of their performance within the baseline phase. Participants were then told to select a goal for the number of repetitions and walking time they would like to complete at the end of the 6-week program. Performance criteria was established based on each participant's established individual goals.

Intervention phase

Participants completed various exercises that replicated circuit training and included the use of weight machines. To keep the participant's HR at a moderate-to-vigorous level, researchers had the participants complete a higher number of repetitions with weights (i.e., 10-15 repetitions or 30 seconds of continuous working out) (Kelemen et al., 1986). The participants were instructed to perform 12-15 repetitions or 30 seconds of continuous working out on the machines with no weight (Kelemen et al., 1986). Participants received a 2 to 1 recovery ratio (i.e., 1 min for every 30 seconds working out) between each set and 1 min between each exercise. If a participant did not respond to the initial verbal command to begin the exercise the researcher provided additional verbal

prompts (e.g. let's go, you can do this) and/or a physical prompt (e.g. tapping the heel or elbow).

Follow-up phase

Participants returned and were reevaluated 9-weeks following the conclusion of the study. All baseline phase procedures were followed for the CP, LE and treadmill walking test.

Data Analysis

Visual analysis allowed the researchers to determine if a functional relationship exists between the exercise program and muscular and cardiovascular endurance. Data analysis will be conducted by determining: (a) Prediction, (b) Verification, and (c) Replication (Cooper et al., 2007).

Social Validity

Social Validity is not only used to document independent variables that are related to socially significant outcomes (dependent variable) but can also identify basic principles of behavior (e.g., theory; Horner et al., 2005). Social Validity in this study was measured by surveying the parents of each participant. Questions focused on if the parents believe this program is effective, sustainable, and cost-effective. Below is a questionnaire provided to each parent at the conclusion of the study.

Table 2. Social Validity Questionnaire for Exercise Program

<p>1. Do you see any physical improvements in your child after completing the weightlifting program?</p> <p>a. Yes b. No</p> <p>If answered yes, please provide an example(s) of how your child's improvement (s).</p>
<p>2. Do you believe your child understands how to use the weightlifting machines at the gym and can continue this weightlifting activity moving forward on their own?</p> <p>a. Yes b. No</p> <p>Please explain your answer.</p>
<p>3. Do you believe the opportunity to work out with other individuals within a gym setting had a positive impact on your child's motivation to complete the program?</p> <p>. Yes b. No</p> <p> Please feel free to explain your answer</p>
<p>4. Do you believe allowing your child to select their weightlifting goals had a positive impact on their motivation to participate and complete the program?</p> <p>. Yes b. No</p> <p> Please feel free to explain your answer</p>
<p>5. Are there any additional comments or suggestions that you believe would have improved or can improve this program moving forward?</p>

RESULTS

Participant 1 in this study completed the Baseline Phase, Criterion 1 Phase, and Criterion 2 Phase. Participant 2 completed the Baseline Phase, Criterion Phase 1, 2, and 3. Below is an individual report of each participant's performance throughout this study.

Participant 1

Participant 1 is a 16-year-old Caucasian male who is considered to require level 2 support by parent and may experience difficulty coping with changes in routine, which may cause challenging behavior. The participant is reported to engage in physical exercise seven days a week and participates in physical education in school. The participant has no prior experience in weight training programs and is not currently involved in any exercise programs. The participant's parent reports the participant takes medication but denies medication having any effect on the participant's heart rate.

Baseline phase

Prior to beginning the CP exercise, the researcher established a weight of 10 lbs (Lorenz et al., 2010). During the CP exercise for Baseline Phase 1, Participant 1 was unable to complete a repetition of 10 lbs, during session 1, and then in sessions 2, and 3, they completed 1 repetition of 10 lbs. Prior to beginning the LE exercise, the researcher established a weight of 30 lbs (Lorenz et al., 2010). Results were similar within baseline testing for the LE exercise as, Participant 1 was unable to complete a repetition of 30 lbs in session 1 and then in session 2, they completed 2 repetitions and 1 repetition in session 3. Prior to Participant 1 attempting a CP or LE within sessions 1, 2, and 3 the researcher

provided the verbal prompt “begin.” Based on Participant's performances across both the CP (i.e., $M = 10$ lbs) and LE (i.e., $M = 30.75$ lbs). Due to the participant's limited verbal expression, the researcher provided 3 visual goals for the CP (i.e., 20, 25, and 30 lbs) and the e LE (i.e., 35, 40, and 45 lbs). The participant expressed the goal of completing 25 lbs for the CP and 45 lbs for the LE by the end of the program.

Criterion phase 1

Following the baseline performance by Participant 1, the criteria of performance for phase 1 was established at 10 repetitions of 15 lbs for the CP. Within session 1, 2, and 3, Participant 1 was provided with two opportunities to complete the established criteria of performance within each session for both the CP and LE. Based on the pre-established performance criteria Participant 1 successfully completed the required repetitions during each opportunity at the requisite weight for each session and was moved forward into criterion phase number 2. These results were similar to the performance of Participant 1 during the LE exercise. The established criteria of performance for phase 1 was set at 10 repetitions of 35 lbs. During this phase, Participant 1 successfully completed trial 1, 2, and 3 at the requisite weight for each session and was moved forward into criterion phase number 2. It should be noted that Participant 1 required additional prompts (verbal, physical) to complete or attempt to complete each of the pre-established performance criteria within Criterion Phase 1.

Criterion phase 2

Following the baseline performance by Participant 1, the criteria of performance for phase 2 was established at 10 repetitions of 20 lbs for the CP. Within session 1, 2, and

3, Participant 1 was provided with two opportunities to complete the established criteria of performance within each session for both the CP and LE. Based on the pre-established performance criteria Participant 1 successfully completed the required repetitions during each opportunity at the requisite weight for each session and was moved forward into criterion phase number 3. These results were similar to the performance of Participant 1 during the LE exercise. The established criteria of performance for phase 2 was set at 10 repetitions of 40 lbs. During this phase, Participant 1 successfully completed trial 1, 2, and 3 at the requisite weight for each session and was moved forward into criterion phase number 3. It should be noted that Participant 1 required additional prompts (verbal, physical) to complete or attempt to complete each of the pre-established performance criteria within Criterion Phase 2.

Follow-up phase

After a 9-week break, Participant 1 was reevaluated to determine the impact of the structured exercise program. All baseline phase conditions were returned and Participant 1 was instructed to complete as many CP and LE repetitions as possible. Within this phase, Participant 1 completed 8 repetitions of 20 lbs for the CP exercise. Additionally, Participant 1 completed 14 repetitions of 40 lbs for the LE. It is important to note, Participant 1 was unable to complete any of the instructed exercises without additional prompts, “hands-on bar,” provided. Below is an illustration of the performance for Participant 1 in both the CP and LE for each phase of this study.

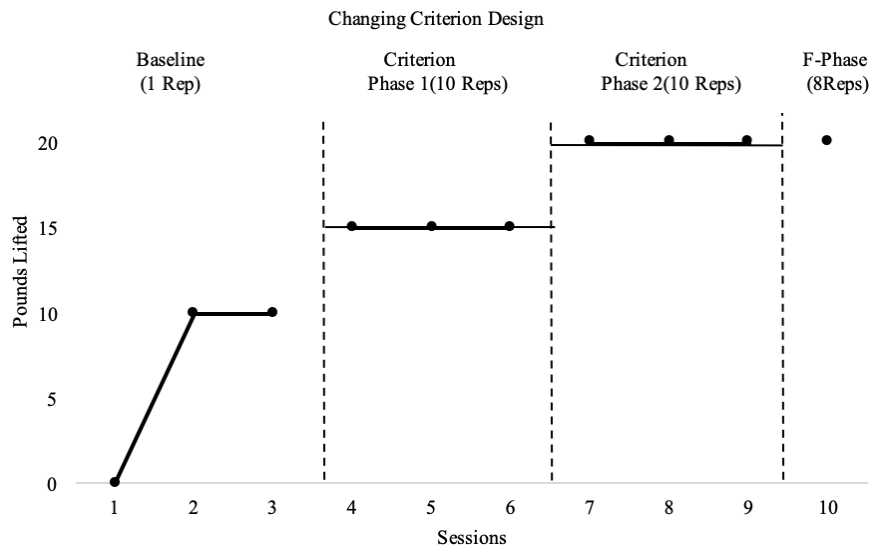


Figure 2. The amount of weight Participant 1 lifted for CP during the baseline, criterion, and follow-up phases.

Note: F-Phase = Follow-up phase

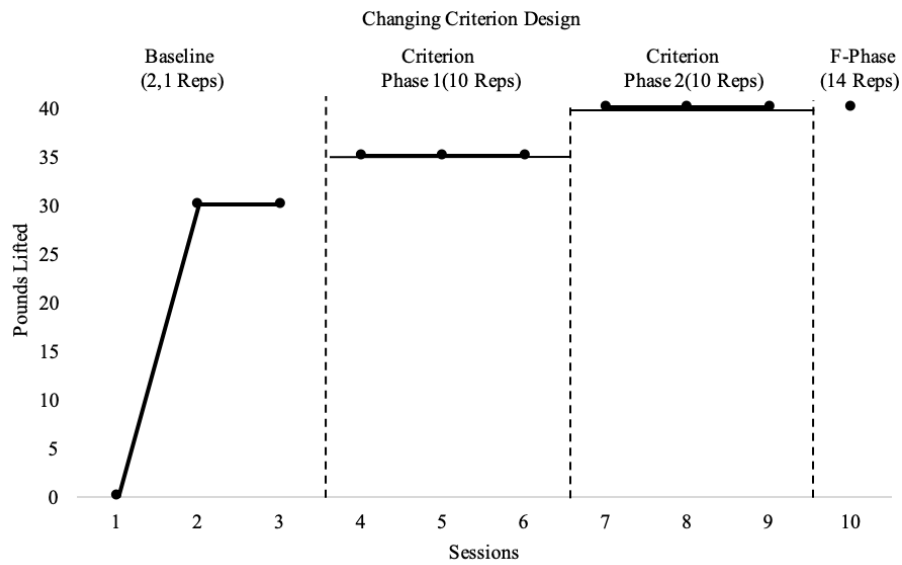


Figure 3. The amount of weight Participant 1 lifted for LE during the baseline, criterion, and follow-up phases.

Note: F-Phase = Follow-up phase

Participant 2

Participant 2 is a 17-year-old Caucasian male who is considered to require level 2 support by parent and may experience difficulty coping with changes in routine, which may result in challenging behaviors. The participant is currently involved in exercise programs and is reported to exercise approximately eight times per week by parent. However, participant has no previous experience in a weight training program. Participant's parent notes that the participant takes medication, but denies medication having an effect on the participant's heart rate.

Baseline phase

Prior to beginning the CP exercise, the researchers established a weight of 30 lbs (Lorenz et al., 2010). During the CP exercise for Baseline Phase 1, Participant 2 completed a total of 16 repetitions in session 1, 12 repetitions in session 2, 23 repetitions in session 3, and 15 repetitions in session 4. Prior to beginning the LE exercise, the researchers established a weight of 75 lbs (Lorenz et al., 2010). During the LE exercise, Participant 2 completed a total of 12 repetitions in session 1, 14 repetitions in session 2, 19 repetitions in session 3, and 15 repetitions in session 4. Prior to Participant 2 attempting a CP or LP within sessions 1, 2, and 3 the researcher provided the verbal prompt “begin.” Based on Participants performances across both the CP (i.e., $M = 40.25$ lbs) and LE (i.e., $M = 98.4$ lbs) the researcher met with Participant 2 to establish program goals. In this meeting Participant 2 expressed the goal of completing 130 lbs for the CP and 130 lbs for the LE by the end of the program.

Criterion phase 1

Following the baseline performance by Participant 2, the criteria of performance for phase 1 was established at 10 repetitions of 70 lbs for the CP. Within session 1, 2, and 3, Participant 2 was provided with two opportunities to complete the established criteria of performance within each session for both the CP and LE. Based on the pre-established performance criteria, Participant 2 successfully completed the required repetitions during each opportunity at the requisite weight for each session and was moved forward into criterion phase number 2. These results were similar to the performance of Participant 2 during the LE exercise. The established criteria of performance for phase 1 was set at 10

repetitions of 100 lbs. During this phase, Participant 2 successfully completed trial 1, 2, and 3 at the requisite weight for each session and was moved forward into criterion phase number 2.

Criterion phase 2

Following the baseline performance by Participant 2, the criteria of performance for phase 2 was established at 10 repetitions of 100 lbs for the CP. Within trial 1, 2, and 3, participant 2 was provided with two opportunities to complete the established criteria of performance within each session for both the CP and LE. Based on the pre-established performance criteria, Participant 2 successfully completed the required repetitions during each opportunity at the requisite weight for each session and was moved forward into criterion phase number 3. These results were similar to the performance of Participant 2 during the LE exercise. The established criteria of performance for phase 2 was set at 10 repetitions of 115 lbs. During this phase, Participant 2 successfully completed trial 1, 2, and 3 at the requisite weight for each session and was moved forward into criterion phase number 3.

Criterion phase 3

Following the baseline performance by Participant 2, the criteria of performance for phase 3 was established at 10 repetitions of 130 lbs for the CP. Participant 2 was provided with two opportunities to complete the established criteria of performance within each session for both the CP and LE. Within this phase Participant 2 successfully met the criteria of performance for the CP in session 1, but was unable to meet the criteria of performance (i.e., was not able complete any repetitions) in sessions 2 and 3. These

results were not similar to the performance of Participant 2 during the LE. During sessions 1, 2, and 3 Participant 2 successfully completed the required repetitions at the requisite weight during each opportunity at the requisite weight for each session.

Follow-up phase

After a 9-week break, Participant 2 was reevaluated to determine the impact of the structured exercise program. All baseline phase conditions were returned and Participant 2 was instructed to complete as many CP and LE repetitions as possible. Within this phase, Participant 2 completed 6 repetitions of 130 lbs for the CP exercise. Additionally, Participant 2 reported feeling fatigued prior to beginning the LE, therefore, no data was collected. Below is an illustration of the performance for Participant 2 in both the CP and LE for each phase of this study.

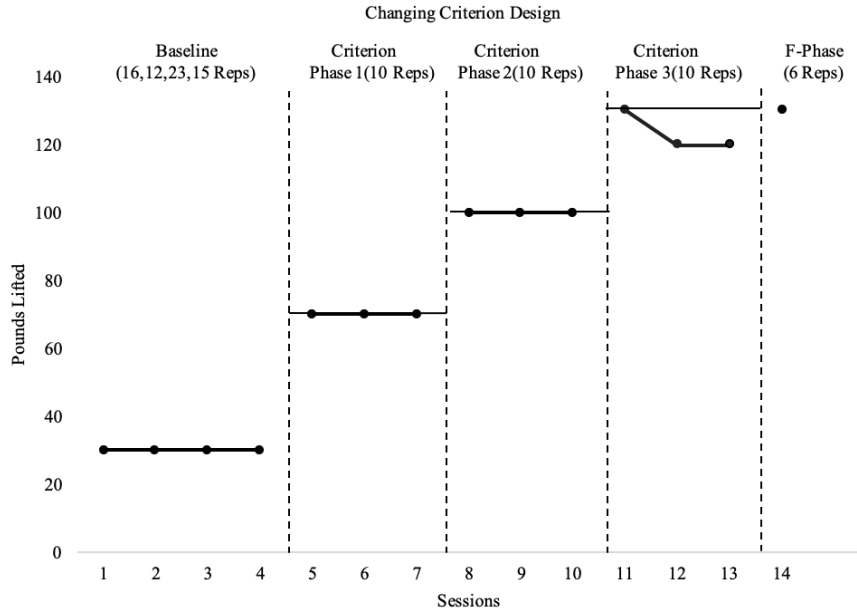


Figure 4. The amount of weight Participant 2 lifted for CP during the baseline, criterion, and follow-up phases.

Note: F-Phase = Follow-up phase

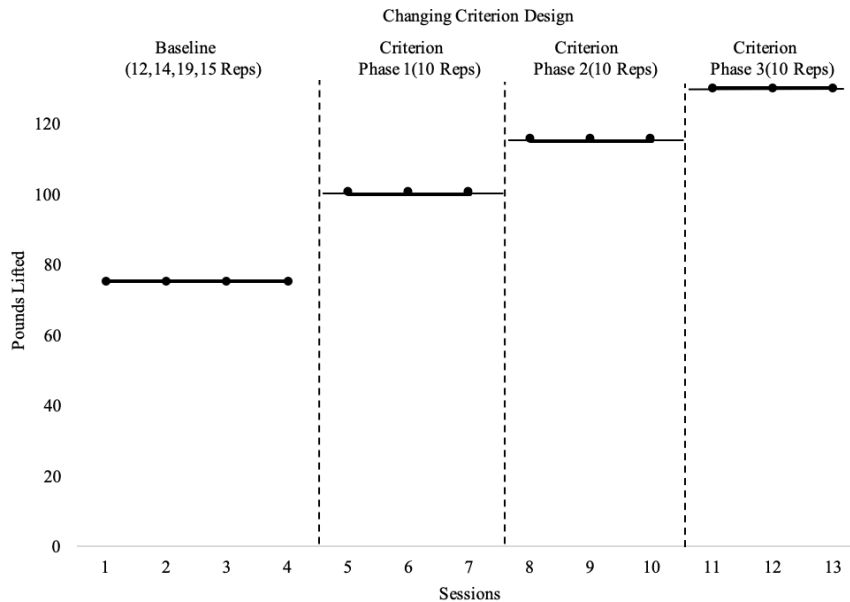


Figure 5. The amount of weight Participant 2 lifted for LE during the baseline and criterion phases.

Participant 2 heart rate

During the Baseline Phase sessions (1, 2, 3, 4), Participant 2, had an average resting HR of 63, peak HR of 154, and averaged 19 min (48.75%) at a moderate HR level. During Criterion Phase 1 sessions (5, 6, 7), Participant 2 had an average resting HR of 65, peak HR of 153, and averaged 35.7 min (39.6%) at a moderate HR level. During Criterion Phase 2 sessions (8, 9, 10), Participant 2 had an average resting HR of 65, peak HR of 160, and averaged 44.3 minutes (49.2%) at a moderate HR level. Finally, in Criterion Phase 3 sessions (11, 12, 13), Participant 2 had an average resting HR of 65, peak HR of 163, and averaged 37.3 min (41.4%) at a moderate HR level. Participant 2 was able to reach a vigorous HR level during Criterion Phase 2, sessions 9 and 10 for a

total of 2 minutes. Participant 2 was again able to reach a vigorous HR level during Criterion Phase 3 once during session 11 for a total of 2 minutes. It should be noted that all sessions lasted a total of 90 mins.

Table 3. Average Resting HR, Peak HR, and Moderate HR Level During the Baseline, Criterion, and Follow-Up Phases.

	Resting HR	Peak HR	Min at Mod HR Level
Baseline	63.25	154.67	19.5/40 min (48.8%)
Criterion Phase 1	65	153.67	35.7/90 min (39.6%)
Criterion Phase 2	65.67	160.5	44.3/90 min (49.2%)
Criterion Phase 3	65	163.67	37.3/90 min (41.4%)

Social Validity

The researchers were unable to receive feedback on this study from the participants' parents. Therefore, the following paragraph is a summary of the responses provided by Participant 2. Participant 2 reported noticing physical improvements which included an increase in muscle strength and weight loss following the completion of the program. Participant 2 also reported improved understanding of how to use the equipment and feel comfortable continuing to participate in weightlifting exercises on

their own in the future. Moreover, Participant 2 reported being provided the opportunity to work out with other individuals improved their motivation and allowed them to feel more focused. Finally, Participant 2 reported having the opportunity to choose their weightlifting goal had a positive impact on their motivation to complete the program and wanted to continue to lift more weights in the future.

The researchers were unable to interview Participant 1 due to his limited verbal expression. Therefore, the paragraph below is a summary of the responses gathered from interviewing his parents. Participant 1's parents did not notice any significant physical improvements following the completion of the program or believe their child could effectively use the equipment in a gym setting without similar support. Conversely, they did report the environment (i.e., exercising around others) improved their child's motivation and they enjoyed watching their child throughout the program. The parents also reported their child experienced increased motivation to participate when he was given the opportunity to set his individual weightlifting goals. The parents also reported that they believe their child increased his understanding of how to use the machines within the gym. Finally, when asked if they had any additional comments about the program, they believed the program was modified to meet their child's current ability (i.e., communication, lifting) levels which was critical to their child's motivation within the program.

DISCUSSION

The purpose of this study was to determine the impact of a token economy board combined with self-determination theory (SDT) on the exercise performance of two individuals with ASD. The researchers believed that allowing each participant to experience the major components of SDT with the addition of a token economy board system would increase the exercise performance levels of the participants. The results of the current study suggest a positive relationship between SDT and the use of the token economy board with the successful completion and meeting of pre-established goals of the exercise program. These results are similar to other studies (i.e., Pan et al., 2022; Todd and Reid, 2006) and suggest that the implementation of the token economy reward positively impacts participants' intrinsic motivation to meet their individual goals. These findings are also consistent with prior literature (i.e., Todd et al., 2019), which show that providing participants the autonomy to engage in self-directed activities and express preferences demonstrates positive results related to intrinsic motivation.

In the current study, participants were provided the autonomy to choose their individual outcomes and work with researchers to develop individual weight-lifting goals. Throughout the criterion phases, both participants successfully met their established individual goals and were able to lift higher amounts of weight when compared to baseline testing. Many exercise intervention programs involving individuals with ASD have shown positive results in increasing strength and endurance (Pitetti et al., 2007; Lochbaum & Crews, 2003; Yilmaz et al., 2004; Fragala-Pinkham et al., 2008).

There is also research supporting the relationship between the implementation of SDT and positive participant outcomes (i.e., quality of life, Parsons, 2018). Additionally, implementation of SDT principles showed improvements of cardiovascular endurance and functional training on vitality in older adults (Solberg et al., 2012). This study determined that students who utilized SDT were more likely to have achieved positive adult outcomes, including being employed at a higher rate when compared to peers (Wehmeyer & Schwartz, 1997). Moreover, Todd (2007) reported positive outcomes for jogging or walking on an outside soccer field when SDT was implemented with individuals with ASD. The above results are similar to the findings in the current study where Participant 1 completed each established exercise goal for each session for CP and LE, and Participant 2 completed each established exercise goal for LE and 2 out of 3 criterion phase goals for the CP. The National Professional Development Center on Autism Spectrum Disorder (2015), as well as the National Autism Institute (2011), have reported a number of EBPs for students within the k-12 grade with ASD. Despite these results, none of the EBPs reported encompass the major components of SDT into one intervention. For teachers/researchers, SDT is a powerful theory that allows the individual student to take control of their own outcomes and then places them in an environment where people of those same interests are located. Additionally, SDT places an emphasis on teaching and checking for understanding under the component of competence. For this reason, SDT should be given consideration when determining appropriate interventions for students with ASD.

Finally, results of this study demonstrate improvements in both participants' performance when compared to their baseline data and indicate that the use of a token economy reward system positively impacted both participants' motivation to complete established goals. These results are supported by previous studies, which show a relationship between the implementation of token reward systems and positive participant outcomes (Bernard et al., 2009; Mirzamani et al., 2011; Pan, 2022; Todd and Reid's 2006; Trocki-Ables et al., 2001). For example, Bernard et al. (2009), reported that use of token economy increased the amount of exercise in children with cystic fibrosis. Additionally, Mirzamani et al. (2011) results show a significant increase in the academic achievement of students with intellectual disabilities when using token economy. Moreover, Trocki-Ables et al. (2001) reported that participants with attention deficit hyperactivity disorder performed at higher levels and decreased times during the one-mile walk/run when verbal praise and tokens were used. In addition to the research above, Todd and Reid (2006) reported the use of self-monitoring boards, verbal cueing, and edible reinforcement on the participation in snowshoeing, walking, and jogging for individuals with intellectual disabilities demonstrated an increase in sustained participation in all three participants when the use of a self-monitoring device remained constant throughout the study. Similarly, Pan (2022), used a token economy board for a participant with ASD in a walking exercise program and had results that indicated a positive relationship between the establishment of the token economy rewards system, participant's behavior, and an increase in the duration of treadmill walking. The above

results provide evidence for the continued use of SDT and token economy boards for individuals with ASD.

Limitations

Limitations within this study include the following. First, the small number of participants decreases the generalization of these results across the population of ASD at this age level. Second, due to limited treatment sessions, it is difficult to report with confidence that a functional relationship exists between the intervention and outcome variables within this study. It should be noted that the researchers attempted to recruit 3-5 participants, but due to limited access to this population and travel requirements and number of treatments per week (i.e. 3) the researchers believe there was a lack of interest from the surrounding community, despite offering these services at no cost. Finally, both participants were additionally enrolled in the physical education course at their local high schools which may have contributed to the results both positively (increased exercise time) and negatively (fatigue). Despite these limitations, the researchers believe they have demonstrated the power of SDT and how a token economy board can be implemented within an exercise program to increase motivation and understanding for individuals with ASD.

Future Research

Future research should explore increasing the number of participants and the length of the study. Including more participants with varying levels of ASD (1, 2, and 3)

in the study to allow for more data to be collected on the effects of SDT on varying neurodevelopmental deficit levels and may provide a better representation of the population. Future researchers may also consider including participants of all genders in the study. Increasing the length of the study can provide more information on the longer-term effects of SDT and token economy reward system on individuals with ASD, which may enhance the relevance of the study. Future researchers can additionally expand the study by including participants' parents in understanding goals and training parents to provide structured opportunities for participants outside of exercise sessions to improve their probability of meeting established goals.

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APPENDICES

Appendix A: Assent Form

ASSENT TO PARTICIPATE IN A RESEARCH PROJECT:

“DETERMINING IF PARTICIPANTS WITH AUTISM SPECTRUM DISORDER (ASD) CAN SUCCESSFULLY MEET INDIVIDUAL ESTABLISHED EXERCISE GOALS WHEN FOLLOWING SELF-DETERMINATION THEORY.”

I am asking for you to agree to participate in a research project on the exercise program. I am conducting this research to determine if participants with autism spectrum disorder (ASD) can successfully meet individual established exercise goals when following self-determination theory.

You will be asked to exercise at a gym, where you will use weight-machines and perform free bodyweight exercises that may increase your overall muscular endurance in your upper and lower body. You will also discuss with researches about implementing a token economy board system throughout your exercise sessions. Through this program you may also develop appropriate gym etiquette and enhance your overall comprehension of attending a gym facility (ex. checking in at front desk, setting up and putting away gym equipment). It will take 6 weeks for the total study. Each week we will meet for 3 sessions, each session will be 1 hour and 30 minutes. Participants, you will also complete a survey questionnaire that refers to exercise. You do not have to answer any questions you don't want to answer.

The participants may feel soreness following session throughout the study which may lead to discomfort. Another risk may be the misuse of gym equipment which can lead to a possible injury. An adult will always accompany each participant during the use of gym equipment, and each participant will be shown how to properly use each equipment during this study if you decide you want to be part of the study. I will not use your name when I write my report and I am the only one who will see your answers to my questions. If you say “yes”, then you may learn new exercises that you can implement by yourself or with others in a gym facility, along with insight on healthy lifestyle practices following the study.

You do not have to agree and you can stop at any time. Your parents have given you permission, but you can still say “no”. If you say “yes” and then change your mind or if something makes you uncomfortable, you can let your parents know. If you have questions, you can ask any researchers present.

Do you want to participate within this 6-week exercise program? If you agree to participate, please answer the following survey questions.

Participant Signature

Date

Appendix B: Parental Consent Form

PARENTAL CONSENT FORM

DETERMINING IF PARTICIPANTS WITH AUTISM SPECTRUM DISORDER (ASD) CAN SUCCESSFULLY MEET INDIVIDUAL ESTABLISHED EXERCISE GOALS WHEN FOLLOWING SELF-DETERMINATION THEORY.

You are invited to participate in a research study. We are master students at Cal Poly Humboldt in the department of Kinesiology and Recreation Administration. This study is being conducted to determine the benefits of a 6-week exercise program for individuals with autism spectrum disorder.

The participants will learn new exercises in a gym setting that they can perform by themselves or with others following the study. This study will also provide insight into a healthier lifestyle and the foundation for continuing to use gym equipment in the future.

The participants may feel soreness following a session of the study. Another foreseeable risk may be the misuse of gym equipment. An adult will accompany each participant during the use of gym equipment, and each participant will be shown how to properly use each equipment during this study.

This study will take place within the student recreation center on the campus of Cal Poly Humboldt. You will also be asked to complete a survey prior to starting the study and at the conclusion of the study.

Your participation in this project is entirely voluntary. Even after you agree to participate, you may decide to stop participation at any time without penalty or loss of benefits to which you or your child may otherwise be entitled. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission.

All data obtained from this study will be maintained in a safe, locked location, and will be destroyed 5 years after the study is completed. This consent form will be maintained in a locked location in the office of my advisor and will be destroyed 3 years after the study is completed. If you have any questions about the research at any time, please email Ruben Diaz (rgd19@humboldt.edu) Nicholas Velazquez (nv40@humboldt.edu), or Martin Calderon (mc146@humboldt.edu) or our advisor, Dr. David Adams at dha13@humboldt.edu.

If you have any concerns or questions about your rights as a participant, contact the Institutional Review Board for the Protection of Human Subjects at irb@humboldt.edu or (707) 826-5165.

Your signature below indicates that you have read and understand the information provided above, and that you willingly agree to your child's participation in this study.

Parents's Signature

Date

Appendix C: Demographic Survey

Demographics Questions:

1. Age of Participant: _____
2. Gender: **Male** | **Female**
3. Ethnicity:
 - **White**
 - **Black or African-American**
 - **American Indian or Alaskan Native**
 - **Native Hawaiian or Other Pacific Islander**
 - **Latino, Hispanic, or Spanish**
 - **Asian or Asian-American**
 - **Middle Eastern or North African**
 - **Other:** _____
4. At what age was your child diagnosed with autism spectrum disorder? _____
5. Looking at the descriptions below for levels of diagnosis of ASD, what level of support do you believe your child needs? (Circle one)
 - Level 1**
Children with ASD level 1 experience some inflexible behavior, like difficulty switching between tasks, staying organized, and planning.
 - Level 2**
Children with level 2 autism may have difficulty coping with changes in routine, which can cause challenging behavior.
 - Level 3**
Children with level 3 autism exhibit marked inflexibility of behavior, with extreme difficulty coping with changes to routine. At this level, restrictive or repetitive behaviors interfere with the individual's ability to function. Changing focus from one activity to another may come with great difficulty and cause significant distress.
6. Are you currently involved in any physical exercise programs?
Yes | **No**
7. In general, at what age were your or your child's physical activity levels a concern? _____
Please mark the following box if your child's physical activity levels are not a concern
8. On average how often does your child exercise within a normal week?
 - a. **0-1 days**
 - b. **1-2 days**

Appendix D: Tables and Figures

Table 1. Total Repetitions of CP and LE for Each Session

1	2	3	4	5
6	7	8	9	10

Table 2. Social Validity Questionnaire for Exercise Program

<p>1. Do you see any physical improvements in your child after completing the weightlifting program?</p> <p>a. Yes b. No</p> <p>If answered yes, please provide an example(s) of how your child's improvement (s).</p>
<p>2. Do you believe your child understands how to use the weightlifting machines at the gym and can continue this weightlifting activity moving forward on their own?</p> <p>a. Yes b. No</p> <p>Please explain your answer.</p>
<p>3. Do you believe the opportunity to work out with other individuals within a gym setting had a positive impact on your child's motivation to complete the program?</p> <p>a. Yes b. No</p> <p> Please feel free to explain your answer</p>

4. Do you believe allowing your child to select their weightlifting goals had a positive impact on their motivation to participate and complete the program?

a. Yes b. No

Please feel free to explain your answer

5. Are there any additional comments or suggestions that you believe would have improved or can improve this program moving forward?

Table 3. Average Resting HR, Peak HR, and Moderate HR Level During the Baseline, Criterion, and Follow-Up Phases.

	Resting HR	Peak HR	Min at Mod HR Level
Baseline	63.25	154.67	19.5/40 min (48.8%)
Criterion Phase 1	65	153.67	35.7/90 min (39.6%)
Criterion Phase 2	65.67	160.5	44.3/90 min (49.2%)
Criterion Phase 3	65	163.67	37.3/90 min (41.4%)

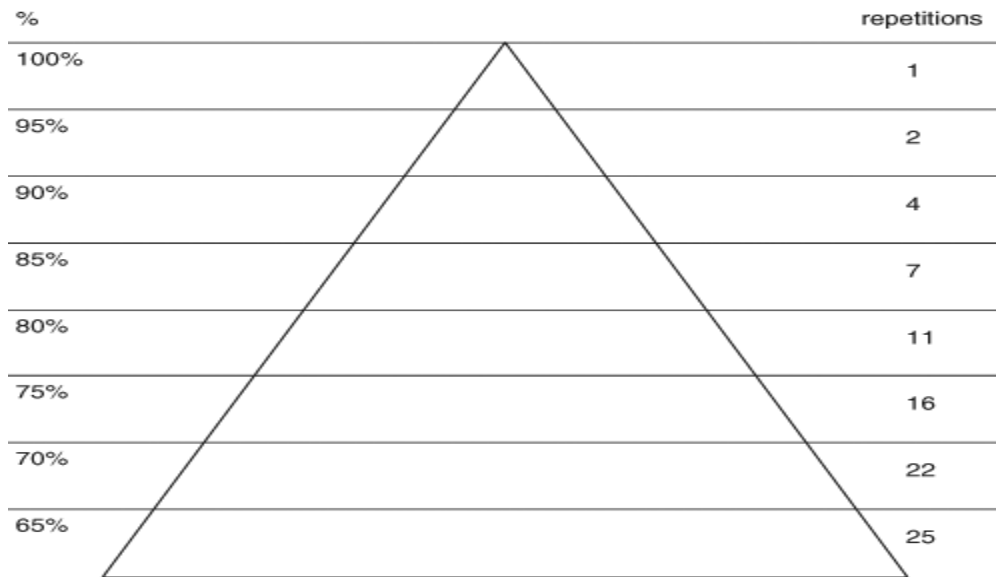


Figure 1. The Holten Curve Scale

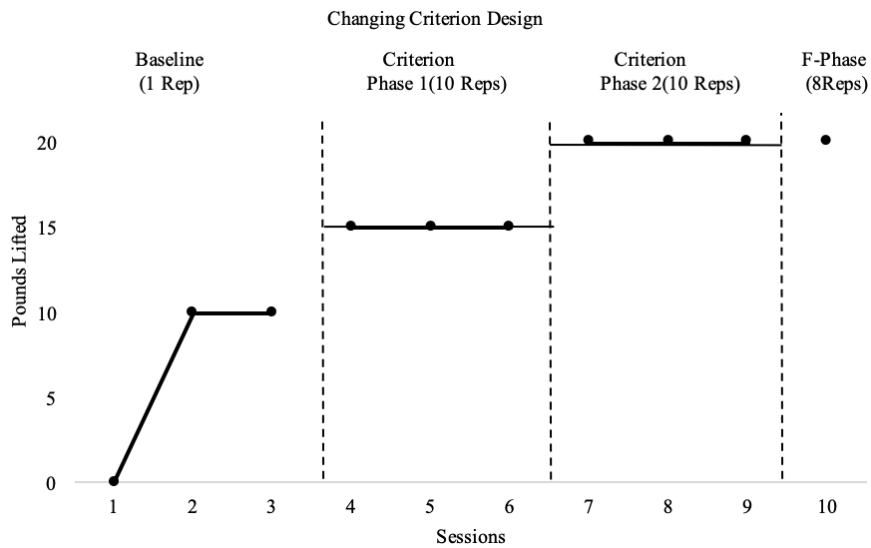


Figure 2. The amount of weight Participant 1 lifted for CP during the baseline, criterion, and follow-up phases.

Note: F-Phase = Follow-up phase

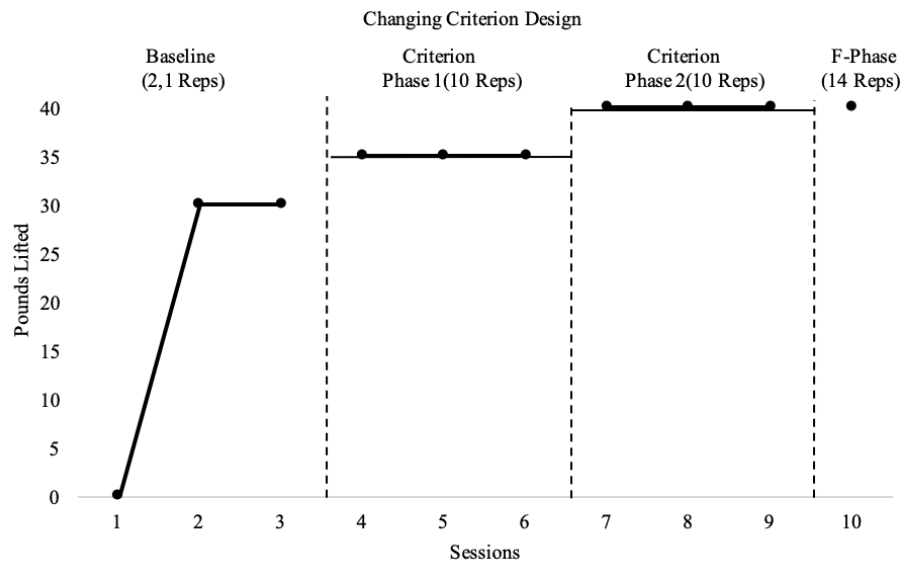


Figure 3. The amount of weight Participant 1 lifted for LE during the baseline, criterion, and follow-up phases.

Note: F-Phase = Follow-up phase

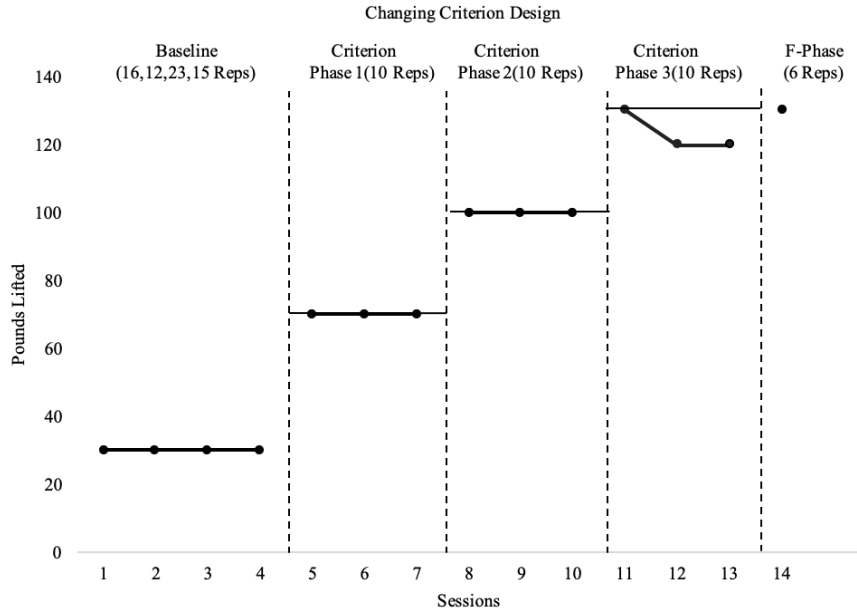


Figure 4. The amount of weight Participant 2 lifted for CP during the baseline, criterion, and follow-up phases.

Note: F-Phase = Follow-up phase

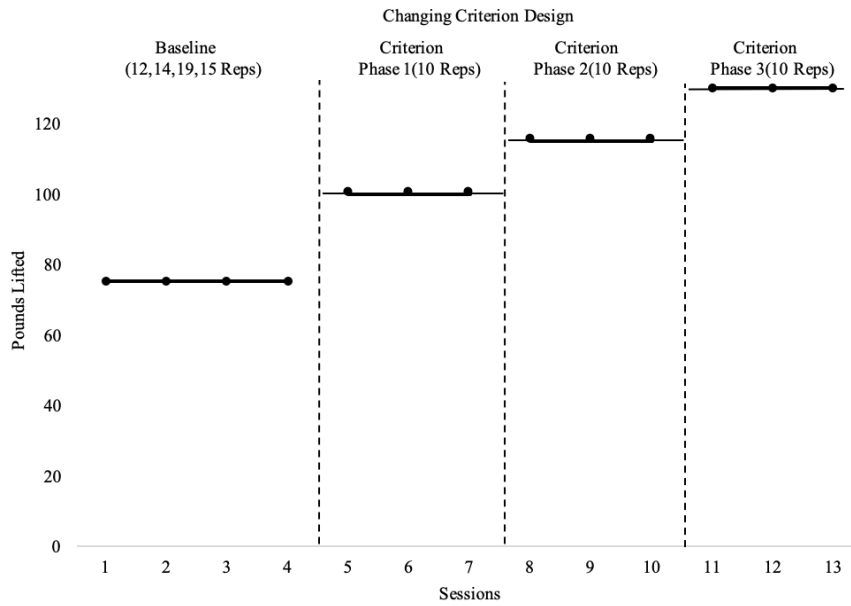


Figure 5. The amount of weight Participant 2 lifted for LE during the baseline and criterion phases.