Physical Disabilities: Education and Related Services, 2017, 36(2), 16-34.
doi: 10.14434/pders.v36i2.23718
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PDERS
ISSN: 2372-451X
http://scholarworks.iu.edu/journals/index.php/pders/index

Article

USE OF VIDEO MODELING TO TEACH WEIGHT LIFTING TECHNIQUES TO ADULTS WITH DOWN SYNDROME: A PILOT STUDY

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Abstract: As adults with Down syndrome (DS) age, their strength decreases resulting in difficulty performing activities of daily living. In the current study, we investigated the use of video modeling for teaching three adults with DS to perform weight lifting techniques. A multiple probe design across behaviors (i.e., lifts) was used to evaluate intervention effectiveness. Data indicated variable effects across participants and lifting techniques. Limitations and suggestions for future research are discussed.

Keywords: *Down syndrome; video modeling; progressive resistance training; strength training*

Introduction

Down syndrome (DS) is one of the most common genetic disorders associated with intellectual disability (Chen & Ringenbach, 2016). Individuals with DS typically have limitations in physical and motor functioning. Infants with DS progress through the same sequence of motor development as those without disabilities; however, their progression is slower due to hypotonia and lax ligaments (Connolly & Michael, 1986; Sacks & Buckley, 2003; Vicari, 2006). Further, individuals with DS generally have lower levels of strength when compared to their typically developing same-aged peers (Angelopoulou et al., 2000; Pitetti, Climstein, Mays & Barrett, 1992; Rimmer, Heller, Wang & Valerio, 2004; Tsimaras & Fotiadou, 2004). Together, delays in motor development and decreased levels of strength can delay an individual's acquisition of functional movement skills across the lifespan (Carmeli, Ariav, Bar-Yossef, Levy & Imam, 2012; Carmeli, Kessel, Coleman & Ayalon, 2002; Cioni, Cocilovo & DiPasquale, 1994; Mendonca, Pereira & Fernhall, 2011). The failure to develop adequate functional movement skills may result in decreased mobility, an increased risk of falls, and the inability to complete activities of daily living (Carmeli, Bar-Chad, Lenger & Coleman, 2002; Horvat & Croce, 1995; Lifshitz, Merrick & Morad, 2008; Maaskant et al., 1996; Smith & Ulrich, 2008).

Fortunately, research suggests that strength training for adults with DS may lead to improvements in their functional ability, (Shields & Dodd, 2004; Smail & Horvat, 2006) overall health, and well-being (Gupta et al., 2011; Holm, 2008; Winders, 1997). Individuals with DS who possess greater strength may be able to complete a broader range of tasks within community settings, potentially increasing their opportunities for employment (Cowley et al., 2010; Shields & Dodd, 2004). Several research teams have demonstrated that adults with DS can increase their strength by participating in progressive resistance training (PRT) (Cowley et al., 2010; Shields & Taylor, 2010; Shields, Taylor & Dodd, 2008). PRT involves lifting an amount of weight for a specific number of repetitions and then gradually increasing the amount of weight lifted while keeping the number of repetitions constant. PRT is regarded as the safest way for an individual to improve muscle strength regardless of age, physical ability, or intellectual functioning (Ratamess, 2011). Cowley and colleagues (2010) evaluated the effects of PRT on the leg strength, aerobic capacity, and the physical functioning of 19 adults (age 27.1 yrs., ±7.5 yrs.) with DS. During the investigation, participants engaged in PRT two days a week for a total of 10 weeks. Data indicated that when compared to a non-PRT control group ($n=11$), participants with DS that engaged in PRT improved their leg strength and the speed at which they could climb a flight of stairs. Similarly, Shields et al. (2008) evaluated a group of 20 adults with DS (age 26.8 yrs., ±7.8 yr.) participating in a supervised group PRT program consisting of six exercises (i.e., three upper body and three lower body). Again, the participants engaged in PRT sessions twice a week for 10 weeks. Results indicated increased upper body muscular endurance and a trend toward increased total muscular strength.

One advantage of using PRT is the need for minimal equipment and, as a result, individuals do not need access to a gym. This is important for individuals with DS, as they may have limited disposable income for gym memberships and reduced access to transportation to and from training facilities (Bartlo & Klein, 2011). Furthermore, training individuals to use PRT in their home may result in increased compliance to an exercise program as the equipment is readily accessible and becomes increasingly familiar as it is present in their daily environment.

Prior to starting PRT, or any strength training program, individuals must learn how to safely and accurately perform the weight lifting techniques. Instructors have used a variety of strategies to teach various physical activities to individuals with DS. One strategy that may offer unique benefits in training weight lifting techniques is the use of video-modeling. Video modeling is a form of observational learning which has been identified as critical to development (Esseily et al., 2015). The concept of observational learning is that learning occurs through observing the behavior of others. It does not require reinforcement to occur, but does require a model (Bandura, 1971). Video modeling provides opportunities for individuals to learn from recorded models that are consistent in form and free of distracting stimuli (Bellini & Akullina, 2007; Biederman & Freeman, 2007). During intervention, participants observe a brief video model and then imitate the modeled behavior(s). Further, researchers have suggested instructional packages that include visual models may be more effective than verbal directions (Maraj et al., 2002; Maraj et al., 2003; Rinigenbach, Mulvey, Chen & Jung, 2012) due to processing difficulties prevalent in individuals with intellectual disability (Heward, 2012).

Video modeling has been used to teach a wide variety of skills (e.g., social skills, transition behaviors) to varied groups including individuals without disabilities (Boyer, Miltenberger, Batsche & Fogel, 2009), with autism spectrum disorder (Burke et al., 2013), and with developmental disorders (Laarhoven, Winiarski, Blood & Chan, 2012). Recently, video modeling has been used to teach physical skills to individuals with developmental disabilities (Buggey, 2005; D'Ateno, Mangiapanello, & Taylor, 2003; MacDonald, Clark, Garrigan & Vangala, 2005). For example, Lo, Burk, and Anderson (2014) taught three high school students with moderate intellectual disability to shoot basketballs using progressive video prompting. The researchers chunked steps of a task analysis and presented video models of one chunk at a time. Data suggested that all of the participants increased the number of steps performed accurately and they maintained their skills following intervention. Similarly, Obrusnikova and Cavalier (2017) utilized video modeling to teach the standing long jump to six middle school children with intellectual disability. Children were shown a video of a person performing the standing long jump and then verbally prompted to perform the same movement. There was an increase in the number of critical elements performed correctly for four of the six participants. Increases in performance were maintained after two weeks of intervention withdrawal. Video modeling had no effect on correct completion of critical elements performed by two participants.

Despite the mounting evidence of the efficacy of video modeling in promoting physical activity for persons with disabilities, to date, there has been no research on its application to strength training techniques. Strength training techniques may differ from other tasks in that they require substantial physical coordination and effort by trainees. Therefore, the purpose of this study was to answer the following research question: Is there a functional relationship between the use of video modeling and the accurate performance of weight lifting techniques by individuals with developmental disabilities?

Method

Participants

Three adult males, ages 24 to 34 years, with DS agreed to participate in the study. All participants regularly attended an Adult Learning Academy at a freestanding facility which serves individuals with DS of all ages. Participants were selected based on their (a) ability to follow verbal and visual multi-step directions, (b) interest in learning weight lifting techniques, (c) ability to imitate gross and fine motor movements demonstrated by a leader, (d) ability to demonstrate gross motor skills with sufficient physical strength to hold and lift necessary equipment, and (e) regular program attendance with no more than two absences in the past month. Individuals were excluded if they had prior experience with strength training, a vision impairment which may have affected their ability to watch the video, or were not available for the entire length of the study. The program coordinator verified that all three participants were within the mild to moderate range of intellectual disability. Parents/guardians signed informed consent and participants signed assent forms. This study was approved by the University Review Board.

All participant identifications were pseudonyms. Jonathan was a 27 year-old White male with DS. He was considered obese based upon his body mass index. He had a limited vocal repertoire and communicated his preferences by responding to yes and no questions. He was able to follow simple spoken instructions and was reported to be more sedentary than physically active. Jonathan lived with his family and utilized public transportation independently.

Geoffrey was a 34 year-old White male with limited communication skills. He spoke a few words and indicated preferences by smiling or shaking his head. When frustrated, Geoffrey would pace back and forth and hit himself on the arm. He was able to follow simple verbal instructions but required assistance when accessing the local transportation system. Geoffrey preferred to be sedentary, but would participate in physical activities if prompted.

Corey was a 24 year-old Black male who spoke in short sentences. He was physically active during the Adult Learning Academy, exercised to videos, and utilized the aerobic exercise equipment consistently.

Setting

The intervention took place in a free-standing facility which houses programs for individuals with DS from across the lifespan. The facility included multiple classrooms, a computer lab, offices, a therapy room, recreation room, and lounge. Approximately 60 adults with DS (20-57 years of age) participated in the Adult Learning Academy with 30-35 attending on any given day. All individuals gathered in the recreation area each morning between 8:00 a.m. and 9:00 a.m. During the first hour of the Adult Learning Academy, study participants went with the researcher, one at a time, to the lounge to view the videos and demonstrate the lifting techniques. Sessions were conducted once daily Monday through Friday.

Equipment

Videos were recorded and subsequently viewed by participants on an iPad which was positioned upright on a table. Other equipment included a circular pillow for punch out squats and a broom handle for the overhead press. These materials were used because they were common in most households and added little additional weight during the performance of the movements which eliminated strength as a limiting factor.

Tasks

The lifting techniques for this study were selected based on their similarity to movements performed by individuals completing activities of daily living. For example, the split squat improves unilateral quadriceps strength needed for going up and down stairs, the punch out squat affects bilateral leg strength required to get up from a seated position, and the overhead press improves upper body strength required to put away items in overhead cabinets. Table 1 provides further details about each of the lifting techniques. For each technique, a certified United States weight lifting coach (second author) developed a list of steps required for each lift (see Table 2). An iPad was used to record a male graduate student performing each lifting technique three times. The videos contained no vocal directions, only the model performing the lifting techniques.

Dependent Measures

Across baseline and intervention sessions, data were collected on the percent of correct steps completed for each lift by recording the number of steps performed correctly, dividing that number by the total number of steps in the task analysis, and then multiplying by 100. Data were collected by trained researchers who watched video recordings of the participants' performance.

Interobserver Agreement

Two graduate students from the exercise science program were trained to collect data from the video recordings. First, the task analysis for each lift was presented and data collection procedures were explained. Subsequently, there were opportunities for the observers to watch and score videotaped performances of non-participants engaging in the lift techniques. At the completion of data collection, inter-observer agreement between the two observers was calculated using a point by point method by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. Initially, inter-observer agreement was below 90%. Retraining of the observers was completed. After the second session of training, inter-observer agreement was 99%.

During baseline and intervention conditions, the observers independently scored videos of the participants. Inter-observer agreement was calculated on 30% of observations. Point by point inter-observer agreement across all techniques for each participant was 100%, 90%, and 90% for Jonathan, Geoffrey, and Corey, respectively.

Table 1

Lifting techniques with basic movement, corresponding motor actions, Activities of Daily Living (ADL), and Instrumental Activities of Daily Living(IADL)

Lifting Technique	Movement	Corresponding Motor Action	ADL/IADL
Split Squat	Standing up with dominate leg directly under the torso, knee straight and non-dominate leg placed behind the body, knee bent and toes on the floor. Bend front leg keeping knee over ankle until back knee is just above the floor. Return to starting position.	Walking up stairs	Transferring, mobility, cleaning the house
Punch-out Squat	Standing straight with legs shoulder width apart, holding weight with straight arms slightly above eye level, bend both knees as if sitting in a chair as deep as possible. Return to starting position.	Standing for long periods of time, sitting in and standing up from a chair	Meal preparation, dressing, grocery shopping
Shoulder Press	Standing with straight legs shoulder width apart, holding bar with underhand grip with arms bent and bar level with clavicles. Push with both hands lifting bar overhead, slowly return to starting position.	Lifting an object overhead to put in a cabinet	Washing hair, putting groceries away, getting dressed

Table 2

List of steps required for each lifting technique

Split Squat	Punch Out Squat	Shoulder Press
Athlete starts in half kneeling position.	Athlete starts by standing.	Athlete starts with feet underneath hips, posture tall, eyes above conversation height.
Front shin is vertical.	Heels are lined up with armpits.	Bar is resting on shoulders in front of neck.
Back toe is turned under.	Posture is tall.	Overhand grip on bar, thumbs wrapped around bar (closed grip)
Posture is tall with should over hip, hip over knee, knee in contact with ground.	Hold a circular pillow where eyes can look at center of the pillow, keeping chin above conversation height.	Elbows in front of bar, pointing towards the ground.
Hands are by the side.	Athlete lowers himself, flexing hips, knees, and ankles.	Press bar overhead, keeping posture tall, ending with arms fully extended, bar over heels.
Eyes look forward, slightly above conversation height.	Eyes continue to look at center of pillow, keeping chin above conversation height.	Return bar to shoulders to finish repetition and return to start position.
Athlete drives up through both legs, keeping posture tall.	Athlete drives up to full hip and knee extension.	Arms are fully extended overhead.
Line of should-hip-knee remains vertical throughout movement.	During movement, knees track over toes (no "caving in" of knees).	Posture is tall.
Athlete ends with back knee still bent.	Athlete's crease of hip will be lower than knee, taking femur "below parallel."	Bar ends over heels.
Athlete lowers body back to half kneeling position to end repetition.	Foot remains flat on the floor at all times during squat.	Arms end in line or slightly behind ears.

Procedural Reliability

Procedural reliability data were collected for 50% of sessions. Procedural reliability was calculated by dividing the number of correctly performed procedures by the number of planned procedures and then multiplied by 100. Procedural reliability data were collected for each trial on the following steps: (a) verbal scripts were followed, (b) only researchers and one participant were in the room, (c) no modeling was provided, (d) no verbal prompting was provided, and (e) no skill feedback was given. Procedural reliability was 100%.

Experimental Design

A multiple probe across behaviors design (Gast, 2010) was used across the three participants. This design was selected because of its capacity to demonstrate a functional relationship between an intervention and irreversible behaviors (i.e., learned behavior). Further, the multiple probe design limited the number of performances of the lifting techniques by the participants without instruction. For each participant, data were collected across all three lifts for a minimum of three sessions or until data were stable. We then introduced the video modeling intervention to the split squat for a minimum of three sessions. Subsequently, we conducted a baseline probe across all three lifts and then introduced video modeling to the punch squat and continue for a minimum of three sessions. Again, we then conducted probe sessions across all three lifts and then introduced the intervention for the overhead lift.

Baseline Sessions

During baseline sessions, the researcher presented a vocal request to perform each lift (i.e., "I want you to lower yourself to one knee as close to the floor as you can and then stand back up;" "Sit down as low as you can, like you are sitting on a short chair;" "Lift the bar high above your head.") and waited for the participant to respond. Following any attempt at performing the movement, the researcher provided nonspecific verbal praise (e.g., "Thank you for doing that."). The researcher prompted three trials per lift technique.

Video Modeling Sessions

During each video modeling session, the researcher presented a previously recorded video model of a single lift technique. The participant was directed to look at the iPad and then the video was started. Again, the video depicted a graduate student performing the lift three times. Subsequently, the participant was told to perform the same lift three times. At the completion of each lift, non-specific verbal praise was provided. Data were collected on the participant's performance of the final lift.

Social Validity

Social validity was assessed using a three-question survey read to participants by the Director of the Adult Learning Academy. A 5-point Likert scale was used (1= strongly agree, 5 = strongly disagree) to measure participant perceptions of the acceptability of weight lifting as an ongoing physical activity. Questions were related to the difficulty of skills learned and whether they would prefer to continue using the lifts.

Results

Corey

Corey's performance data are depicted in Figure 1. Prior to intervention on the split squat, Corey performed an average of 17.5% of steps correctly. Following the introduction of video modeling, he gradually improved his performance to 40%. He maintained performance of the split squat at a level slightly higher than baseline when assessed three weeks post intervention. Prior to intervention on the punch out squat, Corey performed an average 30% of steps correctly. Following the introduction of video modeling, he improved his performance to 80% and maintained performance higher than baseline at 2 ½ weeks post intervention. Finally, prior to intervention on the overhead press, Corey performed an average of 50% of steps correctly. Following the introduction of video modeling, he immediately improved his performance to 80% and maintained performance higher than baseline at two weeks post intervention.

Geoffrey

Geoffrey's performance data are depicted in Figure 2. Prior to intervention on the split squat, Geoffrey performed an average of 20% of steps correctly. Following the introduction of video modeling, he slightly improved performance to 40%. He maintained performance of the split squat at a level slightly higher than baseline three weeks post intervention. Prior to intervention on the punch out squat, Goeffrey performed an average of 60% of steps correctly. Following the introduction of video modeling, he immediately improved his performance to 100% and maintained performance higher than baseline at 2 ½ weeks post intervention. Finally, prior to intervention on the overhead press, Geoffrey performed an average of 40% of steps correctly. Following the introduction of video modeling, he immediately improved his performance to 60% and maintained performance higher than baseline at two weeks post intervention.

Jonathon

Jonathon's data are depicted in Figure 3. Prior to intervention on the split squat, Jonathon performed an average of 10% of steps correctly. Following the introduction of video modeling, he gradually improved his performance to 30%. He maintained performance of the split squat at a level slightly higher than baseline at three weeks post intervention. Prior to intervention on the punch out squat, Jonathon performed an average of 60% of steps correctly. Following the introduction of video modeling, he immediately improved his performance to 80% and maintained performance higher than baseline at 2 ½ weeks post intervention. Finally, prior to intervention on the overhead press, Jonathon performed an average of 35% of steps correctly. Following the introduction of video modeling, he immediately improved his performance to 80% and maintained performance higher than baseline at two weeks post intervention.

Social Validity

All of the participants reported that the exercises were difficult (average score = 1 strongly agree) and had a good time while training (average score = 1 strongly agree). Corey and Geoffrey reported that they preferred to not continue weight lifting (average score = 5 strongly disagree). Jonathan indicated the desire to continue weight lifting (score = 1 strongly agree).

Discussion

The purpose of this study was to determine the efficacy of video modeling as a methodology for teaching adults with DS weight lifting techniques related to their everyday movements. Overall, the data suggested that video modeling resulted in slight improvements in the participants'

Figure 1. Percent of Correct Steps for Corey

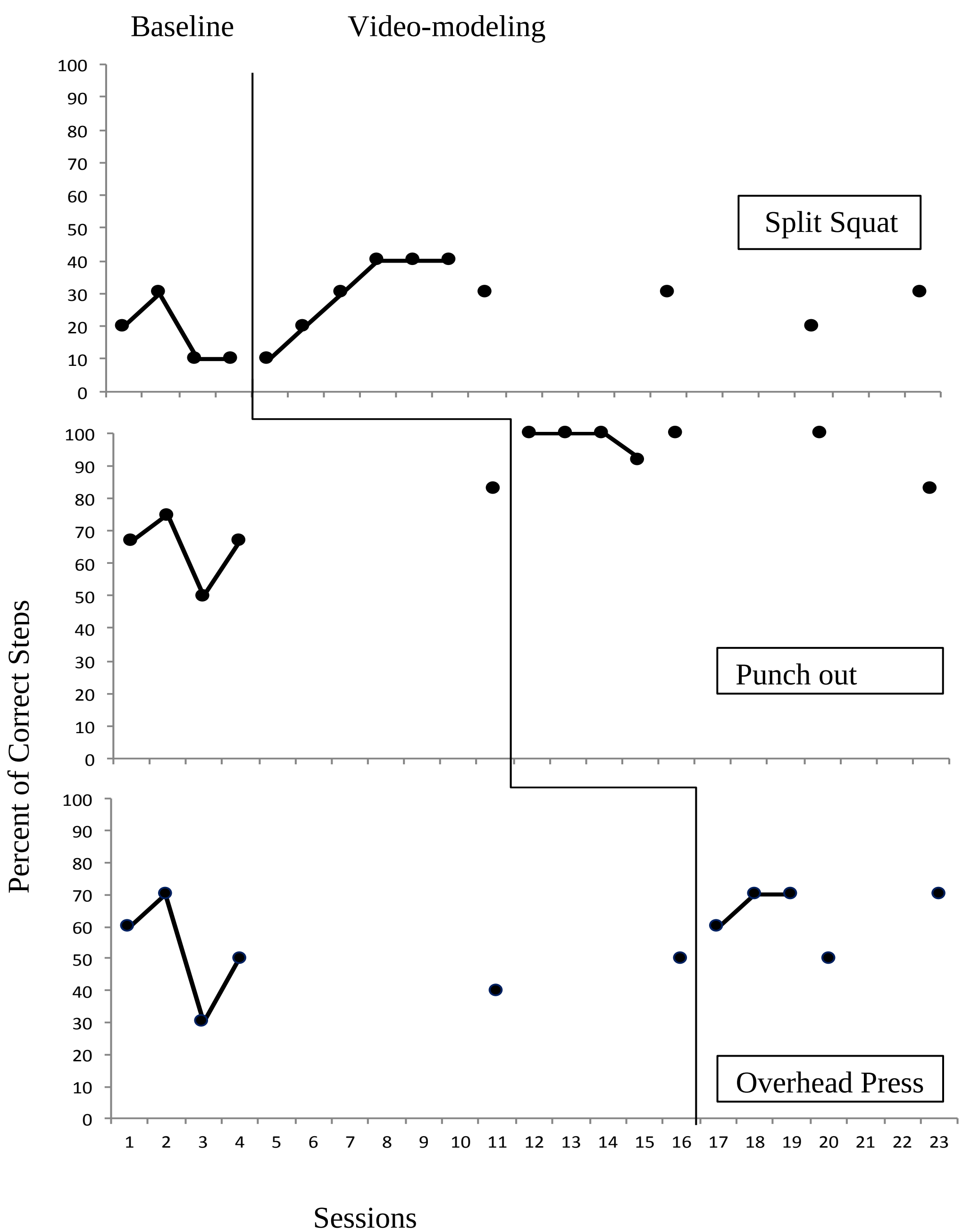


Figure 2. Percent of Correct Steps for Geoffrey

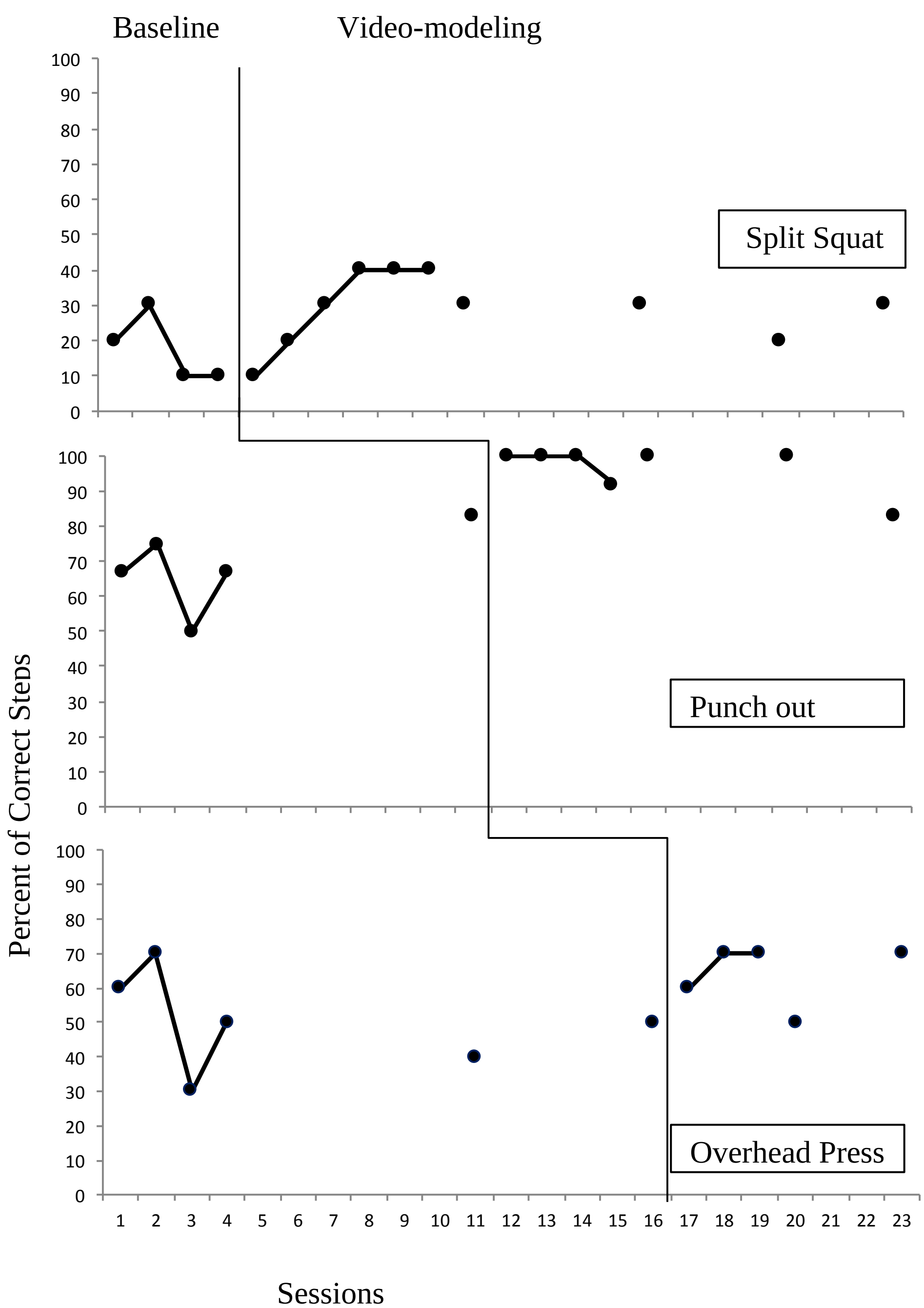
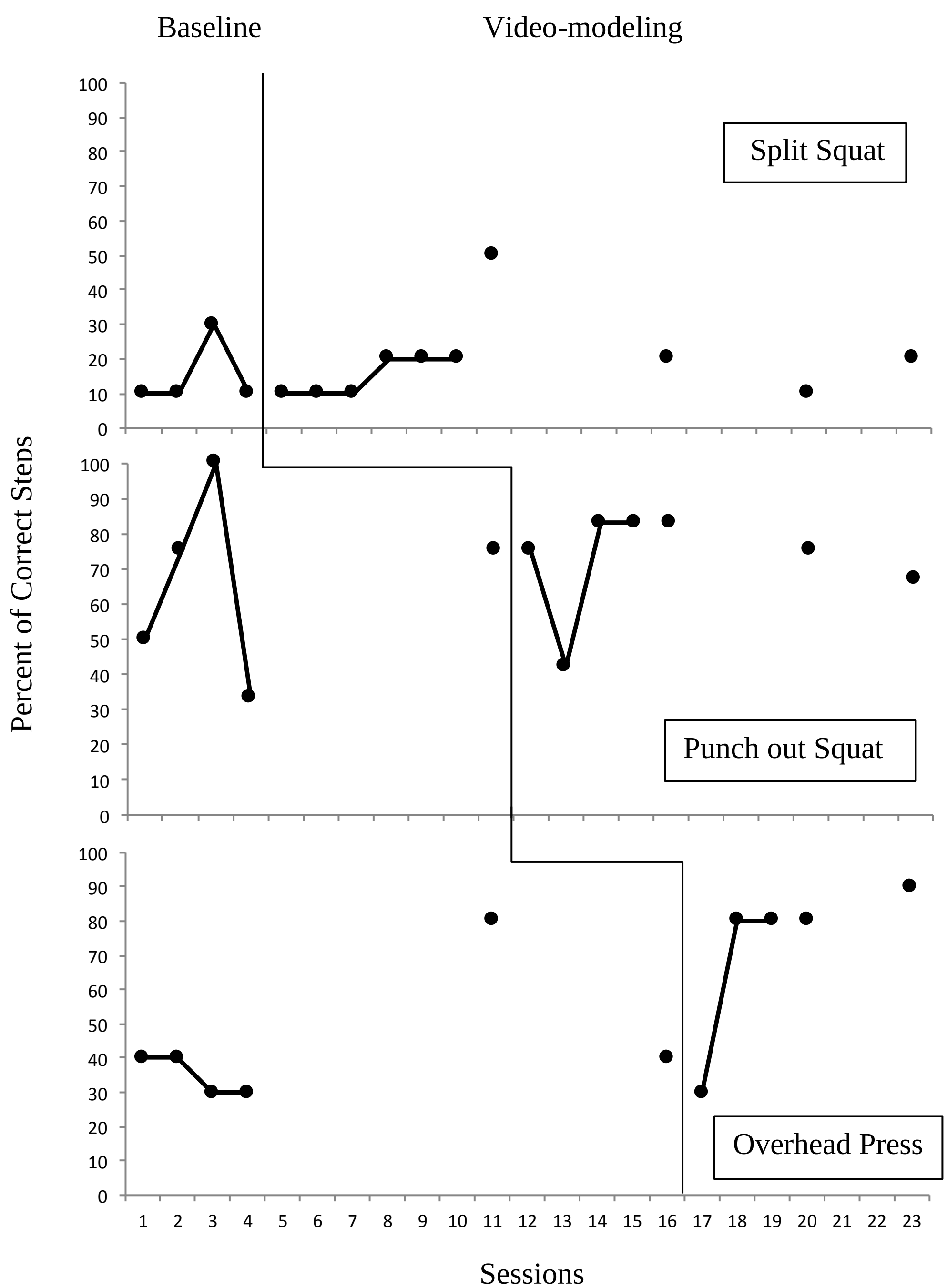


Figure 3. Percent of Correct Steps for Jonathon



performance of the lifts and participants continued to perform better than during baseline sessions several weeks following intervention. Unfortunately, the findings indicated that video modeling alone may not be sufficient for teaching participants with DS to perform weightlifting movements.

These results are consistent with those of previous investigations involving applications of video modeling to teach motor movements. For example, Mechling, Ayres, Bryant and Foster (2014) used continuous video modeling during the instruction of three cleaning tasks to young adults with intellectual disability. Their data showed that two of the three participants acquired targeted skills. Similarly, Crone and Case (2015) compared video modeling to traditional instructions when administering the Test of Gross Motor Development – Third Edition (TGMD-3) to children with autism. Their findings also indicated that video modeling was effective in promoting the performance of motor skills and at levels similar to traditional instructional methods.

One plausible explanation for the participants' meager changes in behavior might be related to the complexity of the lift movements. These lifts required participants to perform multiple movements, involving different parts of the body, in a specific sequence. The motor planning, balance, and coordination necessary to complete the tasks are areas that are often impaired in persons with DS. This explanation is consistent with those of other research teams that have suggested that task difficulty is a critical factor in determining the success of video modeling interventions (Goh & Bambara, 2013; Mulqueen, 2014).

Another potentially inhibitive factor may have been participants' lack of strength in particular muscle groups. Although the lift procedures were designed to not involve any additional weight, it may have been the case that the participants did not have sufficient muscle strength to complete the tasks prior to or during intervention. It might be the case that if the intervention had continued for an extended period of time, the participants might have gradually developed the strength to complete more of the steps accurately.

These findings also may reflect an insufficient intervention dosage or the lack of critical intervention components. The participants in the current study attended the learning academy for a limited amount of time, restricting the total duration of the study. The participants may have required more time to learn the complex movements. Further, the intervention components may not have been sufficient to produce change. The use of video modeling alone does not include explicit feedback, which is a critical active ingredient in most instructional programs. Participants were not provided with the feedback necessary to help them discriminate between correct and incorrect performance.

Several limitations within the current study should be considered prior to interpretation of the results. First, though the researchers collected baseline data prior to intervention, they failed to conduct enough probes to establish a steady rate of responding immediately prior to intervention on the punch out squat and overhead press. They collected a single data point prior to intervention but it may have been the case that this datum did not accurately reflect the participants' current level of performance. Second, it appears that for three of the lifts, participants' performance may have improved slightly during baseline, weakening a demonstration of a functional relationship. Third, the intervention setting did not reflect a setting where the lift might be implemented. In light of challenges associated with promoting stimulus generalization in learners with intellectual disability, future research should involve the instruction of these movements within natural, functional routines. Additionally, they might include the use of light weights within the instructional setting to help learners feel the effect of appropriate lifts on their body.

In the current investigation, we sought to extend the literature on teaching technologies for improving strength and movements in individuals with DS. These skills are essential as they may help individuals prevent injury and maintain a healthy quality of life. The video modeling intervention, alone was not sufficient to produce an effective outcome across all lifts, but did help participants acquire more components of each lift. This result suggests that video modeling might serve as a useful component of a larger intervention package; one that includes video modeling, rehearsal with feedback, and programmed reinforcement contingencies. It is our hope that future research will provide a path forward in this critical area.

References

Adamo, E. K., Wu, J., Wolery, M., Hemmeter, M. L., Ledford, J. & Barton, E. (2015). Using video modeling, prompting, and behavior-specific praise to increase moderate-to-vigorous physical activity for young children with Down syndrome. *Journal of Early Intervention*, *37*, 270-285. https://doi.org/10.1177/1053815115620211

Angelopoulou, N., Matziari, C., Tsimaras, V., Sakadamis, A., Souftas, V., & Mandroukas, K. (2000). Bone mineral density and muscle strength in young men with mental retardation (with and without Down syndrome). *Calcification & Tissue International*, *66*,176-180. https://doi.org/10.1007/s002230010035

Bartlo, P., & Klein, P. (2011). Physical activity benefits and needs in adults with intellectual disabilities: Systematic review of the literature. *American Journal of Intellectual and Developmental Disabilities*, *116*, 220-232. https://doi.org/10.1352/1944-7558-116.3.220

Bellini, S., & Akullian, J. (2007). A meta-analysis of video modeling and video self-modeling interventions for children and adolescents with autism spectrum disorders. *Exceptional Children*, *73*, 264-287. https://doi.org/10.1177/001440290707300301

Biederman, G., & Freedman, B. (2007). Modeling skills, signs and lettering for children with Down syndrome, autism and other severe developmental delays by video instruction in classroom settings. *Journal of Early and Intensive Behavior Intervention*, *4*, 736-734. https://doi.org/10.1037/h0100403

Boyer, E., Miltenberger, R., Batsche, C., & Fogel, V. (2009). Video modeling by experts with video feedback to enhance gymnastics skills. *Journal of Applied Behavior Analysis*, *42*, 855-860. https://doi.org/10.1901/jaba.2009.42-855

Buggy, T. (2005). Video self-modeling applications with children with autism spectrum disorder in a small private school. *Focus on Autism and Other Developmental Disabilities*, *20*, 52-63. https://doi.org/10.1177/10883576050200010501

Burke, R., Allen, K., Howard, M., Downey, D., Matz, M., & Bowen, S. (2013). Tablet-based video modeling and prompting in the workplace for individuals with autism. *Journal of Vocational Rehabilitation, 38*, 1-14.

Carmeli, E., Ariav, C., Bar-Yossef, T., Levy, R. & Imam, B. (2012). Movement skills of younger versus older adults with and without Down syndrome. *Research in Developmental Disabilities*, 33, 165-171. https://doi.org/10.1016/j.ridd.2011.09.008

Carmeli, E**.,** Bar-chad, S., Lenger, R., & Coleman, R. (2002). Muscle power, locomotor performance and flexibility in aging mentally-retarded adults with and without Down syndrome. *Musculoskeletal Neuronal Interaction*, *2*, 457-462.

Carmeli, E., Kessel, S., Coleman, R., & Ayalon M. (2002). Effects of a treadmill walking programme on muscle strength and balance in elderly people with Down syndrome. *Gerontology*, *57*, 106-110.

Chen, J. J., & Ringenbach, S. (2016). Dose-response relationship between intensity of exercise and cognitive performance in individuals with Down syndrome: A preliminary study. *Journal of Intellectual Disability Research*, 60, 606-64. https://doi.org/10.1111/jir.12258

Cihak, D., Fahrenkroq, C., Ayres, K., & Smith, C. (2009). The use of video modeling via a video iPod and a system of least prompts to improve transitional behaviors for students with autism spectrum disorders in the general classroom. *Journal of Positive Behavior Interventions*, *12*(2), 103-115. https://doi.org/10.1177/1098300709332346

Cioni, M., Cocilovo, A., DiPasquale, F., Araujo, M. B., Siqueria, C. R., & Bianco, M. (1994). Strength deficit of knee extensor muscles of individuals with Down syndrome from childhood to adolescence. *American Journal of Mental Retardation*, *99*, 166-74.

Connolly, B. H., & Michael, B. T. (1986). Performance of retarded children, with and without Down syndrome, on the Bruininks Oseretsy test of motor proficiency. *Physical Therapy*, *66*, 344-348. https://doi.org/10.1093/ptj/66.3.344

Cowley, P., Ploutz-Snyder, L., Baynard, T., Heffernan, K., Jae, S.Y., Hsu, S., Lee, M., Pitetti, K., Reiman, M., & Fernhall, B. (2010). Physical fitness predicts functional tasks in individuals with Down syndrome. *Medicine & Science in Sports & Exercise*, *42*, 388-393. https://doi.org/10.1249/MSS.0b013e3181b07e7a

Crone, E., & Case, L. (2015). *A comparison of the effectiveness between traditional and video modeling strategies on motor skill assessments* (Thesis). Available from Creative Commons.

D'Ateno, P., Mangiapanello, K., & Taylor, B. (2003). Using video modeling to teach complex play sequences to a preschooler with autism. *Journal of Positive Behavior Interactions, 5*, 5-11. https://doi.org/10.1177/10983007030050010801

Esseily, R., Rat-Fischer, L., Somogyi, E., O'Regan, K., & Fagard, J. (2015). Humour production may enhance observational learning of a new tool-use action in 18 month old infants. *Cognition and Emotion*, 30, 817-825. https://doi.org/10.1080/02699931.2015.1036840

Gast, D. (2010). *Single subject research methodology in behavioral sciences*. New York, NY, Routledge Publishing.

Goh, A., & Bambara, L. (2013). Video self-modeling: A job skills intervention with individuals with intellectual disabilities in employment settings. *Education & Training in Autism & Developmental Disabilities*, *48*, 103-119.

Gupta, S., Rao, B. K., & Kumaran, S. D. (2011). Effect of strength and balance training in children with Down syndrome: A randomized controlled trial. *Clinical Rehabilitation*, *25*, 425-432. https://doi.org/10.1177/0269215510382929

Heward, W. (2012). *Exceptional children: An introduction to special education*. 10th edition. Pearson Publishing.

Holm. I. (2008). A normative sample of isotonic and isokinetic muscle strength measurements in children 7 to 12 years of age. *Acta Paediatrica*, *97*, 602-607. https://doi.org/10.1111/j.1651-2227.2008.00709.x

Horvat, M., & Croce, R. (1995). Physical rehabilitation of individuals with mental retardation: Physical fitness and information processing. *Critical Reviews in Physical and Rehabilitative Medicine*, *7*, 233-252. https://doi.org/10.1615/CritRevPhysRehabilMed.v7.i3.20

Laarhoven, T., & Laarhoven-Myers, T. (2006). Comparison of three video-based instructional procedures for teaching daily living skills to persons with development disabilities. *Education and Training in Developmental Disabilities*, *41*, 365-381.

Laarhoven, T., Winiarski, L., Blood, E., & Chan. J. (2012). Maintaining vocational skills of individuals with autism and developmental disabilities through video modeling. *Education and Training in Autism and Developmental Disabilities*, *47*, 447-461.

Lifshitz, H**.,** Merrick**,** J., & Morad, M. (2008). Health status and ADL functioning of older persons with intellectual disability: Community residence versus residential care centers. *Research in Developmental Disabilities*, *29*, 301-315. https://doi.org/10.1016/j.ridd.2007.06.005

Lo, Y., Burk, B., & Anderson, A. (2014). Using progressive video prompting to teach students with moderate intellectual disability to shoot a basketball. *Education and Training in Autism and Developmental Disabilities*, 49, 354-367.

Maaskant, M. A., van der Akker, M., Kessels, A. G. H., Haveman, M. J., van Schrojenstein Lantman deValk, H. M. J., & Urlings, H. F. J. (1996). Care dependence and activities of daily living in relation to ageing: Results of a longitudinal study. *Journal of Intellectual Disability Research*, *40*, 535-543. https://doi.org/10.1111/j.1365-2788.1996.tb00664.x

MacDonald, R., Clark, M., Garrigan, E., & Vangala, M. (2005). Using video modeling to teach pretend play to children with autism. *Behavioral Interventions*, *20*, 225-238. https://doi.org/10.1002/bin.197

Mahy, J., Shields, N., Taylor, N., & Dodd, K. (2010). Identifying facilitators and barriers to physical activity for adults with Down syndrome. *Journal of Intellectual Disability Research*, *54*, 795-805. https://doi.org/10.1111/j.1365-2788.2010.01308.x

Maraj, B., Li, L., Hillman, R., Jeansonne, J., & Ringenbach, S. (2003). Verbal and visual instruction in motor skill acquisition for persons with and without Down syndrome. *Adapted Physical Activity Quarterly*, *20*, 57-69. https://doi.org/10.1123/apaq.20.1.57

Maraj, B., Robertson, S., Welsh, T., Weeks, D., Chua, R., Health M., Roy, E., Simon, D., Weinberg, H., & Elliott, D. (2002). Verbal-motor behavior in persons with Down syndrome. In M. Cuskelly, A. Jobling, & S. Buckley (Eds), *Down syndrome across the lifespan* (pp. 175-193). London: Whurr Publishers Ltd.

Mechling, L., Ayres, K., Bryant, K., & Foster, A. (2014). Continuous video modeling to assist with completion of multi-step home living tasks by young adults with moderate intellectual disability. *Education and Training in Autism and Developmental Disabilities*, *49*, 368-380.

Mendonca, G., Pereira, F., & Fernhall, B. (2011). Effects of combined aerobic and resistance exercise training in adults with and without Down syndrome. *Archives of Physical Medicine & Rehabilitation*, *92*, 37-45. https://doi.org/10.1016/j.apmr.2010.09.015

Mulqueen, D. (2014). *Using video modeling and video feedback to improve Olympic weight lifting techniques*. Unpublished manuscript, Dept. of Child and Family Studies, University of South Florida, Tampa, Florida.

Obrusnikova, I., & Cavalier, A. (2017). The effects of video modeling on fundamental motor skill performance of middle school children with intellectual disabilities. *Journal of Developmental and Physical Disabilities*, *29*(5), 757-775. https://doi.org/10.1007/s10882-017-9554-0

Pitetti, K. H., Climstein, M., Mays, M. J., & Barrett, P. J. (1992). Isokinetic arm and leg strength of adults with Down syndrome: A comparative study. *Archives of Physical Medicine & Rehabilitation*, *3*, 847-850.

Ratamess, N. (2011). *ACSM's foundation of strength training and conditioning*. Philadelphia, PA: Lippincott, Williams & Wilkins.

Rimmer, J., Heller, T., Wang, E., & Valerio, I. (2004). Improvements in physical fitness in adults with Down syndrome. *American Journal on Mental Retardation*, *109*, 165-174. https://doi.org/10.1352/0895-8017(2004)109<165:IIPFIA>2.0.CO;2

Ringenbach, S., Mulvey, G., Chen, C., & Jung, M. (2012). Unimanual and bimanual continuous movements benefit from visual instructions in persons with Down syndrome. *Journal of Motor Behavior*, *44*, 233-239. https://doi.org/10.1080/00222895.2012.684909

Sacks, B., & Buckley, S. J. (2003). *Motor development for individuals with Down syndrome – an overview*. DSE Enterprises.

Shields, N. & Dodd, K. (2004). A systematic review on the effects of exercise programmes designed to improve strength for people with Down syndrome. *Physical Therapy Reviews*, *9*, 109-115. https://doi.org/10.1179/108331904225005043

Shields, N., Taylor, N., & Dodd, K. (2008). Effects of a community-based progressive resistance training program on muscle performance and physical function in adults with Down syndrome: A randomized controlled trial. *Archives of Physical Medical Rehabilitation*, *89*, 1215-1220. https://doi.org/10.1016/j.apmr.2007.11.056

Shields, N., Taylor, N., & Fernhall, B. (2010). A study protocol of a randomized controlled trial to investigate if a community based strength training programme improves work task performance in young adults with Down syndrome. *BMC Pediatrics*, *10*, https://doi.org/10.1186/1471-2431-10-17

Smail, K., & Horvat, M. (2006). Relationship of muscular strength on work performance in high school students with mental retardation. *Education and Training in Developmental Disabilities*, *41*, 410-419.

Smith B, & Ulrich, B. D. (2008). Early onset of stabilizing strategies for gait and obstacles: Older adults with Down syndrome. *Gait and Posture*, *28*, 448-455. https://doi.org/10.1016/j.gaitpost.2008.02.002

Temple, V. A., Frey, G. C., & Stanish, H. I. (2006). Physical activity of adults with mental retardation: Review and research needs. *American Journal of Health Promotion*, *21*, 2-12. https://doi.org/10.4278/0890-1171-21.1.2

Tsimaras, B., & Fotiadou, E. G. (2004). Effect of training on the muscle strength and dynamic balance ability of adults with Down syndrome. *Journal of Strength and Conditioning Research*, *18*, 343-347.

Vicari, S. (2006). Motor development and neuropsychological patterns in persons with Down syndrome. *Behavior Genetics*, *36*, 355-364. https://doi.org/10.1007/s10519-006-9057-8

Winders, P. C. (1997). *Gross motor skills in children with Down syndrome: A guide for parents and professionals.* Bethesda, MD: Woodbine House, Inc.

Ya-yu, L. Burk, B., & Anderson, A. (2014). Using progressive video prompting to teach students with moderate intellectual disability to shoot a basketball. *Education and Training in Autism and Developmental Disabilities*, *49*, 354-367.

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