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Increasing physical activity for adults with autism spectrum disorder: Comparing in-person and technology delivered praise

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ABSTRACT

Background/aims/methods: While there are many benefits to regular engagement in physical activity, individuals with autism spectrum disorder often do not engage in healthy levels of physical activity. The purpose of this study was to compare praise delivered through multiple means on increasing engagement in physical activity for individuals with autism spectrum disorder. A single-case alternating treatment design was used to compare two conditions for delivering praise statements, in-person and through technology, for three young adults with autism spectrum disorder and accompanying intellectual disability.

Procedures/outcomes: The study consisted of training; baseline, comparison, best-treatment, thinning, and generalization phases; and social validity interviews. For each session, data were collected on the number of laps completed, duration, and resting/ending heart rates.

Results/conclusions: The number of laps completed increased for all participants during intervention, however, results were mixed regarding the more effective and preferred condition. Participants who excelled in the technology condition also maintained performance levels when praise statements were thinned and generalized performance to a new setting.

Implications: Praise statements can be used to increase levels of physical activity in young adults with autism spectrum disorder and intellectual disability. Exposing individuals to multiple conditions can impact their preferred method for receiving support.

What this paper adds?

This paper adds to the limited literature on adults with autism spectrum disorder as well as the need to research strategies to promote increased physical activity levels in this population. While positive reinforcement is an evidence-based practice for individuals with autism spectrum disorder, additional research like this study is needed to demonstrate different delivery options for providing positive reinforcement such as praise. Using technology to deliver support has the potential to increase independence and responsibility by having participants self-operate the technology, decreasing reliance on personnel.

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1. Introduction

Engagement in physical activity is an important component for establishing healthy habits. The *2008 Physical Activity Guidelines for Americans* recommends children aged 6 through 17 engage in a total of 60-min of daily physical activity in the areas of aerobics, muscle strengthening, and bone strengthening and that adults participate in at least 150-min of moderate-intensity aerobic physical activity each week along with muscle-strengthening activities. For moderate-intensity, such as a brisk walk, people should notice their heart beating faster and harder breathing. Despite the benefits of regular physical activity (e.g., decreased risk for diabetes), children and adults are not engaging in recommended levels of physical activity (US Department of Health and Human Services: Physical Activity Guidelines for Americans, 2008).

Individuals with autism spectrum disorder (ASD) are no exception to this statistic. Not only are individuals with ASD engaging in lower than recommended levels of physical activity, they are engaging in even lower levels compared to typically developing children and adults (Sowa & Muelenbroek, 2012). Due to typically lower levels of sedentary behavior, individuals with ASD were identified as a special risk group for health challenges such as obesity and secondary conditions (e.g., depression, diabetes; Hildebrandt, Chorus, & Stubbe, 2010). Barriers to physical activity for individuals with ASD further intensify the challenge of lowering risk for secondary conditions through increasing rates of engagement in physical activity (Sorensen & Zarrett, 2014). Motor impairments, social skill deficits, and behavioral challenges (e.g., repetitive behaviors) can limit success in physical activities (LaLonde, 2015).

Promising intervention strategies for promoting physical activity for individuals with ASD include prompting, modeling, praise, structured teaching, and goal setting (Sorensen & Zarrett, 2014). These strategies are similar to interventions to promote physical activity for individuals without disabilities (e.g., goal setting, reinforcement; Kurti & Dallery, 2013). In-person verbal supports (i.e., provided directly by personnel) such as prompts and praise were used with individuals with ASD to increase engagement in physical activity (LaLonde, 2015; Todd & Reid, 2006). LaLonde (2015) used an intervention package of goal setting with reinforcers and social praise to increase activity levels of young adults with ASD and intellectual disability (ID). In addition to goal-setting and praise, Todd and Reid (2006) used verbal prompting and edible reinforcers as part of their intervention package to increase time spent walking, jogging, and snowshoeing (Todd & Reid, 2006). The process of thinning reinforcers used in Todd and Reid (2006) included a systematic process that started with participants receiving reinforcers four times during a session. Reinforcers were thinned to one reinforcer per session, with removal during the final four sessions.

While in-person verbal supports are promising for increasing engagement in physical activity for individuals with ASD, receiving verbal supports through technology (e.g., prompts, performance feedback) is another delivery option. Although verbal supports provided through technology (e.g., an iPod) were not used to increase engagement in physical activity for individuals with ASD specifically, they were used with individuals with ASD to increase independence in self-care skills (Mays & Heflin, 2011) and vocational skills (Bennett, Ramasamy, & Honsberger, 2013; Taber-Doughty, 2005) as well as decrease off-task behavior in classroom and vocational settings (Taber, Seltzer, Heflin, & Alberto, 1999).

With technology use in physical activity becoming commonplace, it is important to determine its advantages or disadvantages to provide needed support over more traditional (non-technology) forms of support. The purpose of this study was to compare praise delivered through multiple means on increasing engagement in physical activity for individuals with ASD. Specific research questions included: (a) under which condition do participants engage in aerobic activity for a longer distance when comparing in-person praise statements to technology-delivered praise statements? (b) Can levels of engagement in aerobic activity be maintained when praise statements are systematically thinned? (c) Can levels of engagement in aerobic activity be generalized to a new setting? And, (d) what are participant and teacher perspectives of physical activity as well as the interventions and materials used in the study?

2. Method

2.1. Participants

Three young adults with ASD participated in this study. Participation in the study was open to any student in the secondary life skills program who: (a) had a diagnosis of ASD as determined by the classification and services received in high school (Individuals with Disabilities Education Improvement Act, 2004); (b) was in adequate health to partake in the physical activity (i.e., no medical restriction(s) in place for physical activity participation verified by signed forms from each participant's parent(s) and classroom teacher); (c) had the gross motor function to run or walk and sufficient fine motor ability to operate the technology; (d) was able to follow one-step verbal instructions; and (e) needed support to remain engaged in physical activity such as prompting (i.e., did not engage in physical activity independently). Assessment information for each participant was collected from school records; no additional assessment was given by the research team.

2.1.1. Mason

Mason was a 20-year-old Caucasian male with ASD and ID. He had a reported IQ of 46 as determined by the Wechsler Intelligence Scale for Children-IV (WISC-IV). The Adaptive Behavior Assessment System® Second Edition (ABAS-2) was administered and his General Adaptive Composite (GAC) score was 48. The Gilliam Autism Rating Scale (GARS) was also administered and Mason's results fell into the highly/probable range. In addition to engaging in physical activity during adapted physical education class, Mason also participated on his high school's Unified track team.

2.1.2. Aidan

Aidan was a 21-year-old Caucasian male with ASD and ID. He had a reported full-scale IQ of 40 as determined by the Kaufman Brief Intelligence Test, Second Edition (KBIT-II). The ABAS-2 was also administered and Aidan's GAC score was 43 on both teacher and parent reports. No specific ASD assessment information was available from his school records. Aidan participated willingly in adapted physical education class sessions with regular modeling and prompting support, but did not engage in other physical activities.

2.1.3. Landon

Landon was a 22-year-old Caucasian male with ASD and ID. He had a reported IQ of 56 as determined by the Universal Nonverbal Intelligence Test (UNIT). The ABAS-2 was also administered and Landon's GAC score was 41 on both teacher and paraeducator reports. No specific ASD assessment information was available from his school records. While he was enrolled in adapted physical education class, his teacher stated that he did not participate and often asked to leave the gym area during class periods.

2.2. Setting

The study took place in a public high school in the Midwest. Each participant's classroom was used for training and social validity interviews and two different school gymnasiums were used for physical activity sessions. The first gymnasium was one of two smaller gymnasium spaces located on the second level above the main gymnasium. Participants ran around four orange cones set up at four corners of the 120-foot perimeter path. For the generalization phase, participants used the second gymnasium on the lower level. Each ran along a black line that outlined the outer rim of the basketball court (i.e., structure of the cones was removed). The perimeter of the basketball court was 268 feet.

2.3. Materials

A video camera was used to record each session. The device measured 4.2 × 2.2 × 1.2 inches and weighed 12 ounces. Praise statements were recorded on a MacBook Pro® in the Garageband app (Apple Inc., 2004), shared to iTunes®, and uploaded to two iPod Nanos® and one iPhone®5c. To edit tracks throughout the study (e.g., adding more time between praise statements), adjustments were made to the original recording. The researcher also used an iPhone®5c to measure each participant's heart rate before and after each session with the free iPhysiometer heart rate application (Matsumura & Yamakoshi, 2013).

Participants used an iPad Mini™ 2 to access the video model presented before each session. For technology sessions, participants used either an iPod Nano® or an iPhone®5c to receive their praise statements. Participants could wear their device with an armband, place the device in their pocket, or hold the device in their hand. A variety of headphones were available for participants to use during technology conditions. Types included: (a) in-ear buds, (b) on-ear headphones, (c) ear clip headphones, and (d) wireless ear clip buds. During training, participants chose which headphones they preferred, but also had the opportunity to change headphones throughout the study. All participants chose on-ear headphones and continued using the same headphones throughout the study.

During each session, participants wore the Sportline Digital Distance Tracker Pedometer®. It was available for less than $15 at a local national chain store. Mason and Aidan wore the pedometer on their shoelace, however, Landon refused to wear the pedometer on his shoe. Landon was willing to place the pedometer in his pocket. While participants wore pedometers, the purpose of wearing the physical activity tracker was to informally observe participant tolerance for the tracker during sessions and explore participant interest in wearing the tracker (e.g., researchers asked each participant questions related to the pedometer during social validity interviews).

2.4. Dependent measures and data collection

The dependent variables measured in this study included (a) number of laps completed, (b) duration, and (c) heart rate. The number of laps was determined using event recording. Participants had to be within 5-feet of the last cone to get credit for the final lap of each session. The duration of each session was determined using duration recording. Duration began once a participant took his first step forward (i.e., lifting his foot off the ground) and ended when a participant stopped running or walking (i.e., both feet stopped moving) for greater than 5-s. If a participant had a brief interruption or multiple brief interruptions during a session, the session continued. An interruption was defined as a participant stopping the forward movement of his or her feet for up to 5-s. If an interruption occurred, the total time of the interruption was subtracted from the participant's total duration for that session. If there were multiple interruptions, as long as they lasted less than 5-s each, sessions continued and each interruption was deducted from the total duration of the session.

Heart rate was measured before and after each session. Participants placed the tip of their left index finger over the camera of an iPhone®5c and held it for a few seconds while their heart rate was measured using the iPhysiometer heart rate application. Heart rate measures were used as a reference for participant safety as well as to determine the approximate intensity of exercise sessions. Researchers determined the approximate maximum heart rate for participants by subtracting a participant's age from 220. Researchers used this approximate maximum heart rate to determine the exercise intensity of sessions. For example, if a person wants to exercise at a moderate-intensity such as 70% of their approximate heart rate maximum, they would subtract their age from 220 and multiply the answer by 70%. The answer would be the target heart rate for the exercise session.

Table 1
Praise Statement Sequence for Intervention.

Sequence	Praise Statements
1st	"Nice job running around the cones (insert participant's name)"
2nd	"Keep up the good work running!"
3rd	"You are doing a great job running (insert participant's name)"
4th	"Awesome, way to keep running (insert participant's name)"
5th	"Great job, I like the way you are running!"

2.5. Independent variable

The independent variable was praise statements provided to participants in two conditions: (a) praise delivered in person and (b) praise delivered via technology. A series of five praise statements were used for each participant (see Table 1). Praise was provided on a fixed-time schedule while each participant was engaging in physical activity, including during interruptions. Praise did not continue if a session stopped (i.e., an interruption of greater than 5-s). The researcher's voice was used for both conditions.

The schedule of reinforcement was based on each participant's performance during baseline sessions. Participants received two praise statements within their average baseline duration. For example, if a participant ran an average of 80 s in baseline sessions he would receive a praise statement every 40 s. During thinning conditions, the interval between praise statements was increased for each participant. If levels of engagement dropped (i.e., average of at least two laps less compared to the previous phase), the following thinning condition returned to a denser level than the previous condition.

2.6. Experimental design

A single-case alternating treatment design (ATD) was used during this study (Wolery, Gast, & Hammond, 2010). An ATD was used to compare two conditions for delivering praise statements on the distance each participant ran and/or walked. An ATD includes an intervention phase in which the two conditions or interventions are rapidly alternated during sessions (Wolery et al., 2010). The order in which conditions were presented was determined for each participant separately by pulling pieces of paper with either an A or B out of a bag, with participants engaging in no more than two sessions of the same condition consecutively.

2.7. Procedures

The researcher met with participants separately 3–4 times per week for 1–2 sessions each day, and the study was completed in 7-weeks. There was no time limit to any study session (i.e., participants ran, walked, or jogged as long as they could). The number of sessions for participants was limited to a maximum of two sessions per day due to potential physical exertion.

2.7.1. Baseline

At the beginning of each session the researcher started the video recording, obtained the participant's resting heart rate, attached the pedometer, had the participant watch a video model, and provided verbal directives for the participant to run as long as he could around the orange cones. The video model was used as a prime and presented a young adult male running three laps around the same orange cones used in the study. At the end of each session the researcher measured the participant's heart rate, checked the pedometer, and ended the video recording. Baseline occurred for a minimum of five sessions and took 2-weeks to complete.

2.7.2. Probes

After each participant completed baseline sessions, probe sessions were implemented. The purpose of probe sessions was to evaluate whether or not the evaluated components (headphones, music, generalization setting) had a differential effect on aerobic activity without the intervention since these components would be included in future sessions along with the intervention. The following additions to baseline procedures included: (a) participants were asked to place headphones on their ears during instructions for the headphones probe; (b) each participant chose a preferred song from the researcher's iTunes® account and was asked to put headphones on and press the play button during instructions for the music probe; and (c) participants were instructed to run on the black line instead of around orange cones for the generalization probe occurring in another gymnasium. If the results of a probe session were increased from baseline sessions, additional sessions were conducted for that condition. An additional probe was administered further into the study. Specifically, a baseline probe occurred after the best treatment phase to serve as an additional component of experimental control.

2.7.3. Training

Training occurred after probe sessions to (a) teach participants how to operate the technology and (b) determine ability to follow one-step verbal directives delivered through technology for a novel task in the classroom. Classroom teachers verified each participant's ability to follow one-step verbal directives from personnel, but the use of technology to deliver auditory support such as prompts or praise was new.

For the first part of training, participants reviewed basic technology competencies with the researcher including (a) turning on the iPod Nano®, (b) finding the correct audio track to play, (c) adjusting the volume, and (d) putting on headphones. Evaluating competencies was an informal process. The researcher modeled competencies for each participant, followed by allowing time for participants to practice competencies independently. If a participant was unable to complete competencies independently on the iPod Nano®, an iPhone®5c was available for use. Participants had to independently complete each competency on one of the two devices before moving forward with the second part of training.

For the second part, participants followed one-step auditory directives presented on the same device they used in part one. Participants put on their preferred headphones, found the track that was labeled with their name, pressed play, and followed the directive. Novel tasks included (a) giving their teacher a high five, (b) going to sit in their desk, (c) putting a piece of paper on the teacher's desk, (d) putting a wrapper in the garbage, (e) putting a cup in the sink, and (f) putting a pencil on their desk. Criteria for passing training required participants to reach 100% criterion for two consecutive sessions.

2.7.4. Intervention

Procedures used before and after baseline sessions remained the same for all intervention session. Once a session began in the in-person condition, a script was followed that listed the praise statement sequence as well as what time each praise statement was to be provided to each participant. Praise statements during in-person sessions were provided by the researcher, who stood near the video equipment between cones 3 and 4. The researcher stood in the same location during technology sessions. For the technology condition, participants were given the added directive to put on their headphones and start the recording when they were ready to start. Five sessions were conducted for each condition unless more sessions were needed to determine a best treatment or for stability (Wolery et al., 2010).

2.7.5. Best treatment

The best treatment phase occurred for five sessions in the condition that each participant was most successful. The most successful condition was determined using non-overlapping data (PND; Gast & Spriggs, 2010). Researchers calculated the number of sessions that one condition (e.g., technology) fell into the range of the other condition (e.g., in-person) for the number of laps completed, divided that number by 5, and multiplied by 100.

2.7.6. Thinning

Each participant's ability to continue his level of engagement from intervention sessions, while the interval of time between praise statements was increased, was assessed in thinning sessions over a 2-week period. There were three thinning conditions with three sessions in each condition. Procedures remained consistent with the exception of adding music between praise statements. For participants who excelled using the technology condition, the song each participant chose for their music probe was inserted into their praise statement track. The track was further edited to add the appropriate time needed between statements for each thinning condition. For participants who excelled using the in-person condition, the song each participant chose for their music probe was played through a speaker while the researcher provided praise statements at the appropriate times for each thinning condition.

2.7.7. Generalization

Each participant's ability to transfer his or her performance across settings was determined across three sessions during the 2-day generalization phase. During generalization, participants completed the same aerobic activity with the same support received in the previous thinning phase. The generalization phase took place in the main gymnasium which was the main gym used for general physical education classes. Procedures remained consistent, with the exception of instructions indicating participants would run along the black line. The orange cones were removed and the setting simulated what participants would experience if warming up for physical education class with their peers.

2.8. Data analysis

Data were analyzed using visual analysis. Researchers calculated level change (absolute), trend direction using the split-middle method, and level stability (i.e., stable defined as at least 80% of the data falling on or within a 20% range of the median level for all data points in each condition; Gast & Spriggs, 2010). To support visual analysis, researchers calculated Tau-U (Parker, Vannest, Davis, & Sauber, 2011) using the web-based calculator (see http://www.singlecaseresearch.org/calculators/tau-u). Tau-U compares each intervention with baseline scores. Tau-U scores less than 0.65 are reported as a small effect, 0.66–0.92 as a medium effect, and 0.93–1 as a large effect.

2.9. Inter-observer agreement and treatment fidelity

To ensure reliability of results, the researcher and a second trained observer (undergraduate in the special education program) recorded inter-observer agreement (IOA) data independently from one another. Training for the independent observer included: (a) providing the observer with detailed instructions with all variables operationally defined; (b) an opportunity to practice at least one session with the researcher; and (c) recording two additional practice sessions independently with 100% accuracy before moving on to videos used for IOA.

IOA data were collected during at least 33% of sessions in each study phase. IOA for dependent measures was calculated by dividing the number of recorded agreements by the number of agreements plus disagreements and then multiplying by 100. For duration recording, the total time was considered in agreement if within 5-s of one another. IOA for Mason was 96.3% (range 88.9–100). Aidan's IOA was 98.1% (range 89–100) and Landon's was 96.3% (range 88.9–100).

For treatment fidelity, the same observer who collected IOA used an itemized data sheet with a task analysis of steps the researcher was to carry out with each participant. The independent observer watched videos of each session and recorded completion or incompletion of each baseline and intervention procedure. Treatment fidelity was gathered during at least 33% of sessions in each study phase. Agreement was measured by dividing the number of correctly implemented steps observed by the total number of possible steps and then multiplying by 100. Treatment fidelity for Mason was 100%. Aidan's treatment fidelity was 99% (range 98–100) and Landon's was 97.9% (range 60–100).

2.10. Social validity

Social validity interviews were conducted to capture participant and teacher perspectives on the intervention as well as the physical activity of running. Social validity measures were collected twice, once before intervention was introduced and once after the study was complete. The teachers completed an initial questionnaire containing both Likert and open-ended questions related to opinions on the importance of participants' physical activity levels, practicality of each intervention, and participants' current technology usage as well as an exit questionnaire containing questions relative to how they felt about the study and any changes in opinion from their previous responses. Using a semi-structured interview protocol, participants answered questions related to the importance of physical activity, preferences on running with a person providing support versus running with technology providing support, and what they believed they needed to help them run (e.g., physical activity tracker). Participants could respond verbally or point to pictorial responses that were available for all social validity questions.

3. Results

When assessing the alternating treatments within intervention, the technology condition was superior to the in-person condition for two of the three participants. During thinning sessions, the two participants with increased performance in the technology condition were able to maintain levels of physical activity. Additionally, the same two participants were also able to generalize their level of engagement in physical activity to a new setting. Participant and teacher perspectives were positive towards physical activity, with Mason and Aidan showing preference for the technology condition and Landon showing preference for the in-person condition.

Fig. 1 illustrates the number of laps each participant performed in each session across study phases in addition to grey bars illustrating the duration of each session. Table 2 provides each participant's average for dependent measures across each phase including laps completed, duration, and heart rate reported as percentages of approximate heart rate maximum. Rate (laps per minute) was also included.

3.1. Engagement in physical activity

All three participants increased level of engagement in physical activity during one or both of the intervention conditions. During baseline sessions, level of engagement was stable for each participant with zero trend. Mason averaged 4.2 laps per session and Aidan and Landon averaged 1.0 lap per session. Results of probe sessions were similar to baseline for each participant during headphone and generalization probes as well as the music probe for Aidan and Landon. For the music probe, Mason's first session was increased from his baseline mean; however, two additional music probe sessions were added and performance dropped back to baseline levels. For all participants, there was minimal difference between resting and ending heart rates during baseline and probe sessions.

3.1.1. Intervention

Introducing praise statements corresponded with an increase in engagement in physical activity for all participants. Mason had increasing trends in both conditions, averaging 17.6 laps in the in-person condition (range: 14–28) and 19.4 laps in the technology condition (range: 16–30). Both interventions had an immediate impact on aerobic activity with an absolute change between baseline and intervention from 4 to 15 laps in the in-person condition and 4 to 16 laps in the technology condition. Mason's rate of laps per minute were also similar across conditions, averaging 2.9 laps/minute in the in-person condition and 3.0 laps/minute in the technology condition. Mason's Tau-U score was 1.0 for both in-person and technology conditions (90% CI [0.370, 1.630]), suggesting a strong effect for both conditions. During best treatment, Mason continued sessions in the technology condition, averaging 39.0 laps per session (range: 30–48).

Aidan also had an increasing trend in the technology condition, but a zero trend in the in-person condition, averaging 9.0 laps (range: 8–11) and 4.8 laps (range: 3–6) respectively. While he maintained a slightly slower speed in the technology sessions (1.4 laps/minute compared to 1.9 laps/minute during in-person sessions), he spent an average of four more minutes engaged in aerobic activity during technology sessions compared to in-person sessions. Aidan's Tau-U score was 1.0 for both in-person and technology conditions (90% CI [0.370, 1.630]). During best treatment, he continued sessions in the technology condition, averaging 10.4 laps per session (range: 8–15). Unlike Mason and Aidan, Landon had an increasing trend in the in-person condition and a decreasing trend in the technology condition, averaging 4.8 laps (range: 3–6) and 2.2 laps (range: 2–3) respectively. He averaged 2.0 laps/minute during both conditions. Landon's Tau-U score was 1.0 for both in-person and technology conditions (90% CI [0.370, 1.630]). During best treatment, he continued sessions in the in-person condition, averaging 8.0 laps per session (range: 5–11).

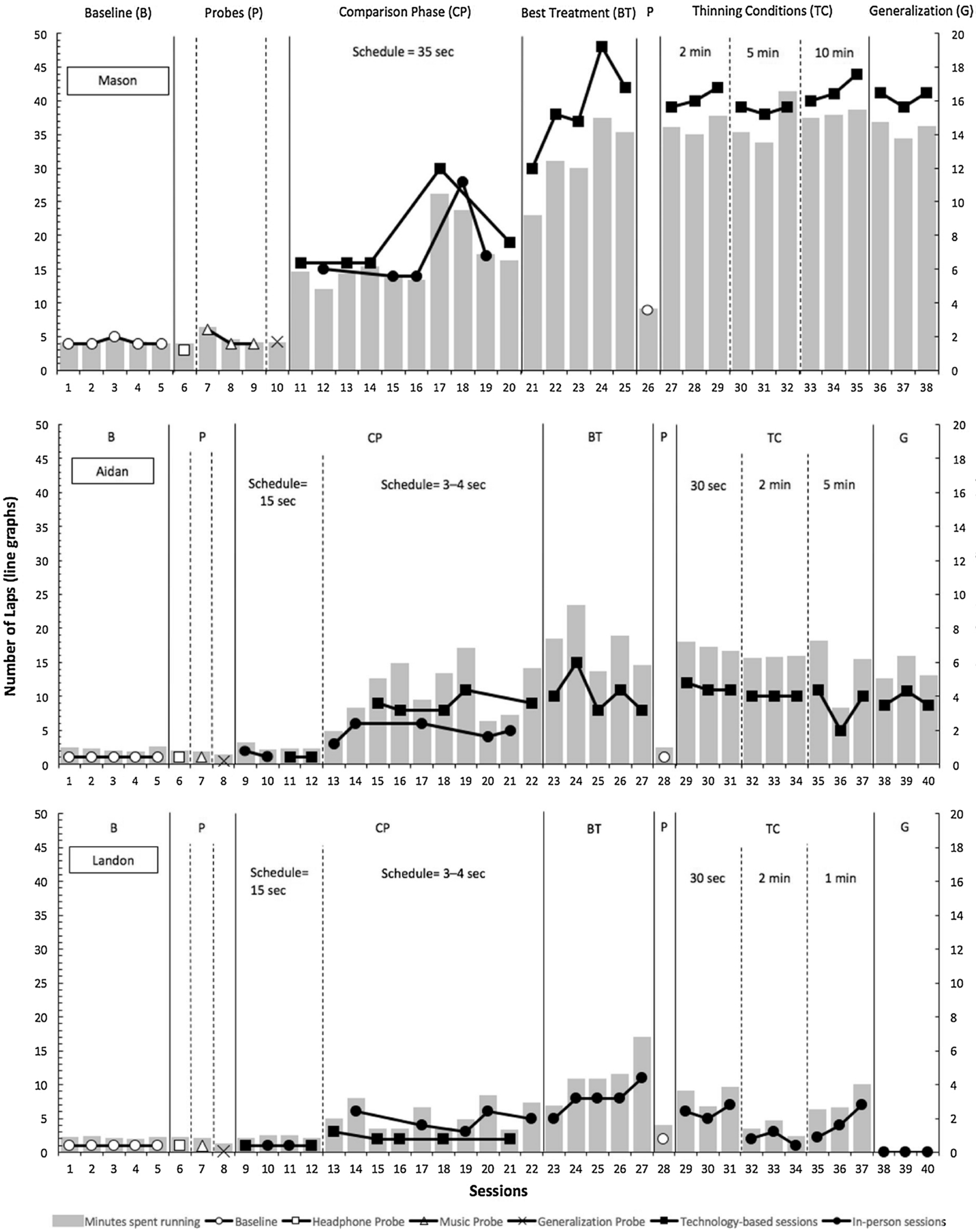

Fig. 1. Number of laps completed and minutes spent in aerobic activity.

Before systematically thinning praise statements, an additional baseline probe was conducted for one session. During this probe, Mason's performance decreased to nine laps, demonstrating good experimental control. While he didn't return to his original baseline level of 4–5 laps, his performance was much lower compared to the previous best treatment phase. Aidan's and Landon's performance dropped back to previous baseline performance levels.

Table 2
Participant Data Averages for Dependent Measures.

		Base	HPP	MP	GP	C-D	C-T	BT	BP	T1	T2	T3	Gen
Mason	Laps	4.2	3.0	4.7	4.3	17.6	19.4	39.0	9.0	40.3	38.7	41.7	40.5
	Duration (min)	1.3	1.2	1.6	1.3	6.0	6.5	12.1	3.3	14.1	14.3	14.8	13.9
	Rate (laps/min)	3.2	2.5	2.9	2.3	2.9	3.0	3.2	2.7	2.9	2.7	2.8	2.9
	% heart rate max-R	49%		47%		49%	48%	46%	46%	45%	45%	46%	44%
	% heart rate max-E	55%		54%		61%	64%	68%	53%	70%	63%	68%	67%
Aidan	Laps	1.0	1.0	1.0	0.4	4.8	9.0	10.4	1.0	11.3	10.0	8.7	9.4
	Duration (min)	0.5	0.4	0.4	0.2	2.5	6.5	6.7	0.6	6.5	5.9	5.2	5.1
	Rate (laps/min)	2.0	2.5	2.5	2.0	1.9	1.4	1.6	1.7	1.7	1.7	1.7	1.8
	% heart rate max-R	50%		51%		50%	52%	47%	51%	50%	46%	46%	45%
	% heart rate max-E	52%		51%		58%	63%	62%	52%	60%	58%	53%	54%
Landon	Laps	1.0	1.0	1.0	0.1	4.8	2.2	8.0	2.0	6.0	2.0	5.0	–
	Duration (min)	0.5	0.5	0.5	0.1	2.4	1.1	4.2	1.2	3.0	1.0	2.7	–
	Rate (laps/min)	2.0	2.0	2.0	1.0	2.0	2.0	1.9	1.7	2.0	2.0	1.9	–
	% heart rate max-R	51%		48%		47%	46%	50%	45%	46%	44%	44%	–
	% heart rate max-E	52%		51%		54%	47%	61%	45%	51%	44%	48%	

Note: This table represents averages for each participant's dependent measures. Duration is represented in minutes.
Base = baseline; HPP = headphone probe; MP = music probe; GP = generalization probe; C-D = in-person intervention sessions; C-T = technology intervention sessions; BT = best treatment; BP = baseline probe; T1 = first thinning condition; T2 = s thinning condition; T3 = third thinning condition; Gen = generalization; % heart rate max-R = resting heart rate reported as% of approximate heart rate maximum; % heart rate max-E = heart rate reported as% of approximate heart rate maximum at the end of each session.

3.1.2. Thinning praise statements

For Mason, praise statements were thinned to every 2-min, 5-min, and 10-min for the first, second, and third thinning conditions respectively. Mason had his top performance of the study during the last thinning condition, averaging 41.7 laps per session. His exercise intensity during those sessions averaged 68% of his approximate heart rate maximum. For Aidan, praise statements were thinned to every 30-s, 2-min, and 5-min for the first, second, and third thinning conditions respectively. Aidan had his top performance of the study during the first thinning condition, averaging 11.3 laps per session. His exercise intensity during those sessions averaged 60% of his approximate heart rate maximum. For Landon, during the first thinning condition (30 s), he averaged 6.0 laps per session (range 5–7). However, during the second condition (2-min), Landon's performance decreased back towards baseline levels. He completed 1–3 laps, averaging two laps per session. Due to the decreased number of laps, decreasing trend, and low stability, the researcher chose to go back to a denser schedule for the final thinning condition. During the final condition (1-min), Landon averaged 5.0 laps per session (range 4–7).

3.1.3. Generalization

During generalization, Mason and Aidan were able to maintain performance levels similar to their previous thinning sessions. Mason completed 39–41.2 laps, averaging 40.5 laps per session and Aidan completed 8.7–10.8 laps, averaging 9.4 laps per session. However, Landon refused to engage in the generalization phase. He watched the video model and listened to instructions. However, once the researcher gave the directive "time to start running now", he walked away from the basketball court and sat down on a chair in the gymnasium. When asked if he wanted to run, he stated "no". Landon's reaction after instructions was consistent for each attempt to engage him in generalization sessions across multiple days.

3.2. Social validity

3.2.1. Participant social validity

All participants were able to indicate which condition they preferred, how important physical activity was to them, and how they felt about using technology. During initial interviews, all participants stated they liked running and felt things like running, walking, and playing ball were important. Mason was able to extend answers beyond "yes" or "it's fun". For example, Mason stated he could not wait to get better at running because he was going to join the school's track team and get new shoes with the school's colors. Aidan and Landon used pictorial responses to assist in answering questions. When asked whether a person or the iPod would help more, Mason and Aidan indicated that a person helping them would be the best and Landon chose the iPod. However, when Landon chose the iPod picture he verbalized "music". It is possible he didn't understand the iPod would be used for a different purpose.

Following the study, all participants stated that they still liked running. When asked which condition they liked the best, each participant switched positions from their initial interviews. Mason and Aidan stated that the iPod helped them more, and Landon indicated a person helped him more. Mason and Aidan both expressed interest in the pedometer, choosing it as something that could help them run more. For questions related to the iPod, Mason provided detailed statements, favoring the iPod over a person helping directly. He mentioned, "I can't do it by myself, I need some help. The iPod enough help". Landon refused to answer questions that included discussion of the iPod and verbalized "no" when asked if the iPod helped him run longer as well as when asked any question related to using an iPod for physical activity or other activities.

3.2.2. Teacher social validity

Two teachers participated in social validity interviews. Both teachers agreed or strongly agreed (i.e., responded with a 4 or 5 on a 5–point Likert scale) that participants had difficulty transitioning to activities requiring physical exertion, physical activity was important for their participants, an intervention increasing time spent in exercise would be beneficial, and they would be willing to implement such an intervention. Teachers mentioned that Mason was more routinely involved in running activities, but not Aidan or Landon. Landon's teacher stated that he often refused to participate and asked to leave when arriving in adapted physical education class. Teachers mentioned that none of the participants used technology for self-directed learning (e.g., video modeling, checklists, auditory prompting), but supported the use of technology to assist their participants. Teachers felt use of technology would increase their independence and decrease their reliance on others. During the exit interview, both teachers agreed or strongly agreed with willingness to introduce technology-based strategies into daily activities. Landon's teacher stated that he was participating in adapted physical education and no longer asking to leave during class time.

4. Discussion

Individuals with ASD typically engage in low levels of physical activity (Sowa & Muelenbroek, 2012). With the many benefits regular engagement in physical activity can provide, it's essential to investigate strategies to increase engagement in physical activity. For this study, the researcher sought to compare in-person and technology-delivered praise statements on engagement in physical activity for participants with ASD. The researchers were also interested in performance maintenance as praise statements were thinned, each participant's ability to generalized performance to a new setting, and participant and teacher perspectives of physical activity. Results indicated mixed findings regarding both the more effective delivery option and preferred system for delivery of praise statements, two of the three participants maintained performance levels when praise statements were thinned and generalized performance to a new setting, and each participant's final preference for delivery system matched their better performing condition.

The findings of this study extend the literature on promoting engagement in physical activity for individuals with ASD in a number of ways. First, the mixed results indicate the importance of both traditional and technology-based strategies as well as the role participant preference can play on the success of a strategy. For two participants, a notable separation of data between conditions was observed. A notable separation was observed for Aiden with his performance being more successful in the technology condition (in-person $\mu = 4.8$ laps and technology $\mu = 9.0$ laps) while Landon was more successful in the in-person condition (in-person $\mu = 4.8$ laps and technology $\mu = 2.2$ laps). However, data separation for one participant was minimal. While the difference between conditions was minimal, Mason performed slightly better in the technology condition. More importantly, Mason expressed his preference for the technology condition throughout intervention and performance increased considerably during best treatment when only technology sessions took place. Furthermore, the condition each participant thought they would prefer in initial interviews was different from the condition they preferred in exit interviews. According to the *mere-exposure effect*, exposure to familiar stimulus leads to more positive ratings than other similar stimuli that were not previously presented (Zajonc, 1968). Before being exposed to both in-person and technology conditions, preference was possibly based on familiarity with previous praise delivery (delivered in-person only) or familiarity with what iPods were typically used for (e.g., listening to music). After having experience with both modes of delivery in the context of praise and physical activity, each participant was able to express their preferred condition with more certainty.

Second, the participants who continued sessions in the technology condition were able to maintain performance during thinning sessions while the participant who continued sessions in the in-person condition was unable to maintain performance. It is possible the music playing between praise statements during thinning conditions acted as a distractor for Landon, but as a motivator for Mason and Aidan. While Landon was unable to maintain performance levels across each thinning condition, Mason and Aidan increased performance during the thinning conditions. Both Mason's and Aidan's performance during music probes were similar to baseline levels, suggesting the importance praise statements served in increased performance levels.

Finally, Mason and Aidan, who were successful with maintaining their performance during thinning conditions, also demonstrated an ability to generalize their performance levels to a new setting. The generalization gymnasium required participants to run around a much larger perimeter than the perimeter they ran around during other phases—148 feet larger. Mason and Aidan's ability to maintain performance levels across settings was similar to results from previous studies where researchers used technology to provide support to participants with ASD with successful results when generalizing tasks or behaviors to new settings (e.g., Taber et al., 1999). While Mason and Aidan were successful in maintaining performance during generalization, Landon refused to engage in generalization sessions. When asked if he was going to walk, he responded "no" each time. It is possible generalization was easier for participants receiving technology-delivered praise because the participants received praise that was *one-step removed* from the context of their environments and more conducive to generalization (i.e., receiving praise through the device and not directly from the researcher in the environment; Charlop-Christy, Le, & Freeman, 2000). However, there are too many unidentified variables that were possibly responsible for Landon's lack of performance in generalization. The conclusion of the study occurred at the same time as the participant's winter break. It is possible that Landon had *checked-out*. In other words, he was ready for break and didn't feel like engaging in physical activity. As well, his lack of engagement may be related to unknown elements present in the generalization environment (e.g., space too large).

4.1. Implications for practice

This study holds implications for practice. First, educators should examine the procedures for both traditional and technology-based interventions. In this investigation, treatment fidelity scores were higher for technology sessions compared to in-person sessions. In-person sessions required much more attention to the participant to implement the praise statements and study procedures with high fidelity. For the technology condition, recording and uploading praise statements to the devices took approximately 5-min per participant. However, once praise statements were recorded and uploaded to iTunes®, there was consistent implementation with high fidelity without any additional work needed by the researcher.

In addition to examining the practicality of implementation for each condition, exposing individuals to both technology and more traditional forms of support provides benefits beyond allowing individuals to make a more informed decision on their preferred method. Specifically, individuals should be familiar with a back-up plan in the event that the device they are using to receive support breaks or is unavailable. For example, if someone knows how to self-monitor with paper/pencil as well as with using a tablet, s/he is able to continue self-monitoring with minimal interruption if the tablet were to break.

The technology itself holds implications as well. Although the devices in this study cost more than $100, there are lower-cost options available. An advantage to using commercially available devices is the decreased likelihood of stigmatization for individuals with a disability (Bouck, Satsangi, Bartlett, & Weng, 2012) as well as the lower price tag that is more typical compared to specialized assistive technology devices (Cihak, Kessler, & Alberto, 2008). Use of a lower-cost technology may also support continued use past the conclusion of the research study since schools, participants, and/or parents might be able to afford the technology (Bouck et al., 2012). Finally, participants demonstrated the ability needed to operate the devices with minimal training. This is similar to other studies examining the effect of self-operated systems for individuals with ASD (Mays & Heflin, 2011; Taber-Doughty, 2005).

4.2. Limitations and future directions

There were limitations to this study worth noting. The experimental design itself was a possible limitation. Specifically, it is possible that one condition was influencing performance in sessions of the other condition. Performance during the best treatment phase increased considerably for one participant, indicating interaction effects are likely. A further limitation in the design was the decision to conclude the study when additional sessions would provide valuable insight for participants. For example, one more thinning condition with no praise may possibly demonstrate Mason's ability to remove the independent variable completely. For Landon, additional sessions should have been conducted after the generalization phase, retuning him to a condition that was previously successful. If Landon engaged in aerobic activity after refusing to engage in the generalization phase, more information would be available supporting that a factor in the generalization environment facilitated a change in behavior.

In addition to design limitations, procedural limitations included not calibrating devices used to measure heart rate. Resting heart rate measure for all participants were within the normal range for adults who are non-athletes, however, they on the upper end of the normal range. While we can't be certain, since heart rate measures were not obtained before participants walked to the upstairs gymnasium, it's possible the higher resting heart rate readings were due to participants walking to the opposite side of the high school, followed by climbing two flights of stairs to get to the gymnasium used for the study.

Related to the intervention, it isn't clear whether the intervention was actually reinforcement based or if the praise statements were serving as discriminative stimuli or prompts; it is possible the intervention served multiple functions. For example, there were a number of occasions when Aidan and Landon stopped engaging in aerobic activity, received a praise statement on their fixed-time schedule, and continued engaging in the session within the 5-s allowed for interruption time. In these situations, the praise statements may have served as prompts to engage in aerobic activity.

Finally, while results suggest verbal praise was effective for increasing engagement in physical activity, it is important to note that one of the participants began to independently self-monitor his behavior starting in the fourth best treatment session (i.e., he created his own intervention package of praise and self-monitoring). Mason began independently monitoring the number of steps he took through observation of his pedometer. While he did not record his data, he was able to recall the steps he took previously and compare them to the current session. With the addition of this self-monitoring, we are unable to determine if he would have been as successful with only receiving praise throughout the remainder of the study.

There are areas of research that merit future consideration within physical activity and individuals with ASD. Future studies should look into the effects of increased engagement in physical activity over time. Similar to previous studies such as Todd and Reid (2006), participants in this study engaged in exercise for fewer than 30-min per session and the study only lasted 7-weeks. Future studies should examine the effects of exercise over an extended period of time (e.g., 4-month program). For studies investigated over an extended period of time, researchers should gather necessary information (e.g., height, weight) to determine fitness levels before and after the completion of the study as well as measure variations in outcomes by the level of intensity of exercise (e.g., light versus moderate physical activity; Sorensen & Zarrett, 2014). For an exercise program taking place over an extended period of time, it would also be interesting to determine if participants could maintain performance levels once praise was thinned completely or if researchers would need to add in another strategy such as goal setting for continued motivation. Specifically, praise alone may not remain effective for a study with a longer duration due to possible satiation effects (Kahng, Iwata, Thompson, & Hanley, 2000).

Researchers should also investigate the most effective delivery options to support individuals through a task. While traditional methods are effective, studies suggest there are advantages of supporting participants with ASD through technology for task completion, managing behaviors, and task engagement (Charlop-Christy et al., 2000; Mays & Heflin, 2011; Taber-Doughty, 2005; Taber et al., 1999). As newer technologies emerge and technologies continue to become more available in schools and homes, researchers must keep abreast of the advantages such instructional and assistive technologies can have for individuals with ASD.

Conflict of interest

The authors declare that they have no conflict of interest.

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References

Bennett, K. D., Ramasamy, R., & Honsberger, T. (2013). The effects of covert audio coaching on teaching clerical skills to adolescents with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 43*, 585–593. http://dx.doi.org/10.1007/s10803-012-1597-6.

Bouck, E. C., Satsangi, R., Bartlett, W., & Weng, P. (2012). Promoting independence through assistive technology: Evaluating audio recorders to support grocery shopping. *Education and Training in Autism and Developmental Disabilities, 47*, 462–474.

Charlop-Christy, M. H., Le, L., & Freeman, K. A. (2000). A comparison of video modeling with in vivo modeling for teaching children with autism. *Journal of Autism and Developmental Disorders, 30*, 537–552. http://dx.doi.org/10.1023/A:1005635326276.

Cihak, D. F., Kessler, K., & Alberto, P. A. (2008). Use of a handheld prompting system to transition independently through vocational tasks for participants with moderate and severe intellectual disabilities. *Education and Training in Developmental Disabilities, 43*, 102–110.

Gast, D. L., & Spriggs, A. D. (2010). Visual analysis of graphic data. In D. L. Gast (Ed.). *Single subject research methodology in behavioral sciences* (pp. 202–204). New York: Routledge.

Hildebrandt, V. H., Chorus, A. M. J., & Stubbe, J. H. (2010). *Trend report of physical activity and health 2008/2009. TNO Innovation for Life*. Leiden: TNO Innovation for Life.

Kahng, S., Iwata, B. A., Thompson, R. H., & Hanley, G. P. (2000). A method for identifying satiation versus extinction effects under noncontingent reinforcement schedules. *Journal of Applied Behavior Analysis, 33*, 419–431.

Kurti, A., & Dallery, N. J. (2013). Internet-base contingency management increases walking in sedentary adults. *Journal of Applied Behavior Analysis, 46*, 568–581.

LaLonde, K. B. (2015). *Increasing physical activity for young adults with autism spectrum disorder. (Doctoral dissertation)*. 529. Retrieved from http://scholarworks.wmich.edu/dissertations/529.

Matsumura, K., & Yamakoshi, T. (2013). iPhysiometer: A new approach for measuring heart rate and normalized pulse volume using only a smartphone. *Behavior Research, 45*, 1272–1278. http://dx.doi.org/10.3758/s13428-012-0312-z.

Mays, N. M., & Heflin, L. J. (2011). Increasing independence in self-care tasks for children with autism using self-operated auditory prompts. *Research in Autism Spectrum Disorders, 5*, 1351–1357. http://dx.doi.org/10.1016/j.rasd.2011.01.017.

Parker, R. I., Vannest, K. J., Davis, J. L., & Sauber, S. B. (2011). Combining nonoverlap and trend for single-case research: Tau-U. *Behavior Therapy, 42*, 284–299. http://dx.doi.org/10.1016/j.beth.2010.08.006.

Sorensen, C., & Zarrett, N. (2014). Benefits of physical activity for adolescents with autism spectrum disorders: A comprehensive review. *Review Journal of Autism and Developmental Disorders, 1*, 344–353. http://dx.doi.org/10.1007/s40489-014-0027-4.

Sowa, M., & Muelenbroek, R. (2012). Effects of physical exercise on autism spectrum disorders: A meta-analysis. *Research in Autism Spectrum Disorders, 6*, 46–57.

Taber, T. A., Seltzer, A., Heflin, L. J., & Alberto, P. A. (1999). Use of self-operated auditory prompts to decrease off-task behavior for a participant with autism and moderate mental retardation. *Focus on Autism and Other Developmental Disabilities, 14*, 159–166.

Taber-Doughty, T. (2005). Considering participant choice when selecting instructional strategies: A comparison of three prompting systems. *Research in Developmental Disabilities, 26*, 411–432. http://dx.doi.org/10.1016/j.ridd.2004.07.006.

Todd, T., & Reid, G. (2006). Increasing physical activity in individuals with autism. *Focus on Autism and Other Disabilities, 21*, 167–176. http://dx.doi.org/10.1177/10883576060210030501.

US Department of Health and Human Services: Physical Activity Guidelines for Americans (2008). Available from: http://www.health.gov/paguidelines/guidelines/.

Wolery, M., Gast, D. L., & Hammond, D. (2010). Comparative intervention designs. In D. L. Gast (Ed.). *Single subject research methodology in behavioral sciences* (pp. 329–381). New York: Routledge.

Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology, 9*(2), 1–27. http://dx.doi.org/10.1037/h0025848.