Let’s Go Under! Teaching Water Safety Skills Using a Behavioral Treatment Package

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Abstract: Drowning is a leading cause of unintentional death among children worldwide. Children with autism spectrum disorder (ASD) are at higher risk for incidents of drowning than their non-disabled peers. Mastering water safety skills, such as underwater submersion, has been associated with a decreased risk for incidents of drowning. Using a combined multiple-baseline and changing-criterion design, this study examined the effects of a behavioral treatment package consisting of shaping, prompting, and positive reinforcement utilized to teach three young children to demonstrate underwater submersion during weekly swimming lessons. During baseline, none of the participants submerged their head underwater despite previous modeling and instruction. Following the implementation of the behavioral treatment package, all three participants submerged their entire head underwater. Each participant maintained this skill following instruction and later developed more advanced swimming abilities utilizing the mastered skill of underwater submersion.

There are many reported potential benefits of teaching children to swim. These include health and safety benefits, developmental advantages, improvements in academic performance, and a strengthening of social-emotional abilities. Reported health benefits include a decreased risk for chronic illness (Chase, Sui, & Blair, 2008), improvement of the symptoms of arthritis (Westby, 2001), weight management (Gappmaier, Nelson, & Fisher, 2006; King, Wasse, & Stensel, 2011; Tremblay, Inman, & Willms, 2000), and a decreased risk for heart disease later in life (Brinks, Franklin, & Spring, 2009). The ability to swim also improves personal safety, as swimming ability has been associated with a decreased risk for drowning (Asher, Rivera, Felix, Vance, & Dunne 1995; Smith, 1995). The Center for Disease Control (CDC, 2014) lists drowning as the fifth highest cause of unintentional death in the United States. Swimming ability is especially critical for children, as drowning is noted as a leading cause of death among children under age 15 worldwide (Peden & McGee, 2003; Petras & Blitvich, 2014; World Health Organization (WHO, 2008), with the highest rates reported in children under the age of five. Teaching children to swim is recommended to minimize the risk for incidents of drowning (Asher et al., 1995; CDC, 2014; Smith, 1995). Related to developmental benefits of learning to swim, Jorgensen (2013) reported that early swimming participation by children is associated with earlier achievement of a range of developmental milestones, including those in motor, cognitive, linguistic, and social-emotional categories. Regular participation in swimming is credited with improved attention and academic performance (Frankl, 1996) and improved psychological and social benefits in adulthood (Berger & Owen, 1992; Tremblay et al., 2000). For example, swimming is associated with a decreased risk for depression and anxiety (Tomas-Carus, Gusi, Hakkinen, & Ortega-Alonso, 2008) and improved self-

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Esteem (Frankl, 1996; Tremblay et al., 2000). Improved family connections and relations are reported when swimming occurs as a family recreational activity (Rogers, Hemmeter, & Wolery, 2010). Learning and regularly participating in swimming can be beneficial to individuals of all ages and for a variety of reasons.

Increasing opportunities for physical activity can especially benefit children with special needs, including children diagnosed with ASD. Children with special needs often have limited access to leisure activities and lower than typical performance in motor skills (Murphy & Carbone, 2008; Smith, 2001); learning to swim can address both of these limitations. In addition, children with ASD often exhibit high rates of stereotypical behaviors which have been successfully decreased by teaching physical activities and games, such as swimming (Leaf & McEachin, 1999; Smith, 2001). Most importantly, teaching a child with ASD to swim increases safety and decreases risk for injury around water. Children with ASD have been reported to demonstrate an increased tendency to wander from supervised locations, often near water environments such as pools or ponds (Italie, 2015). Increasingly, incidents of wandering are associated with incidents of drowning. McIlwain and Fournier (2012) report the wandering behavior of children with ASD as up to four times that of non-ASD siblings; 91% of the deaths reported in children with ASD in the United States between the years 2009–2011 were attributed to drowning that occurred following an incident of wandering or elopement. For all of these reasons, swimming is an important and beneficial skill for children with ASD, and increased attention has been devoted to funding and providing for effective swim instruction for children with a diagnosis on the autism spectrum (Italie, 2015).

The tactics and methods of applied behavior analysis have been used to successfully teach children, including children with special needs, a variety of swimming skills in situations where other methods have failed. Yilmaz, Konukman, Birkan, and Yanardag (2010) taught three autistic boys simple swimming skills using most-to-least prompting. Rogers et al. (2010) taught three foundational swimming skills (kick, front crawl arm strokes, and head turn) to children with autism using a response promoting with constant time delay procedure. Fueyo, Saudargas, and Bushell (1975) examined the effect of specific and non-specific feedback on teaching swimming skills to four handicapped teenagers. Koop and Martin (1983) utilized a behavioral treatment package consisting of modeling, error correction, and positive reinforcement to decrease persistent errors in swim strokes demonstrated by five teen-age competitive swimmers. Each of these studies demonstrated the success of using systematically planned behavioral tactics to develop swimming skills.

Underwater submersion and reorienting one-self after unintended underwater submersion are identified as critical skills for decreasing the risk of drowning among young children (Lifesaving Society, 2012; Smith, 1995). Previous studies using behavioral tactics to teach swimming skills did not target underwater submersion. This skill, while critical for the safety of all individuals, is often resisted by young children. Shaping is a behavioral tactic that is often used to develop new skills when an individual is resistant to practicing a skill or no portion of the skill is within the individual’s repertoire, making the delivery of prompts, praise, or error correction difficult (Cooper, Heron, & Heward, 2007).

This study adds to the existing literature on using behavioral tactics to teach safety skills, specifically water safety skills, to children, including those diagnosed with ASD. In this study, the water safety skill of underwater submersion was taught to three children using a behavioral treatment package consisting of shaping, prompting, and positive reinforcement.

**Method**

**Participants and Setting**

Three children enrolled in swimming lessons at a local recreational center participated in this study. All three were selected by the swimming instructor for participation as they had continually resisted underwater submersion in previous lessons. Subject one, Allison, was a typically developing 4-year-old girl who had been enrolled in swimming lessons for approximately one year. Subject two, Izzy, was a
4-year-old boy diagnosed with pervasive developmental disorder, not otherwise specified (PDD-NOS) who had been enrolled in swimming lessons for one year. Subject three, Kaleb, was an 8-year-old boy diagnosed with pervasive developmental disorder (PDD) who had been enrolled in swimming lessons for three years. Each participant was able to enter the water and swim independently or swim with a floatation device but did not demonstrate underwater submersion, despite previous modeling and instruction. One female swim instructor conducted all aspects of the instruction. At initiation of the study, the instructor was 32 years old, had been a certified swim and water safety instructor for 18 years, and was also enrolled in a local university as a graduate student in applied behavior analysis (ABA). The instructor was employed part-time for the organization at which the swimming lessons were conducted.

The lessons were held at a private, local recreation center in western Massachusetts, in a six-lane, heated, 25-yard pool. The pool measured 3 [1/2] feet deep at one end and slowly descended to 11 feet deep at the opposite end. The lessons took place in an open area of the pool where two side-by-side lanes were accessible. The shallow section of the pool held stairs to descend into the water, while the deeper section of the pool used a ladder attached to the wall. On one side of the room, a glass wall ran parallel to the pool; on the other was a solid wall with bleachers. Instruction was conducted during the participants’ regularly scheduled swimming lessons.

Research Design

Instruction took place over approximately one year of weekly swimming lessons, each lasting 30 minutes in duration and held once per week. A combined multiple-baseline and changing-criterion design (Kazdin, 2011; McDougall, Kawkins, Brady, & Jenkins, 2006) was used to evaluate the effects of a treatment package combining shaping, prompting, and positive reinforcement on the skill of underwater submersion. This combined design was selected due to the presence of multiple participants enrolled in different swim classes with the same instructor who were resisting underwater submersion, a situation suited to the use of a multiple-baseline design across individuals. In addition, the changing criterion design is well-suited to situations in which mastering the target skill requires gradual progression toward a terminal goal, such as in this case, where the target skill was resisted (Kazdin, 2011). The intervention package was implemented successively across the three participants. For each participant, baseline preceded an intervention phase. The length of the baseline condition varied across participants, with baseline measurement continuing for participants two (Izzy) and three (Kaleb) while the treatment package was implemented with subject one (Allison) to allow for inferences to be drawn about the effect of the intervention on the dependent variable (Kazdin, 2011). Further, baseline measurement continued for subject three (Kaleb) while intervention was initiated with subject two. The intervention phase for each participant was divided into sub-phases, with each sub-phase requiring a more complex approximation of the dependent variable in order to access reinforcement. Seven sub-phases were planned, each corresponding to a step of a task analysis of underwater submersion. During intervention, instruction began with step one only (sub-phase 1); each subsequent sub-phase added one additional step of the 7-step task analysis to instruction from the highest step mastered in the previous sub-phase. The seven targeted steps were: 1) chin wet, 2) chin and lips wet, 3) chin, lips, and nose wet, 4) chin, lips, nose, and ears wet, 5) chin, lips, nose, ears, and eyes wet, 6) chin, lips, nose, ears, eyes, and forehead wet, and 7) whole head submerged and wet. The total number of sub-phases varied for each participant as in some cases a participant exceeded mastery criterion within a sub-phase. Each sub-phase continued until the targeted step or steps were demonstrated for three consecutive sessions, at which point instruction advanced to the next sub-phase and the criterion for reinforcement was increased in the following lesson.

Measures

The dependent variable measured was underwater submersion, defined as any occurrence of the swimmer submerging the whole head underwater, including their chin, mouth,
nose, ears, eyes, and hair, for at least five consecutive seconds. Non-occurrences included any attempt at underwater submersion where the participant wet only their face, leaving their hair dry, or leaving the tip of their head out of the water. For measurement purposes, successive approximations of the dependent variable were listed as consecutive steps on the data sheet. Data was recorded on each step completed correctly during each lesson; the total number of steps correct was calculated, recorded, and graphed for analysis purposes. Due to measurement occurring near water, Revlar® waterproof paper (available through Relyco®) was utilized during lessons and the data from each lesson was transferred to a summary sheet at the end of the lesson.

Baseline data was gathered prior to introducing the intervention for all three participants. With participant one, baseline measurement was conducted for three lessons. Baseline measurement continued for participants two and three while the intervention was implemented for participant one. With participant two, baseline continued for 23 lessons and with participant three, baseline continued for 51 lessons. One trial only per lesson was conducted during baseline. If the child did not imitate underwater submersion at that time, the instructor recorded zero steps completed and moved to another skill or activity according to the swimming curriculum. A single trial of underwater submersion per lesson was conducted during baseline due to the participants’ resistance to this skill. Previous to beginning the intervention phase introduced in this study, each of the participants demonstrated resistance in the form of crying (participants one and two) or loud vocal refusal (participant three) when underwater submersion was prompted. As lessons were only one-half hour in duration and other swim skills were targeted for each participant, the instructor wanted to assure that the aversive nature of the skill of underwater submersion would not prevent the remainder of the lesson from succeeding.

In each sub-phase of instruction, a plus mark was recorded on the data sheet next to the steps of underwater submersion correctly demonstrated during each 30-minute swim lesson. During intervention, the swimmer was given three opportunities per lesson to demonstrate underwater submersion: at the beginning, middle, and end of the lesson. This was possible as resistance to underwater submersion no longer occurred. A correct response on any of the steps during any of the three opportunities resulted in a single recording of correct for those steps in that lesson. At the conclusion of the lesson the data for that lesson was transferred onto a paper summary sheet in order that the waterproof data sheet could be re-used. The summary sheet listed the number of steps completed correctly for each participant. The primary swim instructor recorded data during all lessons while in the pool with a grease pencil; the data sheet and pencil were positioned at the side of the pool. Three additional swim teachers, one lifeguard, and a supervising Board Certified Behavior Analyst (BCBA®) were trained as independent observers by the primary swim instructor on how observe, measure and record data for each step or approximation of the target skill. To gather additional data on inter-observer agreement, each subject was also videotaped during several lessons.

Measurement of inter-observer agreement (IOA) occurred during 30% of the total number of intervention sessions (4 of 27 lessons with subject two and 8 of 13 lessons with subject three). Two different independent observers gathered IOA data for subject two; three different independent observers gathered data for subject three. IOA measured 100% across all measured sessions.

Procedure

During baseline, the instructor verbally directed the swimmer to submerge their head underwater and modeled this skill for the child. Praise was delivered if the child correctly imitated the skill; if the child refused or did not demonstrate the skill, the instructor continued with the lesson, focusing on other swim skills.

Within each sub-phase of instruction, prompting using verbal direction and modeling was used to evoke the targeted approximation of underwater submersion, based on the step targeted and the criterion established for reinforcement in that sub-phase. Following correct imitation of the targeted approxima-
tion by the swimmer, positive reinforcement in the form of praise was delivered and access to a brief preferred activity or game was allowed. These activities varied with the lesson and as swim skills advanced, began to include underwater activities such as retrieving items underwater on the pool’s steps. Any trial that resulted in a refusal or an incorrect performance of any part of the targeted step resulted in a repeat of the model combined with a stimulus prompt in the form of a touch to the body part that was supposed to be wet. A second incorrect response resulted in moving to a different swimming skill and returning for a 3rd attempt a few minutes later in the lesson. This sequence was repeated at the beginning, middle, and end of the lesson. After three consecutive lessons with correct performance of the targeted step for that sub-phase, a step was added to instruction and the criterion for reinforcement was increased in the next scheduled session.

Results

Figure 1 displays the results of the intervention across participants and sub-phases of instruction. The ordinate shows number of steps completed correctly and the abscissa displays consecutive swim lessons. During the baseline condition, none of the three participants demonstrated underwater submersion, or any approximation of underwater submersion as defined in the methods section of this study; all three resisted imitating or attempting this skill. Following intervention, all three participants in this study successfully demonstrated...
underwater submersion without resistance. Each individual swimmer progressed at a different pace through the instructional sequence. Participant one, Allison, required 20 lessons following baseline to reach the targeted goal (entire head under water). Following baseline, Allison achieved mastery of step one within three lessons, and in fact exceeded criterion in sub-phase one in each lesson. The final sub-phase required eight swim lessons before mastery was achieved. Subject two, Izzy, required 27 lessons beyond baseline to achieve mastery. Sub-phase four, which required complete underwater submersion, was the longest phase; 18 swim lessons were required before mastery criterion was met. Kaleb, subject three, required 13 lessons beyond baseline to demonstrate mastery of the target skill. Maintenance probes conducted 6, 12, and 24 months after mastery for each participant noted that all three participants maintained the skill of underwater submersion and advanced on related swim skills that required underwater submersion. All three participants, for example, later learned to swim underwater, jump in the pool and submerge underwater from the jump, and swim with their face in the water.

Discussion

Participation in physical activities, such as swimming, is beneficial for many reasons. Among these benefits, swimming can improve health, psychological well-being, attention, academic performance, and social competence. The specific swimming skill targeted in this study, underwater submersion, has the added benefit of potentially increasing an individual’s physical safety when in or near water, as individuals who can right themselves after sudden, unexpected underwater submersion decrease their risk for drowning. The behavioral tactics used in this study successfully taught underwater submersion to three children, two with a diagnosis of ASD, where other methods had failed. Specifically, the results of this study demonstrate that a treatment package including shaping, prompting, and positive reinforcement can successfully teach children to demonstrate specific swimming and water safety skills. Further, this study demonstrated the successful use of behavioral intervention in a community-based recreational facility with typical staffing, as the treatment package was utilized by a swim instructor in the context of regularly scheduled swim lessons. Finally, this study presents an application of a combined multiple-baseline and changing-criterion design in a recreational setting, adding to the literature supporting the usefulness of single-case experimental methodologies in conducting systematic, data-based instruction. Risks associated with use of this treatment package were minimal, but included risks associated with any water exposure for children. In this study, these risks were minimized by the presence of a certified lifeguard in the pool area during lessons and the swim instructor’s certification as a water safety instructor through the American Red Cross®. Further, aquatics experts note the risk that an increase in swimming skills may give parents a false sense of security in regards to the safety of their child around water; consequently, even for a child who can swim and submerge underwater, close continuous supervision of children while swimming is recommended (American Red Cross, 2014).

Desired outcomes of behavioral instruction include generality and maintenance (Baer, Wolf, & Risley, 1968), both of which were achieved in this study. All three participants, including the children diagnosed with ASD, not only mastered the skill of underwater submersion, but maintained this skill for several years beyond instruction and generalized this skill to other swimming skills and water activities. For example, two of the participants later demonstrated more advanced swimming skills that require underwater submersion, including diving, jumping in the pool, and swimming underwater.

There are several limitations to the experimental design utilized and hence the inferences drawn about the intervention effect in this study. The number of participants was small and, therefore, limits the external validity of the overall treatment claims. However, demonstration of the effectiveness of this procedure systematically across three participants, including a typically developing child and two children diagnosed with ASD, suggests that this treatment may be useful for swim instructors in typical recreational facilities offering swim lessons with minimal disrup-
tion where other methods have failed. Other limitations to the conclusions inferred in this study include the varying number of trials conducted during baseline compared to the number of trials during intervention phases, due to swimmer resistance of underwater submersion during baseline, and the rapid changes in performance that exceeded criterion for each of the participants in specific sub-phases of intervention, potentially impacting the evaluation of intervention effect. The use of a multiple-baseline design, and specifically the failure of participants two and three to demonstrate any step of the dependent variable correctly until the intervention was introduced balances these limitations and adds evidence to support the inferences made.

The use of a combined multiple-baseline and changing-criterion design with demonstrated reliable measurement in an inclusive, recreational environment supports the conclusion that behavioral technologies can be flexible and manageable in a range of settings and for a range of target behaviors and skills. This study adds to decades of research that promote the utility of behavioral intervention in teaching socially valid outcomes for individuals with and without developmental disabilities. Furthermore, this study replicates previous research demonstrating the effectiveness of behavioral intervention for teaching swimming and water safety skills, and advances this research, effectively applying a behavioral treatment package to the instruction of underwater submersion.

References


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