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An extension of commonly used toilet-training procedures to children with autism spectrum disorder

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The current study evaluated a toilet-training treatment package described by Greer et al. (2016) with children diagnosed with autism spectrum disorder (ASD). Most of the current research on toilet-training interventions for children with ASD are replications and modifications of Azrin and Foxx (1971) or (more recently) LeBlanc et al. (2005). However, these procedures are composed of components that are not included in studies with typically developing (TD) children. For example, Greer et al. evaluated the effectiveness of three typical components within a toilet-training package, mostly with TD participants: a 30-min sit schedule, placing participants in underwear, and differential reinforcement. The primary purpose of the current study was to replicate and extend the treatment package described by Greer et al. to children with ASD. A secondary purpose was to evaluate modifications necessary for individualized toilet training when the commonly used components were ineffective. The results of Greer et al. were replicated for 11 participants with ASD in the current study, suggesting that intensive toileting interventions (e.g., interventions requiring overcorrection, reprimands, and dense sit schedules) may only be necessary for a subset of individuals with ASD.

Key words: autism spectrum disorder, early intervention, positive reinforcement, toilet training

Behavior analysts often conduct toilet training, especially those working in early intervention settings providing applied behavior analysis (ABA) therapy for individuals with intellectual and developmental disabilities (IDD) or autism spectrum disorder (ASD). Given that toileting involves multiple component skills, it might be advantageous for behavior analysts in early intervention settings to become familiar with age-typical toileting skills as a starting point for intervention. For example, in order to understand the development of toileting skills in typically developing (TD) children, a longitudinal study conducted by Schum et al. (2002) examined the age at which TD children tend to develop toileting (or "readiness") skills. They found that toileting skills begin to emerge between 22 and 30 months of age for TD children. According to Schum et al., "readiness" skills included but were not limited to: understands vocabulary pertaining to elimination, shows interest in the toilet, knows how to urinate in the toilet, washes hands independently, and knows how to wipe effectively. The cohort in Schum et al. included 267 TD children (15 to 42 months old), consisting of 126 girls and 141 boys. Moreover, they found that the girls in their sample acquired toileting skills earlier than the boys. It is important to note that the data were purely descriptive in nature;

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parents were given a survey every week and asked to rate their child's behavior on a 1-5 Likert Scale on 28 different items. Dalrymple and Ruble (1992) distributed a similar survey to caregivers of children with ASD. They found that the average age at the onset of toilet training for children with ASD was older than that of their TD peers. Furthermore, the participants in their sample took an average of 1.6 years to be urine trained and 2.1 years to be bowel movement (BM) trained. Their recommendations included waiting until 4 years of age before beginning toilet training for individuals with ASD.

In their seminal article, Azrin and Foxx (1971) implemented a toilet-training package for nine adults with IDDs living in a residential facility. The package consisted of: differential reinforcement for appropriate eliminations, scheduled sits, overcorrection, and time-out from reinforcement contingent on accidents. However, the use of other punishment-based procedures, including contingent showers and restitution in the form of laundering one's own soiled clothes, have led other researchers to evaluate modified and less-intrusive interventions that may be more acceptable in contemporary society, especially for young children in day programs such as schools and clinics rather than inpatient facilities. LeBlanc et al. (2005) examined a treatment package with three participants diagnosed with ASD consisting of: (a) wearing underwear rather than diapers or pullups, (b) a sitting schedule, (c) positive reinforcement (i.e., praise and delivery of preferred items) and negative reinforcement (i.e., escape from the toilet) for appropriate urinations, (d) increased fluids, (e) communication training, (f) urine sensor and alarm, and (g) reprimands and positive practice for accidents. The package produced a decrease in urinary accidents for all three participants; however, it is unclear which components of the treatment package were necessary for success.

Hanney et al. (2012) replicated the procedures described by LeBlanc et al. (2005) in a subsequent archival analysis with a large sample of children with ASD. Additionally, Cocchiola et al. (2012) evaluated a school-based toilet-training procedure for five preschool aged participants diagnosed with either ASD or developmental delays. Their method involved: (a) placing participants in underwear, (b) 30-min sit schedule, (c) fluid offering, (d) toileting task analysis, including steps to walk in to the bathroom, pull pants up and down, sit on the toilet, and wash hands, (e) reinforcement for appropriate elimination, and (f) a neutral statement when accidents occurred (e.g. "You wet your pants, you need to change") and changing clothes. Although these procedures may be more socially acceptable than those of Azrin and Foxx (1971), they are relatively complex given the number of treatment and punishment-based components (e.g., reprimand and positive practice) involved.

More recently, Greer et al. (2016) conducted a component analysis of toilet-training procedures. They used a nonconcurrent multiple baseline design across subjects to evaluate a more component-lean treatment package consisting of wearing underwear, differential reinforcement, and a dense sit schedule with each component in isolation or in combination. Participants were 19 TD children and one child diagnosed with ASD (*M* age = 2 years 2 months; range, 1 year 7 months to 3 years 3 months). Greer et al. identified wearing underwear as the most essential component, which is consistent with prior literature examining the importance of underwear compared to pull-ups or diapers (Simon & Thompson, 2006; Tarbox et al., 2004). The authors hypothesized that the advantages of switching to underwear included: (a) positive punishment as a function of being wet; (b) increased detectability of accidents by teachers; or (c) positive punishment as a function of soiling preferred underwear (e.g., briefs with popular characters on them). Notably, the treatment package was not immediately effective for every participant following baseline

(i.e., there were still some children having accidents).

Aaron, the participant in Greer et al. (2016) diagnosed with ASD, was placed into the group receiving the total treatment package (i.e., underwear, differential reinforcement, and dense sit schedule) and his data indicate a clear increase in appropriate urinations during treatment relative to baseline. However, it is unknown whether children with ASD will generally respond well to a toilet training procedure designed for TD children, such as that examined by Greer et al. If they do, it might be easier to integrate children with ASD into more typical preschool and school environments, where procedures designed for TD children are used. On the other hand, if more intensive and more cumbersome interventions are necessary, parents and teachers should be given guidance on providing individualized care.

Thus, the purpose of the current study was twofold: (a) to evaluate the effectiveness of the training package described by Greer et al. (2016) with children with ASD, and (b) to develop individualized training for participants in cases when the general treatment package was ineffective.

Method

Participants and Setting

Thirteen children diagnosed with ASD participated and completed the current study (see Table 1 for participant demographics). Two additional participants initially enrolled but were withdrawn for idiosyncratic reasons (i.e., one moved, one child's parents withdrew participation when urination frequency increased at the outset of treatment). Supervising Board Certified Behavior Analysts® (BCBA®) referred participants to the first author based on several criteria: (a) parents indicated that toilet training was a priority in their child's clinical programming, (b) the child was currently wearing diapers or pull-ups, and (c) toilet training had either not been attempted or was reportedly not successful (the latter was only relevant for Edward and Arnie). Children ranged in age from 2 years 4 months to 13 years 10 months (*M* age = 5 years 0 months) at the onset of their participation. Of these participants, nine were male and four were female.

Table 1

Participant Demographics

Participants	Age	Sex	Communication
Ace	7 yr 0 mo	M	Speech Generating Device
Arnie	13 yr 10 mo	M	Speech Generating Device
Audrey	3 yr 0 mo	F	Picture Exchange*
Booker	6 yr 6 mo	M	Picture Exchange*
Chloe	3 yr 6 mo	F	Picture Exchange*
Edward	5 yr 5 mo	M	Picture Exchange*
Greg	3 yr 4 mo	M	Vocal
Jackson	3 yr 6 mo	M	Vocal
Joel	5 yr 4 mo	M	Vocal
Jessica	4 yr 0 mo	F	Vocal
Lola	2 yr 4 mo	F	Picture Exchange
Max	2 yr 11 mo	M	Vocal
Zeus	4 yr 7 mo	M	Vocal

Note. *Indicates subjects for whom a switch to a different modality was made during the study (e.g., switching from picture exchange to a speech generating device). These decisions were made by the clinical team outside the scope of the current study.

Sessions took place across two different centers that provide behavior-analytic services to children with ASD. All participants in the study were present at the center between 3 and 8 hr per day, and data were only collected on toileting procedures occurring in the center. No data were collected at home; however, caregivers were informed not to change toilet-training procedures at home. Investigators informed caregivers of an effective intervention at the conclusion of the study, and provided training as needed.

Participants were scheduled in a 1:1 ratio with a therapist (therapists were employed by the ABA center and typically had a bachelor's degree and/or were Registered Behavior Technicians™). All therapists were trained on

toileting procedures by the first or second author and these procedures were carried out across the day. More specifically, each session was one day at the center which consisted of scheduled sit trials and dry checks. The minimum hour requirement for a session was 3 hr and the maximum was 8 hr. When participants were not in the bathroom, they were included in typical center-based behavior analytic services and center-wide activities (e.g., snack, lunch, recess, and craft time).

Response Measurement

An *appropriate urination* consisted of any amount of urine while the participant was seated on the toilet. An *accident* was recorded if any amount of urine was detected in the participant's undergarments. If an accident occurred outside of a scheduled sit or dry check, this was scored as a separate trial. At the end of each session, a percentage of appropriate urinations was calculated by adding the total number of appropriate urinations, dividing it by the total number of urinations that day (i.e., accidents and appropriate urinations), and multiplying by 100. A *self-initiation* consisted of the participant independently requesting (i.e., not prompted) the restroom using their personal communication modality or independently walking to the restroom outside of a scheduled toilet sit. Appropriate bowel movements (BMs) and BM accidents were recorded and the same contingencies (described below) were in effect; however, criteria for moving to new phases were based on appropriate urinations.

Interobserver Agreement, Procedural Integrity, and Experimental Design

The primary observer across all participants was their scheduled 1:1 therapist at the center. The researchers chose to have a secondary observer in a relatively small number of trials for three reasons: (a) a high level of interobserver agreement (IOA) sessions would have been intrusive given the small confines of the restrooms and privacy concerns, (b) the occurrence of an accident or appropriate urination was relatively obvious as participants rarely produced only a small amount of urine, and (c) the IOA scores obtained were high enough to establish confidence in the scoring criteria (i.e., all above 92% for the measures of primary interest, see below). Thus, a secondary observer independently recorded data on at least one trial per session for an average of 21.50% sessions across participants (range, 6.33% to 38.59%). Secondary observers consisted of research assistants (i.e., staff, undergraduate students, graduate students) trained by the first or second author, and all were trained in HIPAA regulations via the university's training modules. Secondary observers were usually present in shifts throughout the day (i.e., usually 2 or 3 hr at one time) and observed scheduled sits and dry checks. Therefore, IOA data were not only collected when it was obvious or convenient (e.g., when an accident occurred).

We calculated IOA using a trial-by-trial method by adding the number of agreements, dividing by the number of agreements and disagreements, and multiplying by 100. An agreement was scored if both observers recorded the same occurrence or nonoccurrence of urination. For example, an agreement was scored if both observers recorded that a urinary accident occurred. A disagreement was scored if observers did not record the same occurrence or nonoccurrence of a behavior. For example, a disagreement was scored if one observer recorded that the participant was dry and one observer recorded that the participant had a urinary accident. IOA averaged 98.16% (range, 92.31% to 100%) for accidents, 98.55% (range, 95.24% to 100%) for appropriate urinations, and 99.23% (range, 95.24% to 100%) for self-initiations.

The majority of procedural integrity data were collected on the same trials that IOA data were collected. Procedural integrity was

collected on at least one trial per session for an average of 21.96% of sessions across participants (range, 7.14% to 38.51%). Secondary observers recorded therapist's correct or incorrect implementation of: (a) prompting the participant to request the bathroom in their designated communication modality prior to each scheduled sit; (b) placing participants in the correct undergarment type (i.e., pull-ups in baseline and underwear in treatment), (c) taking participants to the bathroom and conducting dry checks at the correct time (within a 10-min window; 5 min before the scheduled time and 5 min after), and (d) requiring the participant to sit for the full sit duration (unless an appropriate urination occurred before 3 min elapsed). In addition, secondary observers scored the therapist's correct or incorrect responses to the participants' appropriate urinations, accidents, and self-initiations. Procedural integrity was scored by adding up the total number of correct implementation components and responses to participants' behavior, dividing by the total number of opportunities, and multiplying by 100. Procedural integrity averaged 85.77% (range, 60.00% to 100%) for prompting a request prior to sit trial, 98.06% (range, 93.20% to 100%) for correct undergarment type, 92.08% (range, 58.70% to 100%) for dry checks occurring within a 10-min window, 81.94% (range, 62.66% to 100%) for correct responses when a participant was dry, 91.51% (range, 80.00% to 100%) for correct responses when a participant was wet (i.e., had an accident), 94.05% (range, 84.21% to 100%) for sit trials occurring within a 10-min window, 95.45% (range, 80.85% to 100%) for requiring a participant to sit for the full sit duration, 92.77% (range, 80.00% to 100%) for correct responses when appropriate eliminations occurred, and 79.17% (range, 0% to 100%) for correct responses to self-initiations. Although the integrity for correct response to self-initiations was low, it averaged above a variable ratio (VR) 2 schedule, so it was deemed acceptable in this context. Integrity errors related to self-initiations were most often errors of omission; however, this finding is tentative because secondary observers had limited opportunities to observe therapist responses to self-initiations with participants who did not reliably self-initiate.

To evaluate the effects of the general treatment package, a nonconcurrent multiple baseline design across subjects was used. All participants started in baseline (described below) and the general treatment package (also described below) was introduced in a staggered manner across participants unless there was an upward trend or variability when visually inspecting the data. If a trend or variability was observed, the baseline condition was extended to a point of relative stability.

Procedure

Preference Assessment

At the beginning of each week, two multiple-stimulus-without-replacement preference assessments (MSWO; DeLeon & Iwata, 1996) were conducted for each participant; one for edibles and one for leisure items (i.e., each assessment was only conducted once). The top two items in the edible MSWO and the top two items in the leisure MSWO were used only for toilet training for the remainder of the week.

Baseline

Procedures were identical to those described by Greer et al. (2016). Participants remained in pull-ups or diapers, were taken to the restroom on a 90-min schedule, were required to sit on the toilet for up to 3 min, and received 30-min undergarment checks. If participants were dry at scheduled undergarment checks, praise was delivered. If an accident occurred, the participant was changed with minimal attention and the schedule for the next sit was not reset. To illustrate, if an accident occurred at 10:01 AM

and the next scheduled sit was at 10:07 AM, the participant was changed with minimal attention at 10:01 AM and taken to the restroom at 10:07 AM. If an appropriate urination occurred during the 3-min toilet sit, then praise and a highly preferred edible and leisure item (identified by the weekly MSWO) were delivered for 30 s, and the toilet sit was terminated early (i.e., the participant was not required to sit for the full 3 min). If a self-initiation occurred, praise was delivered; the participant was taken immediately to the restroom and given the opportunity to sit on the toilet. If an appropriate urination occurred following a self-initiation, praise plus access to a highly preferred edible and leisure item were delivered and the next scheduled sit time was reset. For example, if the participant was scheduled to go to the bathroom at 10:00 AM, but self-initiated at 9:50 AM and urinated on the toilet, then the next scheduled trip would be scheduled for 11:20 AM. Prior to every toilet trip, the participant was prompted to say "potty" in their individualized communication modality. After at least five sessions with no visible trends, the general treatment package was introduced.

General Treatment Package

Procedures were identical to those described by Greer et al. (2016). Participants were changed into underwear upon arrival at the center, taken to the restroom on a 30-min schedule, required to sit for up to 3 min, and received undergarment checks prior to every scheduled toilet sit (i.e., every 30 min). Participants were kept in underwear during therapy but were changed into pull-ups or diapers when caregivers arrived for pick up at the end of the day. Participants received praise plus access to a preferred leisure item for 30 s and one edible (identified by the weekly MSWO preference assessment) if they were dry during a scheduled undergarment check, if they had an appropriate elimination on a scheduled trip, and if they self-initiated (and had an appropriate elimination once given the opportunity to sit on the toilet). Again, participants were prompted to ask for the bathroom in a predetermined communication modality prior to bathroom trips. Therapists usually prompted communication responses in the participant's therapy room before beginning the transition to the restroom. Therapists used least-to-most prompting for self-initiations. Mastery criteria were defined as: (a) achieving 100% appropriate urinations (i.e., no accidents occurring) and (b) maintaining 100% appropriate urinations for at least three consecutive sessions (i.e., days at the center).

Individualized Treatment Plan

For participants who did not meet the mastery criteria in the general treatment package, and for whom there was no visual upward trend in the data, an individualized treatment plan was developed in collaboration with the participant's clinical team. Urination data, collected over a minimum of the last 10 days, were evaluated for one of several patterns. If any temporal patterns were observed (e.g., the majority of accidents occurred within one or two different time periods), a denser sit schedule (e.g., every 15 min) was implemented during those intervals (similar to that described with one participant in Cocchiola et al., 2012). If the denser sit schedule during specific time periods was ineffective, or if no temporal patterns were observed, the denser schedule was implemented across the entire day. For two participants (i.e., Audrey and Edward), a portable toddler potty chair was introduced in the therapy room for ease of access and to reduce the transition time to the restroom. If individualized procedures were effective, schedule thinning and stimulus fading (of the toddler potty chair) were implemented to transition participants back to the general treatment package condition, and they were then entered into the extension phase described below. Finally, if individualized procedures were not effective at reducing accidents and increasing appropriate

urinations, an intensive toilet training procedure was implemented outside the scope of the study, similar to the procedure described by LeBlanc et al. (2005); this only occurred with Edward.

Extension

When participants reached mastery with the 30-min sit schedule, they entered a phase that involved thinning the sit and reinforcement schedules. At this point, the first author discussed progress with the participant's supervising BCBA® and described the recommended progression. The recommended progression for each participant began with schedule thinning contingent on at least three sessions with 100% appropriate urinations at the current sit schedule (i.e., 30 min); first, a 90-min probe was conducted to identify whether schedule thinning was required. If appropriate urinations maintained at 100% for at least five consecutive sessions on the 90-min schedule, reinforcement schedule thinning began. Typically, if responding was below 50% on the first 90-min probe, or if responding was on a decreasing trend, the participant returned to a 30-min schedule and the schedule was thinned by increments of 5 min (i.e., 35, 40, 45 min) every three sessions at 100%. If, during the initial 90-min probe, responding was above 50%, the 90-min schedule was continued until either a downward trend occurred or the participant met mastery criteria. After the sit schedule increased by 15 min (e.g., 30 to 45 min), a 90-min probe was conducted again to identify whether schedule thinning was still required. If participants remained successful and achieved five consecutive sessions at 100%, the reinforcement thinning phase was started. Again, if there was a clear downward trend in appropriate urinations or appropriate urinations were at 50% or below, the participant returned to the prior schedule and schedule thinning continued. To illustrate, if a decrease in appropriate

Figure 1
Results for Participants Who Met Mastery Criteria in Baseline

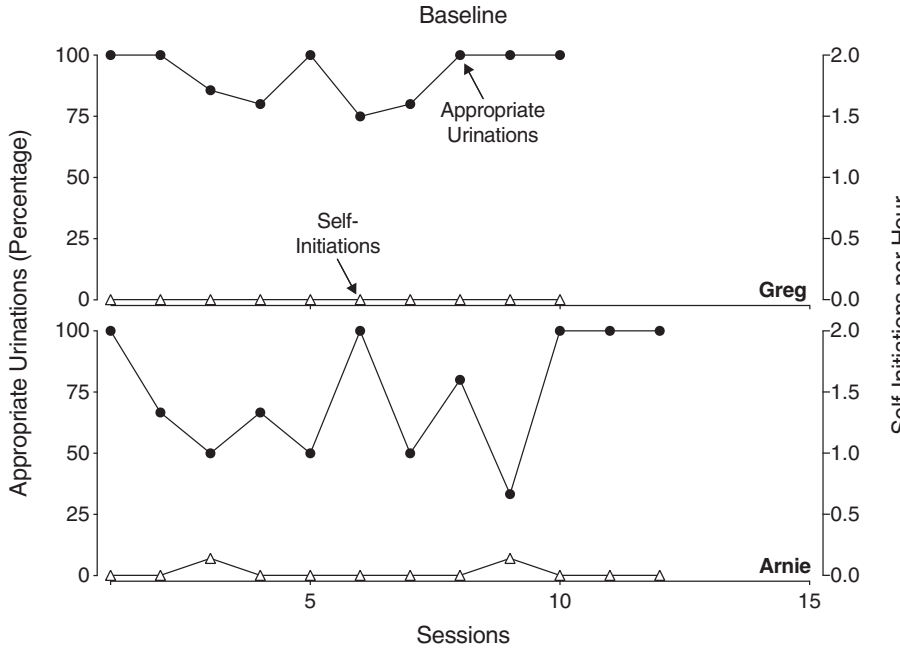
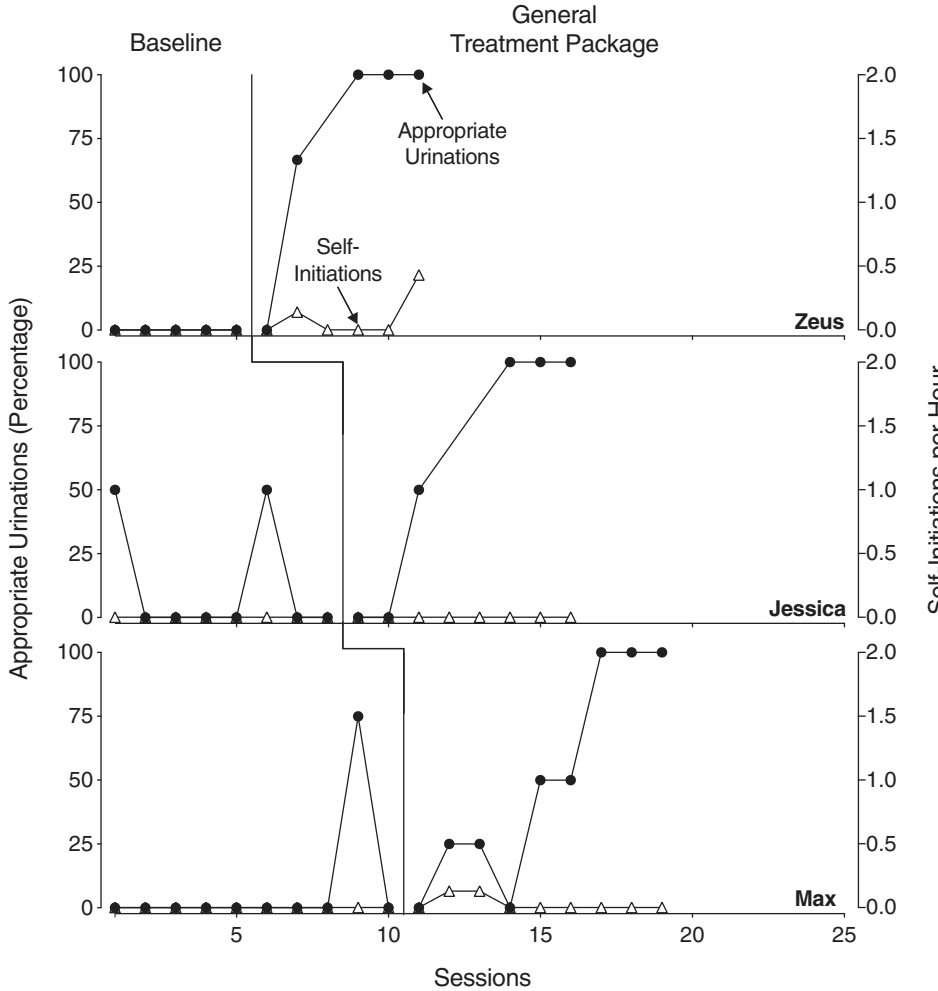


Figure 2
Results for Participants Who Met Mastery Criteria in Fewer than 10 sessions

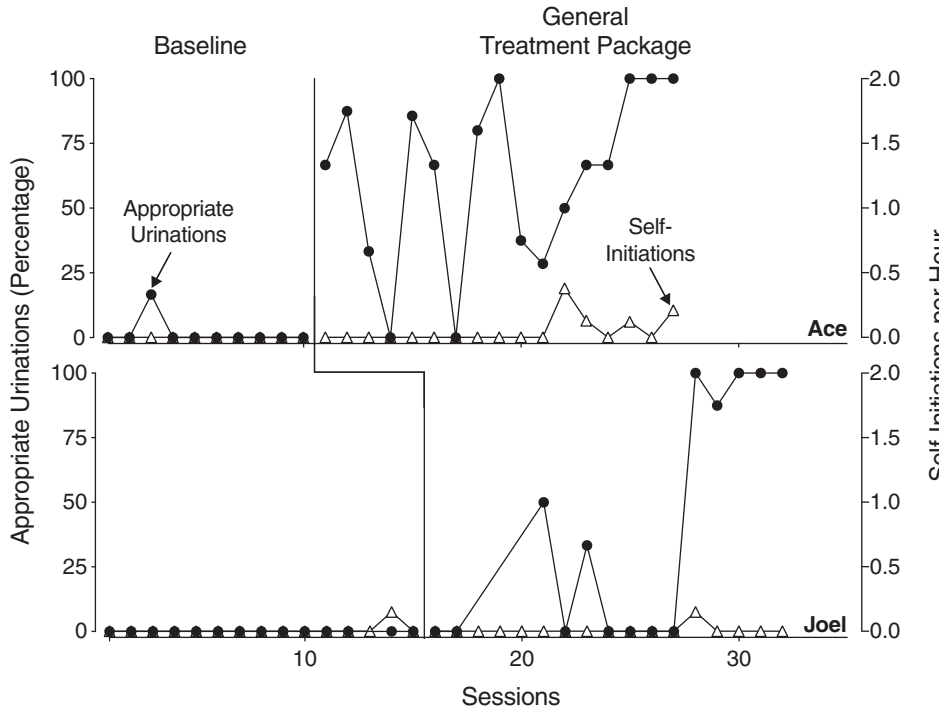


urinations was observed again at the 90-min schedule, the participant was returned to the last schedule associated with 100% appropriate urinations (e.g., 45 min), responding was recaptured (i.e., three sessions at 100% per sit schedule requirement), and schedule thinning resumed to the next 15-min interval (e.g., 60 min). At this point, another 90-min probe was attempted.

After mastery at the 90-min schedule was obtained, reinforcement schedule thinning occurred. The progression for schedule thinning involved the following stages contingent on at least five sessions at 100% appropriate urinations: (a) removing additional dry checks (RT-1), (b) providing reinforcers for appropriate urination only (i.e., removing reinforcer for remaining dry; RT-2), and (c) praise only for appropriate urination (RT-3).

Once the reinforcement schedule was thinned, the penultimate phase consisted of either removing the sit schedule if self-

Figure 3
Results for Participants Who Met Mastery Criteria in Between 11 and 20 Sessions



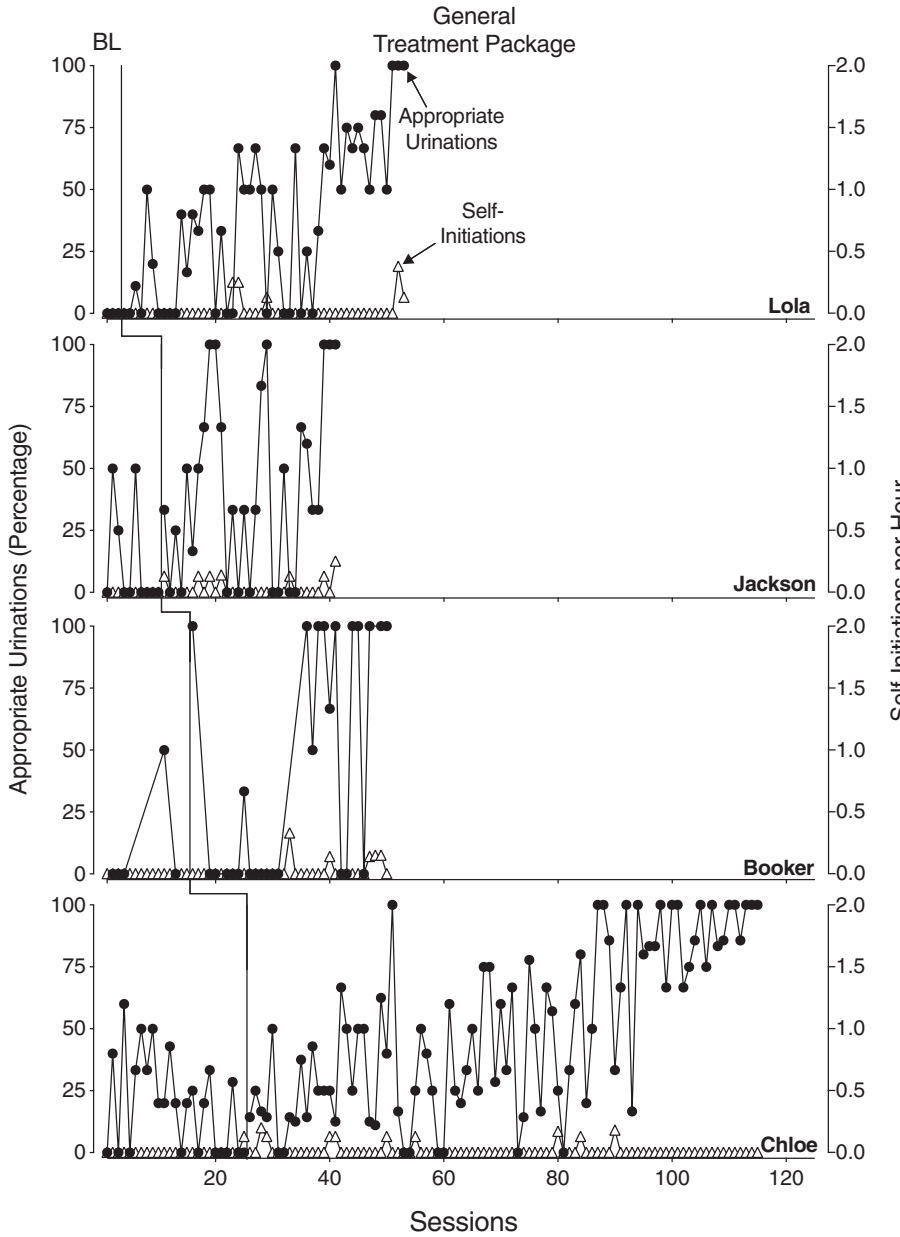
initiations were consistently occurring or maintaining a time-based schedule (i.e., at least four scheduled sits per day—typically, these occurred upon arrival, lunch time, afternoon snack, and before departure; RT-4). The final phase was a 1-month follow up. Before making any of the aforementioned adjustments to the participant's toileting procedures, the first author updated the supervising BCBA® so they could communicate with the participant's clinical team. Therefore, on some occasions, there were some procedural errors with moving participants from a 90-min schedule back to a denser schedule; if needed, there were more than three sessions at 100% (prescribed criterion to commence fading the sit schedule) or five sessions at 100% (prescribed criterion to commence reinforcement thinning) before fading occurred.

Results

Figure 1 displays results for the two participants who met the mastery criteria (i.e., at least three sessions at 100% appropriate urinations) during baseline. Figure 2 displays results for the three participants who met the mastery criteria in under 10 sessions once the general treatment package was implemented. Figure 3 displays the results for two participants who met the mastery criteria in the general treatment package condition in over 10 sessions but under 20 sessions. Figure 4 displays the results for four participants who met the mastery criteria in the general treatment package condition in more than 20 sessions.

Figure 5 displays the results for participants who did not respond (i.e., Audrey) or did not meet mastery (i.e., Edward) in the general treatment package condition. Audrey met

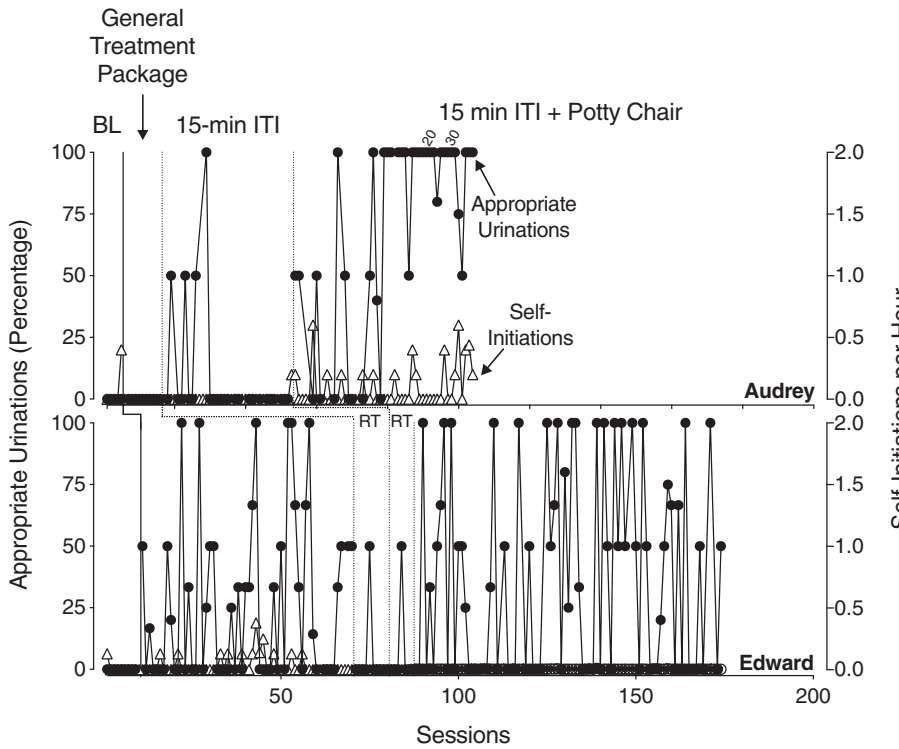
Figure 4
Results for Participants Who Met Mastery Criteria in More Than 20 Sessions



mastery criteria when the 30-min schedule was reduced to a 15-min schedule and a toddler potty chair was introduced. Edward's response to the general treatment package was highly variable. When the denser sit schedule (i.e., every 15 min) and toddler potty chair were introduced, appropriate urinations remained highly variable. Therapy staff at the

Figure 5

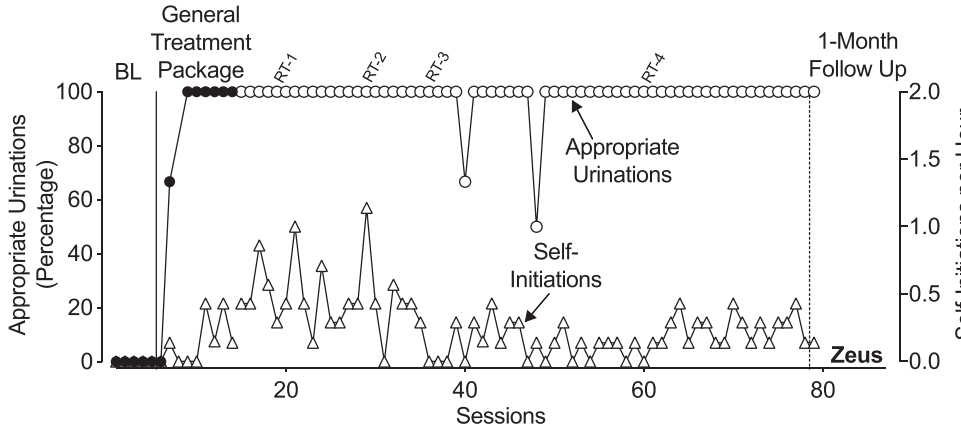
Results for Participants Requiring an Individualized Treatment Plan



Note. RT = risk times. Before implementing the 15-min schedule all day or introducing the toddler potty chair, we attempted the 15-min schedule between 11:30 AM and 2:30 PM when Edward was consistently having the most accidents; however, the data reflected in these sessions reflect the entire session (i.e., not just during the risk times).

Figure 6

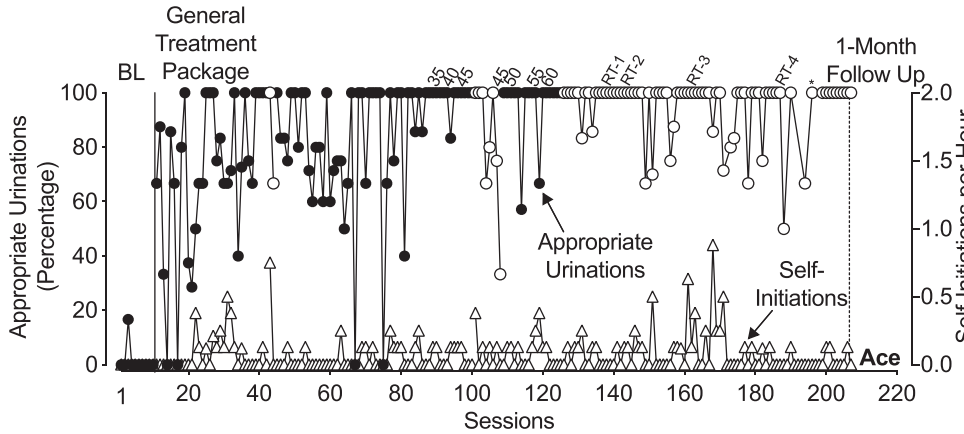
Results of Toilet Training for Zeus



Note. Open circles represent 90-min probe sessions; RT indicates reinforcer thinning steps.

Figure 7

Results of Toilet Training for Ace



Note. Open circles represent 90-min probe sessions. Vertical numbers indicate changes in schedule. RT indicates reinforcer thinning steps. The asterisk above session 196 indicates where scheduled sits were reintroduced.

Table 2

Cumulative Sessions to Mastery by Phase

Participants	BL	30 min	45 min	60 min	90 min	Terminal
Ace	-	27	100	125	130	202
Arnie	12				33	91
Audrey	-	104	113	128	155	
Booker	-	50		83	184	296
Chloe	-	115	176	197	211	257
Edward	-	-				
Greg	10				37	60
Jackson	-	41			62	132
Joel	-	32	50		55	70^{SI}
Jessica	-	16			21	65^{SI}
Lola	-	53	106		119	
Max	-	19	52		62	153
Zeus	-	11			19	65^{SI}

Note. "-" indicates that mastery was not achieved in the corresponding phase. A blank space indicates that sit schedule was not conducted (this was usually due to mastery of probe sessions at leaner schedules). Participants who were successfully self-initiating when the schedule was removed are denoted by ^{SI}.

center continued efforts to toilet train Edward many months beyond the conclusion of this study. Collectively, 12 out of the 13 participants finished the study demonstrating daytime continence (for urination).

Figures 6 and 7 display the general treatment package and extension phases for Zeus and Ace, respectively. These two graphs are representative of the responding displayed by most participants. Zeus did not require incremental schedule increases (i.e., when the 90-min probe was conducted, he remained continent). Ace, however, did not remain continent during the first 90-min probe and required smaller increases in schedule requirements before he remained continent at the 90-min schedule. These graphs also display the reinforcement thinning process (indicated by RT-1, RT-2,

Table 3

Secondary Dependent Measures

	Self-Initiation Correspondence			Appropriate Bowel Movements		
Participants	Baseline	Treatment	Extension	Baseline	Treatment	Extension
Ace	0	50.0	64.4	45.0	50.0	44.6
Arnie	50.0		100	0		50.0
Audrey	0	23.1	50.0	100	61.1	40.0
Booker	-	40.0	48.2	-	-	16.7
Chloe	0	22.0	-	20.3	21.9	30.0
Edward	0	3.6		-	0	
Greg	96.7		100	22.2		75.0
Jackson	0	0	84.0	0	0	57.1
Joel	0	100	92.5	0	56.0	75.9
Jessica	-	-	84.1	0	100	100
Lola	-	8.3	32.7	0	63.6	53.3
Max	-	50.0	71.1	20.0	50.0	86.9
Zeus	-	33.0	82.5	0	-	66.7

Note. The average percentage of self-initiation correspondence (i.e., percentage of self-initiations that were followed by an appropriate urination) by phase and average percentage of appropriate bowel movements by phase. "-" indicates that this behavior did not occur in this phase. A blank space indicates that phase was not conducted.

etc.). RT-4 consisted of removing scheduled sits and taking participants to the restroom only if a self-initiation occurred. Zeus remained continent during this phase. However, Ace did not (when RT-4 was implemented there was a decrease in appropriate urinations in some sessions and there were some sessions during which he did not urinate at all). Therefore, Ace remained on a time-based schedule and self-initiations continued to be reinforced when they occurred.

Table 2 displays the total cumulative number of sessions to mastery at each phase of the study. If a participant met mastery when a 90-min probe was conducted, denser schedules (e.g., 45 min or 60 min) would not have been attempted (i.e., blank space). The terminal goal was a 120-min schedule or removal of the schedule if a participant was reliably self-initiating. For example, Ace did not meet mastery in baseline, and required 27, 100, 125, 130, and 202 cumulative sessions to meet mastery criteria at the 30-min, 45-min, 60-min, 90-min, and terminal schedules, respectively. When scheduled sits were removed completely and only self-initiations were reinforced (starting at session 189, RT-4, in Figure 7), Ace did not remain continent and required scheduled sits (and thus he is not denoted with an ^{SI}). Zeus, a participant denoted with ^{SI} consistently self-initiated when the schedule was removed. Audrey and Lola both met mastery at the 90-min schedule but were withdrawn from the study (both families moved away) before all other treatment components could be faded out, and therefore, terminal mastery was not achieved.

Table 3 displays two of the secondary dependent variables for the current study (i.e., self-initiation correspondence and appropriate bowel movements) and are presented as average percentages by phase (i.e., baseline, treatment, and extension). A self-initiation correspondence was recorded whenever a participant engaged in a self-initiation that was followed by an appropriate urination. It is important to note that these measures were recorded, however, decisions for progressing through the aforementioned phases were made based on appropriate urination percentages only.

Discussion

The current study evaluated an extension of a toilet-training treatment package described by

Greer et al. (2016), but with children diagnosed with ASD. The general treatment package consisted of: (a) wearing underwear, (b) a dense sit schedule, and (c) differential reinforcement. Greer et al. found that this treatment package was most effective for increasing appropriate urinations. Results were replicated for 11 participants with ASD in the current study, suggesting that intensive toileting interventions (e.g., interventions requiring overcorrection, reprimands, and dense sit schedules) may only be necessary for a subset of individuals with ASD. Interestingly, Dalrymple and Ruble (1992) found that children with ASD tend to require on average 1.6 years to be urine trained and they recommended not beginning toilet training children with ASD until 4 years of age. However, the current study, along with several others (see Table 1 in Kroeger & Sorensen-Burnworth, 2009), included participants who began toilet training before the age of four and were toilet trained in less than 1 year (e.g., Chloe, Greg, Jackson, and Max).

It is not clear whether the current procedures are advantageous compared to other procedures commonly used with children diagnosed with ASD, such as the LeBlanc et al. (2005) procedure. It is also not clear whether the delayed responders and the two initial nonresponders would have responded better to a more intensive procedure, had it been introduced initially. Future comparison studies should examine variables such as overall effectiveness, efficiency, parent preference for one procedure type or another, occurrence of problem behavior, child resistance, and so on.

It is possible that maturation effects may have played a role in the acquisition of appropriate urinations, as delayed increases in appropriate urinations were observed. More specifically, it may not have been the general treatment package, per se, that was responsible for the increase in appropriate urinations. These same results may have been achieved if the baseline phase had been extended, due to changes in physical development. Another potential confounding variable is that these participants were concurrently receiving applied behavior analysis therapy outside of their toileting interventions. Learning other skills such as functional communication, academics, independent living, and self-feeding (among others) may have had an influence on their toileting success.

One potential explanation for the differential sessions to mastery across participants might be that children with more exposure to the study's procedures may have been those who met mastery criteria more quickly. For example, participants receiving 40 hr of ABA therapy rather than 15 hr per week may have responded more quickly. However, this did not appear to be the case for the participants in the current study. For example, one of the participants who met mastery criteria in the general treatment package in under 10 sessions (Jessica) received approximately 15 hr of ABA therapy per week, while several of the participants who met mastery in over 20 sessions (e.g., Chloe) or did not meet mastery in the general treatment package or individualized treatment plan (i.e., Edward) received 40 hr of ABA therapy per week.

It is important to consider that although we focused on establishing urinary continence in children with ASD, other toileting responses (e.g., BMs, self-initiating toilet trips) are necessary for individuals to achieve independent toileting. Although not our primary focus, therapists recorded the occurrence of BMs and implemented the same contingencies as those used for urinations based on a participant's progression through the protocol. Additionally, therapists recorded the occurrence of and implemented the prescribed consequences for self-initiations (i.e., requests for the toilet). To not detract from the primary contributions of this study, we provided summary data on the average occurrence of BMs and self-initiations. Notably, for most participants, the average occurrence of appropriate bowel movements and self-initiation correspondence increased

relative to baseline by the end of the study. Additionally, for several participants, an increase in self-initiations occurred during treatment; however, for some (e.g., Audrey and Chloe), self-initiation correspondence remained relatively low suggesting that self-initiations were not yet under appropriate stimulus control and may have been occurring as a form of escape from instructions or to gain access to one of the restricted preferred items. We acknowledge the importance of these other toileting responses, and therefore, are currently performing extensive secondary analyses based on the data we obtained related to these responses and other factors that might contribute to toileting success (e.g., presence or absence of problem behavior).

Procedurally, it might have been problematic to prompt a communication response before every scheduled toilet trip for at least two reasons. First, it is unlikely that children eliminate on every trip to the restroom and, therefore, prompting may not represent the appropriate stimulus conditions for evoking independent requests for use of the restroom. Second, most toileting interventions consist of a relatively dense sit schedule, usually at the onset of toilet training, making self-initiations less likely to occur. We encourage future researchers to target additional toileting responses (e.g., appropriate BMs and self-initiations), evaluate whether a similar methodology is effective in teaching these responses, and identify the conditions under which these skills are likely to emerge.

Another potential limitation of the current study was the lack of involvement from caregivers. At the onset of the study, caregivers consented that their children would begin toilet training, agreed not to change routines at home, and understood that they would be informed and trained if the intervention was effective. Caregivers of participants for whom this procedure was effective were instructed to keep their child in underwear at home and to prompt them to use the bathroom at least every 2 hr if they were not self-initiating. Although no formal data were collected in the home, several caregivers reported that their child began using the bathroom independently without explicit training at home.

More research is needed on the topic of toilet training in multiple settings. It is possible that if toilet training occurred concurrently at home, we would have seen quicker acquisition. It is also possible that because parents frequently conferred with center behavior analysts and therapists, they gathered sufficient information about the treatment procedures and concurrently tried toilet training at home. Future researchers may consider having parents explicitly and actively involved from the onset to identify if that involvement contributes to faster acquisition and decreases the need for more intensive procedures. Additionally, future researchers could examine the effects of toilet training in one setting while testing for generalization of toileting skills across other settings.

In conclusion, these results indicate that at least some children with ASD respond to toileting interventions that are efficacious for TD children. Only a subset of children with ASD in our study required more intensive procedures or failed to achieve continence; however, these procedures still only consisted of reinforcement-based procedures. Future researchers should continue to examine prerequisites to toilet training and patterns of responding to help identify which children will be successful using less intensive interventions, and which will require additional modifications or more intensive procedures. For example, caregivers and practitioners could begin the toileting procedure described by Greer et al. (2016) and, based on patterns of responding, continue or switch to more intensive interventions.

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