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A COMPONENT ANALYSIS OF TOILET-TRAINING PROCEDURES RECOMMENDED FOR YOUNG CHILDREN

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We evaluated the combined and sequential effects of 3 toilet-training procedures recommended for use with young children: (a) underwear, (b) a dense sit schedule, and (c) differential reinforcement. A total of 20 children participated. Classroom teachers implemented a toilet-training package consisting of all 3 procedures with 6 children. Of the 6 children, 2 showed clear and immediate improvements in toileting performance, and 3 showed delayed improvements. Teachers implemented components of the training package sequentially with 12 children. At least 2 of the 4 children who experienced the underwear component after baseline improved. Toileting performance did not improve for any of the 8 children who were initially exposed to either the dense sit schedule or differential reinforcement. When initial training components were ineffective, teachers implemented additional components sequentially until toileting performance improved or all components were implemented. Toileting performance often improved when underwear or differential reinforcement was later added.

Key words: differential reinforcement, sit schedule, toilet training, underwear

A report prepared for the Agency for Healthcare Research and Quality (AHRQ) of the U.S. Department of Health and Human Services (2006) suggested that most children between the ages of 18 and 30 months have the prerequisite skills to begin toilet training, and Brazelton et al. (1999) found that most children complete toilet training by 36 months old. When a child is ready to begin toilet training, the American Academy of Pediatrics emphasizes the important role that childcare centers have in the training process (American Academy of Pediatrics, 1999; Schmitt, 2004b). Childcare centers can help identify when a child is ready to begin training, assist the caregiver with developing a training strategy, implement the training procedures outlined in the strategy, and relay important information about the child's progress during training (American Academy of Pediatrics, 1999).

Questions regarding toilet training are often discussed initially with the family's pediatrician (Christophersen, 1991). Therefore, the pediatric medical community has provided recommendations regarding when and how to toilet train children (Brazelton et al., 1999; Schmitt, 2004a, 2004b; Schum et al., 2002). Recommendations include replacing diapers or pull-on training pants with underwear (Schmitt, 2004a, 2004b), routinely prompting children to sit on the toilet for a few minutes at a time (Schmitt, 2004a), and using incentives such as preferred edible items or leisure materials to encourage success (Schmitt, 2004a, 2004b), as well as other strategies (for additional recommendations, see Brazelton, 1962).

Behavior analysts have evaluated some of these recommended training procedures, often with individuals with intellectual or developmental disabilities and within multicomponent training packages (for a recent review of the training procedures used with children with developmental disabilities, see Kroeger & Sorensen-Burnworth, 2009). For example, Tarbox, Williams, and Friman (2004) found decreases in accidents and increases in appropriate eliminations when diapers were removed for an

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adult with an intellectual disability. Simon and Thompson (2006) extended Tarbox et al. by demonstrating improvements in toileting performance when typically developing children wore underwear instead of diapers. Two of five children had fewer accidents and increased appropriate eliminations while they wore underwear, and a third child's performance improved when underwear use followed increased fluids and longer sits on the toilet. The methodology employed by these experimenters is also noteworthy. In both experiments, researchers evaluated the effects of a single training procedure (i.e., changing the undergarment type) while all other training procedures (e.g., the sit schedule, contingencies for accidents and appropriate eliminations) were held constant. This procedure allowed the experimenters to determine the additive effects of the underwear procedure.

The American Academy of Pediatrics recommends routinely prompting children to sit on the toilet (Schmitt, 2004a). LeBlanc, Carr, Crossett, Bennett, and Detweiler (2005) used a multilevel schedule with three children who had been diagnosed with autism spectrum disorder and who were unresponsive to a less intensive training intervention. Training began with children sitting on the toilet for 10 min with 5-min breaks between sits (Level 1) and ended with 5-min sits and 4-hr breaks between sits (Level 12). Children advanced from Level 1 through Level 12 based on the amount of time spent at each level. All three children demonstrated improvements in toileting performance with this graduated sit schedule. Hanney, Jostad, LeBlanc, Carr, and Castile (2013) replicated the findings of LeBlanc et al. with a larger number of children with autism. Unfortunately, in both studies, introduction of scheduled sits occurred simultaneously with changes to several other training components including (a) prompts and programmed consequences for self-initiations, (b) programmed consequences for urinations, (c) increased fluid consumption, (d) an alarm that signaled accidents, and (e) positive practice following accidents. Thus, the effects of modifying the sit schedule on toileting performance was confounded by the simultaneous introduction of other training procedures. One way to evaluate the effects of dense and lean sit schedules is to employ the methodology used by Tarbox et al. (2004) and Simon and Thompson (2006) in which all training procedures are held constant except the procedure under evaluation (e.g., the sit schedule).

The American Academy of Pediatrics also recommends the use of incentives to encourage the acquisition of toileting skills (Schmitt, 2004a, 2004b). In their seminal study, Azrin and Foxx (1971) provided access to edible items and praise for eliminating in the toilet and access to liquids and a preferred chair for remaining dry. The investigators reported fewer accidents for the group of individuals with these differential-reinforcement procedures. However, differential reinforcement began simultaneously with the start of other training procedures, preventing firm conclusions regarding the effects of differential reinforcement per se.

Presumably, some training components are likely to be more influential than others. Training components may be ineffective, effective only when combined with other components, or even contraindicated. Other training components may be effective when implemented accurately, but may prove to be overly complicated or labor intensive, which may interfere with the caregiver's ability to implement them with sufficiently high levels of procedural integrity. Therefore, it is important to identify the effects of individual training components that comprise training packages so that only those components that contribute to improving performance are implemented, thereby improving the effectiveness and efficiency of toilet training while decreasing the caregiver's burden of implementing ineffective or suboptimal procedures for an extended period of time.

A component analysis of training procedures would allow for the identification of the necessary and sufficient procedures responsible

for changes in toileting performance. Ward-Horner and Sturmey (2010) described two types of component analyses. In the drop-out method, a training program is implemented with all components at full strength, and single components are later withdrawn contingent on stable responding to determine the relative contribution of each component. This method of component analysis identifies which components are needed to maintain responding but offers little information on which components were necessary to produce responding initially. For example, differential reinforcement may be necessary when beginning to toilet train a child, but may no longer be needed as the child develops better bladder control. In contrast, the add-in method identifies which components are necessary to produce responding, which is of primary concern when determining which procedures to include when beginning a training program. In this method of component analysis, individual components are introduced following stable baseline responding, and subsequent components are added successively to determine the additive value of each component.

The purpose of current study was to use a methodology similar to that described by Tarbox et al. (2004) and Simon and Thompson (2006) to evaluate the combined and sequential effects of the training procedures used in an early childhood education center. We conducted an add-in component analysis to evaluate the effects of placing children in underwear, arranging a dense schedule of sits on the toilet, and programming differential reinforcement on the acquisition of toileting skills in children. We specifically targeted increases in urinary eliminations in the toilet, decreases in urinary accidents, and increases in independent requests to sit on the toilet.

METHOD

We evaluated toilet-training procedures with children from three early education classrooms in which enrollment ranged from 5 to 20 children and teacher–child ratios ranged from 1:1 to 1:10. Most training procedures were implemented by classroom teachers who were students enrolled in an undergraduate practicum course on early childhood education and care. Teachers used a least-to-most (vocal, model, physical) prompting strategy to guide child compliance with toileting routines. Bathrooms were located in each classroom and were equipped with child-sized fixtures. A short barrier was used in one classroom to prevent young children from entering the bathroom unsupervised. Older children (in a separate classroom) could move independently between the classroom and the bathroom.

Research assistants conducted weekly edible and leisure multiple-stimulus-without-replacement preference assessments with each child (DeLeon & Iwata, 1996). The two most highly preferred edible and leisure items were selected for toilet training for the upcoming week. Teachers presented children with a choice of one of the two edible items and 30 s of one of the two tangible items when children met the contingencies to access the preferred stimuli. Teachers delivered the preferred stimuli while they continued to implement the other toileting protocols (e.g., performing an undergarment check or sitting the child on the toilet). In the event that a child contacted the reinforcement contingencies more than once in a single visit to the bathroom, the teacher delivered one additional edible item and provided an additional 30-s access to the tangible item. Access to these stimuli was otherwise restricted in the classroom.

Teachers performed undergarment checks when the child arrived in the classroom and again every 30 min throughout the study. To perform an undergarment check, teachers prompted the child to say "potty" or "bathroom" and to walk to the bathroom. Children with dry undergarments received descriptive praise (e.g., "Great job being dry!"). Teachers changed children with wet or soiled undergarments

with minimal attention. All children washed their hands before they left the bathroom.

For scheduled sits on the toilet, teachers prompted the child to say "potty" or "bathroom" and to walk to the bathroom. The teacher performed an undergarment check and then prompted the child to sit on the toilet for 3 min or until the child eliminated in the toilet (i.e., appropriate elimination). Teachers provided descriptive praise (e.g., "I am so proud that you used the potty!") after appropriate eliminations.

Teachers suspended data collection and all toileting routines while children slept, except that children who wore underwear remained in underwear during naptime. Teachers changed children who had accidents during naptime and returned them to the nap area after cleaning the child's cot. Children who were awake during naptime followed all toileting routines and protocols.

Throughout the study, independent requests to sit on the toilet (i.e., self-initiations) resulted in a 3-min sit and teacher praise. Self-initiations reset future scheduled sits on the toilet. For example, if a child was scheduled to sit on the toilet every 30 min and he or she self-initiated, the next scheduled sit occurred 30 min after the self-initiation.

Subjects and Setting

Twenty children (M age = 26 months old; range, 19 to 39) within the age guidelines suggested by AHRQ (2006) who showed little progress with low-intensity toilet-training procedures (i.e., baseline) at a university-based early childhood education center participated. Children were recruited for participation if (a) parents expressed interest in receiving help with toilet training, (b) caregiver report suggested the presence of readiness skills, (c) teachers or classroom supervisors recommended the child for training, and (d) the child's toileting performance did not improve with baseline procedures that included sits on the toilet every 90 min and access to preferred items after appropriate eliminations (see Table 1 for additional information). One child (Aaron) had been diagnosed with autism spectrum disorder. All other children had no known diagnoses. Up to five children participated in each classroom at any given time.

Response Measurement and Interobserver Agreement

Teachers collected frequency data on each child's urinary accidents, appropriate urinary eliminations, and self-initiations throughout the day. An *accident* consisted of urinating anywhere

Table 1
Procedural Information for Each Condition

	Baseline	Package	Underwear	Dense sit schedule	Differential reinforcement
Undergarment type	Diaper or pull-on	Underwear	Underwear	Diaper or pull-on	Diaper or pull-on
Undergarment-check schedule	FT 30 min	FT 30 min	FT 30 min	FT 30 min	FT 30 min
Sit schedule	FT 90 min	FT 30 min	FT 90 min	FT 30 min	FT 90 min
Accidents	Change with minimal attention	Change with minimal attention	Change with minimal attention	Change with minimal attention	Change with minimal attention
Dry undergarments	Praise	Praise plus preferred items	Praise	Praise	Praise plus preferred items
Appropriate eliminations	Praise plus preferred items	Praise plus preferred items	Praise plus preferred items	Praise plus preferred items	Praise plus preferred items
Self-initiations	Praise plus sit	Praise plus sit plus preferred items	Praise plus sit	Praise plus sit	Praise plus sit plus preferred items

other than in the toilet and was recorded each time a child's undergarments were wet. An *appropriate elimination* consisted of urinating in the toilet. These data were converted to a daily percentage of appropriate eliminations by dividing the frequency of appropriate eliminations by the total number of eliminations (appropriate eliminations plus accidents). A *self-initiation* consisted of independently requesting toilet access. Children typically said or signed "potty" or "bathroom" to gain access to the toilet; however, self-initiations also included gestural mands (e.g., pointing to the bathroom) and sitting on the toilet independently.

An independent second observer collected data simultaneously with the primary observer on 16% (range, 8% to 30%) of undergarment checks and 17% (range, 9% to 28%) of toileting opportunities for a combined average of 16% (range, 9% to 29%) of undergarment checks and toileting opportunities. We calculated interobserver agreement coefficients by summing the number of agreements, dividing by the number of agreements plus disagreements, and converting the result to a percentage. An agreement consisted of both data collectors recording the same information for a given category (e.g., both observers recorded that the child was dry). Interobserver agreement averaged 97% (range, 92% to 100%) for accidents, 93% (range, 74% to 100%) for appropriate eliminations, and 95% (range, 83% to 100%) for self-initiations.

The second observer also collected data on procedural integrity by assessing teachers' implementation of each child's training protocol. The second observer collected data on the time at which each child was brought to the bathroom and whether teachers implemented the appropriate undergarment check or sit on 16% (range, 8% to 30%) of opportunities. Appropriate timing consisted of bringing the child to the bathroom within 5 min of the scheduled time. We calculated procedural integrity by summing correct implementations, dividing by the number of correct and incorrect implementations, and converting the result to a percentage. Procedural integrity averaged 90% (range, 78% to 98%) for teachers' implementation of undergarment checks and sits at the appropriate time. Procedural integrity averaged 95% (range, 89% to 100%) for teachers' correct implementation of an undergarment check or sit. For five children (Christy, Ernie, Gayle, Ivy, and Leah), we also assessed teachers' use of the correct undergarment type (diaper or underwear) and whether teachers appropriately delivered preferred items for 12% (range, 8% to 18%) of opportunities. Procedural integrity averaged 98% (range, 92% to 95%) for teachers' use of the appropriate undergarment type and 90% (range, 82% to 96%) for teachers' correct delivery of preferred items.

Procedure

Children initially participated in a set of baseline procedures designed to reflect a low-intensity toilet-training program. Teachers then exposed the children to either a comprehensive toilet-training package comprised of three training components or to each component of the training package sequentially until performance improved or all components had been implemented. For children who participated in the sequential presentation of training components, we counterbalanced the order of components across children. Children were assigned to conditions based on the number of children already assigned to each condition and teacher convenience (e.g., assigning fewer children to more labor-intensive conditions if multiple children were already training in the same classroom). For some children, teachers conducted occasional probes to assess toileting performance in the absence of all training procedures. Those data did not facilitate interpretation of the results of the component analysis and were therefore removed.

Baseline. Children wore disposable diapers or pull-on training pants during baseline. Teachers prompted children to sit on the toilet every

90 min and delivered preferred items after appropriate eliminations. Bowel movements on the toilet also resulted in access to the preferred items; however, bowel control was not a focus of this study. For Aaron, teachers delivered only praise after appropriate eliminations and bowel movements on the toilet.

Underwear. Four children (Danny, Tammy, Sully, and Leah) participated in the underwear condition following baseline. This condition was identical to baseline, except that children wore cotton underwear instead of diapers or pull-ons. When available, children wore plastic pants (i.e., underwear-like briefs made of plastic with elastic waist and leg openings) over their underwear to minimize cleanup responsibilities when accidents occurred. Children remained in underwear throughout the day, including during naptime.

Dense sit schedule. Four children (Alton, Sebastian, Ernie, and Marge) participated in the dense sit schedule after baseline. This condition was identical to baseline, except that teachers prompted children to sit on the toilet every 30 min instead of every 90 min. Each sit lasted 3 min or until the child appropriately eliminated.

Differential reinforcement. Four children (Nancy, Blue, Christy, and Ivy) participated in the differential reinforcement condition following baseline. This condition was identical to baseline, except that remaining dry at undergarment checks and self-initiating also resulted in teacher delivery of preferred items.

Toilet-training package. Six children (Lizzy, Aaron, Gayle, Ingrid, Jim, and Bethany) participated in the toilet-training package following baseline. The package consisted of the teacher implementing the underwear, dense sit schedule, and differential reinforcement components simultaneously.

Design and Data Analysis

Our principal aim was to evaluate the effectiveness of each toilet-training component when implemented alone and when combined (i.e., the training package). A secondary aim was to evaluate the effectiveness of training components added sequentially. To evaluate the effectiveness of single training components (or the training package), we used a nonconcurrent multiple baseline design across subjects by staggering the implementation of the first component (or the training package) across children following the point at which responding had stabilized with previous children using the same procedures. To evaluate the effectiveness of adding training components, teachers added subsequent components sequentially until each child's performance improved. We evaluated the necessity of these additional training components with most children by either returning to a previous condition or implementing a new condition (e.g., a maintenance condition in which all treatment procedures were removed, except that the child continued to wear underwear). We later had teachers reimplement the additional training components to determine their effects on toileting performance. However, we were unable to evaluate the effects of these additional components with all of the children due to time constraints. We examined the possibility that adding training components improved toileting performance by calculating the mean difference for each dependent measure by subtracting the mean of the immediately preceding phase (e.g., accidents during baseline) from the mean of the following phase (e.g., accidents during the training package).

RESULTS

In all figures, the data are from the initial baselines and the initial training components (or the toilet-training package) implemented with each child. Data for the components added after the initial training procedures appear in Table 2. Figure 1 displays the results for children who experienced the training package following baseline. Introduction of the training package did not produce an immediate improvement in performance for Lizzy. She showed a lower level

Table 2
Mean Percentage of Appropriate Eliminations in Baseline and Mean Differences During Component Analysis

		No components	One component			Two components			Three components
Subject	Design	Baseline average	Underwear	DR	Dense sit	Underwear plus DR	Underwear plus dense sit	DR plus dense sit	Package
Jim	ABCDCA′	17.7							58.5
Aaron	ABCA′C	12.5							67.7
Ingrid	ABCDCB	47.6							33.6
Bethany	ABCBCBCBD	5.6							69.1
Gayle	ABAB	40.9							39.3
Lizzy	ABCBD	4							12.2
Tammy	ABCA′CA′	6.3	34.3			59.3			
Sully	ABCDA′	1.5	69.9			18.1			7.1
Leah	ABCDEA′	8.9	–8.9				0		10
Danny	ABABA′B	0	20.6						
Nancy	ABCDEDA′D	44.3		–21.2		59.8			15.5
Blue	ABCDCA′	43.2		–15.5		37.2			23
Ivy	ABCDBDEFE	3.3		9.9				–13.2	4.9
Christy	ABCD	6.1		–1				0	76
Marge	ABABCDEA′E	5			2				80.5
Sebastian	ABCDEDA′D	0			4.4		27.2		50.6
Ernie	ABCDEFE	36.8			31.6			9.1	–12.2
Alton	ABCD	9.7			–1.7				

Note. DR = differential reinforcement. A′ = maintenance (children remained in underwear, but undergarment checks, scheduled sits on the toilet, and all other treatment procedures were removed). [Correction added on 11 January 2016, after first online publication: In Table 2, the DR values listed for 'One component' were erroneous and also attributed to the wrong subjects. The values have been amended for Nancy, Blue, Ivy, Christy, Marge and Sebastian.]

of accidents and a higher level of appropriate eliminations after an extended exposure to the training package. For Lizzy and other children for whom the training package was insufficient, teachers implemented other training procedures (e.g., increased fluids, enhanced differential reinforcement, toileting training alarms) outside the scope of the study.

The training package was correlated with an immediate improvement in Aaron's overall toileting performance. Gayle's performance improved across baseline and package phases, making it difficult to determine if the training package improved her performance. However, she had a higher percentage of appropriate eliminations with the training package. Ingrid's results were similar to Gayle's results in that Ingrid's toileting performance improved over time, regardless of condition. However, we observed a clear decrease in self-initiations with the training package, which was likely due to the dense sit schedule. Jim's training results were similar to Gayle and Ingrid's results, in that his toileting performance improved across phases, limiting our ability to discern what role, if any, the training package had on his performance. Bethany showed an immediate improvement in accidents and appropriate eliminations when teachers introduced the training package. Her self-initiations also remained low with the training package. Two (Aaron and Bethany) of the six children showed a clear benefit from the training package. Delayed improvements during the training package (Lizzy) or increasing trends in baseline (Gayle, Ingrid, and Jim) obscured whether the training package, continued exposure to the low-intensity training procedures (present across conditions), or maturational variables improved toileting performance for the other four children.

Figure 2 displays results for children who experienced the underwear component after

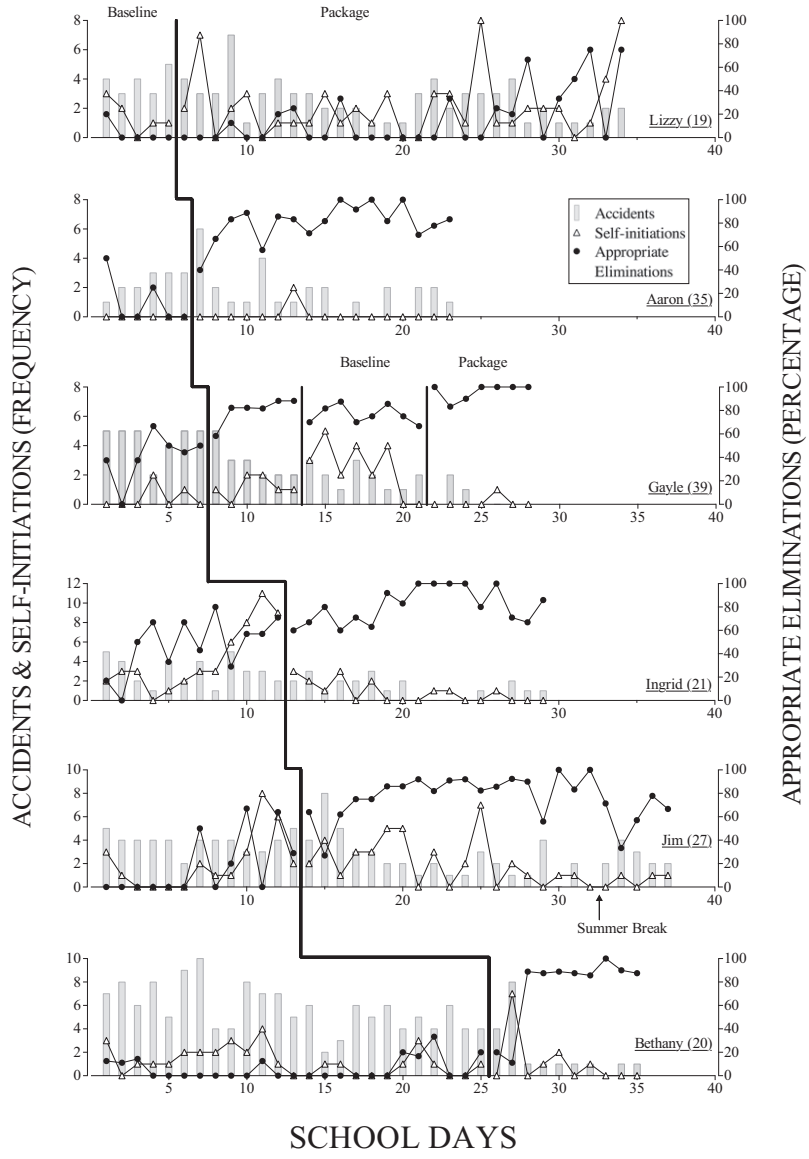

Figure 1. Results of the component analysis for children exposed to the toilet-training package after baseline. Each child's age (in months) is noted parenthetically.

baseline. Danny's first and second exposures to the underwear component were correlated with delayed improvements in toileting performance relative to baseline. For Tammy, a gradual decrease in the frequency of accidents was followed by an increase in the percentage of appropriate eliminations with the underwear component. For Sully, the use of underwear was correlated with overall improvements in performance. Leah's performance remained unchanged after the introduction of the underwear component. Overall, the underwear component seemed to facilitate toilet training for at least two (Tammy and Sully) of the four children.

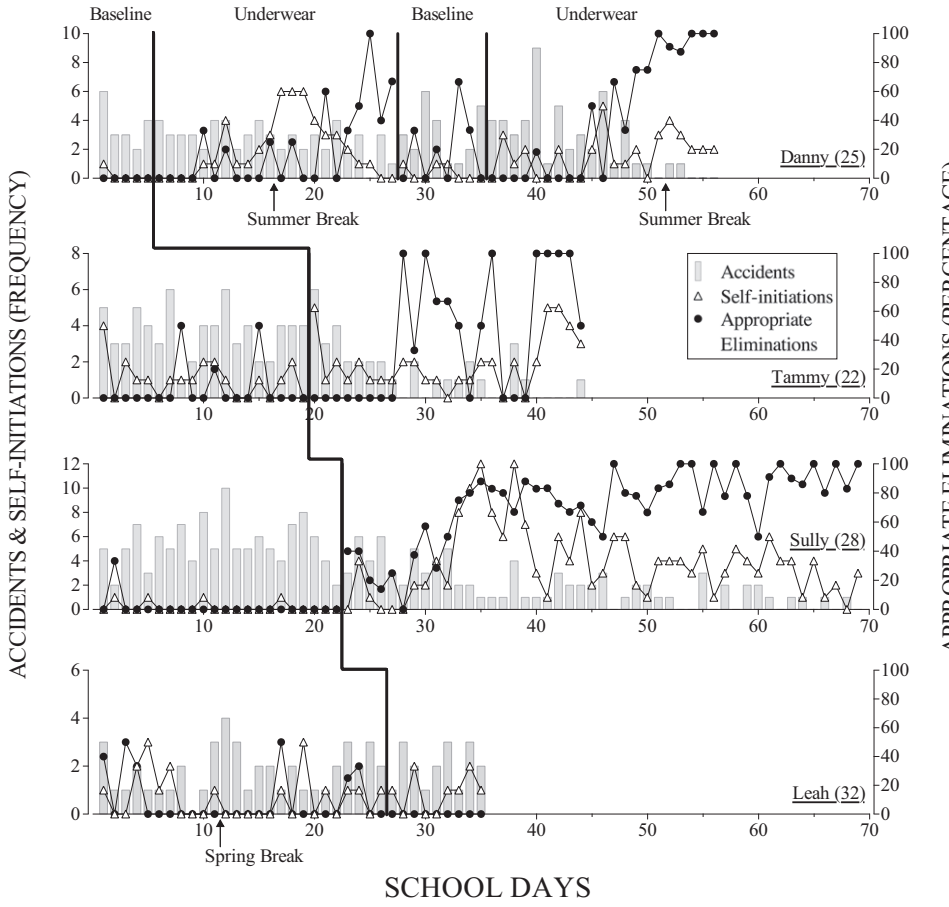

Figure 2. Results of the component analysis for children exposed to underwear after baseline. Each child's age (in months) is noted parenthetically.

Figure 3 displays results for children who experienced the dense sit schedule after baseline. Alton's and Sebastian's toileting performances did not improve with the increased sit schedule. Introduction of the dense sit schedule was correlated with an increase in Ernie's appropriate eliminations, but his frequency of accidents remained unchanged. Marge participated in an extended evaluation of the dense sit schedule to determine whether a longer exposure would facilitate her acquisition of toileting skills. Unfortunately, her performance remained consistently low throughout the evaluation. Overall, the dense sit schedule did not produce overall improvements in toileting performance for any of the four children, and Marge's results suggest that additional exposure was equally ineffective.

Figure 4 displays results for children who experienced differential reinforcement after baseline. For Nancy, Blue, and Christy, differential reinforcement had no effect on performance. Ivy's level of self-initiations increased with differential reinforcement; however, there was no improvement in her levels of accidents or appropriate eliminations. Overall, differential reinforcement failed to produce overall improvements in the toileting performance of any of the four children.

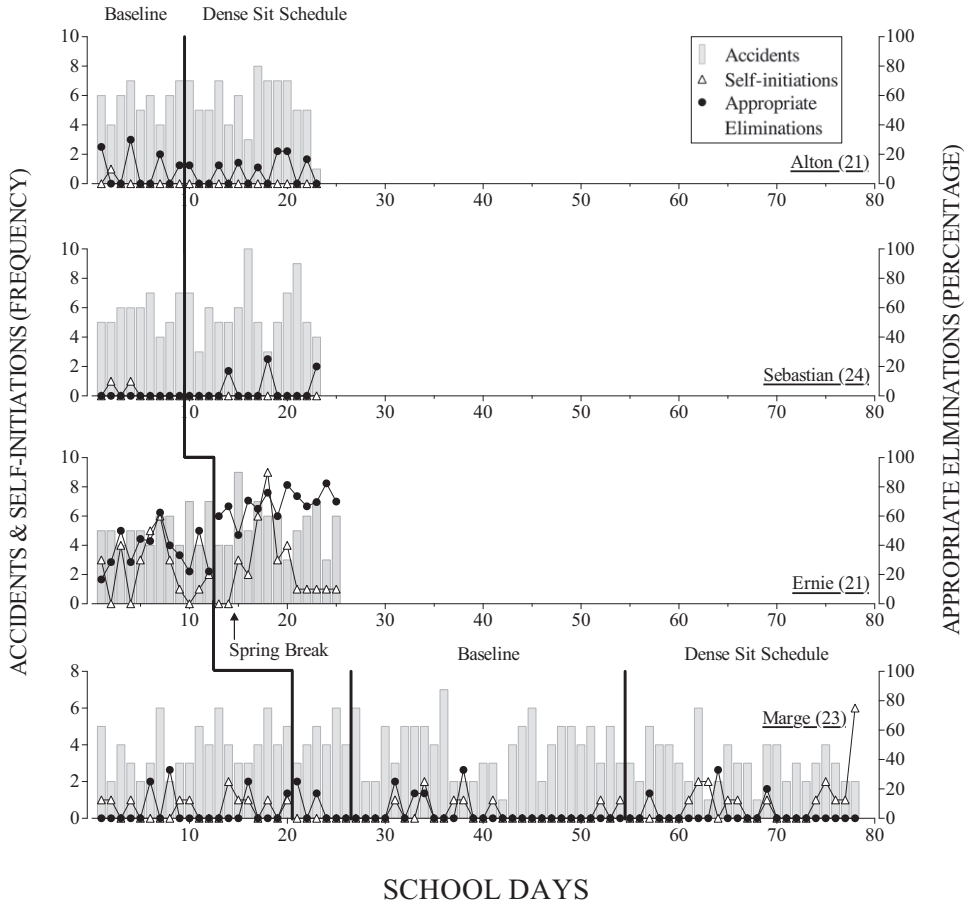

Figure 3. Results of the component analysis for children exposed to the dense sit schedule after baseline. Each child's age (in months) is noted parenthetically.

Prolonged exposure to baseline was correlated with improved toileting performance for two children (Missy and Jasmine; Figure 5). Although baseline contingencies included low-intensity toilet training, it is equally possible that uncontrolled variables (e.g., subject maturation, toilet training outside the classroom) accounted for these results. It is also important to note that similar durations of exposure to baseline contingencies were insufficient to improve other children's performances (see results for Bethany in Figure 1, Sully and Leah in Figure 2, and Marge in Figure 3).

Figure 6 displays summary results of the component analysis for each child who participated in the component analysis. As in the previous figures, Figure 6 includes data from only the initial procedures implemented after baseline. Bars with an asterisk indicate a standardized difference effect size above 1.0, indicating a large effect (Faith, Allison, & Gorman, 1996). We removed asterisks for contraindicated effects (e.g., a large decrease in self-initiations). The training package was associated with improvements in appropriate eliminations and reductions in accidents for each of the six children. Many of these improvements were equal to or above an effect size of 1.0. However, self-initiation effect sizes were below

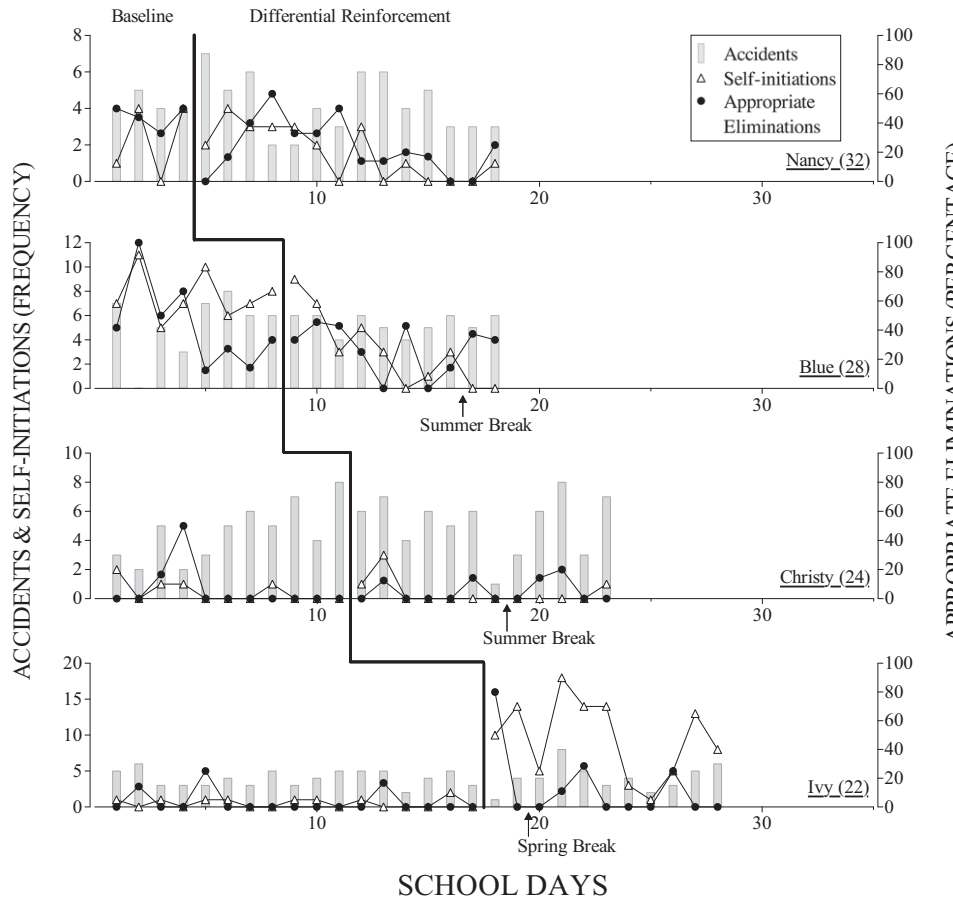

Figure 4. Results of the component analysis for children exposed to differential reinforcement after baseline. Each child's age (in months) is noted parenthetically.

1.0 for all children. We obtained large effect sizes for appropriate eliminations, accidents, and self-initiations for two of the four children who experienced the underwear component after baseline. Unlike the training package and the underwear component of the training package, the dense sit schedule and differential reinforcement did not produce large effect sizes for the majority of children. Regardless of the training procedures used, most children did not demonstrate meaningful improvements in self-initiations. Only three of the 18 children who participated in the component analysis showed large increases in levels of self-initiations. All three of these children experienced either the underwear or differential reinforcement components after baseline.

As noted above, teachers added training components sequentially when individual training components were ineffective (individual data available from the first author). Although these data are difficult to attribute directly to the efficacy of the added components due to a prolonged exposure to other training procedures (i.e., those present in baseline and across conditions) and a lack of within-subject replication with every child, these results may help guide more complete analyses of combining

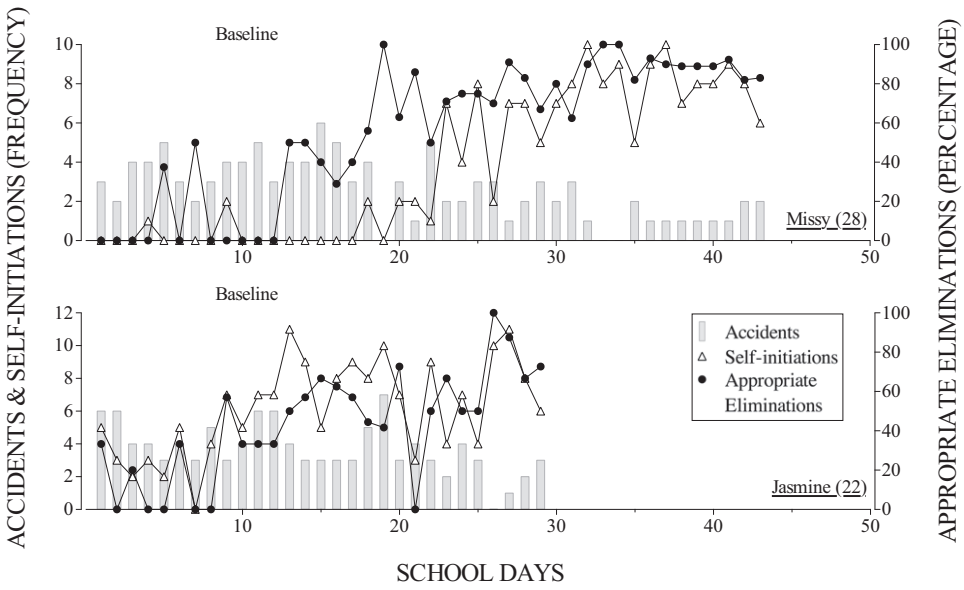

Figure 5. Toilet-training data for Missy and Jasmine, who demonstrated acquisition of toileting skills during baseline. Each child's age (in months) is noted parenthetically.

training components. To analyze these data, we calculated the mean differences in the percentage of appropriate eliminations to determine the additive effects of the various toilet-training procedures used during the component analysis. These results are displayed in Table 2, along with the sequence of conditions (i.e., design) used with each child. Toileting performance often improved when underwear was implemented, regardless of when it was introduced. Underwear was the second or third component for six children (Marge experienced the underwear and differential reinforcement components simultaneously). Of these six children (Nancy, Blue, Ivy, Christy, Sebastian, and Ernie), the introduction of underwear was correlated with increased appropriate eliminations for four of them (Nancy, Blue, Christy, and Sebastian).

Somewhat surprisingly, differential reinforcement appeared to be more effective when it was combined with the other training components, despite its ineffectiveness when used with only with the low-intensity baseline procedures. This component was the second or third component added for five children (Tammy, Sully, Leah, Sebastian, and Ernie), and its use was correlated with improved appropriate eliminations for three of the children (Tammy, Sully, and Sebastian). However, all three of these children wore underwear when differential reinforcement was introduced, which raises the question of whether the effects of differential reinforcement were enhanced for children who also wore underwear or if continued use of underwear alone accounted for these improvements.

DISCUSSION

We evaluated the combined and sequential effects of three recommended toilet-training procedures on levels of accidents, appropriate eliminations, and self-initiations. When these three training components were combined, we observed clear improvements in toileting performance for two of the six children, including the only child (Aaron) with autism. At least two of

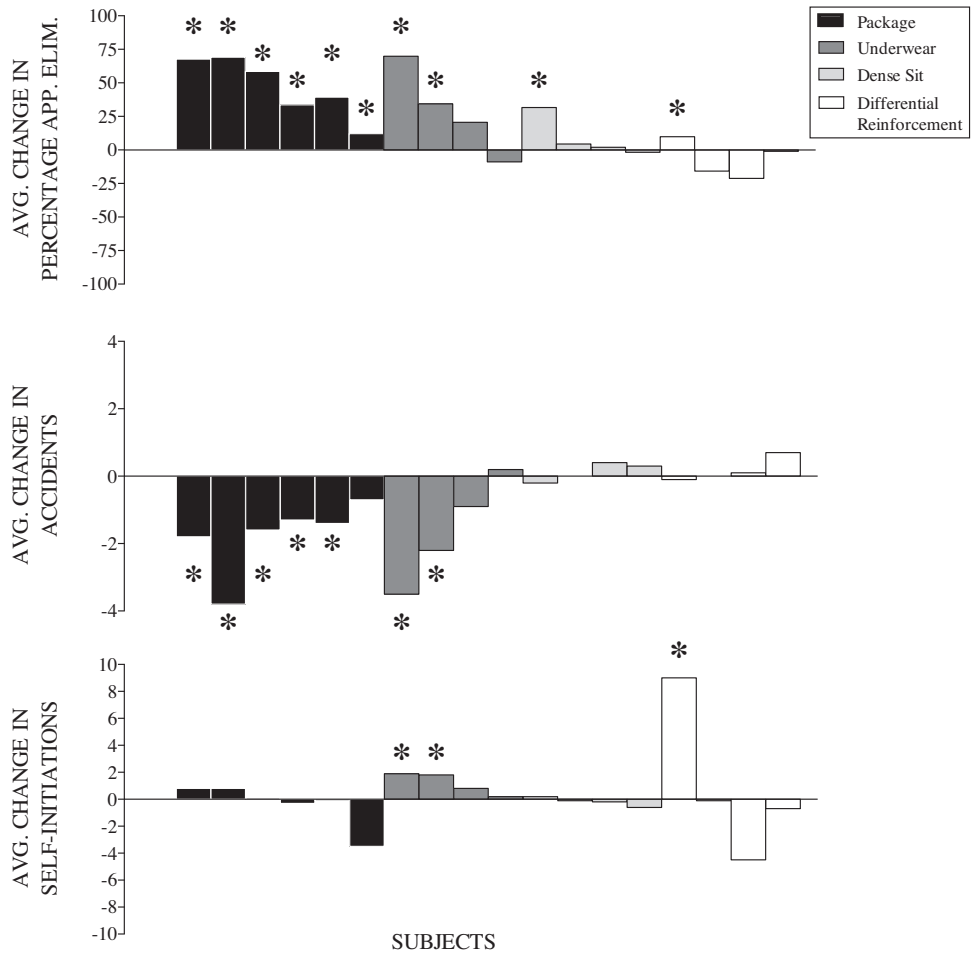

Figure 6. Summary results of the component analysis indicating average change in the percentage of appropriate eliminations, accidents, and self-initiations for all children (except Missy and Jasmine) from the first intervention that followed baseline. Asterisks indicate effect sizes above 1.0.

four children benefited from the underwear component following baseline, and four of six children showed improvements when underwear was added as a second or third component. None of the eight children who experienced the dense sit schedule or differential reinforcement following baseline showed improvements in overall performance. However, three of six children showed improved levels of appropriate eliminations when differential reinforcement was used in conjunction with underwear. At least two children (Missy and Jasmine) showed better toileting performance after prolonged exposure to the low-intensity procedures in baseline.

Placing children in underwear may improve their toileting performance when used with low-intensity training (e.g., periodically prompting the child to sit on the toilet and providing differential reinforcement). Four children experienced the underwear component following baseline, and two of them showed overall improvements in performance (a 50% success rate). Simon and Thompson (2006) used procedures similar to those in this study and

found clear improvements in performance for two of five children (a 40% success rate).

Our methodology did not permit an evaluation of why underwear was effective. However, informal observations conducted by classroom teachers and supervisors noted several potentially relevant stimulus changes that coincided with children beginning to wear underwear. First, children who wore underwear often saturated their clothing when they had an accident, which appeared to be aversive and may have functioned as positive punishment for accidents. Second, classroom teachers more quickly identified and changed children who had an accident while they wore underwear, and many children resisted leaving ongoing (presumably preferred) classroom activities to be changed. Loss of access to these preferred activities may have functioned as negative punishment for accidents. Third, classroom teachers and supervisors noted that some children had strong preferences for specific pairs of underwear that were imprinted with preferred characters (action heroes, cartoon characters, etc.). Children occasionally cried when their preferred underwear was unavailable. Therefore, it is also possible that removing preferred pairs of underwear following accidents may have decreased accidents by way of negative punishment. The operant processes responsible for the effectiveness of the underwear component may differ across children.

Regardless of why underwear is effective, a growing body of research now suggests that caregivers should consider replacing diapers and pull-ons with underwear. However, additional research on the direct and indirect effects of this and other components is needed. As discussed above, the consequences of urinary accidents while wearing underwear may be aversive for some children and may be associated with negative corollary behaviors (e.g., crying, resisting teachers' prompts to walk to the bathroom), which may influence caregiver willingness to implement this component. Future researchers should consider collecting data on negative vocalizations, noncompliance, and disruptive behavior (e.g., tantrums) during toilet training. Ahearn, Kerwin, Eicher, Shantz, and Swearingin (1996) found that of two feeding treatments for children with food refusal, caregivers preferred the treatment associated with lower levels of negative corollary behavior even though both treatments were equally effective in treating food refusal. Similarly, future researchers should evaluate toilet-training procedures in terms of effectiveness, likelihood of producing negative corollary behavior, and caregiver preference.

An additional factor that would likely affect caregiver preference for toilet-training procedures is the effort associated with the procedure. Children were assigned to training components (or the training package) based on how many children had already been exposed to each condition and experimenter convenience, which included how many other children were already being trained in each classroom and how effortful the proposed procedures would be for the teachers. In each classroom, at least one teacher was scheduled to be in the bathroom at any given time, and a second teacher was often required to assist the first teacher. The classroom teachers reported that the two most effortful components of the training package were the dense sit schedule and the underwear components. Although teachers did not collect data on the proportion of the day each child spent in the bathroom, children who experienced the dense sit schedule spent a substantial amount of time each day in the bathroom. Therefore, the dense sit schedule made it difficult for the teachers to complete the toileting procedures with the other children. On the other hand, children who experienced the underwear component required frequent changes of clothing, and this also made it difficult for teachers to complete other responsibilities. These observations have implications for caregivers who attempt to toilet train children at home. Procedures such as these may be burdensome for caregivers and make it difficult to

complete other responsibilities (e.g., going to the grocery store, caring for an infant sibling, preparing dinner). Therefore, future researchers should assess caregiver preference for toilet-training procedures associated with differing levels of effort.

Caregiver satisfaction with the training program would likely be influenced by the level of toileting independence achieved. Independence with toileting routines requires that the child communicate his or her need to use the bathroom. Unfortunately, self-initiations did not increase for the majority of the children, regardless of which training component was implemented. However, teachers prompted children to sit on the toilet at least every 90 min, which may have abolished the reinforcers for self-initiating; the only children whose self-initiations improved after baseline were those who were not exposed to the dense sit schedule. Therefore, the use of a dense schedule to prompt use of the toilet may not be advantageous when training young children. As discussed above, LeBlanc et al. (2005) and Hanney et al. (2013) used a level system in which the sit schedule adjusted as the child progressed through the training program. LeBlanc et al. showed that self-initiations maintained at moderate to high levels for two of three children with this graduated sit schedule. Hanney et al. extended these procedures to an outpatient setting and showed that self-initiations occurred for 57% of the children (14 of 27) over the single day of training. These graduated sit schedules might encourage the acquisition of self-initiations and other toileting skills because the child is unlikely to become dependent on caregiver prompts to use the bathroom.

Another potential benefit of using a graduated sit schedule is that it may help ensure that initially dense reinforcement schedules do not produce reinforcer satiation, in that the availability of reinforcers declines as the sit schedule is thinned. Across all conditions, teachers delivered preferred stimuli after appropriate eliminations and prompted children to sit on the toilet at least every 90 min. Therefore, children could access preferred stimuli at least every 90 min across conditions, which could have limited the effectiveness of these stimuli to reinforce appropriate eliminations. Furthermore, when children experienced differential reinforcement, these same reinforcers also became available for remaining dry at scheduled undergarment checks (i.e., every 30 min) as well as whenever the child self-initiated, perhaps further degrading the reinforcing efficacy of these stimuli. The relatively dense reinforcement schedules may have limited our ability to reinforce remaining dry, appropriately eliminating, and self-initiating.

We did not explicitly evaluate each child's prerequisite skills (e.g., remaining dry for more than 2 hr, demonstrating "interest" in the toilet, being able to sit for 3 min, cooperating with instructions and rules) before the start of the study. We informally screened children for the presence of at least some prerequisite skills, and all children were older than 18 months (AHRQ, 2006). However, as Brazelton et al. (1999) noted, no two children have the same physiological timetable at which to begin toilet training. Researchers should consider evaluating which prerequisite skills are predictive of successful toilet training. However, successful training likely depends on both the presence of specific readiness skills and the implementation of effective and preferred training procedures.

In conclusion, our findings contribute to the behavioral research on toilet training by evaluating the efficacy of three recommended procedural components when combined or implemented sequentially. Given that most programs are comprised of multiple components, researchers should continue to address the question of which components are necessary and sufficient to improve toileting performance. The results of these investigations should identify more effective and efficient strategies for toilet training young children.

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