Journal of
Applied Behavior Analysis

Journal of Applied Behavior Analysis 2020, **9999,** 1–18 NUMBER 9999 ()

Transitioning from rich to lean reinforcement as a form of error correction

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Discrete trial instruction (DTI) is a ubiquitous tool used by practitioners in early intervention programs. A common approach to correcting errors during DTI involves providing a single prompt of the target response when a mistake is made (i.e., single-response repetition). Modifications to the single-response repetition approach have been developed to improve acquisition; however, these modifications are often aversive techniques (e.g., increased effort, response cost) and may not be preferred by the children or considered socially acceptable by caregivers. We conducted this study to evaluate the use of a transition from rich to lean reinforcement as a form of error correction. We compared the rich–lean condition to the single-response repetition approach during DTI for 4 boys diagnosed with autism. The rich–lean condition was (a) more efficient in improving accuracy in 6 out of 9 tasks, (b) more preferred by all participants, and (c) socially validated by caregivers.

Key words: acquisition, discrete trial instruction, error correction, transitions

Discrete trial instruction (DTI) is a fundamental component of any applied behavior analytic early intervention program for children diagnosed with autism (Maurice et al., 1996). It has been successfully used to improve the acquisition of new repertoires such as stimulus discriminations, imitation, receptive language, and expressive language (Smith, 2001). The general process of DTI involves the presentation of individual units of instruction that are intended to evoke a relatively brief response from the child, which is then determined to be correct or incorrect. A correct response often produces praise and a reinforcer selected from a preference assessment, whereas an incorrect response includes some form of error correction to improve performance on the next repeated trial.

In a common approach to error correction, a mistake is followed by a single prompt to repeat the correct response (single-response repetition; Worsdell et al., 2005). The child's repetition of the response produces praise, but no preferred item, and the next trial is initiated. Multiple variations of error correction have been developed to improve acquisition and may vary with respect to the response effort (i.e., repetitions of the correct response) or consequence (e. g., response cost) provided contingent on a mistake. For example, Worsdell et al. (2005) compared the performance on a sight-word reading task for 11 adults diagnosed with intellectual and developmental disabilities. During Study 1, errors were either followed by the single

We would like to extend our thanks to Dr. Kimberly Shamoun of Behavioral Intervention Psychological Services, PC for her support in this study.

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doi: 10.1002/jaba.717

prompt or multiple prompts to repeat the correct response five times. In all cases, the increased effort of repeating the correct response multiple times following an error improved acquisition of the sight words.

For some children, repetition of the correct response may not be enough to improve performance during DTI. Fisher et al. (2014) introduced a response cost procedure to increase the saliency of the discrimination between a correct and incorrect response for three children diagnosed with autism. During the intervention, preferred edible items were placed in a transparent container following each correct response. The therapist then delivered the container with the accumulated edibles contingent on the third consecutive correct response. However, if an error was made the container was emptied and the participant had to again make three consecutive correct responses in order to earn the edibles. The inclusion of the response-cost procedure resulted in more correct trials across all three participants when compared to a differential reinforcement baseline without error correction.

Another variation of a response-cost procedure during error correction involves a brief timeout (Carroll et al., 2015). Carroll et al. (2015) compared multiple error-correction procedures for five children with developmental disabilities. One of the procedures evaluated included a 2-s timeout following an incorrect response whereby the therapist removed the materials and turned away from the child before re-presenting the trial with a prompt. Overall, the authors found this procedure to be effective in improving skill acquisition in four of the five participants and the most efficient[1] procedure for one participant.

Modifications to the single-response repetition approach to error correction may successfully improve performance during DTI. However, the modifications likely do so by increasing the aversive properties of the consequence for an incorrect response and delaying access to reinforcement. For example, repeating a correct response multiple times following an error may not only be aversive, it increases the duration before the next trial can be initiated, reducing the potential rate of reinforcement.

Paden and Kodak (2015) evaluated a modification that increased the reinforcing value of correct responses. Four boys diagnosed with autism were presented with three error correction conditions during DTI. A condition with high magnitude reinforcers (i.e., a greater amount of edibles) for correct responding was compared to a condition with low magnitude reinforcers (i.e., fewer edibles) and another condition with only contingent praise. The findings were mixed with the high-magnitude reinforcement resulting in the most efficient acquisition with only two of the four participants. It may be that the efficacy of high- and low-magnitude reinforcers could be enhanced by including a shift in those reinforcers (i.e., transition) in a single error correction procedure.

Perone and Courtney (1992) found that simply transitioning between fixed-ratio (FR) schedules of varying reinforcer magnitude can share similar aversive properties to punishment. In a basic preparation with pigeons, the authors arranged for transitions in rich (i.e., greater magnitude) and lean (i.e., lesser magnitude) reinforcement during the FR schedules with (multiple schedule) and without (mixed schedule) a signal identifying the contingency shift. Interestingly, extended pausing in responding only occurred when there was a signaled change in context from rich to lean reinforcement. In other words, pigeons stopped responding even though doing so reduced access to the available lower-magnitude reinforcement.

Jessel and Ingvarsson (2017) developed an error correction procedure with four

[1]Efficiency refers to the number of sessions required to meet the mastery criteria.

participants diagnosed with developmental disabilities that incorporated similar transitions from rich to lean reinforcement based on basic preparations. Correct responses in the condition with the transition produced the more-preferred items selected from a previously conducted preference assessment. Following an incorrect response, the participants were provided a less-preferred item for their attempt and a single prompt to repeat the correct response. Furthermore, participants were now in a context in which more-preferred items were no longer available and only less-preferred items could be obtained for a correct response. The less-preferred context continued for two to three trials before the availability of more-preferred items for correct responding was reintroduced. The error correction procedure that included the transition was effective at improving accuracy in two of the three participants in which the single-response repetition approach was also deemed effective. In addition, the error correction procedure that included a transition in reinforcement schedules was found to be more efficient than the single-response repetition approach in one of those two cases.

Jessel and Ingvarsson (2017) found that it was possible to modify the single-response repetition error correction procedure to eliminate repeated prompts, the loss of earned edibles, or timeout. Using the rich-to-lean transition, the rate of reinforcement can be maintained, creating an effective form of error correction in a rich and, possibly preferred environment. However, in addition to the rich-to-lean transition, the modified error correction procedure included access to lean reinforcement following incorrect attempts, which could have impacted the efficacy of the treatment. Furthermore, preference assessments were only conducted one time at the beginning of a child's participation. Therefore, the value of the preferred items could have changed throughout the study, altering the contrast between the transitions (i.e., the rich items may have lost value with repeated exposure and the lean items may have gained value over time).

The purpose of this study was to conduct an evaluation of the rich–lean DTI error-correction model. We compared the efficacy, efficiency, and preference for the rich–lean condition to that of the single-response repetition approach with four participants across nine different tasks. In addition, daily preference assessments were conducted and we isolated the effects of the transition by reinforcing only correct responses and not attempts.

Method

Participants, Materials, and Setting

Four boys diagnosed with autism were selected to participate in this study because they were receiving applied behavior-analytic services including DTI (see Table 1). Ian was 16 years old and spoke in single word utterances. Ian had around five years of experience with DTI and was exposed to a variation of the single-response repetition method that included

Table 1

Participant Information

	Demographic Information		Task Information		Preferred Items	
	Age	Diagnosis	Target	Trials	More	Less
Ian	16	Autism	Tacting Items (grocery, sports, instruments)	10	Airheads®	Crackers
Carlos	12	Autism	Intraverbals (bathroom, bank)	10	Peach rings	Cheese crackers
Roy	11	Autism	Reading Words (one word, two words)	10	iPad®	Legos®
Archie	9	Autism	Tacting Items (grocery, vegetables)	10	Chocolate	Pretzels

repeated presentations of the instruction when the error was made. Ian had previously mastered targets from categories such as common household items, animals, and familiar people. During the current study, his DTI tasks included tacting different categories (i.e., grocery, sports, and instruments). Carlos was 12 years old and spoke in fully fluent sentences. Carlos was presented with different intraverbal tasks (e.g., "You dry your hands with a…[towel]." "You collect money from an…[ATM]."). Carlos had less than a year of experience with DTI. In addition, this was Carlos' first experience with the error correction procedures using intraverbal targets. The third participant, Roy, was 11 years old during his participation and spoke in short disfluent sentences. This was Roy's first introduction to DTI and he had no experience with either error correction procedure. His tasks included reading one and two words on index cards. Archie was 9 years old and spoke in short disfluent sentences. Archie was exposed to DTI for less than a year and experienced the same modified procedures as Ian. Archie tacted pictures of grocery items and vegetables presented to him on index cards during the study. All targets and categories of targets were entirely novel and never presented outside of participation in this study.

Sessions were conducted in a designated area with a table and chairs in each participant's home. Each session was 10 trials and two to three sessions were conducted within a 1-hr visit. The therapists used color coded index cards to present the instructions and indicate the specific error correction condition being implemented. During error correction sessions, 17.5 cm tall by 12 cm wide transparent displayettes were used to present a visible picture of an available preferred item. The displayettes were plastic three-dimensional displays with an insert for pictures to be slid inside and held up throughout the session within view (30 cm from the participant).

Measurement

We defined a correct response as the participant initiating the targeted vocal response within 5 s of an instruction and completing the response without any prompts or error correction. Any other response, or a lack of responding within 5 s of the instruction was considered incorrect. We calculated a percentage of accurate responding during each session by dividing the number of correct responses by the total number of trials and multiplying the quotient by 100. Error correction sessions were terminated for a specific condition once a participant met the mastery criterion of three sessions with 80% accurate responding or higher. We deemed any condition that met mastery criteria as efficacious. In addition, we used the number of sessions to meet the mastery criterion as a measure of treatment efficiency. The error correction procedure that required the least amount of sessions to reach mastery criteria was considered more efficient and the procedure that required the most sessions was considered less efficient. During the concurrent-chains analysis we measured cumulative selections of the available options. A selection was defined as tacting the condition or pointing to the condition. A preference for one condition over another was determined when the participant consistently selected the condition at least three times in a row.

Interobserver Agreement and Treatment Fidelity

All sessions were videotaped and a second observer independently scored at least 30% of the videos. An agreement was defined as both the primary and secondary observers scoring a response as correct or incorrect in an individual trial. Interobserver agreement (IOA) was then calculated by adding the total number of agreements within a session and dividing the sum by 10 (i.e., total number of trials within a session). We then calculated mean IOA across sessions for each participant. The IOA for all four

participants was 100%. We also calculated IOA of condition selections during the concurrent-chains analysis. A secondary observer observed all selections, for both participants and caregivers, and the IOA was 100%.

In addition, we calculated treatment fidelity using the same videos scored for IOA. Procedures were outlined in a task analysis, detailing how the therapist should (a) deliver instructions, (b) respond to errors, and (c) respond to correct answers across the baseline and error correction conditions. Each implementation of the individual components of the error correction procedures was scored as being correctly or incorrectly implemented. Treatment fidelity was calculated by dividing the total number of correct implementations by the total number of error correction components. Treatment fidelity for Ian, Carlos, Roy, and Archie during the single-response repetition error correction condition was 100%, 99% (range, 90-100%), 100%, and 100%, respectively. Treatment fidelity for Ian, Carlos, Roy, and Archie during the rich–lean condition was 100%, 99% (92-100%), 100%, and 100%, respectively.

Lastly, we calculated IOA with at least 30% of the videos for which treatment fidelity was scored. A secondary observer independently scored implementation of all procedures, and the exact scores of each implementation were compared to that of the primary observer. An agreement was defined as both the primary and secondary observer reporting that an error correction component was implemented correctly or incorrectly. The number of agreements was then divided by the total number of error correction components. IOA of treatment fidelity for Ian, Carlos, Roy, and Archie was 98% (range, 91-100%), 100%, 98% (range, 91-100%), and 99% (range, 98-100%), respectively.

Design

We evaluated the comparison of the single-response repetition and rich–lean approaches in an adapted alternating treatments design (Sindelar et al., 1985). Independent instructional sets of a single category (e.g., different sports terms) were included in each of the two error correction conditions. A list of 10 targets from the same category was first established. Each target was then assigned a condition using a random number generator. Targets were randomly assigned rather than matched along some form of response dimension because (a) matching one dimension (e.g., syllables) could possibly confound another (e.g., visual or auditory similarity) and (b) random assignment provides an equal probability that each target will be placed in a certain condition. The list of all targeted items is presented in Table 2.

Following baseline, the two error correction conditions were rapidly and randomly alternated; however, a single condition could not be implemented more than three times in a row. In addition, the adapted alternating treatments design was conducted multiple times with each participant across different categories of materials (e.g., different sports terms, different vegetables) in a concurrent (Ian) and noncurrent multiple baseline design (Carlos, Roy, and Archie). Therefore, the effects of the error correction procedures were replicated in a staggered fashion within participants.

Procedure

Preference Assessment

We conducted a multiple stimulus without replacement (MSWO; Deleon & Iwata, 1996) preference assessment to inform the selection of preferred items to be included in the error correction comparison. Six to eight items were placed in an array in front of the participant. All items included in the preference assessment were reported to be preferred and nominated by the caregivers and therapists. Following a selection, the participant was given enough time to consume (edible item) or engage (leisure item) with the item before it was removed

Table 2

Targets across Participants

	First Baseline		Second Baseline		Third Baseline	
	SRR	Rich–lean	SRR	Rich–lean	SRR	Rich–lean
Ian	Receipt, cash register, bag, cart, coins	Cashier, wallet, basket, price, coupon	Jersey, baseball, helmet, hoop, tennis ball	Trophy, weights, racket, net, bowling ball	Clarinet, saxophone, harmonica, flute, maraca	Violin, guitar, harp, tuba, trumpet
Carlos	Toilet, floss, razor, cabinet, soap	Lotion, toilet paper, hairdryer, nail clipper, mirror	Taxes, checkbook, piggy bank, ATM, account	Statement, vault, wallet, manager, bank teller	--	--
Roy	Jacket, face, wash, phone, brush	Shoes, clean, hair, answer, table	Red ball, glass cup, blow bubbles, big house, let's go	Hot chocolate, ice skate, orange shoe, I'm hungry, good day	--	--
Archie	Coupon, price, coins, cashier, cart	Bag, wallet, basket, receipt, cash register	Eggplant, tomato, peas, celery, spinach	Onion, broccoli, lettuce, pepper, mushroom	--	--

Note. SRR refers to single-response repetition.

from the array. The MSWO with the full array was conducted three times with each participant. The item consistently selected (i.e., mean of the three presentations) first was determined to be more preferred. The item consistently selected in the middle of the rankings was determined to be moderately preferred. Finally, the item consistently selected last was determined to be less preferred. Furthermore, the less preferred items had to still be selected and consumed. If the participant refused to accept the item, the next lowest item would have been determined to be less preferred. We did this to ensure that the lowest item was still preferred and not aversive. The results of the preference assessments for each participant are presented in Table 1.

We also conducted MSWOs with a restricted array of the more-preferred, moderately-preferred, and less-preferred items every day before sessions to ensure that preferences did not shift. Whatever item the participant selected first that day would have been used as the more-preferred item and the item selected last would have been used as the less-preferred item. However, shifts in preference did not occur and participants' preferences remained consistent throughout their participation.

Baseline

The therapist presented an initial instruction at the beginning of each trial (e.g., "What is it?") during the baseline condition. The participant had 5 s to initiate a response. If the response was correct, the therapist provided brief praise and proceeded to the next trial. If the participant did not respond or the response was incorrect, the therapist did not provide any correction or feedback and moved on to the next trial. The intertrial interval was approximately 5 s.

Single-Response Repetition Approach

The single-response repetition error correction procedure included the top selected item

from the daily preference assessment as the more-preferred reinforcer. A picture of the more-preferred item was placed in a displayette and was visible throughout the session. Much like baseline, the therapist provided an instruction when each trial was initiated. Following a correct response, the therapist provided the more-preferred item. If this item was an edible (Ian, Carlos, and Archie) the participant was given enough time to consume the item before the next trial was introduced. If the more-preferred reinforcer was a leisure item, the participant (Roy) was provided with 45-s access before the item was removed and the next trial initiated. Following an incorrect response, the therapist corrected the participant and provided a single prompt such as, "Nope, it is a car. What is it?" The therapist provided praise if the participant imitated the correct response or repeated the answer (e.g., "It is a car") if they did not imitate the correct response before moving on to the next trial. In other words, the time between trials was never extended even following multiple errors and the participant was not required to respond by the final repetition of the answer from the therapist.

Rich–Lean Approach

At the beginning of sessions in the rich–lean condition, the picture of the more-preferred item was placed in the displayette for the participant to see. This condition was identical to the single-response repetition condition if the participant did not make any errors. In other words, a correct response following the instruction produced access to the more-preferred item. In addition, following an incorrect response, the therapist initiated the single-prompt error correction procedure.

Unlike the single-response repetition condition, following an error, the therapist turned the displayette around to present the picture of the less-preferred item and verbally informed the participant of the change in available reinforcers (e.g., "Nope, we are now earning blocks. It is a car. What is it?"). The displayette remained on the less-preferred item for the subsequent two trials regardless of responding, and any correct responses produced the less-preferred item whereas any incorrect responses were followed by the corrective prompt sequence. In addition to receiving the less-preferred item, the participant whose error correction procedure included leisure items was provided reduced access (i.e., 15-s). Once the two trials were completed, the therapist turned the displayette back around to make the more-preferred item visible and verbally informed the participant of the change (e.g., "We are working for [more-preferred item] again").

Concurrent-Chains Analysis

We conducted a concurrent-chains analysis to determine the preference for the rich–lean procedures in comparison to the single-response repetition approach after the error correction comparison was completed. During the concurrent-chains analyses, four sets of materials were presented in a random order once the participants had met mastery criteria. Two sets were duplicates of the tasks from the rich–lean and single-response repetition approaches but with the coordinated colors removed (i.e., white index cards). These two sets served as controls to ensure that participants did not simply prefer the task items. If a participant selected either of those sets, the session began without the displayette and the therapist only provided brief praise in a neutral tone contingent on correct responses. The selection of the materials dictated the session (i.e., single-response repetition or rich–lean condition). Prior to conducting the concurrent-chains analysis, participants were prompted to select each condition to expose them to all available conditions. The concurrent chains analysis was conducted multiple times; one for every comparison the participant experienced. Each analysis was discontinued following three consecutive selections of the same condition.

We also conducted a concurrent-chains analysis to directly evaluate caregivers' preferences for the DTI programs following their child's participation. After a participant mastered all the material, the therapist explained to the parent the difference between the conditions (see Supplemental Material for scripts). Furthermore, all parents observed multiple sessions as they were being conducted and had a general understanding of what their child was experiencing prior to the explanation. The baseline from the error correction comparison served as the control during the concurrent-chains analysis. The therapist then laid out three sets of randomly chosen materials for the control, single-response repetition, and rich–lean procedures and asked the caregiver to, "Please select how you would like your child to learn the material." The therapist conducted the selected condition and randomized the order in which the next trial was presented. The error correction procedure with three consecutive selections was determined to be more preferred.

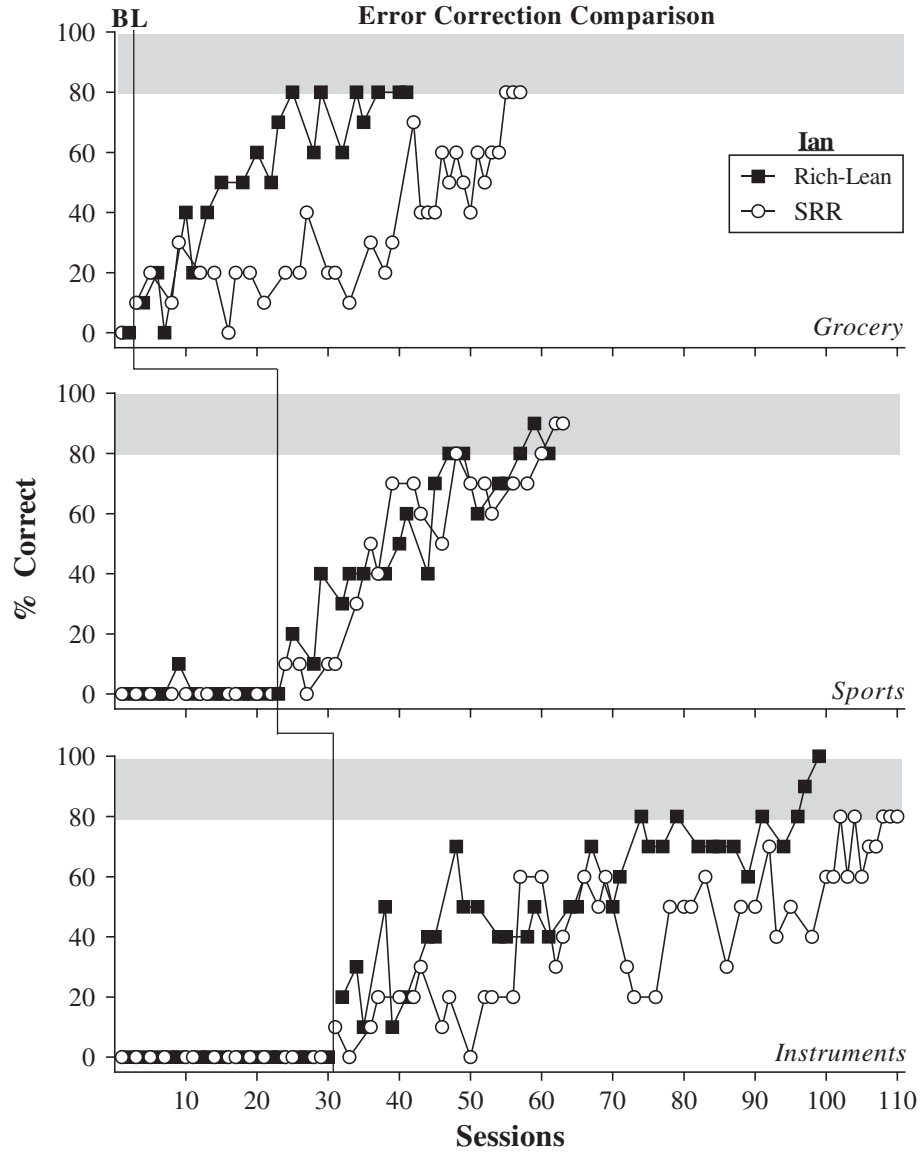
Social Validity Questionnaire

The therapist also asked caregivers to complete a brief questionnaire at the end of the child's participation (see Supplemental Material for full questionnaire). The questionnaire included questions on a 7-point Likert scale regarding the caregiver's satisfaction with their child's progress on the targeted programs, the helpfulness of the two DTI programs the child experienced, and the acceptability of the rich–lean approach. Higher scores on the questionnaire represented higher measures of social validity. In addition, caregivers were asked to select which approach, if any, they would recommend to others. Lastly, additional space was available for optional open-ended comments.

Results

The results of Ian's error correction comparison are presented in Figure 1 and the relative efficiency of the single-response repetition and rich–lean approaches is summarized in Table 3. Except for one session, Ian did not correctly tact any grocery, sports, or instrument objects during baseline. Both error correction procedures resulted in an increased percentage of correct responding and Ian met mastery criterion across groups of targeted items. However, the rich–lean condition consistently resulted in a more efficient mastery of items (M = 25 sessions; range, 20-35) in comparison to the single-response repetition condition (M = 33.7 sessions; range, 21-45). During baseline (Figure 2), Carlos accurately responded to a minimal number of bathroom related intraverbals and did not answer any bank intraverbals correctly. Both error correction procedures increased correct responding and Carlos met mastery criterion using the single-response repetition and rich–lean approaches. Much like Ian, the rich–lean approach resulted in quicker acquisition and mastery of targeted items (M = 8 sessions; range, 5-11) than the single-response repetition condition (M = 11.5 sessions; range, 9-14). Roy did not read the targeted words before the error correction procedures were introduced (Figure 3). After the error correction procedures were introduced, Roy's accuracy on all tasks improved. Roy differed from Ian and Carlos in that he mastered the items in fewer sessions during the single-response repetition approach (M = 9 sessions; range, 8-10) and required more sessions of the rich–lean condition (M = 16.5 sessions; range, 14-19). The results of Archie's error correction comparison are presented in Figure 4. Archie did not correctly tact any grocery items or vegetables during the baseline condition. Once the error correction procedures were introduced, Archie met mastery criterion for both sets of items. However, the efficiency of the error correction approaches was mixed. Archie required fewer sessions to meet mastery criterion during the rich–lean condition (M = 13.5 sessions; range, 11-16) with the grocery items and fewer

Figure 1
Results of the Error Correction Comparison for Ian.



Note. Horizontal grey bars represent the mastery criteria. SRR refers to single-response repetition.

sessions during the single-response repetition approach (M = 12.5 sessions; range, 12-13) with the vegetables.

The results of Ian's concurrent-chains analysis are presented in Figure 5. Ian began each concurrent-chains analysis often choosing between all conditions. However, after multiple exposures he shifted his selections to the rich–lean condition. In all three sets of materials, Ian preferred (i.e., minimum of three consecutive

Table 3

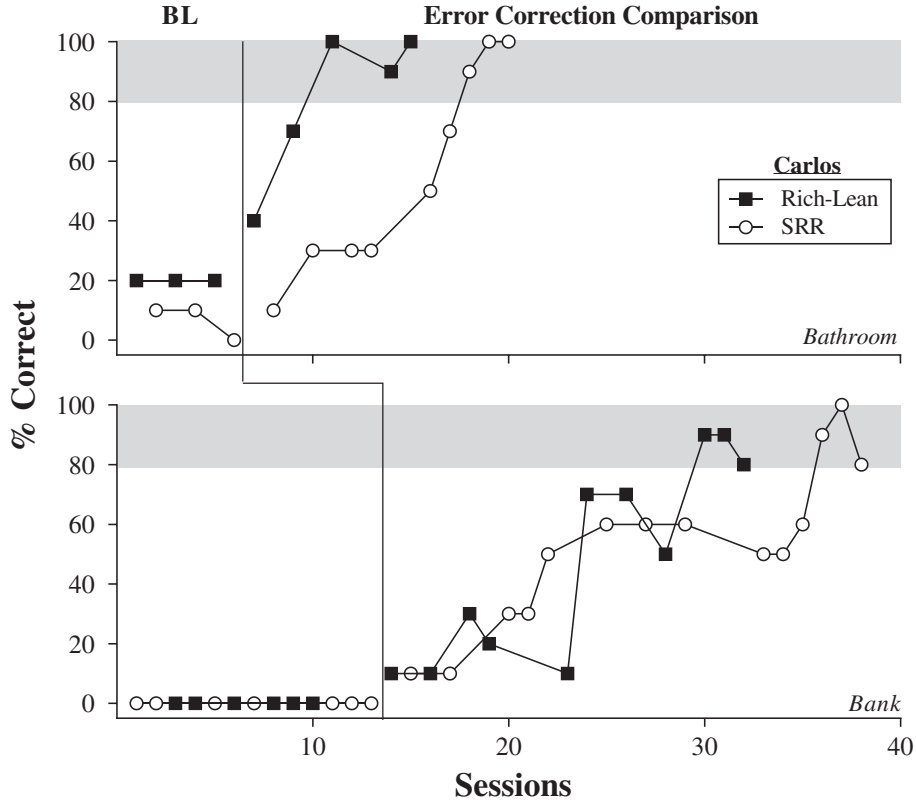
Measure of Efficiency of Error Correction Approaches

	First Comparison		Second Comparison		Third Comparison	
	SRR	Rich–lean	SRR	Rich–lean	SRR	Rich–lean
Ian	35	**20**	21	**20**	45	**35**
Carlos	9	**5**	14	**11**	--	--
Roy	**10**	14	**8**	19	--	--
Archie	13	**11**	**12**	16	--	--

Note. SRR refers to single-response repetition. Bold indicates the more efficient error correction procedure. Dashes indicate that there was no third comparison.

Figure 2

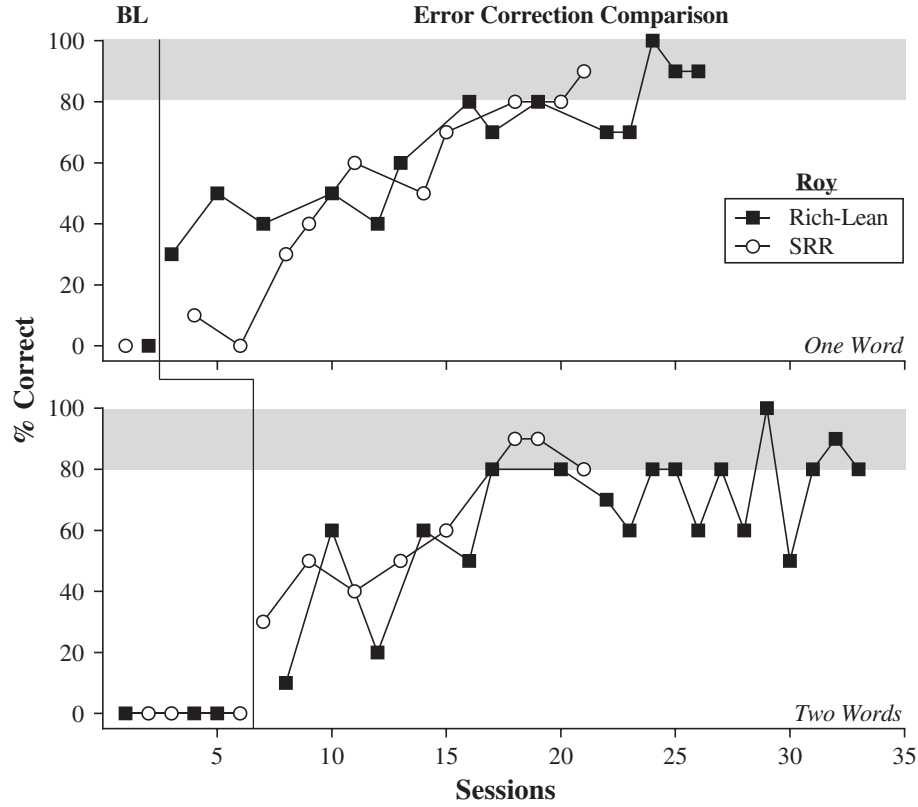
Results of the Error Correction Comparison for Carlos.



Note. Horizontal grey bars represent the mastery criteria. SRR refers to single-response repetition.

selections) the rich–lean condition over the single-response repetition approach. The results of the concurrent-chains analysis for Carlos, Roy, and Archie are presented in Figure 6. Carlos consistently selected the rich–lean condition, whereas Roy and Archie initially selected both the single-response repetition and rich–lean approaches, but shifted their selections to

Figure 3
Results of the Error Correction Comparison for Roy.



Note. Horizontal grey bars represent the mastery criteria. SRR refers to single-response repetition.

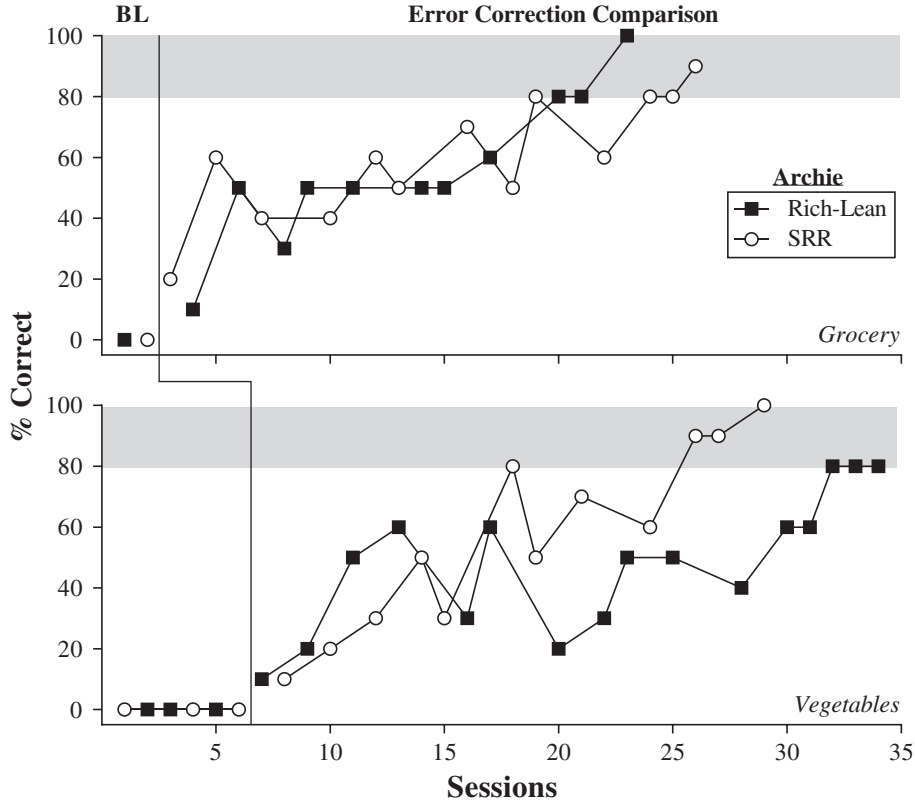
the rich–lean approach. The results of the concurrent-chains analysis with caregivers are presented in Figure 7. All parents exclusively selected the rich–lean procedures to conduct with their children.

Following the conclusion of their child's participation, the caregiver completed a social validity questionnaire (Table 4). All caregivers reported being highly satisfied with their child's improvements on the targeted tasks (M = 6.25, range = 6-7). In addition, caregivers reported the single-response repetition approach to be helpful (M = 5.5, range = 4-7). However, the rich–lean approach received higher scores (M = 6.5, range = 6-7). Lastly, all caregivers rated the rich–lean procedures to be acceptable (M = 6.25, range = 5-7) and reported that they would recommend its use over the single-response repetition approach to others.

Discussion

We compared accuracy in nine treatment comparisons with four participants during DTI using the single-response repetition and recently developed rich–lean approaches to error correction. The rich–lean approach was effective in improving accuracy in all applications and was the most efficient procedure in 67% of the error correction comparisons. It is important to note that although the improvements in efficiency were somewhat mixed, all

Figure 4
Results of the Error Correction Comparison for Archie.



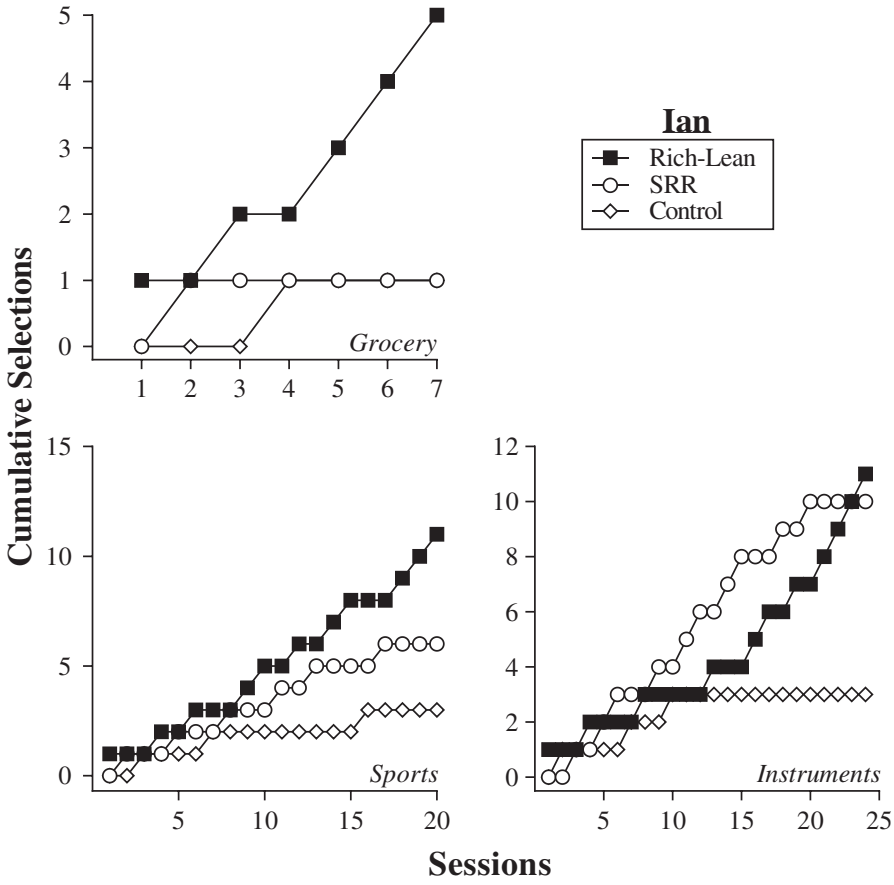
Note. Horizontal grey bars represent the mastery criteria. SRR refers to single-response repetition.

participants and their caregivers preferred the rich–lean approach.

The single-response repetition approach, consisting of presenting a single prompt to evoke the correct response, has been found to be an effective tool in many cases (Howlin et al., 2009). However, it is likely that modifications to the single-response repetition approach will be required for some children and preferred by others. Researchers have developed multiple strategies to improve performance when necessary by including aversive procedures such as repeated practice and response cost (Fisher et al., 2014; Worsdell et al., 2005). Although the use of punishment may improve the effectiveness of the error correction procedure, it may (a) reduce the overall preference and acceptability for the participants and caregivers and (b) reduce the total amount of exposure to positive reinforcement when initially learning a new repertoire. Therefore, clinicians may want to consider reserving potentially aversive procedures for very limited cases and researchers may want to consider comparing the effectiveness and social acceptability of those procedures with the current rich–lean approach.

The results seem to support basic research suggesting that transitions between rich and lean reinforcement could be sufficiently punishing in the absence of overtly aversive procedures (Perone & Courtney, 1992). Everly

Figure 5
Results of the Concurrent-Chains Analyses for Ian.

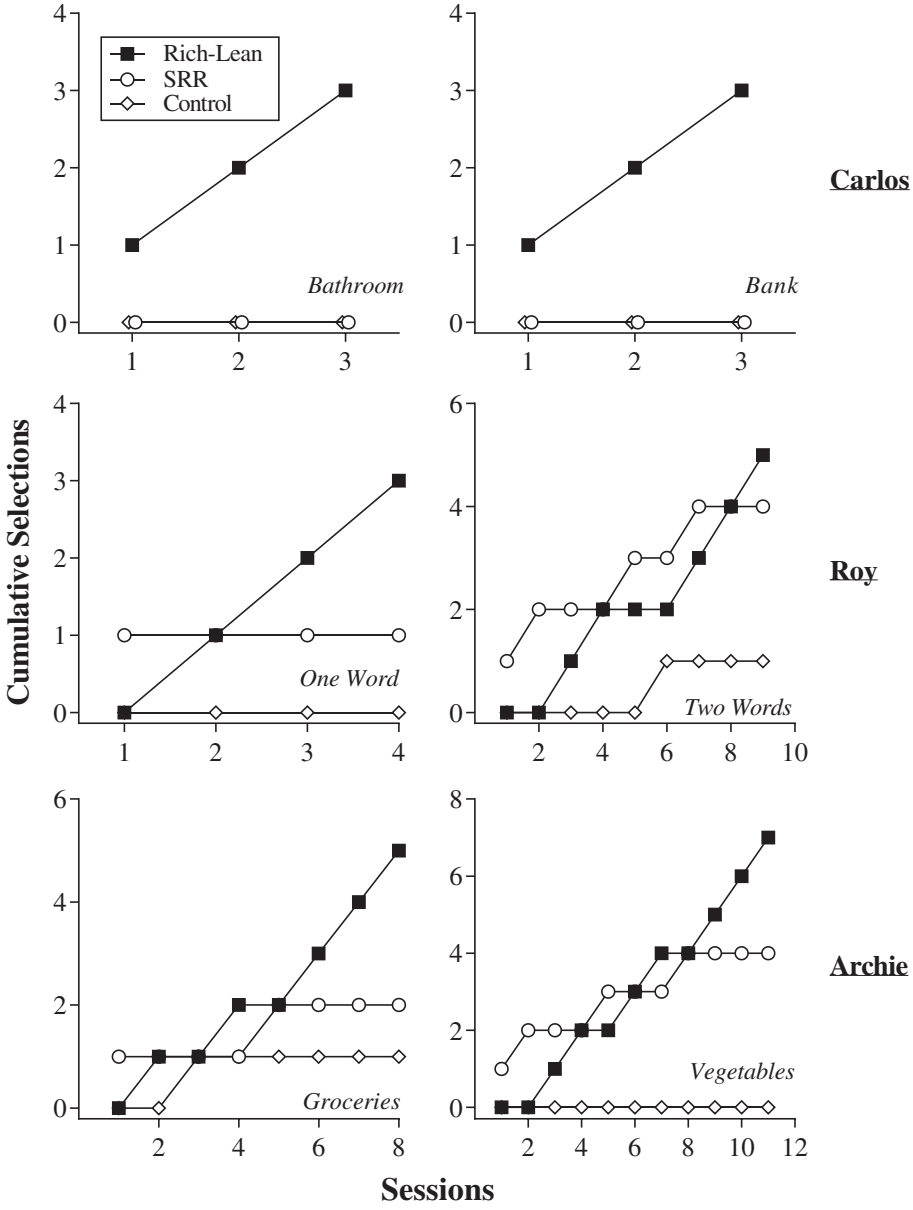


Note. SRR refers to single-response repetition.

et al. (2014) bolstered the evidence by evaluating escape responding with pigeons in the presence of signaled rich-to-lean transitions. The researchers provided pigeons with the opportunity to turn off the lights that served as discriminative stimuli for the FR schedule in effect. All of the pigeons tended to turn off the light during the lean schedule of reinforcement and two of the four pigeons used the "off" key more often when that lean schedule was preceded by a rich reinforcement schedule. That is, the light signaling the transition was likely to be an aversive stimulus when transitioning from rich to lean schedules of reinforcement because the pigeons would escape the light's presence when given the opportunity.

Jessel and Ingvarsson (2017) attempted to apply basic preparations of DTI by including a transition to lean reinforcement following errors. However, this study was more of a translational approach to identifying a possible extension to a clinically relevant situation. The present study continued to evaluate a DTI procedure that can be conducted with high fidelity and is preferred by the children and caregivers involved. Furthermore, the rich–lean approach may improve outcomes in comparison to the single-response repetition approach and does

Figure 6
Results of the Concurrent-Chains Analyses for Carlos, Roy, and Archie.



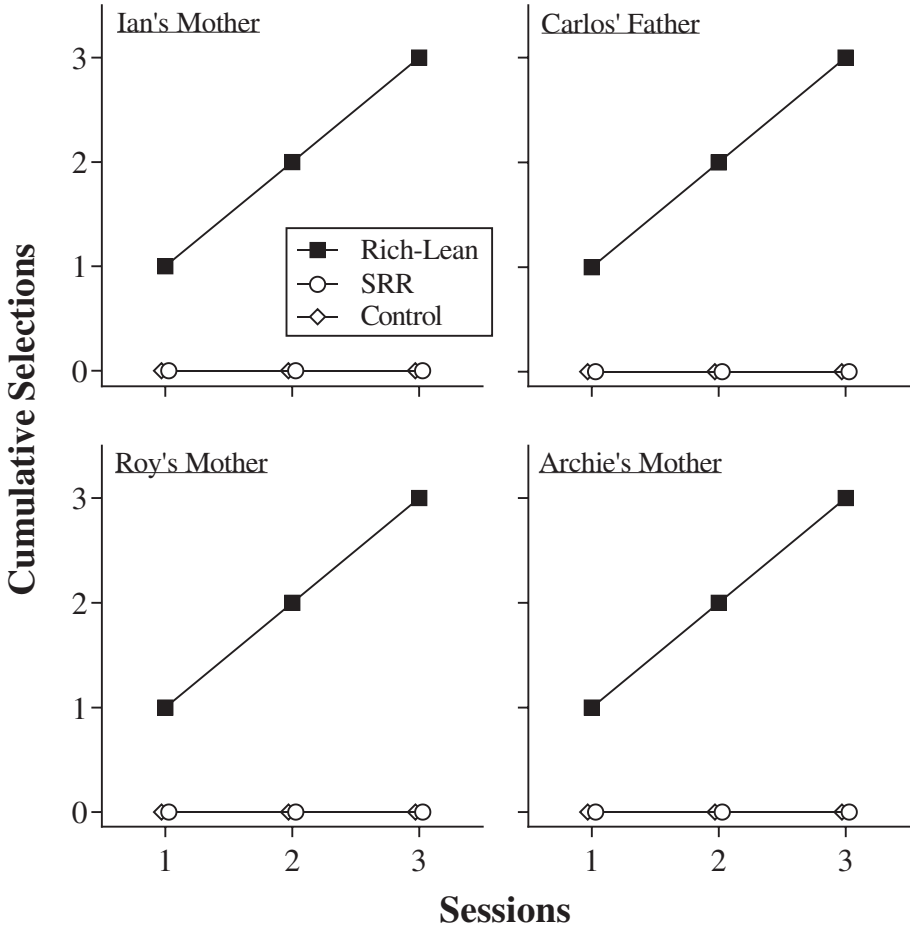
Note. SRR refers to single-response repetition.

not require techniques such as increased effort, timeout, or token loss. However, we are limited in suggesting that the rich–lean approach can replace these techniques because a direct comparison was not made in the current study.

It is important to point out that the only participant whose performance was consistently better in the single-response repetition condition did not earn edible items. Interestingly, these results seem to correspond with the

Figure 7

Results of the Concurrent-Chains Analyses for Caregivers.



Note. SRR refers to single-response repetition.

Table 4

Social Validity Results Completed by Caregivers

	Ian	Carlos	Roy	Archie	*Mean*
Satisfaction with improvement	6	6	6	7	*6.25*
Helpfulness of the SRR approach	5	6	7	4	*5.5*
Helpfulness of the rich–lean approach	6	6	7	7	*6.5*
Acceptability of the rich–lean approach	5	7	7	6	*6.25*
Recommendation	Rich–lean	Rich–lean	Rich–lean	Rich–lean	--

Note. Caregivers answered questions using a 7-point Likert scale with 1 representing the lowest value (not satisfied/helpful/acceptable) and 7 representing the highest value (highly satisfied/helpful/acceptable). SRR refers to the single-response repetition.

outcomes of Jessel and Ingvarsson (2017) even though the participants in both studies experienced a unique, double-disparity arrangement (i.e., simultaneous manipulation of two parameters of reinforcement). Williams et al. (2011) used a similar double-disparity arrangement during a translational study with adults diagnosed with intellectual disabilities. In the rich reinforcement condition, participants earned more money on smaller FR requirements, whereas in the lean condition, participants earned points exchangeable for less money on a larger FR requirement. The inclusion of both parameter manipulations (i.e., rate and magnitude) likely enhanced the aversiveness of the transition from rich to lean reinforcement; however, the same effects were not obtained in our study.

It is unclear which variables account for the differences in these double-disparity arrangements. It may be that, although a hierarchy can be established with leisure items, the relative reinforcing value between each item may not be as pronounced as with preferred edible items. In other words, there may have been greater contrast between the more-preferred and less-preferred edible reinforcers, which increased the aversive quality of the transition. Researchers may want to consider evaluating double-disparity arrangements with edible items during error correction procedures. For example, the rich reinforcement could consist of large amounts of the more-preferred edible (e.g., five pieces of chocolate) and the lean reinforcement could consist of small amounts of the less-preferred edible (e.g., one piece of cereal).

To ensure a sufficient level of contrast between rich and lean reinforcers, future research could be conducted evaluating different assessments for identifying more- and less-preferred items that would better predict the effectiveness of the transition used in the rich–lean approach. This preference assessment should address two important qualities. First, both the more- and less-preferred items have to be reinforcing in an absolute sense (i.e., the participant may choose the more-preferred item first but will consume the less-preferred item when the more-preferred item is not available). This requirement exists to ensure the overall context remains reinforcing and that the participant is not transitioning from rich reinforcement to punishment. Second, the reinforcing value between the more- and less-preferred items must be large enough to make that transition punishing without the use of aversive stimuli.

In a translational arrangement, Jessel et al. (2016) created a context in which children with autism were instructed to physically transition between different activities. The authors attempted to replicate basic findings of extended pausing during rich to lean transitions with a more practical measure. Jessel et al. not only measured the difference in time it took to transition between the more-preferred and less-preferred activities but also tracked the physical dawdling for one participant. The results suggest that transition duration and excessive dawdling were more likely to be observed when the child transitioned from rich to lean schedules of reinforcement. Furthermore, Jessel et al. developed a practical assessment in Experiment 2 that only required the transition to and from a single rich context and a single lean context. The practical assessment may better predict the qualitative contrast between more- and less-preferred items in comparison to a typical preference assessment such as an MSWO. That is, if pausing, extended transition durations, or dawdling are not observed the therapist may want to revisit the assessment with new items of greater disparity before using the rich–lean procedures.

Overall, the rich–lean approach was informed by basic research, demonstrated as feasible in translational evaluations, and socially validated in practical applications. Further investigation could continue

evaluating variables that are relevant to clinicians and any barriers to the widespread adoption of rich–lean procedures. For example, although direct and indirect measures of social validity were included, we are limited in identifying more global indices of happiness (Green & Reid, 1996; Parsons et al., 2012). Participants may have preferred the rich–lean approach relative to the single-response repetition approach but we did not measure the construct of happiness associated with either context (e.g., smiling, laughing, positive statements). In addition, we could improve the social acceptability and marketing of the procedures among parents and teachers by reducing the use of behavior-analytic terminology (Becirevic et al., 2016). We designated the rich–lean procedures as the *Losing Little, Gaining More* approach for the caregivers of the current study. Losing little refers to the transition from rich to lean reinforcement because this is not as imposing as a complete loss of reinforcement. Gaining more refers to the ability of this rich to lean transition of reinforcement to improve performance on DTI tasks. Therefore, it may be possible to maintain technological definitions for applied researchers while using more widely acceptable terminology for our constituents.

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Received July 12, 2019
Final acceptance March 10, 2020
Action Editor, Florence DiGennaro Reed

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