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# Imitation fluency in a student with autism spectrum disorder: an experimental case study

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# Imitation fluency in a student with autism spectrum disorder: an experimental case study

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**ABSTRACT**
Children with autism spectrum disorders need imitation due to its application for learning other behaviors. Behavior analysis has procedures for effectively teaching imitative behaviors. Imitation can only be considered mastered, however, when imitation of untaught behaviors occurs. To explore the relationship between taught and untaught imitative behaviors, Accuracy Building and Frequency Building to a Performance Criterion (FBPC) was provided to a four-year-old girl with autism. Twelve motor movements were taught during instructional sessions while another three remained untaught/unreinforced. The first set of three motor imitations occurred in the Accuracy Building condition where the child received prompts, corrections, and reinforcement. Upon achieving the exit criterion of 100% correct, the FBPC condition began and the participant built frequency, or practiced the taught imitative behaviors until meeting a performance criterion. Imitation of untaught behaviors was assessed in every third instructional session. A repeated acquisition design revealed the combination of Accuracy Building and FBPC led to the stimulus control of taught imitative behaviors. In addition, the behavioral fluency of taught imitations contributed to the steady growth of untaught behaviors indicating the participant had learned imitation.

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Autism is a severe developmental disability. Commonly manifesting within the first three years of life, children with autism spectrum disorder (ASD) have significant impairments in social interactions including verbal and nonverbal communication and exhibit incidences of stereotypic behaviors (American Psychological Association [APA], 2010). Imitation is a foundational skill of social communication (Dawson & Adams, 1984; Rogers, 1999). Imitation also significantly contributes to early language abilities of children with ASD (Toth, Munson, Meltzoff, & Dawson, 2006). Even the rate of language development in the early childhood period can be best predicted by imitation (Charman et al., 2003; Stone & Yoder, 2001). Compared with typically developing children, children with ASD rely more heavily on imitation for language acquisition (Carpenter, Pennington, & Rogers, 2002).

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Many children with ASD exhibit impairments in imitation with body movements and gestures (Rogers, Bennetto, McEvoy, & Pennington, 1996) and actions on objects (Stone, Ousley, & Littleford, 1997). A long history of research has targeted various aspects of motor imitation acquisition. Stone et al. (1997), for instance, examined the motor imitation skills of young children with ASD. Results showed that though both contribute to communication development, imitation of body movement is predictive of language ability and is more difficult than imitation of actions with objects. It is especially difficult for children with ASD to imitate complex and novel sequences of actions (Dawson & Adams, 1984; Rogers et al., 1996). A typical imitation training starts with an adult providing a verbal (e.g., Watch me. Do this) and nonverbal (e.g., motor action) stimulus to initiate interactions. Corrections/prompts are given if the child makes an incorrect response or makes no response, as in the Discrete Trial Method (Buffington, Krantz, McClannahan, & Poulson, 1998; Lovaas, Freitas, Nelson, & Whalen, 1967). Reinforcement is contingent on the correct response, and only in its presence is the preferred tangible item delivered. Most criteria target accuracy, which may be set up as percentage correct (e.g., 80–100%) over several trials such as performing 80% for three consecutive trials (Holding, Bray, & Kehle, 2011).

The specific contingency of adult modeling and student imitating does not end with accuracy of the taught/reinforced behaviors, however. Imitation can only be considered mastered, and therefore functional, when imitation of untaught/unreinforced behaviors occurs. Cooper, Heron, and Heward (2007) defined imitation as "A learner who learns to do what the model does is likely to imitate models that have not been associated with specific training, and those imitations are likely to occur in many situations and settings, frequently in the absence of planned reinforcement" (p. 415). That is, imitation can and shall occur without direct reinforcement if a similar, but different, imitative response has been reinforced in the past.

When learners acquire imitation, additional assistance (i.e., prompts) and reinforcement are provided to increase the probability of target behaviors. During acquisition-level training, additional assistance and reinforcement control the occurrence of the correct behaviors. When learners begin imitating independently, the control is transferred to the model's behavior (Martens, Daly, Begeny, & VanDerHeyden, 2011). The close similarity of behavior topography becomes the natural reinforcer. Consequently, the learners are more likely to imitate a variety of the model's behaviors, even in the absence of explicit teaching and contrived reinforcement as demonstrated in classic imitation studies (e.g., Baer, Peterson, & Sherman, 1967). In other words, unreinforced/untaught imitative responses occur as a result of a strengthened stimulus control between the modeled stimulus and the imitative responses.

Young and her colleagues (1994) argued that imitation is achieved if the reinforced and unreinforced imitative responses have similar topography. The imitative behaviors must belong to the same functional response class. Young et al. (1994) examined imitative behaviors across and within three types of response topographies: vocal, toy play, and pantomime. Four young children with autism were taught to make a series of imitations while taking probe trials on imitative responses that were not taught/reinforced. The results demonstrated imitation of untaught/unreinforced behaviors only occurred within the same functional class (i.e., both reinforced and unreinforced imitations have similar topographies) and not across response types. Nevertheless, performing an untaught/unreinforced imitative response does not happen automatically for children with ASD and therefore requires proper planning to strengthen the stimulus control (Kleeberger & Mirenda, 2010).

Stimulus control is strengthened by the repeated reinforcement of the targeting contingency, that is the presence of responding during the appearance of the discriminative stimulus. Multiple opportunities in a timed interval to exhibit the behavioral contingency, beyond initial acquisition methods, characterize the establishment of behavioral fluency, which is major discovery of Precision Teaching. Precision Teaching began in the 1960s and offers users a system for monitoring progress, problem solving, making discoveries, and differentiating instruction (Kubina & Yurich, 2012). Through measuring behavioral fluency, Precision Teaching provides a precise definition of behavior and captures the strength of stimulus control with the unit of measurement frequency. As a result of a strengthened stimulus control, one expects to see the increase of the probability of the target responses. Behavior frequency, or the rate of response measured as a frequency, provides users with a complex performance measurement tool and a sensitive indicator of response strength (Binder, 2010; Martens et al., 2011).

Behavioral fluency is functionally defined as a behavior that reaches an accuracy and speed criterion indicative of competent performance (Binder, 1996; Johnson & Layng, 1992). The criterion is called a performance standard and is measured with frequency or rate (i.e., correct and incorrect responses per unit of time such as 60 words typed correctly per minute). Compelling fluency research has supported the positive effects of behavioral fluency demonstrating when learners with autism meet a performance standard, associated effects of retention, endurance, and application also occur (Cohen, 2005; Fabrizio & Moors, 2003; Holding et al., 2011; Kerr, Smyth, & McDowell, 2003; Twarek, Cihon, & Eshleman, 2010). Research suggests that generalization may also be positively affected by behavioral fluency (Young, West, Howard, & Whitney, 1986).

If behavioral fluency leads to functionality of a response, many important behaviors such as imitation would show critical learning outcomes such as retention, endurance, application, and generalization. Therefore, untaught/unreinforced behaviors should occur contingent upon the fluent taught/reinforced imitative responses. In order to achieve behavioral fluency and obtain the associated outcomes (e.g., generalization), systematic practice must occur. The core process for achieving behavioral fluency is frequency building (i.e., systematic practice) which includes timed repetition of a behavior and performance feedback (Kubina & Wolfe, 2005). Kubina and Wolfe (2005), therefore, proposed incorporating frequency building into the curriculum and interventions for children with autism.

On the other hand, however, the popularity of behavioral fluency in "best practices" does not match that in the research community. Heinicke, Carr, Leblanc, and Severtson (2010) questioned the empirical evidence of frequency building with learners with autism. They challenged the necessity of allocating resources in additional practices and reinforcement beyond the point when the learners have met the accuracy criterion. We agree there should be more empirical studies to confirm, or to reject, the practices of frequency building. Over 35 studies demonstrate the effects of frequency building and the direct attainment of behavioral fluency (Kubina & Yurich, 2012), thereby suggesting learners with autism may experience similar outcomes.

The attainment of behavioral fluency as measured by a performance criterion, a frequency of correct and incorrect responding, signals a strong state of stimulus control. An emerging set of empirical studies confirms strong effects for behavioral fluency and enhanced stimulus control for learners with autism (e.g., Cohen, 2005; Holding et al., 2011; Twarek et al., 2010). The present study aimed at specifically examining how behavioral fluency could contribute to the stimulus control of imitation. The experimenters asked the following questions:

(1) What effects does Accuracy Building (model-reinforce) have on the accuracy and speed (i.e., celeration) of motor imitation of a four-year-old girl with autism?
(2) What effect does Frequency Building to a Performance Criterion (FBPC) (timed-practice and reinforcement) have on the frequency of motor imitation of a four-year-old girl who has achieved an accuracy criterion (i.e., 100% correct)?
(3) What effects do Accuracy Building and FBPC of taught imitative behaviors have on accuracy and speed of untaught imitative behaviors within the same response class?

## Method

### Participants

Olivia was a four-year-old African American girl enrolled in a private autism support program in Western Pennsylvania. She was diagnosed with autism at the age of three. Since that time, she had received center-based services through the current agency. She also received 30 min of individual speech therapy and 30 min of group speech therapy each week. Olivia did not have any vocalizations. She used pointing and a few signs (such as “more”) to make requests. Olivia would cry as a means to protest. The most recent evaluation results from the Battelle Developmental Inventory-Second Edition (standard score mean of 100, *SD* = 15, score range of 40–160) indicated her overall developmental functioning at score of 60, which was significantly below her typically developed peers. Olivia could match-to-sample a few colors, numbers, pictures, and objects. She was very active and would engage in a variety of gross and fine motor actions such as unzipping and removing clothing items with prompts. Olivia would attempt to imitate some movements during circle time, though she could not consistently or accurately imitate actions. Her most recent Individualized Education Program included an annual goal of imitating 10 motor movements at 90% correct accuracy.

### Setting

Olivia was taken to an empty classroom within the school while the first author implemented the intervention. Two empty rooms adjacent to each other across the hallway of Olivia’s classroom were used in rotation depending on whichever was available during the session. Tables, chairs, and shelves were stationed in the rooms. Olivia was positioned to sit on a chair facing the experimenter, next to a table. Various toys such as blocks, bubbles, puppies, and edible items (e.g., candies and cereals) were placed on the table. Olivia was allowed to play with the toys for a few minutes prior to the beginning of the intervention. When the intervention started, the experimenter would push the items away and only offer them as potential reinforcers contingent upon the target behaviors. A palm-sized video camera was positioned on the far corner of the table or the upper shelf next to the wall, whichever was available and out of Olivia's reach. Sessions were videotaped for use of data collection.

### *Response measurement*

The frequency of imitative motor movements served as the response measure or dependent variable. A "model-alone" procedure described by Young et al. (1994) was used throughout the study. A count up timer was set to monitor the elapsed time of each trial. The experimenter said to Olivia, "Look at me, press the button so we can start." When she looked at the experimenter and pressed the timer start button, the trial began. The experimenter provided the first imitative modeling stimulus with a verbal request of "Olivia, do this." A correct response was determined if a matched imitative response occurred within five seconds of the model. Reinforcement was not provided for correct responses. Under the conditions when Olivia did not make a response within five seconds or the response was incorrect, no prompts or corrections were provided. The experimenter then presented the next modeling stimulus.

There were a total of 15 selected imitative actions, divided into three actions per set, including four taught/reinforced sets (Sets A–D), and one untaught/unreinforced set (see Table 1 for a complete description of the selected motor movements). The set of taught motor imitations was assessed at the end of every instructional session while the set of untaught behaviors was assessed every third instructional session, immediately after the intervention imitation set. Each imitative behavior in the set was randomly presented twice, which yielded a total of six responses per assessment session. Immediately following the assessment, the child received a preferred tangible item regardless of how well she performed during the assessment session. Tangible items (i.e., toys or food) mentioned earlier were used to reinforce participation and completion of the assessment.

### *Intervention*

The intervention, or independent variable, was a combination of Accuracy Building, which contained the use of discrete trial instruction (Smith, 2001), and a procedure of frequency building, namely FBPC, which refers to the timed repetition of a behavior with corrective or confirmatory performance feedback (Kostewicz & Kubina, 2011; Kubina & Yurich, 2012). The detailed steps used in instructional sessions of various motor movements are described in the "Procedures" section. Fifteen motor movements were selected and divided into three actions per set (Sets A–D and Untaught Behaviors). Two movements in Set A were duplicated with the existing imitation instruction

**Table 1.** Descriptions of selected motor movements.

| Imitation set | Motor movements | Description |
|---|---|---|
| Set A | Pat table | One or two hands, palm(s) facing down in contact with table, a repeatedly up and down motion |
| Set A | Touch head | One or two hands, palm(s) opening, in contact with top or back of head |
| Set A | Clap hands | Two hands, palms facing inward, repeatedly striking the opposite palm |
| Set B | Pat laps | One or two hands, palm(s) facing down, in contact with one's laps with a repeated up and down motion |
| Set B | Cross forearms | Arms across front of the chest; palms touching the opposite arms |
| Set B | Stretch arms | Arms stretch forward (elbows may bend slightly), fingers forward |
| Set C | Wave hand(s) | One or two hands, palms facing out, wrist(s) remaining stable, fingers pointing up, continuously swinging from left to right, then eight to left |
| Set C | Open and close fist(s) | One or two hands, forearm(s) lifted, repeatedly open and close palm(s) |
| Set C | Point to nose | The tip of index finger touching one's nose |
| Set D | Pat elbow | Hand repeatedly tapping the opposite elbow in front of the chest |
| Set D | Sign "thank" | Palm facing in and fingers pointing up, touching the mouth and moving forward away from the mouth |
| Set D | Sign "sorry" | Holding a fist, rubbing the palm side in a circle on the chest with a repeated movement |
| Untaught behaviors | Pat shoulder(s) | One or two arm(s) cross in front of the chest, palm(s) repeatedly tapping the opposite side of the shoulder areas (including shoulders and/or the opposite corner of the chest) |
| Untaught behaviors | Pat tummy | One or two hands, palm(s) facing down, repeatedly tapping one's belly |
| Untaught behaviors | Sign "all done" | Both hands in front of the chest, forearm lifted, palms facing in and fingers pointing up, flipping the hands over so that both palms facing out with a repeated movement |

implemented in Olivia's individual program (i.e., clapping hands and patting table). The initial assessment indicated that Olivia independently imitated clapping hands and patting table, when given one action at a time followed by reinforcement. She could not imitate any of the other selected motor movements, listed in Table 1. Since the start of the intervention, imitation had been temporarily withheld from Olivia's curriculum in order to prevent a confounding effect.

All imitative movements were explicitly taught during instructional sessions except the set of untaught behaviors. Each instructional session took approximately 15 min and ended with assessment. New sets of motor imitations started with an Accuracy Building condition and then FBPC condition once the child met the performance criterion (PC) of FBPC.

### *Experimental design*

A modified repeated acquisition design was used to determine the effects of intervention on measured response (i.e., dependent variable). The repeated acquisition design has the advantage of handling irreversible behaviors. The main characteristics of the design, also, best suited the experimental question. Namely, the repeated acquisition design works with two or more equivalent learning tasks where acquisition needs to be examined repeatedly from one task to the next under two or more different experimental conditions (Kennedy, 2005). Porritt, Van Wagner, and Poling (2009) used a repeated acquisition design studying behavioral fluency with pigeons. They indicate the repeated acquisition procedure offers great sensitivity for detecting the effects of variables such as rate of responding. In this study, Accuracy Building and FBPC were used with four different sets of taught imitative behaviors across time.

## Data display

The experimenters chose to display the data on sections taken from Standard Celeration Charts (SCCs) (Figures 1 and 2) (Graf & Lindsley, 2002; Lindsley, 2005; Pennypacker, Gutierrez, & Lindsley, 2003). The horizontal axis has 140 lines each representing a calendar day. The vertical axis has a ratio scale covering 0–100 counts per minute. Because zero does not exists in the multiply world and should not appear connected to the graph (Giesecke et al., 2001; Schmid & Schmid, 1979), the figure shows zero disconnected from the rest of the chart. The "Counting Times," the time lapsed to complete sets of behaviors, also displays on the right vertical axis of the chart.

The SCC has several advantages providing information not available on other charts or graphs. The advantages include displaying data in real time, therefore showing the experimental results as they actually occurred. The SCC's ratio scale allows for comparisons across the whole range of behaviors. Because the ratio scale shows proportional changes, a change from 1 to 2 has the same distance of a change from 10 to 20. Correct behaviors occurring at low frequencies can be compared and assessed proportionally to high-frequency behaviors. Another advantage of the SCC

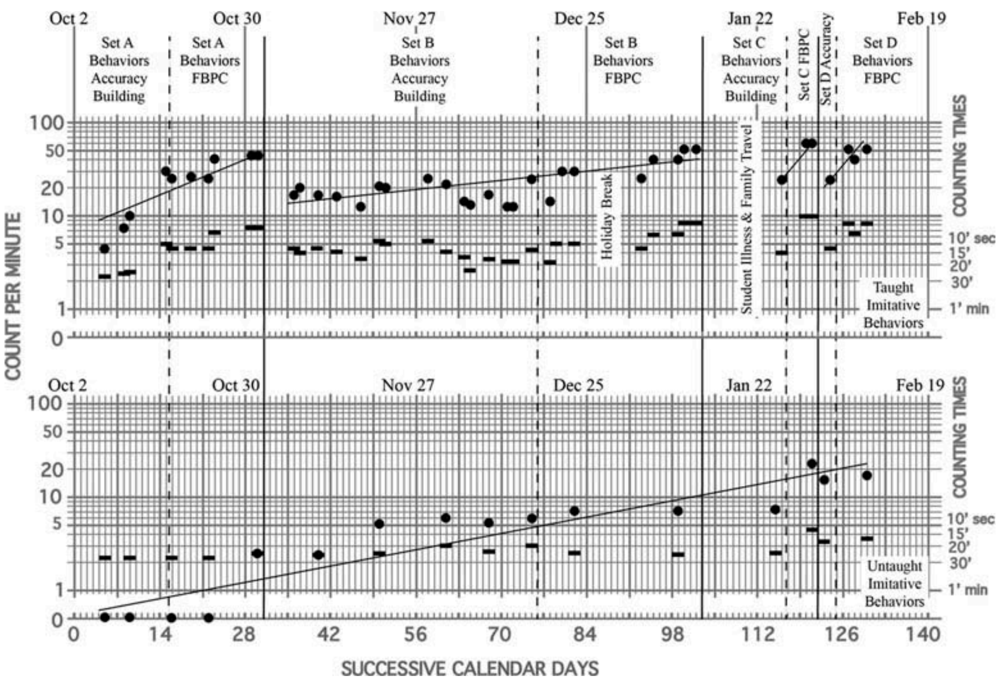


**Figure 1.** Celeration lines for taught (dots in upper chart) and untaught imitative behaviors (dots in lower chart) across four sets of motor movements. Celeration lines are drawn across calendar days. Time bars (small horizontal dashes) show differential time interval for the measured behavior.

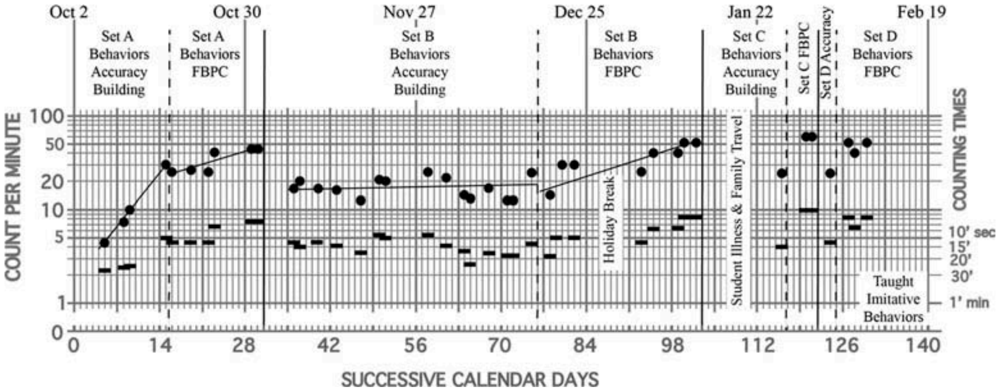


**Figure 2.** Celeration lines for taught imitative behaviors (dots) across Accuracy and Frequency Building conditions. Celeration lines are drawn across calendar days. Time bars (small horizontal dashes) show differential time interval for the measured behavior.

is the ability to calculate celeration. Celeration is a unit of behavior change. It is the change in the frequency per unit of time or number over time over time (i.e., number/min/week; Graf & Lindsley, 2002; Johnston & Pennypacker, 2009). For example, if a behavior occurs at 10 per minute at the beginning of the week and at the end of the week, the behavior is 20 per minute, a celeration value of ×2.0 [7 days]. The ×2 means the behavior has doubled or grew by a factor of ×2 for 7 days. The celeration lines were fitted to the data by using the focus line method (Graf & Lindsley, 2002; Kubina & Yurich, 2012).

## Procedures

### Accuracy building condition

The experimenter initiated the procedure by giving command to the child, "look at me," and when the child complied, the session started. The experimenter then provided the first imitative modeling stimulus with a verbal request of "Olivia, do this." No other verbal cue regarding the actual imitative stimulus was provided. Least-to-most prompts were used during the Accuracy Building teaching condition. That is, if Olivia did not respond, or the response was incorrect, the experimenter modeled the imitative stimulus one additional time, then provided partial physical guidance by gently pulling Olivia's hand to the desired direction. For example, in the imitative stimulus of touching head, the experimenter held Olivia's hand up to ear level. If Olivia completed the imitation, she received a preferred tangible item (i.e., potential reinforcer). If she still did not respond, or the response was incorrect, the experimenter modeled the imitative stimulus again. Then the experimenter provided a full physical guidance by hand-over-hand completing the imitation. Upon the completion of the imitation, Olivia received a preferred tangible item. The next imitative stimulus was then presented. Each teaching session consisted of a total of 15–20 responses.

During Set A instruction, Olivia successfully imitated the selected movements without prompts during instruction, but the same result was not observed during assessment. She imitated one or two movements and then screamed when another model was provided. Olivia's teachers confirmed that she was almost always on a continuous schedule of reinforcement. When the schedule of reinforcement was thinned too fast, going from a CRF to six responses per reinforcement (i.e., FR6), disruptive behavior occurred. Therefore, when Olivia began Accuracy Building and received instruction, the schedule of reinforcement was adjusted and systematically thinned to foster resistance to extinction. Once Olivia had successfully imitated the selected movement, a variable ratio of three or VR3 was then instituted in subsequent sessions. That is, Olivia received a preferred tangible item on an average of every three correct responses. The unpredictable nature of the variable ratio schedule produces steady rates of response (Cooper et al., 2007). Immediately following the session, a model-alone assessment procedure was used to record Olivia's performance.

### FBPC condition

After Olivia achieved 100% correct in assessment during the Accuracy Building condition (i.e., six out of six correct responses), the FBPC condition began. A series of instruction trials of various motor movements was implemented during the FBPC condition. Adapting explicit timing procedures described by Kubina and Yurich (2012), sessions of the intervention were conducted (explicit timing procedure described later). Each frequency building session included five 10-second practice trials.

At the beginning of each trial, a countdown timer set for 10 seconds was shown to Olivia. The experimenter provided the first imitative modeling stimulus with a verbal request of "Olivia, do this." No other verbal prompt was provided. An imitative modeling stimulus, rotating among responses in the three imitation responses, was presented contingent upon Olivia's response (correct or incorrect). There was no other interaction between the experimenter and the child until the end of the 10-second trial. Praise was provided immediately following the trial. Furthermore, Olivia received a preferred tangible item contingent upon whether she achieved the predetermined performance criterion.

The initial performance criterion was the frequency measure obtained from model-alone assessment procedure at the last accuracy building condition (rounded up) minus one. For example, on the fourth session when Olivia completed 6 correct responses within 12 seconds, equivalent to 5 correct responses per 10 seconds, the initial fluency aim in frequency building condition was set as 4 correct responses per 10 seconds. When she achieved the initial performance criterion for five trials, a new performance criterion was established by adding one more response to the highest performance in the previous sessions, up to 8 correct responses per 10 seconds. Immediately following the session, a model-alone assessment procedure was used to record her performance during FBPC conditions. A new set of three imitative responses was introduced when Olivia had achieved six correct responses within eight seconds for two days during model-alone assessment.

### Imitation of untaught behaviors measurement

Every third session, a timed measure was given to assess imitation of untaught behaviors using the model alone assessment procedure. The standardized assessment procedure occurred as described previously; no reinforcement or performance feedback was provided during the assessment.

## Results

Table 2 displays the data of Olivia's taught and untaught imitative behaviors across Accuracy and Frequency Building conditions, shown in two cycle charts taken from SCC in Figure 1. On the chart, dots represent correct behaviors (shown as per minute data). The small horizontal dashes called a time bar display the time interval for the measured behavior. To calculate the "per minute" frequency, one must multiply the number of corrects by a time multiplier (i.e., 60 seconds divided by the lapsed time). The time multiplier shows the relationship of one minute and the lapsed time, which is also used to mark the time bar. For example, in the top tier of Figure 1, the first time bar and data point show two correct imitative behaviors in 27 seconds. The time multiplier, therefore, equals 60 seconds divided by 27 seconds, which is 2.2, the physical location of where one draws the time on the chart. Mathematically, the time bar multiplier is 2.2 times the count of 2 corrects which equals 4.4 or the "per minute" frequency for the first data point. While Olivia did not perform 4.4 correct behaviors, the SCC is designed to display all behaviors as a "per minute" frequency for ease of comparison. The actual and per minute counts with times and dates appear in Table 2.

The top tier of Figure 1 displays Olivia's celeration across four sets of imitative behaviors. The solid condition change lines indicate when Olivia moved from one set of behaviors to the next. The dashed condition change line for each behavior set show when Olivia changed from Accuracy Building to FBPC. Olivia's imitative behaviors for Set A behaviors grew by ×1.5 [25 days] while her progress was less evident for Set B behaviors, with a celeration of ×1.1 [72 days]. Olivia quickly met her performance criterion for Set C behaviors within three sessions, with a celeration of ×3.4 [6 days]. Her growth for Set D behaviors was ×3.2 [8 days]. By the eighth day (the fourth session), Olivia had achieved the performance criterion.

Given an additional analysis of the data, each of the four sets of imitative behaviors occurred in two phases, Accuracy Building and then FBPC, as shown in Figure 2. For the first set of imitative behaviors Olivia learned, Set A, in the Accuracy Building phase, correct imitations grew by ×2.8 [11 days]. During this phase, the time it took for Olivia to complete the imitative behaviors lessened; the time bars show a trend of shorter counting times across the phase. On the SCC, Figure 2, as the time bar moves higher up on the chart that means the time is becoming shorter. The "Counting Times" shown on the far right of Figure 2 displays the time intervals.

During the FBPC stage for Set A behaviors, imitative behaviors grew by ×1.35 [14 days] until Olivia reached the frequency aim of six correct responses within eight seconds for two days. Similar to the previous Accuracy Building phase, the time

**Table 2.** Accuracy and frequency data of taught and untaught imitative behaviors.

| | Taught imitative behaviors | | | Untaught imitative behaviors | | |
|---|---|---|---|---|---|---|
| | Number correct (out of 6) | Time (seconds) | Corrects per minute | Number correct (out of 6) | Time (seconds) | Corrects per minute |
| Accuracy Building Set A | | | | | | |
| 7 October | 2 | 27 | 4.44 | | | |
| 10 October | 5 | 25 | 12.00 | | | |
| 11 October | 4 | 24 | 10.00 | 0 | 30 | 0 |
| 17 October | 6 | 12 | 30.00 | | | |
| Frequency Building Set A | | | | | | |
| 18 October | 6 | 14 | 25.71 | 0 | 30 | 0 |
| 21 October | 6 | 13 | 27.69 | | | |
| 24 October | 6 | 14 | 25.71 | 0 | 30 | 0 |
| 25 October | 6 | 9 | 40.00 | | | |
| 31 October | 6 | 8 | 45.00 | | | |
| 1 November | 6 | 8 | 45.00 | 1 | 23 | 2.61 |
| Accuracy Building Set B | | | | | | |
| 7 November | 4 | 14 | 17.14 | | | |
| 8 November | 5 | 15 | 20.00 | | | |
| 11 November | 4 | 13 | 18.46 | 1 | 24 | 2.50 |
| 14 November | 4 | 14 | 17.14 | | | |
| 18 November | 4 | 11 | 21.82 | | | |
| 21 November | 4 | 11 | 21.82 | 2 | 23 | 5.22 |
| 22 November | 4 | 12 | 20.00 | | | |
| 29 November | 4 | 13 | 18.46 | | | |
| 2 December | 5 | 14 | 21.43 | 2 | 20 | 6.00 |
| 5 December | 4 | 16 | 15.00 | | | |
| 6 December | 5 | 21 | 14.29 | | | |
| 9 December | 5 | 17 | 17.65 | 2 | 22 | 5.45 |
| 12 December | 4 | 18 | 13.33 | | | |
| 13 December | 4 | 18 | 13.33 | | | |
| 16 December | 6 | 14 | 25.71 | 2 | 20 | 6.00 |
| Frequency Building Set B | | | | | | |
| 19 December | 5 | 19 | 15.79 | | | |
| 20 December | 6 | 12 | 30.00 | | | |
| 23 December | 6 | 12 | 30.00 | 3 | 23 | 7.83 |
| 3 January | 6 | 13 | 27.69 | | | |
| 5 January | 6 | 9 | 40.00 | | | |
| 9 January | 6 | 9 | 40.00 | 3 | 25 | 7.20 |
| 10 January | 6 | 7 | 51.43 | | | |
| 12 January | 6 | 7 | 51.43 | | | |
| Accuracy Building Set C | | | | | | |
| 26 January | 6 | 15 | 24.00 | 3 | 23 | 7.83 |
| Frequency Building Set C | | | | | | |
| 30 January | 6 | 8 | 45.00 | | | |
| 31 January | 6 | 8 | 45.00 | 5 | 13 | 23.08 |
| Accuracy Building Set D | | | | | | |
| 2 February | 6 | 14 | 25.71 | 5 | 18 | 16.67 |
| Frequency Building Set D | | | | | | |
| 6 February | 6 | 7 | 51.43 | | | |
| 7 February | 6 | 9 | 40.00 | | | |
| 9 February | 6 | 7 | 51.43 | 5 | 16 | 18.75 |

required to complete a trial lessened across the sessions, meaning that Olivia imitated behaviors more quickly than she had at the beginning of the phase. The FBPC phase for Set A behaviors ended when Olivia met the performance criterion.

Accuracy of Set B imitative behaviors took longer to obtain than the combined calendars days in both previous phases (i.e., 39 days for Accuracy Set B versus a combined 25 days for Accuracy and FBPC Set A). The celeration remained flat for Accuracy Set B with a ×1.0 [39 days]. The time bars displayed no trend indicating

Olivia became neither faster or slower across the phase. Olivia ended Accuracy Set B when she reached the aim of six out six correct.

With FBPC Set B, Olivia's correct imitative behaviors grew by ×1.2 [25 days]. Across the sessions, Olivia took less time to make her responses as indicated by the time bars changing and moving upward on the chart. The first time bar in FBPC phase shows a counting time of 19 seconds, and by the end of this phase, her last time bar showed 7 seconds. In this FBPC condition, two periods of extended absences occurred. The first was marked by a holiday break and the second a period was a mixture of student illness and then family travel.

Olivia achieved the performance criterion quickly for Sets C and D. For Accuracy Sets C and D, she only took one day to meet the aim. For FBPC Set C, she reached the performance criterion in two days, the minimum number of session necessary to complete the condition. With very few data points, celeration cannot be calculated. Likewise, for FBPC Set D, Olivia needed only three days to reach the performance criterion. In both FBPC Sets C and D, the time bars indicate brief counting times (range seven to nine seconds).

The SCC in bottom tier of Figure 1 shows the data of untaught imitative behaviors in which Olivia did not receive any corrective feedback or reinforcement for responding. During Accuracy and FBPC Set A, Olivia did not demonstrate any correct responses until her last performance frequency, of which she had one correct in 23 seconds. Over the next condition (i.e., Accuracy and FBPC Set B), Olivia started to emit more correct responses within a similar time frame (counting times range 20–25 seconds).

During Accuracy and FBPC Sets C and D, Olivia had the highest amounts of correct untaught imitative behaviors (i.e., 5 out of 6 corrects) in the shortest period of time (range 13–18 seconds) through the entire study. In other words, Olivia became very fast and accurate at performing the imitation behaviors without requiring explicit teaching or reinforcement. Overall, the data pattern from the beginning of Accuracy Building Set A to the final FBPC Set D shows a progressive amount of corrects. The celeration for the untaught imitative behaviors was ×1.2 [126 days].

## Discussion

With the growing numbers of students with autism, effective behavioral interventions are very important for practitioners and the students whom they serve. Heinicke et al. (2010) argue the published research literature for behavioral fluency "is currently insufficient to answer many important questions about the parameters of its effective clinical implementation" (p. 228). The present case study demonstrates how behavioral fluency in a controlled experiment can help a learner with autism and has socially valid clinical implications. The present experiment asked three questions aimed at helping a four-year-old with autism benefit from an intervention geared toward engendering behavioral fluency: What separate effects do Accuracy Building and FBPC have on the accuracy and speed of motor imitation of different sets of motor behaviors? And do Accuracy Building and FBPC affect imitation of untaught behaviors?

The accuracy building procedure was very similar to discrete trial instruction (Buffington et al., 1998; Smith, 2001), which is typically measured by an exit criterion of 80–100% correct (Binder, 1996; Holding et al., 2011); however, the present study used the higher exit measure of 100%. Discrete trial instruction has a number of studies demonstrating its value and usefulness for helping students acquire instructional content (DiGennaro-Reed, Reed, Baez, & Maguire, 2011; Ghezzi, 2007; Sigafoos et al., 2006). The results further establish and replicate discrete trial instruction as an effective method for promoting accurate responding.

The present study added precise measurement of behavior through frequency (i.e., timed performance). Typically discrete trial instruction involves measuring behavior with only percent correct. In this current study, after the participant meets the criteria of accuracy, frequency building begins. FBPC involves the timed performance of a student with corrective or confirmatory feedback given after the timing ends (Kubina & Yurich, 2012). Part of the goal of FBPC is for the student to move beyond accuracy and reach the performance criterion that signals the learner has attained behavioral fluency. Discrete trial instruction and frequency building should be viewed as complimentary to one another and not as a dichotomous choice. Discrete trial instruction, Accuracy Building in the present study, leads to accuracy while FBPC leads to high frequency, high accuracy behavior, or behavioral fluency.

Figure 1 displays a celeration analysis for each complete phase with Accuracy Building and FBPC (see top tier of Figure 1). The modified repeated acquisition design called for examining each subsequent celeration across time. From Set A to B, the celeration turned down or was not as fast, namely Set A ×1.5 [25 days] versus set B ×1.1 [72 days]. Since Set A contained behaviors that overlapped with Olivia's original Individualized Education Program (see "Limitations" section), it may not reflect a representative baseline of novel imitation behaviors. From Set B to C, the celeration significantly turns up or becomes faster, changing from ×1.1 [72 days] to ×3.4 [6 days]. Similarly, moving from Set C to D, the celeration stays very high with a celeration comparison of ×3.4 [6 days] to ×3.2 [8 days].

The modified repeated acquisition design demonstrated celerations generally become steeper across time, a phenomenon known as agility (Lindsley, 2001). For example, if a celeration for one phase has a slope of ×1.2, the next phase celeration grows steeper at ×1.4, and the third phase celeration has a ×1.6, the rising slopes quantified by celeration indicate the speed of learning growing from phase to phase. Agility demonstrates a student quickly learning new skills and concepts and adjusting performance to new information (Johnson & Street, 2012). Moving from Sets A and B to Sets C and D steeper slopes appear. As Olivia became fluent with past sets of behaviors, she learned the new sets more quickly than the previous ones.

Figure 2 shows a celeration analysis of each phase broken down into subphases. Accuracy Set A produced a high celeration of ×2.8 [11 days]. By measuring with frequency, two main points come to light. First, in the Accuracy Building phase, the behavior improved rapidly as evidenced by the high celeration. Celeration quantifies the learning that took place across the 11 days. Second, Olivia also became more efficient. The time bar convention in Figure 1 moves upwards across the condition demonstrating Olivia used less time to complete the imitated behaviors. When Olivia moved to the FBPC phase with Set A behavior, the celeration turned down to a lower, but still significant value of ×1.35 [14 days]. Olivia continued to become more efficient performing a greater extent of correctly imitated behavior in less time. Both the Accuracy Building and FBPC intervention were beneficial in accelerating imitated behaviors.

For Set B behaviors (i.e., pat lap, cross forearms, and stretch arms), Accuracy Building produced a celeration of ×1.0 [39 days]. With the new set of behaviors, Olivia did not become more accurate across time as shown by the majority of her data bouncing up and down between four and five corrects. At the end of the phase, she finally hit the exit criterion of six. Olivia also did not become more efficient during Accuracy Building; her time bars show variability across the condition.

With FBPC Set B, the celeration came to ×1.2 [25 days]. FBPC produced a higher celeration than the Accuracy Building condition. Additionally, Olivia became more efficient. Figure 1 shows that during the FBPC, a break occurred for the Christmas holiday. After an absence of 11 days, the performance frequency shows very good retention; before break, Olivia's performance was 6 correct in 12 seconds and after break her performance was 6 correct in 13 seconds.

For Sets C and D in both Accuracy Building and FBPC, Olivia made such rapid progress that there were not enough data points to calculate celerations. During Accuracy Sets C and D, the exit criterion was reached on the first day. Both data points in each phase could be considered efficient with her performance frequencies of 6 correct in 15 seconds and 6 correct in 14 seconds for Set, C and D, respectively. Additionally, when Olivia entered the FBPC phase for Sets C and D, her performance data continued to grow to higher frequencies. Even though Olivia achieved 100% accuracy, building frequency continued to increase her performance. By the end of each FBPC phases, Olivia met the performance criterion with all imitated behaviors. The data show that a student with autism can meet the high accuracy and fast performance suggested by the research supporting Precision Teaching (Fabrizio & Moors, 2003; Holding et al., 2011; Kubina & Wolfe, 2005; Kubina, Morrison, & Lee, 2002).

The present experiment demonstrated Accuracy Building effectively increased accuracy for a student with ASD. Additionally, the frequency building procedure, as in FBPC, can be used for a student with ASD. The findings respond to the researchers such as Heinicke et al. (2010) who question the efficacy of frequency building and "fluency training." A second point is frequency building does not negatively affect accuracy by asking the student to perform the behavior faster. Olivia did perform the behaviors correctly and achieved the performance criterion during FBPC. The performance criterion had a very high level of accuracy and must occur at a fast pace or what is functionally defined as fluency (Binder, 1996, 2005).

One of the seminal articles on imitation suggested, "Imitation is not a specific set of behaviors that can be exhaustively listed. Any behavior may be considered imitative if it temporally follows behavior demonstrated by someone else, called a model, and if its topography is functionally controlled by the topography of the model's behavior" (Baer, Peterson, & Sherman, 1967, p. 405). In Figure 1, the bottom half of the modified SCC shows Olivia's imitation of the untaught behaviors (i.e., pat shoulders, pat stomach, and the American Sign Language sign for "all done"). The celeration for the single phase was ×1.2 [126 days]. Across time, Olivia never received instruction or feedback for these three imitated behaviors. It would appear the ×1.2 [126 days] celeration occurred because Olivia had learned how to imitate.

Two questions arise from the data illustrated in the bottom half of Figure 1; how long did it take for Olivia to learn imitation and what accounts for the stronger stimulus control when imitating untaught behaviors? The very first appearance of an untaught imitation occurred 25 days into the experiment. The initial Accuracy Building phase did not have an effect, but once Olivia reached the performance criterion for frequency building, or the end goal for the FBPC phase, she imitated an untaught behavior.

When analyzing Olivia's data, she experienced jump ups in performance frequency three additional times beyond the first appearance of imitating untaught behaviors. On the dates of November 12, December 23, and January 31, Olivia jumped up in performance, respectively, from one to two, two to three, and then three to five. Furthermore, when including the first jump up of zero to one on the first of November, three out of four of the jump ups occurred when Olivia was in the FBPC phase. And for two of the jump ups in FBPC, Olivia had just met the goal or performance criterion of frequency building. The data suggest imitating untaught behaviors occurred as a function of cumulative strengthening of stimulus control.

One of the primary characteristics of the attainment of behavioral fluency is performance stability defined by highly accurate and fast responding (Binder, 1996; Johnson & Layng, 1992; Kubina & Yurich, 2012). In the four sets of taught imitative behaviors, A, B, C, and D, Olivia first met an accuracy criterion, but with the subsequent meeting of the performance criterion of frequency building, she exhibited very strong stimulus control for the taught behaviors. The stimulus control exhibited with the untaught behaviors improved almost exactly in concert with the stimulus control improvements in the taught behaviors. In other words, the stimulus control that was strengthened was that of imitation.

Other explanations plausible for changes in behaviors across time are maturation or history effects (Kazdin, 2011). The untaught imitative behaviors grew at ×1.2 [126 days] celeration. Weekly celerations of ×1.25 or greater are considered acceptable growth celerations for taught behaviors (Kubina & Yurich, 2012). That is, the untaught behavior grew at a rate almost equivalent to what acceptable growth celerations are for taught behaviors. It is unlikely maturation alone accounted for the growth and may be plausibly explained by the influence of stimulus control being developed by the repeated attainment of the high performance criterion for the taught behaviors. History effects are also not likely as an explanation for the changes in untaught imitations because Olivia never received feedback or reinforcement for those behaviors. Stated differently, she had no history with untaught behaviors.

The study ended February 9. On February 28, 15 behaviors were presented to Olivia, some of which are in the experimental sets of taught and untaught imitative behaviors while four novel behaviors of standing up, sitting down, stomping feet, and stretching arms upward were also included. Olivia performed all behaviors with 100% accuracy. Furthermore, she completed all of the 15 behaviors in

21 seconds. The fact that Olivia was still highly accurate and fast with her previously learned behaviors and four completely novel behaviors suggests she had developed stimulus control for imitation.

## Limitations

The present study has two main limitations. First, one possible reason for the high celeration in acquisition for Set A behaviors (clap hands, pat table, and touch head) could be due to the overlap between previous classroom instructional procedures and the three behaviors chosen in Set A. Two of these three behaviors in Set A were past targets in her classroom due the imitative behaviors being part of Olivia's Individualized Education Program.

A second limitation is the difficulty level of the actual modeled behaviors. Some behaviors involve more complicated movements than others. As an example, for "pat shoulder(s)," Olivia had to use her right hand and touch and her left shoulder. The behavior involved having an arm cross the body to touch the opposite shoulder. Olivia would oftentimes use her right arm to touch her right shoulder without crossing the body. The more complicated modeled behaviors could have adversely influenced her celeration.

## Future directions

While the present study demonstrated that FBPC is attainable for a young child with ASD, more research is necessary to show frequency building will have generality for imitation. Also, expanding research to more students with and without disabilities would show the extent to which frequency building can positively impact imitation. The results of the present study also bring forward the question as to whether or not behavior analysts or teachers still need accuracy building or would frequency building alone suffice. Put differently, would frequency building alone contribute to the stimulus control of imitation?

## Conclusion

The present study demonstrated that the combination of Accuracy Building and FBPC led to the stimulus control of taught imitative behaviors. The data also show that the high performance criterion required for behavioral fluency is attainable. In addition, Olivia gained a steady growth of untaught behaviors and correctly imitated novel behaviors almost three weeks after the study ended, which suggests that Accuracy Building and FBPC also led to the stimulus control of untaught imitative behaviors. The present study provides emerging evidence that stimulus control can be developed for imitation by attaining behavioral fluency (i.e., highly accurate and fast performance) for limited sets of imitative behaviors.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## References

American Psychological Association [APA] (2010). *Autism*. Retrieved from http://www.apa.org/topics/autism/index.aspx

Baer, D. M., Peterson, R. F., & Sherman, J. A. (1967). The development of imitation by reinforcing behavioral similarity to a model. *Journal of the Experimental Analysis of Behavior*, *10*, 405–416. doi:10.1901/jeab.1967.10-405

Binder, C. (1996). Behavioral fluency: Evolution of a new paradigm. *The Behavior Analyst*, *19*, 163–197.

Binder, C. (2005). Behavioral fluency. In M. Hersen, G. Sugai, & R. Horner (Eds.), *Encyclopedia of behavior modification and cognitive behavior therapy: Education applications* (Vol. *3*, pp. 1185–1188). Thousand Oaks, CA: Sage.

Binder, C. (2010). Building fluent performance: Measuring response rate and multiplying response opportunities. *The Behavior Analyst Today*, *11*, 214–225. doi:10.1037/h0100702

Buffington, D. M., Krantz, P. J., McClannahan, L. E., & Poulson, C. L. (1998). Procedures for teaching appropriate gestural communication to children with autism. *Journal of Autism and Developmental Disorders*, *28*, 535–545. doi:10.1023/A:1026056229214

Carpenter, M., Pennington, B. F., & Rogers, S. J. (2002). Interrelations among social-cognitive skills in young children with autism. *Journal of Autism and Developmental Disorders*, *32*, 91–106. doi:10.1023/A:1014836521114

Charman, T., Baron-Cohen, S., Swettenham, J., Baird, G., Drew, A., & Cox, A. (2003). Predicting language outcome in infants with autism and pervasive developmental disorder. *International Journal of Language & Communication Disorders*, *38*, 265–285. doi:10.1080/136820310000104830

Cohen, M. J. (2005). The effect of increasing the rate of clerical skill performance on challenging behavior. *Journal of Precision Teaching & Celeration*, *21*, 2–12.

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied behavior analysis* (2nd ed.). Columbus, OH: Merrill Publishing.

Dawson, G., & Adams, A. (1984). Imitation and social responsiveness in autistic children. *Journal of Abnormal Child Psychology*, *12*, 209–226. doi:10.1007/BF00910664

DiGennaro-Reed, F. D., Reed, D. D., Baez, C. N., & Maguire, H. (2011). A parametric analysis of errors of commission during discrete-trial training. *Journal of Applied Behavior Analysis*, *44*, 611–615. doi:10.1901/jaba.2011.44-611

Fabrizio, M. A., & Moors, A. L. (2003). Evaluating mastery: Measuring instructional outcomes for children with autism. *European Journal of Behavior Analysis*, *4*, 23–36.

Foley, K., & Fabrizio, M. A. (2005). Teaching sound frequency imitation to a child with autism. *Journal of Precision Teaching & Celeration*, *21*, 22–24.

Ghezzi, P. M. (2007). Discrete trials teaching. *Psychology in the schools*, *44*, 667–679. doi:10.1002/pits.20256

Giesecke, F. E., Mitchell, A., Spencer, H. C., Hill, I. L., Loving, R. O., Dygdon, J. T., & Novak, J. E. (2001). *Engineering graphics* (8th ed.). Upper Saddle River: NJ: Prentice Hall.

Graf, S., & Lindsley, O. (2002). *Standard celeration charting 2002*. Youngstown, OH: Graf Implements.

Heinicke, M. R., Carr, J. E., Leblanc, L. A., & Severtson, J. M. (2010). On the use of fluency training in the behavioral treatment of autism: A commentary. *The Behavior Analyst*, *33*, 223–229.

Holding, E., Bray, M. A., & Kehle, T. J. (2011). Does speed matter? A comparison of the effectiveness of fluency and discrete trial training for teaching noun labels to children with autism. *Psychology in the Schools*, *48*, 166–183. doi:10.1002/pits.20535

Johnson, K. R., & Layng, T. J. (1992). Breaking the structuralist barrier: Literacy and numeracy with fluency. *American Psychologist*, *47*, 1475–1490. doi:10.1037/0003-066X.47.11.1475

Johnson, K. R., & Street, E. M. (2012). *Response to intervention with precision teaching: Creating synergy in the classroom*. New York, NY: Guilford.

Johnston, J. M., & Pennypacker, H. S. (2009). *Strategies and tactics of behavioral research* (3rd ed.). New York, NY: Routledge.

Kazdin, A. E. (2011). *Single-case research designs: Methods for clinical and applied settings*. New York, NY: Oxford University Press.

Kennedy, C. H. (2005). *Single-case designs for educational research*. Boston, MA: Allyn & Bacon.

Kerr, K., Smyth, P., & McDowell, C. (2003). Precision teaching children with autism: Helping design effective programmes. *Early Child Development and Care*, *173*, 399–410. doi:10.1080/0300443032000079087

Kleeberger, V., & Mirenda, P. (2010). Teaching generalized imitation skills to a preschooler with autism using video modeling. *Journal of Positive Behavior Interventions*, *12*, 116–127. doi:10.1177/1098300708329279

Kostewicz, D. E., & Kubina, R. M. (2011). Building science reading fluency for students with disabilities with repeated readings to a fluency criterion. *Learning Disabilities: A Multidisciplinary Journal*, *17*, 89–104.

Kubina, R. M., Morrison, R., & Lee, D. L. (2002). Benefits of adding precision teaching to behavioral interventions for students with autism. *Behavioral Interventions*, *17*, 233–246. doi:10.1002/bin.122

Kubina, R. M., & Yurich, K. K. L. (2012). *The precision teaching book*. Lemont, PA: Greatness Achieved.

Kubina, R. M., & Wolfe, P. S. (2005). Potential applications of behavioral fluency for students with autism. *Exceptionality*, *13*, 35–44. doi:10.1207/s15327035ex1301_5

Lindsley, O. R. (2001). Celeration and agility for the 2000's. *Journal of Precision Teaching Celeration*, *17*, 108–111.

Lindsley, O. R. (2005). Standard Celeration Chart system. In M. Hersen, G. Sugai, & R. Horner (Eds.), *Encyclopedia of behavior modification and cognitive behavior therapy. Volume III: Education applications* (pp. 1545–1548). Thousand Oaks, CA: Sage.

Lovaas, O. I., Freitas, L., Nelson, K., & Whalen, C. (1967). The establishment of imitation and its use for the development of complex behavior in schizophrenic children. *Behaviour Research and Therapy*, *5*, 171–181. doi:10.1016/0005-7967(67)90032-0

Martens, B. K., Daly, E. J., Begeny, J. C., & VanDerHeyden, A. (2011). Behavioral approaches to education. In W. Fisher, C. Piazza, & H. Roane (Eds.), *Handbook of applied behavior analysis* (pp. 385–401). New York, NY: Guilford Press.

Pennypacker, H. S., Gutierrez, A., & Lindsley, O. R. (2003). *Handbook of the Standard Celeration Chart*. Cambridge, MA: Cambridge Center for Behavioral Studies.

Porritt, M., Van Wagner, K., & Poling, A. (2009). Effects of response spacing on acquisition and retention of conditional discriminations. *Journal of Applied Behavior Analysis*, *42*, 295–307.

Rogers, S. J. (1999). An examination of the imitation deficit in autism. In J. Nadel & G. Butterworth (Eds.), *Imitation in infancy* (pp. 254–283). Cambridge: Cambridge University Press.

Rogers, S. J., Bennetto, L., McEvoy, R., & Pennington, B. F. (1996). Imitation and pantomime in high functioning adolescents with autism. *Child Development*, *67*, 2060–2073. doi:10.2307/1131609

Schmid, C. F., & Schmid, S. E. (1979). *Handbook of graphic presentation* (2nd ed.). New York, NY: John Wiley & Sons.

Sigafoos, J., O'Reilly, M., Ma, C., Edrisinha, C., Cannella, H., & Lancioni, G. E. (2006). Effects of embedded instruction versus discrete-trial training on self-injury, correct responding, and mood in a child with autism. *Journal of Intellectual & Developmental Disability*, *31*, 196–203. doi:10.1080/13668250600999160

Smith, T. (2001). Discrete trial training in the treatment of autism. *Focus on Autism & Other Developmental Disabilities*, *16*, 86–92. doi:10.1177/108835760101600204

Stone, W. L., Ousley, O. Y., & Littleford, C. D. (1997). Motor imitation in young children with autism: What's the object? *Journal of Abnormal Child Psychology*, *25*, 475–485. doi:10.1023/A:1022685731726

Stone, W. L., & Yoder, P. J. (2001). Predicting spoken language level in children with autism spectrum disorders. *Autism*, *5*, 341–361. doi:10.1177/1362361301005004002

Toth, K., Munson, J., Meltzoff, A. N., & Dawson, G. (2006). Early predictors of communication development in young children with autism spectrum disorder: Joint attention, imitation, and toy play. *Journal of Autism and Developmental Disorders*, *36*, 993–1005. doi:10.1007/s10803-006-0137-7

Twarek, M., Cihon, T., & Eshleman, J. (2010). The effects of fluent levels of big 6 + 6 skill elements on functional motor skills with children with autism. *Behavioral Interventions*, *25*, 275–293. doi:10.1002/bin.317

Young, J. M., Krantz, P. J., McClannahan, L. E., & Poulson, C. L. (1994). Generalized imitation and response-class formation in children with autism. *Journal of Applied Behavior Analysis*, *27*, 685–697. doi:10.1901/jaba.1994.27-685

Young, K. R., West, R. P., Howard, V. F., & Whitney, R. (1986). Acquisition, fluency training, generalization and maintenance of dressing skills of two developmentally disabled children. *Education and Treatment of Children*, *9*, 16–29.