Published by the
American Psychological Association

BEHAVIORAL DEVELOPMENT BULLETIN

bao JOURNALS

Volume 19 | Number 1 | March 2014

ISSN 1942-0722

WWW.BAOJOURNAL.COM

BEHAVIORAL DEVELOPMENT BULLETIN

A Behavior Analysis Online Journal & An American Psychological Association Publication

VOLUME 19 NUMBER 1 MARCH 2014

Governing Board: Behavior Analysis Online Journal
Published by: American Psychological Association
Volume 19, 2014

» MANUSCRIPT SUBMISSION

Please submit manuscripts electronically via email to the editors.

- Michael L. Commons: commons@tiac.net
- Martha Pelaez: martha.pelaez@fiu.edu

Guidelines for submission are available on the following webpage: http://www.baojournal.com/BDB%20WEBSITE/Submissions.html

» MISSION STATEMENT

The mission of *The Behavioral Development Bulletin* (BDB) provided developmental psychologists with peer reviewed scientific information of interest. It is to inform the field of developmental psychology by taking a behavioral analytic approach, including research in cognitive development, child emotional development, developmental theory and socialization. There are three goals. One is to understand development in behavioral terms. The second is to reach out to developmental psychology with the innovations that behavior-developmental approaches have provided. Thirdly, we see behavior analysis as providing interventions that measure and promote development. That means that we are interested in educational and clinical interventions that stimulate and increase the likelihood of development. Under the topic of the measurement of development that includes what are the sequences of development in different areas.

Since its inception in 1991 (M. Pelaez, Editor), the journal has published articles of an inter-and-multidisciplinary nature including areas of socio-biology and behavioral methodology. *The Behavioral Development Bulletin* (BDB) is especially relevant to behavior analysts who study the developmental processes responsible for behavior changes and their progressive organization. *The Behavioral Development Bulletin* (BDB) hopes to provide answers by looking at the biological and environmental factors that affect behavioral development, while maintaining primarily interest in the role of environmental contingencies in behavior change.

Contents

Preface

Michael Lamport Commons, Editor
Harvard Medical School

This issue of the *Behavioral Development Bulletin* (BDB) includes studies that add to or suggest usage of existing behavior analytic interventions to improve learning, communication, parent training, data collection techniques, and communication and behavior in children with Autism.

The opening study by Hook, Hixson, Decker & Rhymer used Progressive time delay (PTD) to teach two first-grade students to discriminate between the letters *b* and *d*. Whereas, one participant mastered the discrimination after four sessions and maintained the skills, the other participant showed gradual improvement, but continued to make some errors. In the next study, Broto and Greer tested the effects of a functional writing protocol on the accurate functional and structural responses in mathematical algorithms written and read by 6 typically developing 2nd grade students using a delayed pre- and post-experimental probe design. Results showed an increase in the number of functionally accurate written algorithms was a function of the procedure. In the third article, Costa and Pelaez add to the research on positive effect of intensive tact instruction on the communication of typically developing, yet linguistically diverse children. They explored the effects of a modified, intensive tact instruction intervention on the emission of spontaneous, or unprompted, tacts and mands during play in two typically developing, preschool siblings. In the fourth article, Tiano and McNeil compared knowledge of behavioral principles, as measured by the Knowledge of Behavioral Principles as Applied to Children (KBPAC), for a community sample of 40 mother-father pairs of a young male child. Results indicated that mothers and fathers exhibited similar levels of knowledge. The KBPAC was also correlated with social position, parent report of child behavior problems, and parental education. In the fifth study, Gongola, Barton, Gongola, Rosales and Speece used private blog sites to minimize the challenges posed by distributed research team variables during data collection practices on interobserver agreement and treatment integrity. The use of private blog sites as a technological modality allowed video to be feasibly reviewed throughout the study (i.e., researchers viewed a video from home as opposed to, driving lengthy distances) while offering a superior option in contrast to traditional in vivo practices. In the sixth article, Greenberg, Tsang and Yip's did a partial replication of the intensive tact instruction tactic on two male and one female participants with autism (age = 6–9 years). The study showed collateral effects in the number of mands emitted for two of the three students. This study adds to the external validity of the intensive tact instruction tactic with an older age-range of students. Finally, the seventh study by McDonald, Reeve and Sparacio evaluated the effectiveness of a tactile cue, the Gentle Reminder™, as a prompt to increase instructor use of behavior-specific praise and token reinforcement. The instructor's use of reinforcement increased more than once every 10-min when the tactile cue was implemented. There was a decrease observed in the level of the students' stereotypic behavior after introduction of the tactile prompt and the instructor's increased use of reinforcement. This study had been accepted as a part of volume 10, 2010 of BDB in the Special Section on Early and Intensive Behavioral Intervention in Children.

Lastly, I would like to thank my co-editor, associate editors, reviewers and managing editor for their help in putting this issue together.

BEHAVIORAL DEVELOPMENT BULLETIN

VOLUME 19
NUMBER 1
MARCH 2014

Progressive time delay to remediate letter discrimination difficulty

Joshua M. Hook[1], Michael D. Hixson[2], Dawn Decker[2] and Katrina N. Rhymer[2]

ABSTRACT

Reading is hindered when students have difficulty discriminating letters. Given their visual similarity, the letters *b* and *d* can be challenging for some individuals. Progressive time delay (PTD) was used to teach two first-grade students to discriminate between the letters *b* and *d*. During the procedure, a problem was presented and a prompt immediately provided. As students correctly responded to the problem, the delay between the problem and the prompt was gradually increased. Student 1 mastered the discrimination after four sessions and skills were maintained. Student 2 showed gradual improvement but continued to make some errors. Implications for practice are discussed.

KEYWORDS: progressive time delay, letter discrimination

There are approximately 44 phonemes or sounds in the English language. These phonemes are mapped on to letters, letter combinations, and spelling rules to form written words. The letters and letter combinations for each phoneme are called phonograms. The job of the reading teacher is to teach the student to respond differentially to each of the phonograms. Differential reinforcement is commonly used to produce discriminative behavior. Therefore, responding in a certain way in the presence of one stimulus is reinforced, while other responses are not reinforced, and responding in a different way to another stimulus is reinforced, and so on. However, this approach is not always effective in all situations. A particularly difficult discrimination involves letters that are the reverse of each other, such as *b* and *d* and *p* and *q* (Asso & Wyke, 1971). Prior to letters, the name of an object does not change based on its orientation. A chair is still a chair and mommy is still mommy, regardless of their orientation, but, of course, the orientation of letters can change their name. It may be that this previous learning history, in which orientation has not been a feature related to a reinforcement contingency, makes the discrimination of these letters especially demanding (Gibson, Gibson, Pick, & Osser, 1962). The letters *b* and *d* are also problematic because the sounds they represent are similar (Carnine, Kame'Enui, Silbert, & Tarver, 2003). In behavior analysis, specialized teaching procedures, generally called errorless learning, have been developed and used with all types of learners to teach difficult discriminations (e.g., Etzel & LeBlanc, 1979; Sidman, 2010; Terrace, 1963). The procedures may not result in completely errorless performance, but errors are minimized, which is important because of the tendency for errors to produce more errors (Sidman & Stoddard, 1966). Errorless learning procedures include stimulus fading, stimulus shaping, and prompt delay.

Errorless learning and letter discrimination

Previous researchers have investigated the use of errorless learning procedures on discriminating alphabet letters. Stimulus fading was compared to a trial and error (i.e., differential reinforcement) procedure by Griffiths and Griffiths (1976) to teach *b*–*d* and *p*–*q* letter discriminations to four and five year old preschoolers. Pictorial prompts were paired with the letters and gradually faded. For example, a picture of a baseball bat with a ball lying next to it was on a flashcard next to the letter *b*. The bat and baseball resembled the letter *b*. Fewer trials to criterion were required for the discrimination using stimulus fading than trial and error, and few or no errors were made by each child when stimulus fading was used. All children preferred stimulus fading to trial and error.

A series of experiments evaluated the effects of superimposition with stimulus fading and an intervening response on a *b*–*d* discrimination task with preschoolers and then with older children with mental retardation (Lancioni, Hoogeveen, Smeets, Boelens, & Leonard, 1989). In the first experiment a bunny face was superimposed on the letter *b* and faded over trials. This procedure was not effective. In the next part of the study, an intervening response was taught to the letter *b* by teaching the children to move a wooden carrot to the mouth of the bunny superimposed on the letter *b*. It was hypothesized that this would require the children to focus more on the orientation of the letter as the carrot was moved

1 Midland Public Schools, Midland, MI. 2 Department of Psychology, Central Michigan University. Correspondence concerning this article should be addressed to Michael D. Hixson, Psychology Dept., Central Michigan University, Mt. Pleasant, MI 48859. E-mail: mike.hixson@cmich.edu

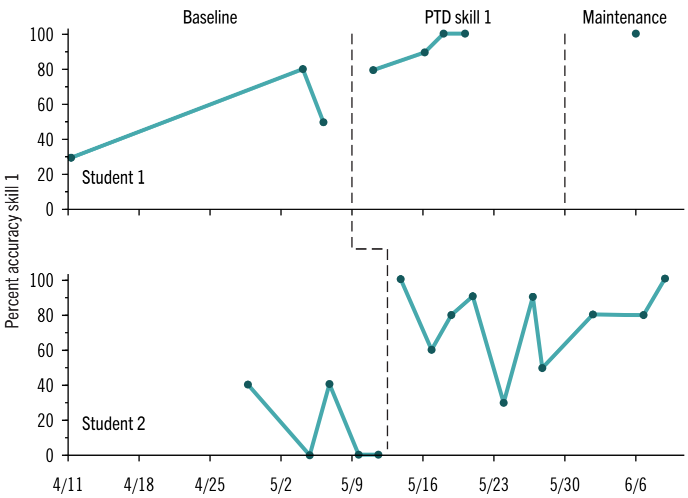

Figure 1. Pointing to letter after hearing letter name (Skill 1)

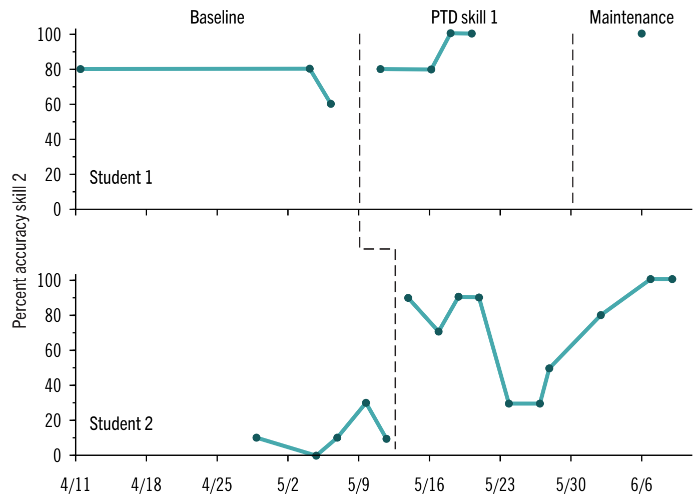

Figure 2. Pointing to letter after hearing letter sound (Skill 2)

from the left to the bunny's mouth. This procedure was also not effective. Next, bunny faces were placed on both letters (*b* and *d*). The experimenter demonstrated moving the carrot to both letters using the left to right motion and indicated that it was wrong with the *d* rabbit (i.e., the carrot went towards the back of the head of the *d* rabbit). The children were taught to move the carrot to the correct rabbit. This training required the children to focus on the orientation of the letter. As in the previous conditions, the bunny faces were faded. The children were successful on the *b*–*d* discrimination test after this training. Similar results were found for the preschoolers and for the older children with mental retardation.

Another study compared stimulus fading and constant time delay for teaching preschoolers to point to easily confused letters and numbers (Bradley-Johnson, Sunderman, & Johnson, 1983). The stimulus fading procedure involved adding color prompts that highlighted distinctive features of the stimuli. Correct responses were reinforced with a penny and praise. In the time delay condition, the experimenter waited four seconds before pointing to the correct letter or number. Correct responses that occurred before the prompt were reinforced with a penny and praise. The children in the time delay condition made significantly fewer errors on a posttest than those in the stimulus fading group or the control condition.

Comparison of procedures

When typical instructional procedures are ineffective for learners, errorless learning procedures should be pursued. Stimulus shaping, in which the physical features (topography) of the stimulus are progressively altered from a beginning stimulus to the final discriminative stimulus (Etzel & LeBlanc, 1979), has demonstrated efficacy (Schilmoeller, Schilmoeller, Etzel, & LeBlanc, 1979; Sidman & Stoddard, 1966) especially if the features of the stimulus being shaped are related to the final criterion to be discriminated (Etzel, 1997; Schilmoeller, Schilmoeller, Etzel, & LeBlanc, 1979). Stimulus fading has also shown to be effective in teaching discriminations, especially when the fading is criterion-related (Gold & Barclay, 1973), but creating the materials for stimulus fading and stimulus shaping can be time intensive. Constant time delay has also been shown to be a valuable method and it is easy to implement, but it may be less efficient than progressive time delay, which, generally requires less trials to reach criterion and produces less errors (Walker, 2008). In constant time delay the delay is constant, but in progressive time delay the interval between the prompt and the question vary. Initially, the prompt follows the question immediately, and then the interval between the prompt and the question is lengthened based on correct responding by the learner.

There may be occasions when stimulus control does not transfer with time delay procedures because the participant always waits for the prompt, even when the delay is large (Glat, Gould, & Stoddard, 1994; Oppenheimer, Saunders, & Spradlin, 1993). One study required participants to emit an overt differential response after the problem was presented, which facilitated correct performance under the progressive time delay procedure (Glat, Gould, & Stoddard, 1994). This may have been helpful because it forced the participants to attend to the problem. Progressive time delay may not be effective with all students; therefore, practitioners should be prepared to implement more intensive instructional procedures, such as stimulus fading and stimulus shaping when necessary (Etzel & LeBlanc, 1979).

This study investigated whether progressive time delay is an effective procedure for remediating student difficulties in discriminating between the letters *b* and *d*. Another question of interest was whether there would be generalization or transfer across different discriminative behaviors. In the following procedures, successful discrimination between the letters *b* and *d* involved a hierarchy of four skills related to *b* and *d* letter discrimination. Would teaching the first skill result in the acquisition of the other skills and would the skills be maintained over time?

» METHOD

Participants and setting

Participants were two first-grade-students at an elementary school located in an affluent town in Michigan. The study took place during the spring, past the period when most first grade students

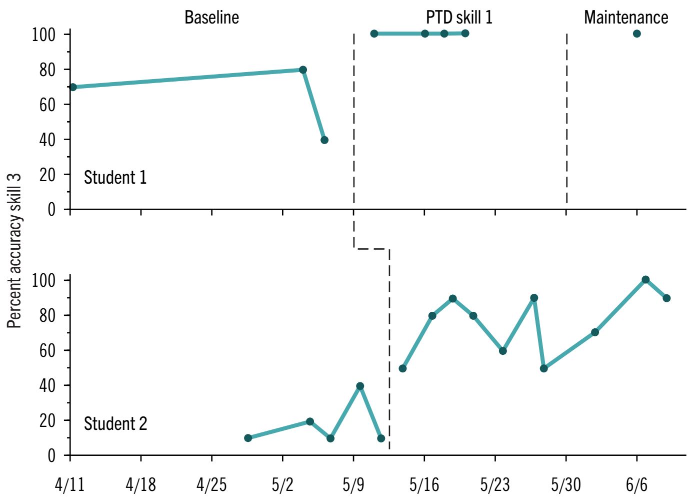

Figure 3. Saying letter name after researcher points to letter (Skill 3)

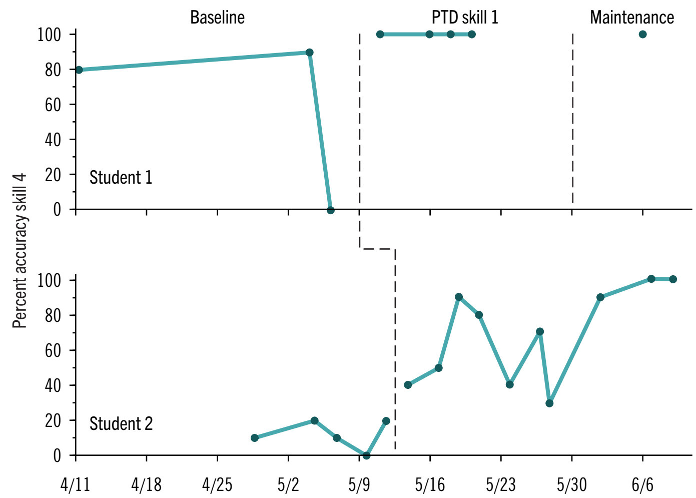

Figure 4. Saying letter sound after examiner points to letter (Skill 4)

have mastered *b* and *d* letter discrimination. Thus, deficits in this area were viewed as significant and requiring remediation to effectively progress with reading development. Student 1 was in general education and Student 2 had an Individualized Education Plan (IEP). Student 2 was eligible in the state of Michigan as a student with a Speech and Language Impairment. The participants were recruited with assistance from all first-grade teachers at the participants' school. Teachers were provided a description of an informal assessment to identify students demonstrating difficulty discriminating between letters *b* and *d*. The description asked teachers if students reversed the two letters in their writing or reversed the sounds in reading. It also asked teachers to have students read a sequence of letters, which included the letters *b* and *d*, and it asked them to have the students read words containing these letters. Following parent consent and child assent, each student's *b* and *d* discrimination skills were assessed by the first author. Student performance on the first of four skills on this assessment determined inclusion in the study. The inclusion criterion was less than or equal to 7 out of 10 correct answers on this task. The data from the inclusion assessment was used as the first data point in the baseline condition.

All sessions took place in the students' school building in a private room with minimal distractions. Intervention sessions were held approximately three times per week, lasted about 15 minutes, and took place over approximately four weeks.

The materials used for the progressive time delay procedure were a timer and two 3"×5" index cards. One card had the letter *b* printed on it, and the other with the letter *d*. Using size 48 Arial font, the letters were printed onto printing labels and were attached to the center of the cards.

Design

The study employed a multiple baseline across two participants. Following the third baseline assessment, the first participant entered the intervention phase. The remaining participant continued in the baseline phase for two additional assessments before beginning the intervention.

Treatment integrity

A treatment integrity checklist was completed by a school psychology graduate student trained in administering the intervention. Responses to the questions on the checklist were answered as either "yes" or "no" and reflected the instructor's adherence to seven components of the intervention. Observations of the sessions were made possible by using audio-visual recordings of the sessions. A minimum of 20 percent of the total intervention sessions were evaluated for treatment integrity. The results indicated 93% of questions on the checklists were answered in favor of maintaining strict adherence to the intervention's components.

Dependent variable

The dependent variable was the percent correct for each of the following four skills:

Skill 1 – Hear letter name → point to letter

Skill 2 – Hear letter sound → point to letter

Skill 3 – See letter → say name

Skill 4 – See letter → say letter sound

The first skill (Skill 1) measured was the ability of the student to point to the correct letter, either *b* or *d*, in response to the instructor's verbal request. It was also of interest to observe whether teaching Skill 1 generalized to the remaining skills (Skills 2, 3, and 4). A data recording sheet was used to track dependent variable measurement.

Interobserver agreement

Video recordings of the sessions permitted a graduate student trained in behavioral observations to record student responses on at least 20 percent of sessions. Using trial-by-trial agreement, interobserver agreement was calculated by dividing the number of agreements multiplied by 100, by agreements plus disagreements. When averaged across the three participants, interobserver agreement calculations yielded an average of 99.17% agreement between raters. Individual interobserver agreement results for Student 1 and Student 2 were 99.17%, and 98.75%, respectively.

Procedure

Measurement of the dependent variable. Ten test trials were conducted to measure the accuracy of each of the four skills (i.e., forty total trials). During the intervention phase, the test trials occurred immediately following the progressive time delay instruction. Correct and incorrect responses were recorded and percent accuracy was calculated for each of the four skills based on the 10 trials. For each skill there were five trials for each letter. The left-right position of the letters was pseudo-randomly determined, such that over the ten trials each letter was on the right and left sides an equal amount.

The following was the method of assessment:

Skill 1. The examiner presented both cards to the participant at once, and asked the student to point to the letter *b* (or *d*, depending on pseudo-randomization).

Skill 2. The examiner presented both cards to the participant at once, and asked the student to point to the letter that made the /*b*/ sound (or /*d*/).

Skill 3. The examiner presented one letter at a time to the participant and asked, "What letter?"

Skill 4. The examiner presented one letter at a time to the participant and asked, "What sound?"

Intervention: progressive time delay (PTD). The PTD procedure targeted the less accurate letter, as identified on the most recent assessment of the dependent variable. To describe the procedure for Skill 1, *b* will be assumed to be the less accurate letter. To begin, one *b* and one *d* flashcard were laid flat on the desk in front of the participant. The student was instructed to point to the letter *b*, and then the instructor immediately pointed to the letter *b*, thereby prompting the correct response. If the student did not then point to the letter *b*, the instructor told the student to point to it. Student responses were considered correct if the correct response occurred before or after the prompt. In other words, the response was correct whether it was prompted or unprompted.

Following five consecutive correct responses, the delay between the presentation of the problem and the prompt increased by 1 second. The delay between the problem and the prompt continued to increase by 1 second after every five consecutive correct responses up to a 5 second delay. However, when an incorrect response occurred, with or without a prompt, the instructor reversed the procedure back to the previous delay interval. For example, if the delay between the problem and the prompt was at 2 seconds, and the student emitted an incorrect answer during the third trial, the instructor immediately shortened the delay to 1 second. Five consecutive correct responses would then be required before advancing to the 2-second delay interval again.

Skill progression. Progression to the subsequent skill was based on achieving 100% accuracy, for both letters, on two consecutive dependent variable assessments. It was anticipated that mastery of an earlier skill might result in transfer or generalization across skills. Therefore, if mastery of a skill resulted in subsequent skill mastery, the PTD procedure was not necessary for those skills which already met the mastery criterion. Once mastery was established for all four skills, the participant met the exit criterion for the study.

Maintenance. The intervention ended when the participant learned the skills. Two to four weeks after the intervention phase, ten test trials were again administered to assess each of the four skills for Student 1.

» RESULTS

Figures 1 through 4 display the percentage of correct responses for each of the four skills. Percent accuracy for Skill 1 during baseline yielded means of 53.3%, and 16% for Students 1 and 2 respectively. Student 1's performance increased to 100% correct by the third session of the intervention. Student 2's performance was below chance level during baseline and improved during the intervention, but Student 2 still made errors during most of the intervention sessions. The percentage of non-overlapping data points (NPD) between baseline and intervention phases for Skill 1 yielded percentages of 75%, and 90% for students 1 and 2, respectively.

With instruction only in Skill 1, Student 1 met the exit criterion for all four skills. For Student 2, the school year expired before meeting the exit criterion on Skill 1. Thus, only Skill 1 was taught in this study. The instruction on Skill 1 appears to have improved performance on Skills 2, 3, and 4 for both students.

Differences between baseline and intervention means for Skill 2 yielded positive mean increases 16.7% (Student 1) and 61% (Student 2), while NPD for Students 1 and 2 were 50%, and 80%, respectively. For Skill 3, positive increases in means were observed for Student 1 (36.7%) and Student 2 (58%), with 100% NPD for both students. Similar results were observed on Skill 4, with Student 1 and Student 2 achieving 100% non-overlapping data and mean increases of 43.3% (Student 1) and 57% (Student 2). An immediate change in skill was observed upon change from baseline to intervention condition for all skills except for Student 2 Skill 2.

The maintenance assessment yielded scores of 100% accuracy on all four skills for Student 1. Student 2 did not receive the maintenance assessment because the school year ended prior to meeting the mastery criteria.

» DISCUSSION

Students 1 and 2 showed improvement during the intervention, but Student 2 continued to make some errors. There was evidence of generalization or transfer across skills as instruction on Skill 1 was associated with improvements in the other skills.

The four skills were conceptualized as moving from easy to more difficult. The first two skills involved selecting the correct stimulus and the last two required producing the stimulus. Selection is generally considered easier than production (Vargas, 2009, Chapter 8). Also, it was presumed, based on typical instructional sequences, that students would probably be more familiar with the letter names than the letter sounds. The baseline data, however, do not support this. All of the skills appeared to be of approximate equal difficulty. It was hypothesized that teaching an early skill would result in later skills becoming learned, thus, demonstrating a generalization or transfer effect.

This generalization was most salient for Student 1. For Student 2, the last two sessions (sessions 9 and 10) averaged between 90% and 100% accuracy for the four skills, which suggested that with more time the PTD procedure for Skill 1 may have generalized to mastery of all four skills.

We think it would be unwise for a teacher to assume that teaching one of these skills will lead to the acquisition of the others. Studies have shown that teaching a selection response does not necessarily result in being able to produce the response (e.g., Guess & Baer, 1973; Wynn & Smith, 2003), but it sometimes does, even in people with an intellectual disability (Ribeiro, Elias, Goyos, & Miguel, 2010) or very young children (Horne & Lowe, 1996). Procedures have been developed to teach such transfer (Gilic & Greer, 2011; Horne, Hughes, & Lowe, 2006).

Discrimination skills were assessed 2–4 weeks following the intervention condition to assess whether the skills remained in the student's repertoire. Consistent with results from Walker (2008), the skills were maintained for the student who reached criterion.

One hallmark of PTD is its potential to reduce or eliminate errors while learning. Student 1, who demonstrated the best response to the intervention had low errors. In contrast, Student 2 made incorrect responses about 15–20% of the time during the intervention. The performance of Student 2 was highly variable. In fact, for Skill 1 and Skill 2, the performance was below the 50% chance level in the baseline condition. In Etzel and LeBlanc's (1979) analysis of effective instruction, universally applying instructional procedures will not likely produce universal success. This analysis is congruent with the results of this study, which demonstrated different levels of instructional need between the participants. Student 1 represented a type of student who was not responding to typical instructional methods, yet responded well to the simplified instruction of PTD. Student 2 did not respond well to typical instructional methods and continued to have some difficulty even with PTD. In light of the poor baseline performance, Student 2 may have benefited from more intensive instructional procedures that draw more attention to the differences in spatial orientation between the two letters, such as stimulus fading or stimulus shaping.

Limitations and future research

This study used only a two participant multiple baseline design, therefore, the results should be interpreted cautiously. Student 2 did not reach mastery and, therefore, maintenance data was not collected. Future research should be conducted over a longer time period to evaluate whether skills are maintained. The PTD procedure is quite simple to implement in terms of programming and material development. In contrast, materials and programming for other errorless learning procedures such as stimulus fading can be costly and time intensive (Bradley-Johnson, Sunderman, & Johnson, 1983). However, this effort may be necessary for some learners. Future research that compares stimulus fading or stimulus shaping with PTD for students with the most significant letter discrimination difficulties may clarify the appropriate procedure to use.

Given that the intervention took 15 minutes per session, three times per week, it could be viewed as too time intensive because it is one-on-one. However, when considering the performance of Student 1, the investment of four sessions appears well worth it. Additionally, the potential development of a computer program to carry out the PTD procedure for letter discrimination would eliminate the need for one-on-one instruction. Future studies may also wish to investigate this procedure with four or more participants to better understand participant response to the intervention.

It is likely that some individuals will not respond well to typical methods of instruction for learning difficult discriminations (Etzel & LeBlanc, 1979). This study used a simple errorless teaching procedure, PTD, to reduce the difficulty of the *b* and *d* letter discrimination task and to reduce errors when learning. The results of this study provide some support for the use of PTD as a technique to remediate letter discrimination difficulty and add to the body of literature on errorless learning. ■

REFERENCES

Asso, D., & Wyke, M. (1971). Discrimination of spatially confusable letters by young children. *Journal of Experimental Child Psychology, 11*, 11–20. doi:10.1016/0022-0965(71)90059-2

Bradley-Johnson, S., Sunderman, P., & Johnson, C.M. (1983). Comparison of delayed prompting and fading for teaching preschoolers easily confused letters and numbers. *Journal of School Psychology, 21*, 327–335. doi:10.1016/0022-4405(83)90046-8

Carnine, D.W., Kame'Enui, E.J., Silbert, J., Tarver, S. (2003). Direct Instruction Reading-Fourth Edition. Virginia: Prentice Hall.

Etzel, B.C., & LeBlanc, J.M. (1979). The simplest treatment alternative: The law of parsimony applied to choosing appropriate instructional control and errorless-learning procedures for the difficult-to-teach child. *Journal of Autism and Developmental Disorders, 9*, 361–382.

Etzel, B.C. (1997). Environmental approaches to the development of conceptual behavior. In D.M. Baer & E.M. Pinkston (Eds.), *Environment and behavior* (pp. 52–79). Boulder, CO: Westview Press.

Gibson, E.J., Gibson, J.J., Pick, A.D., & Osser, H. (1962). A developmental study of the discrimination of letter-like forms. *Journal of Comparative and Physiological Psychology, 55*, 897.

Gilic, L., & Greer, R.D. (2011). Establishing naming in typically developing two-year-old children as a function of multiple exemplar speaker and listener experiences. *The Analysis of Verbal Behavior, 27*, 157–177.

Glat, R., Gould, K., & Stoddard, L.T. (1994). A note on transfer of stimulus control in the delayed-cue procedure: Facilitation by an overt differential response. *Journal of Applied Behavior Analysis, 27*, 699–704. doi:10.1901/jaba.1994.27-699

Gold, M. W. & Barclay, C.R. (1973). The learning of difficult visual discriminations by the moderately and severely retarded. *Mental Retardation, 11*, 9–11.

Griffiths, K. & Griffiths, R. (1976). Errorless establishment of letter discriminations with a stimulus fading procedure in pre-school children. *Perceptual and Motor Skills, 42*, 387–396. doi: 10.2466/pms.1976.42.2.387

Guess, D., & Baer, D.M. (1973). An analysis of individual differences in generalization between receptive and productive language in retarded children. *Journal of Applied Behavior Analysis, 6*, 311–329. doi: 10.1901/jaba.1973.6-311

Horne, P.J., Hughes, J.C., & Lowe, C.F. (2006). Naming and categorization in young children: IV: Listener behavior training and transfer of function. *Journal of the Experimental Analysis of Behavior, 85*, 247–273. doi: 10.1901/jeab.2006.125-04

Horne, P.J., & Lowe, C.F. (1996). On the origins of naming and other symbolic behavior. *Journal of the Experimental Analysis of Behavior, 65*, 185–241. doi: 10.1901/jeab.1996.65-185

Lancioni, G.E., Hoogeveen, F.R., Smeets, P.M., Boelens, H., & Leonard, S.N. (1989). Errorless discrimination of reversible letters: Superimposition and fading combined with an intervening response. *The Psychological Record, 39*(3), 373–385.

Oppenheimer, M., Saunders, R.R., & Spradlin, J.E. (1993). Investigating the generality of the delayed-prompt effect. *Research in Developmental Disabilities, 14*, 425–444. doi:10.1016/0891-4222(93)90036-J

Ribeiro, D.M., Elias, N.C., Goyos, C., & Miguel, C.F. (2010). The effects of listener training on the emergence of tact and mand signs by individuals with intellectual disabilities. *The Analysis of Verbal Behavior, 26*, 65–72.

Schilmoeller, G.L., Schilmoeller, K.J., Etzel, B.C., & LeBlanc, J.M. (1979). Conditional discrimination after errorless and trial-and-error training. *Journal of the Experimental Analysis of Behavior, 31*, 405–420. doi:10.1901/jeab.1979.31-405

Sidman, M. (2010). Errorless learning and programmed instruction: The myth of the learning curve. *European Journal of Behavior Analysis, 12*, 167–180.

Sidman, M., & Stoddard, L.T. (1966). Programming perception and learning for retarded children. In N.R. Ellis (Ed.), *International review of research in mental retardation* (151–207). New York & London: Academic Press.

Terrace, H.S. (1963). Errorless transfer of a discrimination across two continua. *Journal of the Experimental Analysis of Behavior, 6*, 223–232

Vargas, J.S. (2009). *Behavior analysis for effective teaching*. New York: Routledge.

Walker, G. (2008). Constant and progressive time delay procedures for teaching children with autism: A literature review. *Journal of Autism Development Disorder, 38*, 261–275. doi:10.1007/s10803-007-0390-4

Wynn, J.W., & Smith, T. (2003). Generalization between receptive and expressive language in young children with autism. *Behavioral Interventions, 18*, 245–266. doi:10.1002/bin.142

BEHAVIORAL DEVELOPMENT BULLETIN

VOLUME 19
NUMBER 1
MARCH 2014

The effects of functional writing contingencies on second graders' writing and responding accurately to mathematical algorithms

Joan A. Broto[1] and R. Douglas Greer[1]

ABSTRACT

We tested the effects of a functional writing protocol on the accurate functional and structural responses in mathematical algorithms written and read by 6 typically developing 2nd grade students using a delayed pre- and post-experimental probe design. The participants wrote an algorithm on how to solve word problems and observed their peer completing the steps written in the algorithm. A yoked-contingency game board was implemented in which both the participants and the peers could move up on the game board if the peer was able to solve the word problem based on the participant's written algorithm. The results showed an increase in the number of functionally accurate written algorithms written by the writers as a function of the procedure.

KEYWORDS: writing, algorithm, mathematics, word problems

A recent study reports that fourth grade students in the USA perform 11th in mathematics compared to other economically advanced countries, while eighth graders in the USA perform 9th (Gonzales, Williams, Jocelyn, Roey, Kastberg, & Brenwald, 2009). Even though mathematics performance scores of American students have increased from 1995, there is still a need to further improve American students' mathematics scores. One of the important components of mathematics includes the writing of, and accurately responding to, written mathematical algorithms. The National Council of Teachers of Mathematics (NCTM, 2000) outlines the goals of mathematics education. Students need to be able to not only solve word problems they also need to be able to communicate effective mathematical operations through writing. NCTM states that students should be able to:

> *….organize and consolidate their mathematical thinking through communication; communicate their mathematical thinking coherently and clearly to peers, teachers, and others; analyze and evaluate the mathematical thinking and strategies of others; use the language of mathematics to express mathematical ideas precisely (p. 60)*

Joining language and mathematics instruction is seen as a key curricular activity (Candia, 1998). One of the benefits of linking writing and mathematics is to allow teachers to identify their students' deficits in producing and responding to math algorithms (Rothstein & Rothstein, 2007). Researchers have also reported improvements in students' mathematical skills when students were asked to write about their mathematical thinking (Cai, Jakabcsin, & Lane, 1996; Fukawa-Connelly & Buck, 2010; Kline & Ishii, 2008; Langer & Applebee, 1987; Staats & Batteen, 2009). Skinner's (1957) theory of verbal behavior may offer an effective operational approach to this educational objective.

"Writing-to-learn" is an approach in teaching mathematics that incorporates writing and language instruction. It is theorized to be a way to enhance learning where learners develop the skills to communicate mathematical operations as well as to follow algorithms (Johanning, 2000; Kline & Ishii, 2008). Writing-to-learn in mathematics also supports student learning because as with writing in other curricular areas, students are required to "organize, clarify, and reflect on their mathematical thinking" (Burns, 2004; Gammill, 2006).

Some examples of writing-to-learn activities include the use of journal writing, reports, essays, solving math problems, explaining mathematical ideas, expository writing, and writing about learning processes (Burns, 2004; Johanning, 2000). Researchers have reported that the use of "writing-to-learn" in their mathematics classroom resulted in better student performance, and better student understanding of mathematical concepts and their own learning processes (Burns, 2004; Cai, Jakabcsin, & Lane, 1996;

1 Teachers College and Graduate School of Arts and Sciences, Columbia University. For correspondence, please contact: Joan A. Broto, Ph.D., ABA, BCBA-D, 6722 Kneale Place, Burnaby, BC V5B2Z2 Canada, (604) 441-6553, Email: joan.broto@gmail.com, R. Douglas Greer, PhD, SBA, SRS, Box 76, Teachers College, Columbia University, Thorndike Hall 529G, 525 West 120th St., New York, NY 10027, E-mail: RDG132@columbia.edu. The research reported was completed as part of the requirements for the PhD dissertation by the first author under the sponsorship of the second author.

Flesher, 2003; Fukawa-Connelly & Buck, 2010; Staats & Batteen, 2009; Zollman, 2009). Unfortunately, the actual stimulus control and responses involved in the process and the procedures used in the studies lack clarity.

Although research on "writing-to-learn" in mathematics has demonstrated the effects of writing on overall academic achievement, the procedures implemented could not be directly observed and measured. One of the several branches of language research involves the function of language from a behavioral perspective and is called verbal behavior analysis. Skinner (1957) set forth the initial theory that led to basic and applied research in verbal behavior and its development. The contributions of this analysis to education, speech therapy, and language development has grown exponentially in the last two decades, leading to the identification of environmental experiences that contribute to productive and emergent language functions (Barnes, Holme, Barnes-Holmes, & Cullinan, 1999; Greer, 2008; Hayes & Hayes, 1989; Michael, Palmer, & Sundberg, 2011). Findings of these analyses have complemented current findings in language development by providing evidence of the role of experience in the emergence of language (Hoff & Shatz, 2009). In the field of Verbal Behavior, writing is a type of verbal behavior that extends the speaker role (Greer, 2002; Greer & Ross, 2008; Skinner, 1957), which is to affect the listener, or in this case, the reader. One experimentally tested intervention from verbal behavior analysis is referred to as the writer immersion protocol and uses the natural cultural motivational operations of writing functions to expand or induce the functional and improve the structural components of writing (Helou, Lai, & Sterkin, 2007; Greer & Ross, 2008; Jodlowski, 2000; Madho, 1997; Reilly-Lawson & Greer, 2006; Visalli-Gold, 2005). Writer immersion is a tactic during which all communications are done in writing and the writer is required to affect the behavior of the reader as a measure of effective writing (Greer, 2002; Greer & Ross, 2008). Other writing curricula are devoted to the structural components of writing, which are usually, but not limited to, spelling, punctuation, grammar, capitalization, and sentence structures. However, in addition to learning the structure of writing, students also need to learn the *function* of writing, which is to affect the behavior of the reader (Greer, 2002). In order to affect the behavior of a reader, a writer must write such that a reader can accomplish the writer's intent. That is the writer must construct an algorithm that results in a reader accurately following the algorithm. In the verbal behavior approach and its historical precedent (Dewey, 1910) the structure of writing needs to be driven by the function.

During writer immersion, teachers and students in the classroom are not allowed to vocally communicate, they must write to one another instead. This can create the motivating operation (Michael, 1982, 2000, 2004) or the need-to-write; in order for the student to obtain the desired outcome. The student is required to write such that a reader can deliver the specified reinforcer. For example, if a student needs an eraser, he has to write "Can I have an eraser please?" and wait for the teacher to respond in writing, "Yes you may," or to give the student the eraser (Reilly-Lawson & Greer, 2005).

The other component of the protocol includes delivering instruction that meets the criterion for learn units (Emurian, 2004; Emurian, Hu, & Durham, 2000) in the context of writing a set of directions to a task, and having a peer read the written directions and attempt to follow them. The procedure is continued until the peer reader accomplishes the task. In order for the peer reader to correctly accomplish the task, the writer has to ensure her writing structures are accurate and her writing can function to change the behaviors of the peer reader. The writer edits and rewrites his or her instructions until the reader can accurately follow them (Reilly-Lawson & Greer, 2005). To increase the probability that a motivating operation is in place, recent studies have added the peer-yoked contingency component. The peer-yoked contingency component can be implemented during writer immersion in which both the writer and the peer reader win a point or a reinforcer once the peer reader has accomplished the task successfully; hence, the writer and the reader are yoked to a common reinforcer (Helou, et al., 2007).

Several studies showed that the implementation of a variety of writer immersion tactics resulted in increases in the structural and functional writing skills of the participants (Helou, et al., 2007; Jodlowski, 2000; Madho, 1997; Reilly-Lawson & Greer, 2006; Visalli-Gold, 2005). Madho (1997), for example, had participants write a set of directions for a peer to follow. Rewriting and corrections were implemented until the participants were able to write a set of directions that the peer can follow correctly without revisions. Several writer immersion studies also tested the effects of having a peer serving as peer editors or observing the peers receiving learn units. Jodlowski (2000) tested the effects of peer editing, teacher editing, and serving as a peer editor on student self-editing behavior. In three experiments, the experimenter tested the different components together and separately and found that students who served as a peer editor required fewer corrections to rewrite their essays versus when they only rewrote their essays. Visalli-Gold (2005) conducted two experiments to test the effects of receiving corrections and editing from a teacher versus observing peers receiving corrections and edits on untaught grammatical and structural components of students' writing. The results showed that the participants who observed their peers receiving learn units also improved in their functional writing responses.

Reilly-Lawson and Greer (2006) and Helou et al. (2007) conducted several experiments to further test the effects of writer immersion and self-editing on the structural and functional components of writing with middle school students diagnosed with emotional and behavior disorders. The results showed that editing the participants' writing, along with a yoked peer contingency component, improved the structural components and functional components of writing across all participants.

Even though studies on writer immersion showed functional effects on the structural and functional components of writing, there has been no research conducted on the effectiveness of the procedure or its components on writing mathematically and on solving problems as a function of reading algorithms. One possible application is writing mathematical algorithms or writing to explain how one is able to solve a certain problem. Mathematical algorithms are rules, written verbal stimuli, of arithmetic that include addition, subtraction, multiplication, division, extraction of roots, duplication, mediation, and regression (Reese, 1992). Although

Table 1. Components and procedures of a CABAS® AIL classroom

Components and instructional procedures
a) Learn unit (direct and observed)
b) Model demonstration learn units for more advanced students with observational learning (model of how to do the problem followed by probes and learn units)
c) Rule posting and reinforcement for following rules
d) Point system (individual, small group, and whole classroom) for accuracy and social behavior
e) Class wide peer tutoring
f) Differentiated instruction by small groups across all academic areas
g) Choral responding in small or large groups
h) Response board responding
i) Mastery objectives followed by fluency objectives
j) Personalized System of Instruction (PSI) for advanced students (Keller, 1968)
k) The use of book reports to assess students' reading comprehension skills. (The book reports included a summary of events of a story including the beginning, middle, and end, description of characters, and description of story setting)
l) Public posting of responses to math facts fluency, reading scores, correct completion of book reports, and class-wide learning data
m) CABAS® AIL decision protocol for when interventions are needed and where to locate the source of the learning problem
n) Use of Learning Pictures on a web server (showing mastery of objectives in the curricula and numbers of learn units needed to achieve mastery or fluency)

students may be able to follow algorithms to solve problems (Keohane & Greer, 2005; Marsico, 1998) students may not necessarily be able to *write* algorithms. The following of algorithms has been identified by the verbal behavior community as verbally-governed behavior, which is any behavior under the control of verbal stimuli (Glenn, 1987; Greer, 2002; Skinner, 1957; Vargas, 1998). Research on verbally governed behaviors has focused on following rules or the consequences that maintain or increase the frequency of verbally-governed behaviors (Ayllon & Azrin, 1964; Catania, Matthews, & Schimoff, 1982; Catania, Shimoff, & Matthews, 1989; Matthews, Catania, & Schimoff, 1985; Matthews, Shimoff, Catania, & Sagvolden, 1977; Shimoff, Catania, & Matthews, 1981; Vaughan, 1989; Verplanck, 1992). Research on *verbally-governing* behaviors has been limited to the writer immersion protocol for language arts or the emission of speech to affect the behavior of listeners (Greer & Ross, 2008). There is a lack of research on writing in mathematics, in particular in writing mathematical algorithms that we have identified as verbally governing behavior (instead of verbally-governed behavior).

Based on the results of writer immersion and yoked-peer contingency procedures on the increases in functional and structural components of writing, we wanted to test the effects of the procedure on writing mathematical algorithms. The current study sought to answer the following research questions: Will the use of a peer-yoked functional writing procedure, in which the writer observes the effects of their writing on a reader's behaviors, result in increases in the functional and structural components of students' written algorithms? Will the peer readers also learn to write functional algorithms after they observe their peers' written algorithms?

» METHOD

Participants

There were 6 participants (3 writers and 3 peer readers) selected for this study. All of the participants were 2nd grade students enrolled in an Accelerated Independent Learner (AIL) classroom (Greer, 2010) where all instruction is based on scientific procedures and student responses are continuously measured. The participants were selected from a second-grade classroom located in a metropolitan city. The public charter school was located in an urban setting and all of the students in the classroom received free lunch. There were 19 students in the classroom, 18 students were African-American and 1 student was Hispanic.

The components of the AIL model include the use of data collection and graphs to make moment-to-moment educational decisions and the implementation of educational tactics and protocols to increase learning outcomes. The classroom also implemented a token economy system in which students received plastic coins that could be exchanged for backup reinforcers. A group contingency was also implemented in which the students' groups in the classroom could earn points for a 10-minute free time at the end of the day. A class-wide contingency was implemented in which the whole class could earn a celebration for following directions, walking quietly in the hallway, or for completing classroom work. See Table 1 for the components of a CABAS® AIL classroom and instructional procedures implemented in the classroom (Greer, 2010).

The participants were selected because they were at or above grade level in reading, as measured using the *Developmental Reading Assessment, 2nd Edition* (DRA2). Thirteen out of 19 students in the classroom were at or above grade level in reading and mathematics. The DRA2 was one reading assessment used in the classroom and the students in the school were tested every 6–8 weeks. The students' DRA2 scores ranged from Level 16 to Level 36, or the grade equivalent of first to third grade reading levels. The participants selected for this study had already achieved the 2nd grade benchmark according to the DRA2; hence, the participants had grade level or higher fluency for textual responding and reading comprehension. All of the participants were also able to add and subtract basic math facts and they were proficient mathematically. This was indicated by their unit chapter tests in which the participants were performing at or above the grade standards.

The six participants were paired into groups of 2, Participants A (writer) and D (peer reader), Participants B (writer) and E (peer reader), and Participants C (writer) and F (peer reader). All of the participants completed pre-experimental and post-experimental probes for the dependent variable measures. The participants' verbal repertoires and capabilities (Greer & Ross, 2008) as well as their DRA2 test scores are shown in Table 2.

Setting and materials

All probe and experimental sessions were conducted in the classroom. In the center of the room were four groups of four to six desks per group. The classroom library and leisure area were located in the far end of the classroom by the windows. All sessions were conducted at a U-shaped table that was placed in a separate area of the classroom. The table was at the back of the room, adjacent to the classroom library. The table was normally

Table 2. Participants verbal repertoires (Greer & Ross, 2008) and DRA2 score

Participant	Age	Verbal cusps and capabilities in repertoire	DRA2 score and grade equivalent
A (writer)	8	Reader/Writer/Emerging Self-Editor Listener half of Naming Textual Responding at 120 wpm for 2nd-grade level text Transformation of stimulus function across saying and writing	DRA2 level 28 GE: 2
B (writer)	8	Reader/Writer Listener half of Naming Observational Learning Textual Responding at 120 wpm for 2nd-grade level text Transformation of stimulus function across saying and writing	DRA2 level 28 GE: 2
C (writer)	7	Reader/Writer/Emerging Self-Editor Listener half of Naming Observational Learning Textual Responding at 145 wpm for 2nd-grade level text Transformation of stimulus function across saying and writing	DRA2 level 28 GE: 2
D (peer reader)	8	Reader/Writer Full Naming Observational Learning Textual Responding at 150 wpm for 3rd -grade level text Transformation of stimulus function across saying and writing	DRA2 level 34 GE: 3
E (peer reader)	8	Reader/Writer/Emerging Self-Editor Full Naming Observational Learning Textual Responding at 120 wpm for 2nd-grade level text Transformation of stimulus function across saying and writing	DRA2 level 28 GE: 2
F (peer reader)	8	Reader/Writer/Emerging Self-Editor Listener half of Naming Observational Learning Textual Responding at 120 wpm for 3rd -grade level text Transformation of stimulus function across saying and writing	DRA2 level 36 GE: 3

Note. DRA2 = Developmental Reading Assessment® 2nd Edition; GE = grade equivalent.

used for small group instruction and the participants sat on the outer end of the table, with the experimenter sitting across the participants at the inner part of the U-shaped table. Other students in the classroom were engaged in regular instruction with teacher assistants during the study.

The materials used in this study were pencils and writing paper for each participant to write the algorithms and to solve word problems. All problems were presented on paper and probe questions were typed using Comic Sans 14 pt. font size. Word problems during training sessions were typed or handwritten. The types of problems included change, combine, equalize, and compare problems. Change and combine problems are problems that involve addition whereas equalize and compare problems are problems that involve subtraction. See Table 3 for an example of the word problems used during experimental probe and training sessions.

Dependent variables and response definitions

There were several variables measured in this experiment. All of the dependent variables were measured during pre and post intervention probe sessions. The first dependent variable was the functionality of the written algorithms, the second dependent variable was the number of correct responses to probe questions, and the third dependent variable was the accuracy of the structural components of the written algorithms. All participants (writers and peer readers) completed the experimental probes. The unconsequated probes consisted of four types of problems, two exemplars of each type, with a total of eight problems. The four problem types included change, combine, compare, and equalize problems (Jordan & Hanich, 2000). Multiple questions were presented in which the participants were asked to write the steps they need to solve the problem. The problems presented during the pre- and post-experimental probe sessions were similar in structure to those used in the intervention sessions, however, the specific language and numbers were different.

Table 3. Examples of story problems as presented by Jordan and Hanich (2000)

Type of problems
Change problems 1) Alex had 7 pennies. Then Bethany gave him 2 more pennies. How many pennies does Alex have now? 2) Carol had 8 pennies. Then Doug gave her some more pennies. Now Carol has 12 pennies. How many pennies did Doug give her?
Combine problems 1) Emily has 7 pennies. Farrah has 6 pennies. How many pennies do they have altogether? 2) Gina and Haley have 12 pennies together. Gina has 7 pennies. How many pennies does Haley have?
Compare problems 1) Ian has 10 pennies. Joan has 5 pennies. How many pennies does Ian have more than Joan? 2) Karl has 9 pennies. Lisa has 4 pennies. How many pennies does Lisa have less than Karl?
Equalize problems 1) Max has 12 pennies. Noah has 10 pennies. How many pennies does Noah need to have as many as Max? 2) Oliver has 5 pennies. Petra has 10 pennies. What could Oliver do to have as many pennies as Petra?

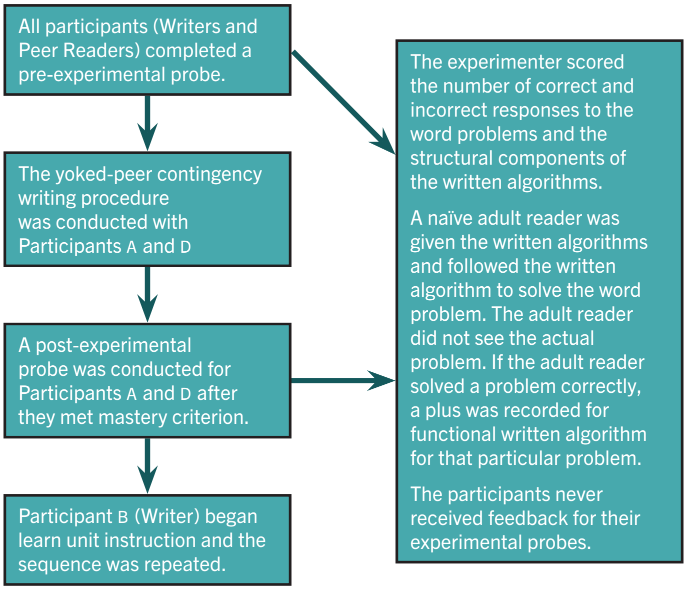

Figure 1. Flowchart of experimental sequence

During the experimental probe sessions, the participants (writers or peer readers) sat across from the experimenter and were given the direction, "Please complete the problems and try your best. If you do not know how to solve a problem, you cannot ask for help, just skip the question or write 'I don't know.'" The experimenter put the written problems in front of the participants and said "Go" to indicate the start of the probe session. Underneath each problem, the experimenter also asked the participants to write the steps on how to solve the problem; therefore, the participants had to solve the problem and write the steps (the algorithm). The experimenter delivered tokens throughout the probe session contingent upon participation to reinforce the participants for completing the problems. Tokens were not delivered contingent on correct responses, they were delivered contingent upon the participants engaging in the task. After the participants (writers and peer readers) completed the problems, the experimenter collected the papers, delivered more tokens, and told the participants to go back to their seats. The experimenter scored each paper after all participants were finished and did not provide feedback to the participants. The response definitions for the dependent variables are presented below.

Functionality of the written algorithms. A written algorithm was defined as functional if another adult naive reader was able to solve a word problem by following the written algorithm. During the experimental probe sessions, the participants (writers and peer readers) wrote algorithms to solve each of the eight word problems presented. A naive adult reader was given the written algorithm without seeing the actual problem and attempted to solve the problem based on the written algorithm. The readers functioned as observers who were naïve to the conditions of the experiment. If the reader solved the problem correctly, a plus was recorded for that particular problem. If the reader did not solve the problem correctly, a minus was recorded. The total possible number of correct responses was 8 for each participant.

Number of correct responses to word problems. A second dependent variable was the number of correct responses to word problems presented during the experimental probe sessions, solved by the writers and peer readers. A correct response was defined as the correct solution to a problem. An incorrect response was defined as an incorrect solution to a problem or if the participant did not write any answer to a problem. The total possible correct responses were eight.

Structural components of the written algorithms. The structural components of the written algorithms were the percent of correct punctuation marks, the percent of correct words spelled, the percent of correct words capitalized, and the percent of correct grammar usage. Except for the number of words written, all other structural components were counted based on the total number of sentences. For example, if the participant wrote three sentences, the structural components were scored out of three for one problem. The total number of possible responses varied depending on the number of sentences written for each problem. The number of correct responses was converted into percentages.

Experimental design and procedures

The design of the study was a delayed pre- and post-probe design to control for maturation and instructional history. All of the participants (writers and peer readers) received a pre-experimental probe at the onset of the study. A pilot study with three different writers showed that all of the participants were able to solve the word problems but they were not able to write about the word problems. In this study, Participant A (writer) received the intervention procedure along with Participant D (peer reader). None of the peer readers received the writing intervention. After Participant A (writer) met mastery criterion during the intervention, both Participant A (writer) and Participant D (peer reader) completed a post-experimental probe. Intervention then began for Participant B (writer) and Participant E (peer reader) as the peer confederate. Please see Figure 1 for a flowchart of the experimental sequence. The post-probe was delivered between three to four weeks after the pre-probe was conducted.

Independent variable: a peer-yoked functional writing procedure

Prior to the onset of the functional writing intervention the experimenter sat with the writer and the peer reader (for example, with Participants A and D) and showed the participants the game board. The board game consisted of five spaces on the left for the participant and the peer reader, and five spaces on the right for the experimenter. At the top of the game board, the name or picture of a reinforcer was written and taped to the board.

The experimenter said, "We are going to play a game. You will be on a team together and you're playing against me. The winner of the game will earn (reinforcer). The game will be about math. "_____" (writer's name) will write some directions and if "_____" (peer reader's name) can solve the problem correctly, your team will move up on one step on the game board. If "_____" (peer reader's name) gets a wrong answer, I will move up one space on the game board." The experimenter then asked the peer reader to go back to his or her seat and the experimenter continued with the writer.

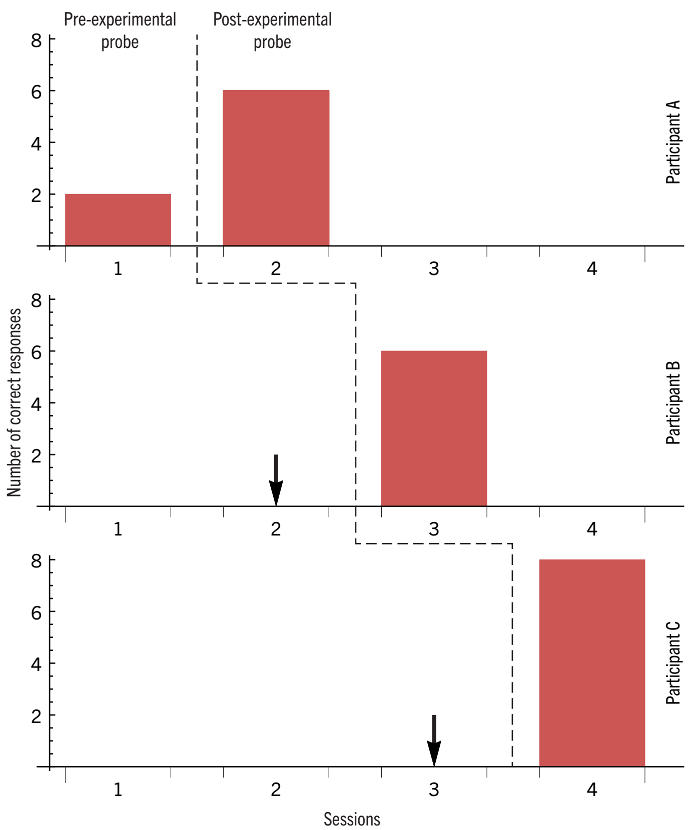

Figure 2. The number of correct problems solved by a naïve adult reader as a function of verbally governing algorithms written by Participants A, B, and C (Writers) during experimental probe sessions.

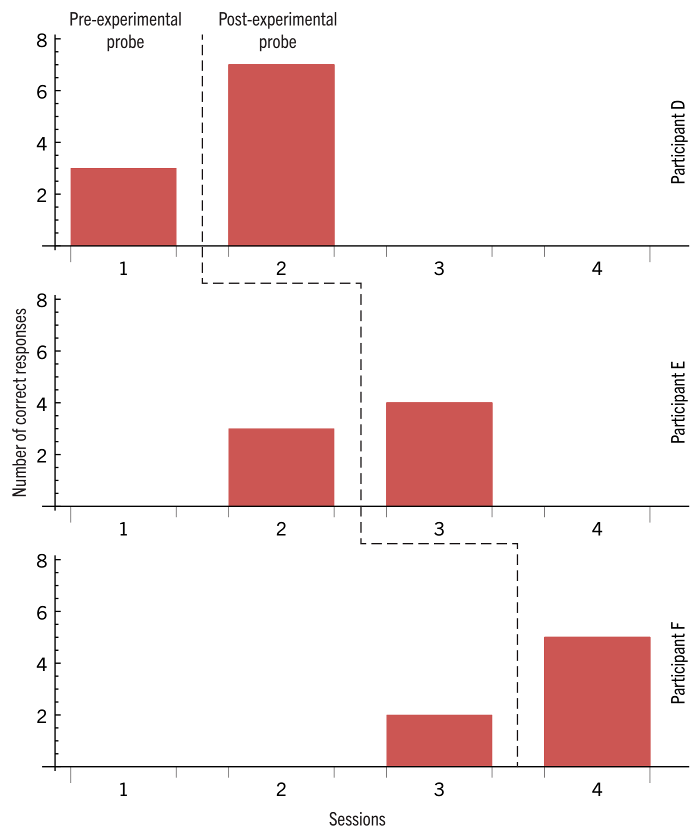

Figure 3. The number of correct problems solved by a naïve adult reader as a function of verbally governing algorithms written by Participants D, E, and F (Peer readers) during experimental probe sessions.

During each session, the writer sat with the experimenter and the experimenter gave the writer a word problem to solve. If the writer solved the word problem correctly, the experimenter delivered reinforcement (i.e. praise) and asked the writer to write the algorithm telling "_____" (peer's name) how to solve that word problem on a different piece of paper. The experimenter asked the writer to solve the word problem first to ensure he or she was able to solve the problem correctly before writing *about* the problem. If the writer did not solve the word problem correctly, the experimenter delivered a correction by telling the participant how to solve the problem correctly and gave the writer another word problem to solve that was similar in structure.

After the writer responded to a problem correctly, then the experimenter asked the writer to write the algorithm to solve the word problem. The word problems presented during the procedure involved using manipulatives (blocks). Through the use of manipulatives, the writer was able to observe the component steps performed by the peer reader. After the writer wrote the algorithm, the experimenter corrected the spelling, punctuation, and capitalization of the algorithm. This was done by showing the writer what the correct spelling, punctuation, and capitalization should be and asked the writer to rewrite the algorithm with the corrections. The algorithm was given to the peer reader to follow. The experimenter only corrected the structure and not the content or the functionality of the algorithm.

The peer reader then attempted to solve the problem using the algorithm provided while the writer sat next to the peer reader. The peer reader did not see the question and only followed the directions given by the writer. The peer reader read the algorithm out loud and used the blocks to solve the problem. For example, if the participant wrote "First take 16 blocks," then the peer reader took out 16 blocks. The next step in the algorithm may have been, "Then take seven more blocks," and the peer reader did so. The participant had to write another step to solve the problem, for example, "Now add them all up and you have the answer."

The writer met mastery criterion for the procedure when the peer reader was able to solve the word problem at 100% accuracy for five different problems. If the peer reader was not able to solve the word problem correctly the first time, the writer rewrote his or her algorithm until the peer reader was able to complete the word problem correctly. If the peer reader was not able to solve the problem correctly the first time, the experimenter moved up a space on the game board. However the writer and the peer reader could only advance on the game board if the problem was solved correctly on the first opportunity.

The sequence of steps is as follows: 1) a writer completed a word problem and wrote the algorithm of how to complete the problem out of view of the peer reader, 2) the experimenter delivered corrections for the capitalization, spelling, and punctuation of the written algorithm, 3) the writer corrected his or her errors

Table 4. Number of correct word problems solved by the writers during pre-experimental and post-experimental probe sessions

Participant	Pre-experimental probe	Post-experimental probe
A	7/8	7/8
B	4/8	8/8
C	5/8	7/8

Table 5. Number of correct word problems solved by the peer readers during pre-experimental and post-experimental probe sessions

Participant	Pre-experimental probe	Post-experimental probe
D	6/8	8/8
E	7/8	7/8
F	2/8	5/8

and rewrote the steps, and 4) the experimenter gave the written algorithm to a peer reader who read the steps, while sitting next to the writer, and attempted to solve the problem based on the written algorithm by using blocks. The actual problem was hidden from the peer reader. This was done to eliminate the possibility that the peer reader might be able to solve the problem just from reading the word problem. If the peer reader was able to solve the problem correctly, the writer and the peer reader moved up one space on the game board. If the peer reader was not able to solve the problem correctly the first time, the experimenter moved one up on the game board. If the writer and the peer reader were able to move five spaces on the game board, they both earned a reinforcer.

Interscorer agreement

A second independent observer provided interscorer agreement. For Participant A (writer), IOA was calculated for 100% of probe sessions, with 100% agreement for the number of words written and 100% agreement for the structural components. IOA was also calculated for the training sessions, in which a second observer scored the participants' written algorithms for functionality or if the peer reader solved the problem correctly. IOA for Participant A was conducted for 100% of training sessions, with 100% agreement on each of the three measures.

For Participant B (writer), IOA was calculated for 50% of probe sessions, with 100% agreement for the number of words written and 100% agreement for the structural components. IOA for Participant B was conducted for 100% of training sessions, with 100% agreement. For Participant C (writer), IOA was calculated for 100% of probe sessions, with 100% agreement for the number of words written and the structural components. IOA was also calculated for 100% of training sessions with 100% agreement.

For Participant D (peer reader), IOA was calculated for 100% of probe sessions, with 100% agreement for the number of words written and a mean of 96% agreement for the structural components (range 88%–100% agreement). For Participant E (peer reader), IOA was calculated for 100% of probe sessions, with 100% agreement for the number of words written and a mean of 96% agreement for the structural components (88%–100% agreement). For Participant F (peer reader), IOA was calculated for 50% of probe sessions, with 100% agreement for the number of words written and 100% agreement for the structural components.

Data collection

For the dependent variables, if the adult reader solved the problem correctly, a plus (+) was recorded. If the adult reader did not solve the problem correctly, a minus (–) was recorded. The total number of possible correct responses was eight. Data were presented as the number of correct responses. The participants' responses to the word problems were also scored. If the participant solved a word problem correctly, a plus (+) was recorded. If the participant did not solve a word problem correctly, a minus (–) was recorded. Data were presented as the number of correct responses. For the written algorithms, the number of words written was counted, recorded, and reported as number of words written. The numbers of correct and incorrect spelling, punctuation, and capitalization were calculated based on the total number of sentences and converted into percent correct.

For the independent variable, during learn unit instruction a plus (+) was recorded for correct responses and a minus (–) was recorded for incorrect responses. The number of rewrites during the peer-yoked contingency procedure was also recorded and reported as the number of rewrites for each word problem. The structural components of the written algorithms during the procedure were counted, recorded, and converted into percentages.

Table 6. The number of rewrites by the writers for each problem during the procedure

Participant	Problem	(Type)	Rewrites
A	1	(Change)	0
	2	(Combine)	0
	3	(Compare)	1
	4	(Equalize)	3
	5	(Change)	0
	6	(Compare)	1
	7	(Combine)	0
	8	(Equalize)	0
B	1	(Compare)	3
	2	(Change)	0
	3	(Combine)	0
	4	(Equalize)	1
	5	(Change)	0
	6	(Combine)	0
	7	(Compare)	0
C	1	(Combine)	2
	2	(Compare)	1
	3	(Change)	0
	4	(Equalize)	3
	5	(Change)	0
	6	(Combine)	0
	7	(Equalize)	1
	8	(Compare)	1
	9	(Combine)	0
	10	(Change)	0
	11	(Equalize)	0
	12	(Compare)	1
	13	(Change)	0
	14	(Equalize)	0

» RESULTS

The results for the number of word problems solved by a naïve adult reader for the probes showed that for all six participants there was an increase in the number of correct responses by a reader who followed the written algorithms to solve the word problems presented in probe sessions. Figures 2 and 3 show the delayed pre- and post-probe design testing the effect of the peer-yoked contingency writing protocol on the functional effects of the written algorithms. For Participant A (writer), the number of word problems solved correctly by a naïve reader increased from two to six following the intervention procedure. For Participants B (writer) and C (writer), the number of word problems solved correctly by a naïve reader increased from zero to six and zero to eight, respectively. For Participants D (peer reader), the number of word problems solved correctly by a naïve reader increased from three to seven. For Participant E (peer reader), the number of word problems solved increased from three to five, and for Participant F (peer reader) the number increased from two to five. The latter two participants showed less of an effect.

Participant A (writer) was able to solve the word problems with seven correct responses out of eight prior to the implementation of the peer-yoked functional writing procedure. The number of correct responses remained the same after the implementation of the procedure. For Participant B (writer), the number of correct responses to the word problems increased from four correct to eight correct responses. For Participant C (writer), the number of correct responses increased from five to seven correct responses. Participant D's (peer reader) number of correct responses increased from six to eight correct responses. Participant E's (peer reader) number of correct responses remained the same; she had seven correct responses. For Participant F (peer reader), the number of correct responses increased from two to five correct responses. See Tables 4 and 5 for the number of correct responses during the pre-experimental and post-experimental probes for all participants.

There were several measures for the structural components of the written algorithms. The structural components were punctuation, capitalization, spelling, and grammar. Data were recorded as the number of correct components for every sentence, and the total number of correct components was calculated into a percentage. The results showed an increase in the structural components across the participant writers. There were mixed results for the peer readers; some of the percent correct structural components remained the same or decreased for one participant. Figures 4 and 5 show the percent correct of the structural components of the written algorithms.

During the intervention procedure, the participants had to write revisions based on the responses of the reader. Table 6 shows the number of algorithms the participants completed, the type of word problems, and the number of revisions required.

» DISCUSSION

In this experiment, the results demonstrated a functional relation between the functional writing procedure with yoked-contingency game board and the number of correct functional and structural components for all three writers. None of the writers were able

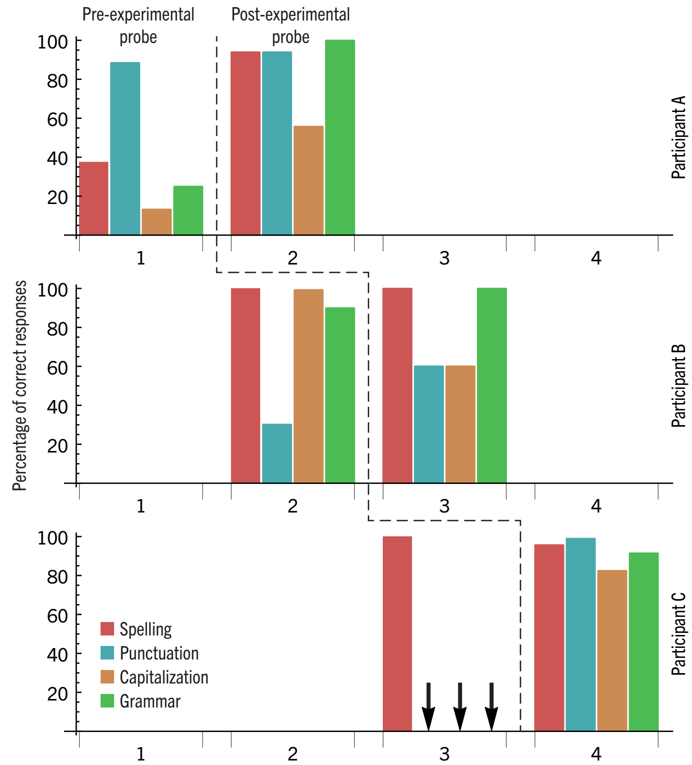

Figure 4. Percent of correct structural components in the algorithms written by Participants A, B, and C (Writers).

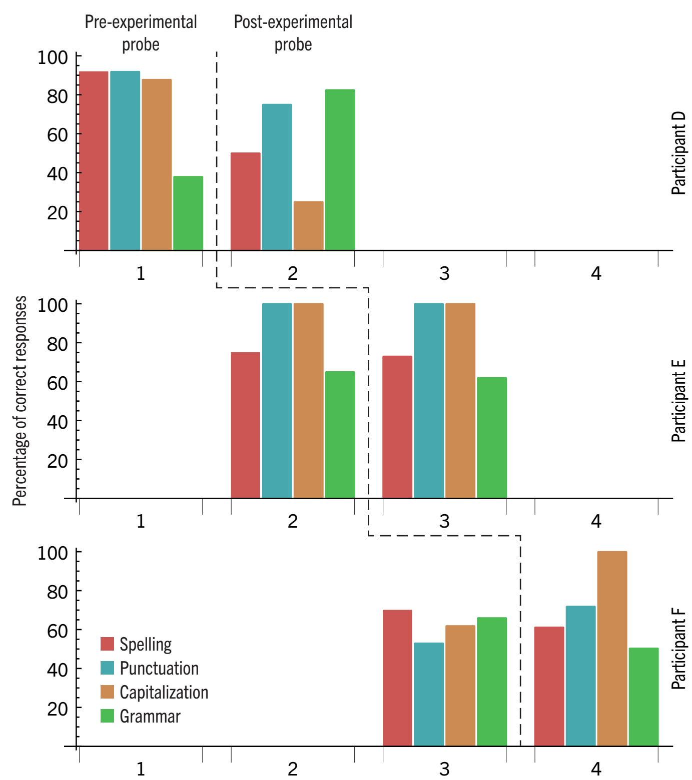

Figure 5. Percent of correct structural components in the algorithms written by Participants D, E, and F (Peer Readers).

to write functional algorithms in the beginning of the study, and after the implementation of the writing procedure they were able to write at least six functional algorithms out of the eight total opportunities. This result is consistent with other writer immersion studies, in which the participants learned to write essays that affected the readers (Helou, Lai, & Sterkin, 2007; Jodlowski, 2000; Madho, 1997; Reilly-Lawson & Greer, 2006; Visalli-Gold, 2005). The percent correct of the structural components for the writers improved after the implementation of the procedure, whereas the percent correct remained the same or decreased for the peer readers. This could be explained by the learn units the writers received during the intervention procedure that resulted in the improvements of the structural components, whereas the peer readers never received feedback on their written algorithms during the experimental probe sessions.

There were possible explanations for the results obtained. One possible explanation for the effects of the functional writing procedure on the increase of the functional written algorithms is the use of establishing operations in the procedure. As with other writer immersion studies, the role of the establishing operation is key to learning the function of writing which is to affect the behavior of the reader (Greer & Ross, 2008). The writing procedure created a natural motivational condition for the writers to write functional algorithms and the use of the game board, or the yoked-peer contingency, enhanced that motivational condition. The writer had to write functional algorithms in order for his or her peer to respond correctly to the word problem while at the same time, the writer and the peer need to work together in order to obtain the reinforcer (Davies-Lackey, 2005; Stolfi, 2005).

Another possible explanation was the presence of the audience in the tasks. The use of audience seems to improve students' writing even though most students believe that they eventually write for their teacher (Applebee, 1981, 1984; Bull, 1990; Gilbert, 1989; Long, 1990). In this experiment, the writers knew they were writing for their peers and they could observe the peer's responses immediately. The peer's behaviors then affected the behaviors of the writer in which they had to change the way they wrote in order for the peer to figure out the correct answer. The writers did not have to "imagine" their audience, they had an audience and this seemed to improve their writing. In one of the first studies on writer immersion, Madho (1997) found the effects of receiving responses from peers improved the target participant's writings, therefore the peer serves as an additional motivational condition in the yoked contingency as well as the target audience for the writers, and this combination may be the key component to effective writing procedures.

One interesting finding in this study was the effects of the procedure on the verbally governing responses of the peer readers. No other writer immersion studies tested the effects of the protocol on the responses of the peer readers and the results of this study showed that the peer readers could learn to write effectively and functionally by observing the responses of their peer writers. Visalli-Gold (2005) conducted a study to test the effects of the peers observing learn units presented to the target students and the effects on the structural components of writing; however, in this study the peers never observed the writers receiving learn units from the experimenter. The peer readers in this experiment participated as peer readers in a pilot study, therefore the peer readers were already familiar with the procedure. Nevertheless, the peer readers never received corrections in terms of the structural components. Jodlowski (2000) found that serving as a peer editor resulted in improvements in the peer editor's own writing as well as fewer number of learn units to write effective essays. In this study the peer readers did not edit the writing of their peer writers but they observed the *changes* in their peers' writing. This observation of the changes in the written algorithms could possibly have an effect on their own writing.

One possible explanation of the effect of observation was that the peer readers all had the observational learning capability in their repertoires which enabled them to learn through observing the consequences delivered to their peers (Davies-Lackey, 2005; Gautreaux, 2005; Greer & Ross, 2008; Greer, Singer-Dudek, & Gautreaux, 2006; Periera-Delgado, 2005; Rothstein & Gautreax, 2007; Reilly-Lawson & Walsh, 2007; Stolfi, 2005; Walsh, 2009). In this study the peer readers did not observe the learn units delivered to the writers, however they observed the changes in the peer's writing and the consequences delivered after the writers made the changes. If the writer did not write a functional algorithm, the peer reader could not solve the problem correctly. Nevertheless, after the writer edited his or her written algorithm, the peer reader was then able to solve the problem.

The results also showed that being able to solve word problems did not result in the ability to write about the word problems, which demonstrated the difference between procedural and conceptual knowledge (Miller, 1983 as cited by Reese, 1989). The participants in this study were able to solve the word problems with accuracy (verbally governed responses) however they were not able to write about the problems (verbally governing responses). It could be that verbally governed responses (or following an algorithm) are similar to listener responses, whereas verbally governing responses (writing about the algorithm) are similar to speaker responses. Reading is an extension of the listener behavior, and following verbally governed algorithms may be a similar type of listener behavior. On the other hand, writing is an extension of the speaker response, therefore producing verbally governing responses may be a type of writing behavior. Greer and Speckman (2009) stated that initially the listener and speaker responses are separate; however, they have identified the "joining" of the two responses as a necessary developmental capability in order for students to advance to more complex repertoires. If verbally governed responses and verbally governing responses are indeed similar to listener and speaker responses, it may be that students need to be taught both in order for the joining to occur.

One limitation in this study was the lack of measurement of the component steps of the written algorithms. Each algorithm was measured as either a correct or incorrect response; however, we did not measure the number of correct and incorrect steps in each algorithm. By measuring each step of the algorithm we could have a better picture in terms of the components of each algorithm and as the students write more complex algorithms breaking down the algorithm into component steps may be necessary.

Another limitation in this study was the level of difficulty of the problems. Some of the writers only needed on average, one rewrite in the procedure, especially for questions that consisted of addition problems. Students learn through the learn unit and receiving corrections through rewriting (Jodlowski, 2000; Madho, 1997; Reilly-Lawson & Greer, 2006; Visalli-Gold, 2005). In this study the writers learned quickly, from the first problem they encountered, what needed to be done in order for them to move up one space on the game board. Most of the writers had difficulty with compare and equalize problems and those were the problems that required two or more rewrites; however, there should have been more variations in the types of word problems as well as in the level of difficulty of the problems. Change and combine problems consist of problems that are addition problems whereas compare and equalize problems consist of subtraction problems. Although not all of the participants had difficulties with the compare and equalize problems, the errors occurred more often with these types of problems. This result is consistent with the findings by Hartlep and Golz (2009) that addition word problems are generally easier to solve than subtraction word problems.

An additional possible limitation to this study was that the peer readers only had to solve five word problems correctly before they could obtain the reinforcer. It is possible that the participants may not have had enough opportunities to respond to different types of word problems. Increasing the number of opportunities to respond would have led to more learning opportunities and the chance for the participants to receive more learn units (Greer, 2002; Greenwood & Delquadri, 1981).

A further limitation included the use of a pre- and post- probe design. It is possible that re-administering the probes could have had an effect on the increases in the functional and structural components of the written algorithms. We tried to minimize the effect by not providing the participants feedback on their written algorithms; that is, we did not provide reinforcement or correction and simply delivered reinforcement for participating in the study.

The findings of this study showed the effects of functional writing contingencies on verbally governing algorithms produced by typically developing second grade students. There is a great need for students to be able to write across curricular areas and even though the "writing-to-learn movement" and procedures have shown promising results (Bangert-Drowns et al., 2004); there were no studies that demonstrated the direct effects of writing on the reader in the field of mathematics. The procedures implemented in this study used the establishing operation and the presence of an audience and they may be the key components in teaching students to produce effective writing in mathematics (Greer & Ross, 2008; Helou et al., 2007). The observational learning capability was also a key component in writing effectively. In the classroom, this procedure could easily be implemented in small groups and the use of a board game could function as a motivational component for the students to write. Students could compete with one another or with the teacher, and not only would the students observe the effects of their writing immediately they would also be motivated to write and work together with their peers. In prior studies the researchers have avoided students competing with other students to presumably advance students' positive social interactions with each other. This has been identified to be beneficial as a component of the social listener protocol that has resulted in more social conversation between children diagnosed with Autism Spectrum Disorder (Reilly-Lawson & Walsh, 2007). However, this may or may not be the case with typically developing children and is also a topic for future research. This study contributes both to the field of applied behavior analysis and the field of teaching by providing a measurable and effective method to teach writing in mathematics. It also contributes to our basic understanding of verbal behavior development in that the effects of a functional writing intervention points to the verbal nature of mathematics, suggesting that verbal development needs to incorporate the verbal behavior components of mathematics education. ■

REFERENCES

Applebee, A.N. (1981). *A study of writing in the secondary school.* Urbana, IL; National Council of Teachers of English.

Applebee, A.N. (1984). *Contexts for learning to write: Studies in secondary school instruction.* Norwood, NJ: Ablex.

Ayllon & Azrin (1964). Reinforcement and instructions with mental patients. *Journal of Experimental Analysis of Behavior, 7*(4), 327–331. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/journals/299/

Bangert-Drowns, R.L., Hurley, M.M., & Wilkinson, B. (2004). The effects of school-based writing-to-learn interventions on academic achievement: A meta-analysis. *Review of Educational Research, 74*(1), 29–58. doi: 10.3102/00346543074001029

Bull, R. (1990). *Mathematics coursework: A student's guide to success*. London: Macmillan.

Burns, M. (2004). Writing in math. *Association for Supervision and Curriculum Development, 62*(2), 30–33.

Cai, J., Jakabcsin, M.S., & Lane, S. (1996). Assessing students' mathematical communication. *School Science and Mathematics, 96*(5), 238–246. doi: 10.1111/j.1949-8594.1996.tb10235.x

Candia, M. (1998). *Writing mathematically: The discourse of investigation.* Bristol, PA: Farmer Press, Taylor & Francis Inc.

Catania, C.A., Matthews, B.A., & Shimoff, E. (1982). Instructed versus shaped human verbal behavior: Interactions with nonverbal responding. *Journal of the Experimental Analysis of Behavior, 38,* 233–248. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/journals/299/

Catania, C.A., Shimoff, E., & Matthews, B.A. (1989). An experimental analysis of rule- governed behavior. In S.C. Hayes (Ed.), *Rule-Governed Behavior: Cognition, contingencies, & instructional control* (pp. 119–150). Reno, NV: Context Press.

Davies-Lackey, A. (2005). *Yoked peer contingencies and the acquisition of observational learning repertoires* (Doctoral dissertation). Retrieved from ProQuest Dissertation and Theses database. (UMI No. 3159730).

Dewey, J. (1910). *Educational essays.* London: Blackie & Son.

Emurian, H.H. (2004). A programmed instruction tutoring system for JAVA™: Consideration of learning performance and software self-efficacy. *Computers in Human Behavior, 20, 423–459.*

Emurian, H.H., Hu, X., Wang, J., & Durham, D. (2000). Learning JAVA: A programmed instruction approach using applets. *Computers in Human Behavior, 16*, 395–422.

Flesher, T. (2003). Writing to learn in mathematics. *Writing Across the Curriculum, 14,* 37–48. Retrieved from http://wac.colostate.edu/journal

Fukawa-Connelly, T. & Buck, S. (2010). Using portfolio assignments to assess students' mathematical thinking. *Mathematics Teacher, 103* (9), 649–654. Retrieved from www.nctm.org/eresources

Gammill, D.M. (2006). Learning the write way. *International Reading Association, 59* (8), 754–762. doi:10.1598/RT.59.8.3

Gautreaux, G.G. (2005). *The effects of monitoring training on the acquisition of an observational learning repertoire under peer tutoring conditions, generalization and collateral effects.* (Doctoral dissertation). Retrieved from ProQuest Dissertation and Theses Database. (UMI No. 3174795).

Gilbert, P. (1989). *Writing, schooling and deconstruction: From voice to text in the classroom.* London: Routledge.

Glenn, S.S. (1987). Rule as environmental events. *The Analysis of Verbal Behavior, 5,* 29–32.

Gonzales, P., Williams, T., Jocelyn, L., Roey, S., Kastberg, D., & Brenwald, S. (2009).

Highlights from TIMSS 2007: Mathematics and science achievement of U.S. fourth and eighth-grade students in an international context. National Center for Education Statistics. Retrieved from http://nces.ed.gov/pubs2009/2009001.pdf

Greenwood, C.R. & Delquadri, J.C. (1995). Classwide peer tutoring and the prevention of school failure. *Preventing School Failure, 39 (4),* 21–25.

Greer, R.D. (2002). *Designing teaching strategies: An applied behavior analysis systems approach.* New York: Academic Press.

Greer, R.D. (2008). The ontogenetic selection of verbal capabilities: Contributions of Skinner's verbal behavior theory to a more comprehensive understanding of language, *International Journal of Psychology and Psychological Therapy, 8 (3),* 363–386.

Greer, R.D. (2010). *CABAS® AIL general education classes: Standard procedures for supervisor and teacher forms.* Unpublished manuscript.

Greer, R.D. & Ross, D.E. (2008). *Verbal behavior analysis: Inducing and expanding new verbal capabilities in children with language delays.* Boston, MA: Allyn and Bacon.

Greer, R.D., Singer-Dudek, J., & Gautreaux, G. (2006). Observational learning. *International Journal of Psychology, 41 (6),* 486–499.

Greer, R.D. & Speckman, J. (2009). The integration of speaker and listener responses: A theory of verbal development. *The Psychological Record, 59,* 449–488.

Hartlep, N.D. & Gosz, J. (2009). The homework debate: How much homework is helpful for students to acquire mathematical procedural knowledge? *NERA Conference Proceedings 2009,* Paper 19. Retrieved from http://digitalcommons.uconn.edu/nera_2009/19

Hayes, S.C., & Hayes, L.J. (1989). The verbal action of the listener as a basis for rule-governance (153–190). In S.C. Hayes (Ed.), *Rule-governed behavior: Cognition, contingencies, and instructional control.* New York: Plenum.

Helou, Y.J., Lai, J. & Sterkin, V. (2007). The effects of writer immersion on teaching the function of writing with middle school students. *Journal of Early and Intensive Behavior Intervention, 4* (2), 483–389. Retrieved from http://www.baojournal.com/JEIBI/JEIBI-VOL-4/JEIBI-4-2.pdf

Hoff, E. & Shatz, M. (Eds.) (2009). *Blackwell handbook of language development*. Malden, MA: Wiley-Blackwell

Jodlowski, S.M. (2000). *The effects of a teacher editor, peer editing, and serving as a peer editor on elementary students' self-editing behavior.* (Doctoral dissertation). Retrieved from ProQuest Dissertation and Theses database. (UMI No. 9970212).

Johanning, D.I. (2000). An analysis of writing and postwriting group collaboration in middle school pre-algebra. *School Science and Mathematics, 100* (3), 151–160. doi:10.1111/j.1949-8594.2000.tb17250.x

Keller, F.S. (1968). "Goodbye, teacher…" *Journal of Applied Behavior Analysis, 1* (1), 79–89. doi:10.1901/jaba.1968.1–79

Keohane, D.D. & Greer, R.D. (2005). Teacher's use of verbally governed algorithm and student learning. *International Journal of Behavior Consultation and Therapy, 3* (1), 252–271. Retrieved on May 10, 2010, from www.baojournal.com/IJBCT/IJBCT-index.html

Kline, S.L. & Ishii, D.K. (2008). Procedural explanations in mathematics writing: A framework for understanding college students' effective communication practices. *Written Communications, 25* (4), 441–461. doi: 10.1177/0741088308322343

Langer, J.A. & Applebee, A.N. (1987). *How writing shapes thinking: A study of teaching and learning (NCTE Research Report No. 22).* Urbana, IL: National Council of Teachers of English.

Long, R.C. (1990). The writer's audience: Fact or fiction'. In G. Kirsch & D.N. Roen (Eds.), *A Sense of Audience in Written Communication* (pp. 73–84). Newbury Park, CA: Sage Publications.

Madho, V. (1997). *The effects of the responses of a reader on the writing effectiveness of children with developmental disorders.* (Doctoral dissertation). Retrieved from ProQuest Dissertation and Theses database. (UMI No. 9809740).

Marsico, M.J. (1998). *Textual stimulus control of independent math performance and generalization to reading.* (Doctoral dissertation). Retrieved from ProQuest Dissertation and Theses database. (UMI No. 9822227).

Matthews, B.A., Catania, A.C., & Schimoff, E. (1985). Effects of uninstructed verbal behavior on nonverbal responding: Contingency descriptions versus performance description. *Journal of the Experimental Analysis of Behavior, 43,* 155–164. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/journals/299/

Matthews, B.A., Shimoff, E., Catania, A.C., & Sagvolden, T. (1977). Uninstructed human responding: Sensitivity to ratio and interval contingencies. *Journal of the Experimental Analysis of Behavior, 27,* 453–467. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/journals/299/

Michael, J. (1982) Distinguishing between discriminative and motivational functions of stimuli. *Journal of the Experimental Analysis of Behavior, 37 (1),* 149–155.

Michael, J. (2000). Implications and refinements of the establishing operation concept. *Journal of Applied Behavior Analysis, 33 (4),* 401–410.

Michael, J. (2004). *Concepts and principles of behavior analysis: Revised Edition.* Kalamazoo, MI: Association for Behavior Analysis.

Michael, J, Palmer, D.C., & Sundberg, M.L. (2011). The multiple control of verbal behavior. *The Analysis of Verbal Behavior. 27,* 3–22.

National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics.* Reston, VA: Author.

New York State Education (2005). *Mathematics core curriculum.* Retrieved from http://www.emsc.nysed.gov/ciai/mst/math/standards/core.html

Pereira-Delgado, J.A., & Greer, R.D. (2009). The effects of peer monitoring training on the emergence of the capability to learn from observing instruction received by peers. *The Psychological Record, 59,* 407–434.

Reese, H.W. (1992). Problem solving by algorithms and heuristics. In S.C. Hayes & L.J. Hayes (Eds.), *Understanding Verbal Relations* (pp. 153–179). Reno, NV: Context Press.

Reese, H.W. (1989). Rules and rule-governance. In S.C. Hayes (Ed.), *Rule-Governed Behavior: Cognition, Contingencies and Instructional Control* (pp. 3–84). Reno, NV: Context Press.

Reilly-Lawson, T. & Greer, R.D. (2006). Teaching the function of writing to middle school students with academic delays. *Journal of Early and Intensive Behavior Intervention, 3 (1),* 151–169. Retrieved from http://www.baojournal.com/JEIBI/JEIBI-VOL-3/JEIBI-3-1.pdf

Reilly-Lawson, T. & Walsh, D. (2007). The effects of observational training on the acquisition of reinforcement for listening. *Journal of Early and Intensive Behavioral Interventions, 4 (2),* 430–452.

Rothstein, M.B. & Gautreaux, G.G. (2007). The effects of a peer-yoked contingency on observational learning and the collateral emergence of naming. *Journal of Early and Intensive Behavioral Interventions, 4(2),* 453–469.

Rothstein, A. & Rothstein, E. (2007). Writing and mathematics: An exponential combination. *Principal Leadership (High School Edition), 7*(5), 21–23. Retrieved from www.principals.org/knowledgecenter/publications.aspx

Shimoff, E., Catania, A.C., & Matthews, B.A. (1981). Uninstructed human responding: Sensitivity of low-rate performance to schedule contingencies. *Journal of the Experimental Analysis of Behavior, 36,* 207–220. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/journals/299/

Skinner, B.F. (1957). *Verbal behavior.* Acton, MA: Copley Publishing.

Staats, S. & Batteen, C. (2009). Context in interdisciplinary algebra writing assignment. *Journal of College Reading and Learning, 40*(1), 35–50.

Stolfi, L. (2005). *The induction of observational learning repertoires in preschool children with developmental disabilities as a function of peer-yoked contingencies* (Doctoral dissertation). Retrieved from ProQuest Dissertation and Theses database. (UMI No. 3174899).

U.S. Department of Education (2008). *The final report of the National Mathematics Advisory Panel.* Retrieved from http://www2.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf

Vargas, E.A. (1988). Event-governed and verbally-governed behavior. *The Analysis of Verbal Behavior, 6,* 11–22.

Vaughan, M.E. (1985). Repeated acquisition in the analysis of rule-governed behavior. *Journal of the Experimental Analysis of Behavior, 44,* 175–184. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/journals/299/

Vaughan, M.E. (1989). Rule-governed behavior in behavior analysis: A theoretical and experimental history. In S.C. Hayes (Ed.), *Rule-Governed Behavior: Cognition, contingencies,* & *instructional control* (pp. 97–118). Reno, NV: Context Press.

Verplanck, W.S. (1992). Verbal concept "mediators" as simple operants. *The Analysis of Verbal Behavior, 10,* 45–68. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/journals/609/

Visalli-Gold, D.A. (2005). *The effects of students' observation of teacher presented learn units on the writing of observing students.* (Doctoral dissertation). Retrieved from ProQuest Dissertation and Theses database. (UMI No. 3174915)

Walsh, D.M (2009). *The effects of the observational system of instruction on the emergence of Naming, advanced Naming under lecture conditions, and observational learning with middle school students diagnosed with behavior disorders*. (Doctoral dissertation). Retrieved from ProQuest Dissertation and Theses database. (UMI No. 3373572).

Zollman, A. (2009). Students use graphic organizers to improve mathematical problem-solving communications. *Middle School Journal, 41*(2), 4–12.

BEHAVIORAL DEVELOPMENT BULLETIN

VOLUME 19
NUMBER 1
MARCH 2014

Implementing intensive tact instruction to increase frequency of spontaneous mands and tacts in typically developing children

Annela Costa[1] and Martha Pelaez[1], Ph.D.

ABSTRACT

The present study explored the effects of a modified, intensive tact instruction intervention on the emission of spontaneous, or unprompted, mands and tacts during play in two typically developing, preschool siblings. Intensive tact instruction involved presenting each participant 100 opportunities per session to tact stimuli prior to engaging in play. Picture cards were used as the tacting stimuli, which varied across five categories and five sets. Participants were reinforced for correct tacting responses or were conversely corrected for inaccurate or omitted responses. When compared to baseline, both participants exhibited increase in spontaneous tacts following such instruction. Mands only increased slightly for one participant. This study adds to the research on the positive effect of using intensive tact instruction to help typically developing yet linguistically diverse children communicate.

KEYWORDS: non-English speakers, language, mands, tacts, intensive tact instruction

Overview of Verbal Behavior

Language delays can be a common occurrence in the preschool years (Ward, 1999). These delays can be linked to repercussions in both language and learning later in adulthood. Nevertheless, when young children present delays in verbal development, such as a limited tact repertoire, basic verbal operants can be established via interventions in order to facilitate more complex verbal abilities (Delgado & Oblak, 2007). A plethora of effective interventions have in turn been developed to target such delays (Turan, 2012). Many of these interventions have been applied to individuals with developmental delays, behavioral disorders, or specific language impairments (e.g., Pistolejvic & Greer, 2006). The present study sought to explore the effects of an intervention for increasing basic and fundamental verbal operants (i.e., mands and tacts) specifically with typically developing yet linguistically diverse children.

Similar to many behavioral repertoires, verbal behavior can be considered within a developmental context (Greer & Keohane, 2006). Individuals transition from being listeners and speakers to readers, writers, and ultimately verbal mediators (Greer & Keohane, 2006). Verbal development was defined by Greer and Speckman (2009) as the acquisition of capabilities that allows an individual to learn new relationships and multiple responses, to learn at a faster rate, and to learn in novel ways not possible before the acquisition of certain verbal capabilities. Skinner identified several fundamental verbal operants that facilitate such development: echoics, autoclitics, intraverbals, textual responses, mands, and tacts (as cited in Pistolejvic & Greer, 2006). In an unpublished manuscript preceding the publication of *Verbal Behavior* (1957), Skinner (1948) further postulated that these acquisitions arise in part from generalized secondary reinforcers, as when a child is smiled at for cooing or receives verbal praise for correctly naming objects or colors.

Through typical development, a child acquires increasingly complex behaviors. As a speaker, for example, a child progresses from uttering basic vocalizations and echoics to emitting mands and tacts, and finally engaging in conversational units, which involve a full exchange between a listener and a speaker. These increasingly complex repertoires are achieved through behavioral cusps. As defined by Rosales-Ruiz and Baer (1997), a cusp is a change in behavior that has implications for the individual beyond those of the change. These implications promote development and the acquisition of new cusps (Hixon, 2004). For example, imitation is a behavioral cusp that facilitates the learning of new behaviors. In turn, echoics, a type of verbal imitation, facilitates the acquisition of tacts. As stated by Commons (2014, May), tacting is a fundamental step towards human language development.

In particular, mands and tacts are two forms of somewhat complex verbal functions that are pivotal to early language development as they form the basis for more complex verbal responses like conversational units (as cited in Casarini, Cattivelli, & Cavallini, 2011). Tacts are verbal operants controlled by a nonverbal stimulus or antecedent, such as an event or object that is reinforced through

1 Florida International University

generalized or social reinforcers (Lamarre & Holland, 1985). For instance, if a child is shown a cookie as a nonverbal antecedent he or she may tact "cookie" without necessarily wanting the edible and may be reinforced with a parent's nod or verbal praise. Mands are verbal operants for which a response is reinforced by a consequence specific to the response (Lamarre & Holland, 1985). For example, if a child is hungry he or she may mand "cookie" which is in turn reinforced by access to the cookie. Skinner (1948) noted that mands are not elicited by an antecedent stimulus but rather by drives (e.g., child is hungry). Mands and tacts can be communicated via gestures, emotional displays, vocalizations, manual sign language, speech generating devices, or a picture exchange communication system (PECS) (Albert, Carbone, Murray, Hagerty & Kerwin, 2012).

Mand and tact training

A review of the literature indicates that training of verbal repertoires, in particular of mands and tacts, has been a widely researched area across participants, behaviors, and contexts. Greer and Keohane (2006) reported over 100 studies that assessed various aspects of verbal behavior. For example, tact and mand training has been effectively implemented with some children with Autism Spectrum Disorder who exhibit most palilalia (Karmali, Greer, Nuzzolo-Gomez, Ross, & Rivera-Valdes, 2005); with traumatically brain injured adults with aphasia (Sundberg, San Juan, Dawdy, & Argüelles, 1990); and with individuals with intellectual disabilities (Ribeiro, Elias, Goyos, & Miguel, 2010). Tact and mand training has also been shown to increase emission of untrained verbal operants. Because mands and tacts are behavioral cusps, once acquired, these verbal operants allow for rapid development of other verbal repertoires without direct training of these repertoires. Finn, Miguel, and Ahearn(2012), for instance, provided participants with autism spectrum disorder either tact or mand training; yet three of the four participants displayed transference of training to the untrained verbal operant. Similarly, Albert, Carbone, Murray, Hagerty, and Sweeney-Kerwin (2012) found that using mand training to increase unprompted or pure mands of missing items also increased unprompted, related tacts.

Intensive tact training

Similarly, increased emissions of spontaneous and unprompted mands and tacts, known as pure mands and tacts, have been achieved via intensive tact instruction. Such instruction has been explored with other verbal components like conversational units and intraverbals as well as with participants exhibiting language delays and emotional and behavioral disorders. As cited in Pistolejvic and Greer (2006), establishing a tacting repertoire is fundamental to developing other verbal operants, including more complex ones like naming concepts, conversational units, and reading. Specifically, in intensive tact instruction, a child is presented with 100 daily opportunities to tact stimuli (e.g., a card with a two dimensional picture) under the paradigm of a "learn unit" (Pistolejvic & Greer, 2006). Learn units explicitly outline student-teacher interactions and define the antecedent of a behavior, the desired response, and the consequence of such a response or lack thereof (Greer & McDonough, 1999). For example, in the context of verbal behavior, a learn unit exists when a teacher asks the child "Do you want a cookie?" (i.e., antecedent); the child responds with a mand (i.e., desired response); and the teacher reinforces the mand with access to the edible as a consequence. More specifically, in Pistolejvic and Greer (2006), attending participants were presented a stimulus picture and asked to emit a response or tact. A correct response or tact was reinforced via a generalized reinforcer such as verbal praise. If the response was incorrect or otherwise not emitted, the researcher provided a correction as a consequence of having the participant echo the correct response for which no reinforcement was provided. In their procedures, participants received instruction on five sets of stimuli, each consisting of four stimulus pictures per five categories (i.e., community helpers, transportation, animals, instruments, and food). Upon mastery of a set (i.e., 90 correct tacts out of 100 in two sessions or 100 correct tacts out of 100 in one session), participants were observed in non-instructional settings, such as the playground, hallway, and cafeteria, for pure mands and tacts. Pistolejvic and Greer (2006) demonstrated that such intense daily instruction increased pure, or spontaneous and unprompted, mands and tacts, results which were later replicated by Delgado and Oblak (2007).

Lydon, Healy, Leader, and Keohane (2009) also explored the effects of intensive tact instruction on the emission of pure tacts, pure mands, and conversational units. Lydon et al. (2009) demonstrated that although such instruction was less effective in increasing pure mands and conversational units, it was nonetheless effective in increasing pure tacts. Greer and Du (2010) further explored whether the increase in pure mands and tacts in non-instructional settings were due to intensive tact instruction or simply the increase in learn units delivered. As such, Greer and Du (2010) compared emission of pure tacts, mands, and intraverbals under generic instruction (e.g., calendar, letters, number) and under tact-targeted instruction, both conditions providing 100 additional stimuli presentations, or "learn units". Greer and Du (2010) supported past conclusions that intensive tact instruction was, in fact, functionally related to an increase in pure tacts and pure mands as well as an increase in intraverbals. Moreover, this effect was not simply due to the increase in stimuli presentation.

Schauffler and Greer (2006) further explored the use of intensive tact instruction to increase school appropriate tacts and thus appropriate conversational units emitted by adolescents with emotional and behavioral disorders. Prior to instruction, participants emitted few tacts and few conversational units that followed standard language usage and that were functionally appropriate for school. Through 100 daily tact presentations, they showed that intensive tact instruction could also lead to a significant increase in appropriate speech. The effectiveness of tact instruction found in Schauffler and Greer (2006) can be attributed to the fundamental role tacts play in the development of more complex verbal repertoires like conversational units.

Overall, these studies indicate that intensive tact instruction is an effective intervention functionally related to emission of spontaneous and unprompted, or pure, verbal operants, namely of mands and tacts, with participants with developmental and language delays. Yet, as Delgado and Oblak (2007) note, such intensive tact instruction requires further implementation with

Table 1. Sets of stimuli for participants A and B

Category	Set 1	Set 2	Set 3	Set 4	Set 5
Home	Chair Spoon Fridge Pillow	Clock Fork Cup Knife	Bookshelf Light switch Sink Bed	Door Stove Table Sofa	Key Plate Telephone Lamp
Leisure	Train Bicycle Blocks Skate	Radio Helmet Tricycle Headphones	Car Bubbles Airplane Paint	TV Ball Puzzle Wagon	Trampoline Swings Bowling Boat
Food	Chicken Chips Popsicle Toast	Grapes Apple Hamburger Cookies	Hotdog Pizza Ice cream Carrot	Jelly Juice French-fries Candy	Banana Soda Cereal Bread
Clothes	Cap Underwear Blouse Dress	Diaper Sweater Pants t-shirt	Belt Snow hat Watch Sandals	Boots Shorts Lifejacket Swimsuit	Socks Mittens Sneakers Jacket
Health	Arms Eyeglasses Hand Foot	Dentist Toothache Ear Back	Stomach Legs Nose Mouth	Doctor Bandage Headache Earache	Hair Head Stomach ache Eye

typically developing children. To the researcher's knowledge, the literature reviewed did not touch upon the acquisition of such tact instruction with unique populations such as children with limited English proficiency.

Current study

The present study specifically aimed to explore the expected increase of mands and tacts via a modified intensive tact instruction in a non-instructional context with typically developing, preschool children. More specifically, would intensive tact instruction prior to play in a non-instructional setting increase the frequency of spontaneous mands and tacts in typically developing children?

» METHODS

Design

The present study utilized a multiple probe design across participants. This design included a baseline phase and multiple probes following instruction on each set of stimuli. The purpose of using probes was to keep participants on a treatment phase rather than withdrawing treatment.

Participants

The participants were a sibling dyad consisting of a four-year, 10-month old male, Participant A, and a three-year, 8-month old female, Participant B. The participants lived in a Spanish-speaking, two parent household with the parents and paternal grandparents as their primary caregivers. Their primary spoken language was Spanish and they were not proficient in English. Although the participants were able to repeat phrases in English when prompted and with prior instruction, tact and mand repertoires were primarily emitted in Spanish.

Participant A was in a part-time voluntary prekindergarten program. Parents self-reported that he had adjusted well to school and had thus far mastered his colors, numbers, and letters. Several reinforcers, such as stickers, pencils, computer time, sweet edibles, and superhero caricatures, were identified as being potentially reinforcing. Participant B, on the other hand, was not enrolled in any school program. Potential reinforcers were also identified, including stickers, sour edibles, coloring or drawing, and princess caricatures. One-word speech, in Spanish, developed before 12 months of age for both participants. As such, both participants were considered typically developing and had not presented any developmental or language delays.

Setting

The observations and interventions were conducted in the participants' home environment. Initial observations of the participants' verbal behavior were conducted in the participants' 9 × 13 foot play room. The room consisted of a television set, couch, chairs, and children's toys, including male and female toys (e.g., superhero costumes, play kitchen, dolls). Interventions and ensuing observations were conducted in the same room using a rectangular children's table with two chairs.

Materials

Stimuli sets in the present study were modified from *Do2Learn*, a website that provides educational resources for children with disabilities. Specifically, two-inch, black and white picture cards were printed across five categories: home, leisure, food, clothes, and health. These picture cards were pasted on multicolored, 2.5 × 3 inch index cards to differentiate among categories (e.g., home pink; leisure green; food blue; clothes yellow; health purple). Moreover, because of their typical development and closeness in age, participants received the same types of stimuli sets (see Table 1). Clipboards and data sheets were used to record participants' tacts during instruction as well as spontaneous mands and tacts during observational sessions; a timer was also used during these observational sessions.

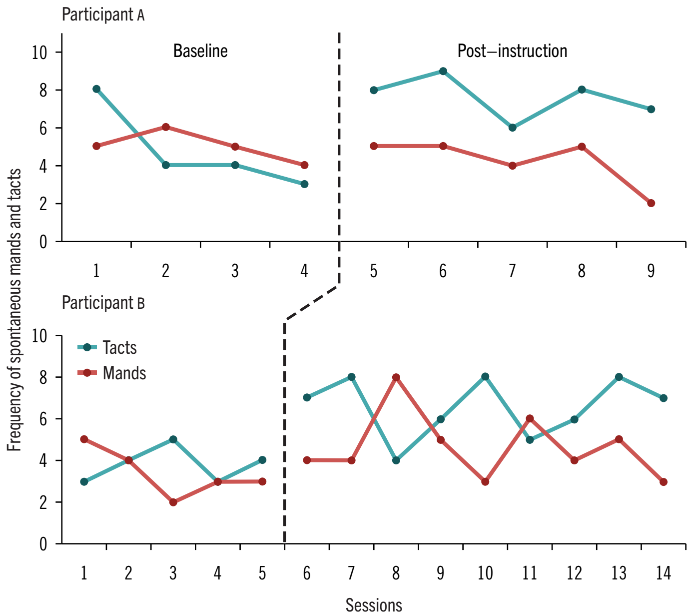

Figure 1. Spontaneous mands and tacts emitted pre and post-instruction

Dependent Variable

Frequency of spontaneous mands and tacts were identified as the target behavior to be observed. Spontaneous tacts were operationally defined as naming or tacting responses that occurred in the presence of physical stimuli (e.g., cookie) in the absence of a verbal stimulus (e.g., teacher asking "What is this?"). Spontaneous tacts emitted by participants included responses such as "puzzle," "pencil," and "mask" in the presence of these respective items. These tacts were emitted in the absence of prompts from the researcher. Likewise, spontaneous mands were operationally defined as demands that occurred without verbal prompts (e.g., do you want a cookie) and were reinforced by access to demands. Examples of spontaneous mands included demands such as "I want a piece of paper" or "crayons." Furthermore, although participants were observed to provide autoclitic phrases such as "I want…" or "This is…," mands and tacts were considered correct regardless of the emission of autoclitics as these operants were not previously trained.

Intervention

The intervention was implemented during instructional sessions prior to play. The length of these sessions varied upon how long the participants took to tact the stimuli. *Intensive tact instruction* involved the presentation of 100 picture card stimuli for each participant to tact. Participants received instruction across the five sets of categories in no particular order. Categories in a set were alternated until the participants had received 20 presentations of the four stimuli in each of the set's five categories, equivalent to 100 stimuli presentations per session. During instruction, the researcher presented the stimulus for the participants to tact, that is, name without prior prompting. If a correct response was emitted within three seconds of presentation, the researcher provided reinforcement in the form of nods and verbal praise. If an incorrect response was emitted or no response was emitted, the researcher corrected the participants by providing the correct response and asking participants to echo the response. The participants were not reinforced for correct responses during this correction procedure. Participants received instruction until mastery was achieved. Mastery level required at least 70 correct tacts out of 100 per two consecutive sessions or 80 correct tacts out of 100 tacts per session. This intervention was conducted in the participants' primary language (i.e., Spanish). They were not proficient in English.

Procedure

Baseline. Prior to implementing the abovementioned intervention, participants were observed for emission of spontaneous mands and tacts during play at home in 15-minute sessions. Participant A began intensive tact instruction following the fourth session as stability was reached. Stability was achieved when the frequency of spontaneous mands and tacts varied no more than two standard deviations from each respective mean. Participant B remained on baseline until Participant A achieved mastery on the first set of stimuli. Participant B then began intensive tact instruction after the fifth session.

Intensive tact instruction. At the onset of each instructional session, participants were shown a potential reinforcer and told that at the end of the activity they would have access to the reinforcer. These positive reinforcers were identified a priori during a functional assessment and served to reward participants for completing the instructional sessions. Echoic training then ensued before beginning the intensive tact instruction. The researcher presented each stimulus or picture card in a category in a particular set to the participant, named the stimulus, and asked the participant to echo. The researcher individually presented and named the stimuli in the home category for Set 1 and the participant echoed the words "chair," "spoon," "fridge," and "pillow" (see Table 1). This training was conducted at the onset of each new category of stimuli introduced in a set.

Subsequently, the researcher began intensive tact instruction with each individual participant. As mentioned above, the participant was presented with the picture cards to tact. If the

Table 2. Regression for main effects

	R	R^2	*β*	*t*	Significance
Constant	.64	.41	—	5.34	.000*
Participant A or B	—	—	.26	2.14	.039
Tact or mand	—	—	.42	3.53	.001*
Baseline vs post instruction	—	—	.46	3.80	.000*

Note. *$p < .01$. The value assigned to the independent variables were as follows: participant B = 1 and participant A = 2; mand = 1 and tact = 2; baseline = 1 and post = 2.

participant emitted the correct tacting response within three seconds of presentation, the researcher provided reinforcement in the form of nods and verbal praise. If an incorrect or no response was emitted, the participant was then corrected and not reinforced. Participants received instruction on a particular set until mastery was achieved (i.e., at least 70 correct tacts out of 100 for two consecutive sessions or 80 correct tacts out of 100 tacts for one session). If mastery was achieved in one session, the participant moved on to the following set in the next session; if mastery was not achieved by participants in a particular session, the participant continued receiving intensive tact instruction on the set on the following session. Upon receiving instruction, the participants were observed for emission of spontaneous mands and tacts during play for 15 minutes.

Data collection

The frequency of spontaneous mands and tacts were recorded at baseline and after each instructional session. These 15-minute sessions occurred during play at home with both participants present. The researcher also collected data on the participants' number of correct tacts emitted during tact instruction.

Interobserver agreement

Interobserver agreement was randomly calculated for approximately 30% of post-instruction observations by dividing the smaller number of responses by the larger number of responses and multiplying by 100. Mean agreements of 72% and 74% were found for Participant A for mands and tacts, respectively. The mean agreements of mands and tacts emitted by Participant B were 77% and 83%, respectively.

» RESULTS

A multiple regression analysis was conducted with frequency of mands and tacts serving as the variable to be predicted. Table 2 presents the results of the main effect and each of the independent variables. The results showed that the intervention made the largest difference (baseline = 1, post intervention = 2). The frequency of mands and tacts ($\beta = .46$) made the second largest difference, followed by type of verbal behavior (mands = 1, tacts = 2) ($\beta = .42$) and individual differences (participant B = 1 and participant A = 2) ($\beta = 0.26$) made a smaller but still large difference. The overall main effect of all three independent variable together had an $R = 64$. Thus, the model was able to account for approximately 41% of the variance of participants responses, $R^2 = .41$.

As shown in Figure 1, at baseline, Participant A emitted an average of 4.7 tacts (*SD* = 2.22) and 5.0 (*SD* = 0.82) mands across four, 15-minute sessions during play. Further analysis of post-instruction sessions indicated that Participant A emitted an average of 7.6 tacts (*SD* = 1.14) in five sessions while an average of 4.2 mands (*SD* = 1.30) were emitted during this period. Furthermore, as Figure 2 illustrates, Participant A achieved mastery (i.e., 70 correct tacts out of 100 in two consecutive sessions or 80 correct tacts out of 100 in one sessions) on each of the five sets upon one session of instruction in each set, emitting an average of 87.6 correct tacts out of 100.

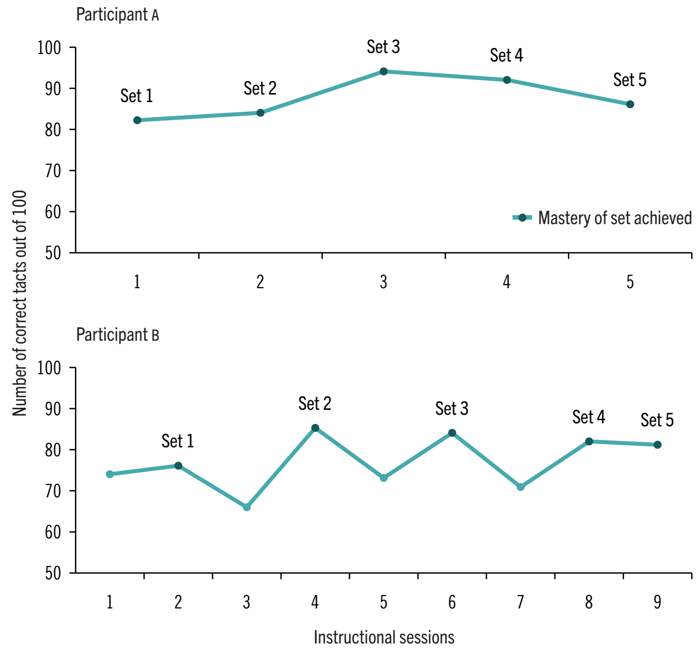

Figure 2. Number of correct tacts out of 100 emitted during instruction

Similarly, during baseline sessions, Participant B emitted an average of 3.8 tacts (*SD* = 0.84) and 3.4 mands (*SD* = 1.14). Although more variable, Figure 1 indicated an increase in tacts and a slight increase in mands after instruction. Across 9 sessions of instruction, Participant B emitted an average of 6.5 tacts (*SD* = 1.42) and 4.6 mands (*SD* = 1.58) during play following tact instruction. Participant B achieved mastery on each of the five sets after 9 sessions of instruction, as shown in Figure 2, and emitted an average of 76.8 correct tacts out of 100.

» DISCUSSION

The present study aimed to explore the effects of intensive tact instruction on the emission of spontaneous mands and tacts during play in typically developing children with limited English proficiency, an area that had not yet been addressed in the literature. Pre- and post-instruction results suggested that for both participants such instruction seemed to increase frequency of spontaneous tacts. Yet, as noted by Lydon et al. (2009), tact instruction did not necessarily lead to an increase in mands, particularly in Participant A who remained stable in the emission of spontaneous mands. Although Participant A emitted on average more tacts than Participant B, the latter emitted more spontaneous tacts during post-instruction when compared to baseline. Nevertheless, participants received unequal instructional sessions as Participant A reached mastery upon one session of instruction on each of the five sets and thus received less instruction. The differences noted between participants could also be potentially attributed to age differences as Participant B was 1 year and 2 months younger that the latter. It is also worth acknowledging that instruction (i.e., the 100 tacting presentations) was not dispersed throughout the day but rather conducted in its' entirety prior to play. Moreover, due to time constraints, instructional sessions varied in the time of day delivered and were not conducted consecutively. A downward trend for tacts and mands was also noted for participants during baseline and post instruction. This trend could be attributed to the presence of the researcher during observational sessions. This trend could also be a product of the reinforcement provided before and during instruction, which can lead to a decrease in the desired response during non-reinforced testing.

Moreover, the use of such tact instruction presents several implications. The present study served to expand the literature on the effects of intensive tact instruction in typically developing yet linguistically diverse children. This present study indicates that intensive tact instruction can be effectively implemented in participants' native language. Implementing tact instruction in individuals' primary languages could potentially benefit those who exhibit limited English proficiency and language delays. Similar to past studies (e.g., Delgado & Oblak, 2007; Pistoljevic & Greer, 2006), tact instruction was conducted in non-instructional settings, yet, it was implemented in the participants' home environment during play. This indicates that intensive tact instruction could be effective in increasing such verbal operants in more cooperative and interactive contexts (i.e., children playing together).

Further research should be conducted to explore the effects of intensive tact instruction on the emission of spontaneous mands and tacts in non-primary languages, which could potentially benefit English language learners. Likewise, tact instruction should be investigated with individuals with developmental or language delays who are also limited English speakers. The context in which mands and tacts are emitted could also be explored, namely the effects of tact instruction in cooperative, interactive situations. It would also be worth exploring the differences noted among participants, such as the effects of receiving more instructional sessions on the emission of mands and tacts. In sum, despite a few limitations, the present study explored intensive tact instruction with a unique population and towards a more cooperative context, leading to other potential avenues in research and further supporting the previously established effectiveness of intensive tact instruction. ■

REFERENCES

Albert, K.M., Carbone, V.J., Murray, D.D., Hagerty, M., & Sweeney-Kerwin, E.J. (2012). Increasing the mand repertoire of children with autism through the use of an interrupted chain procedure. *Behavior Analysis in Practice*, *5*(2), 65–76.

Casarini, F., Cattivelli, R., & Cavallini, F. (2011). Comprehensive application of behavior analysis to schooling in Italy. *European Journal of Behavior Analysis*, *12*(1), 205–216.

Commons, M.L. (2014, May). *What is necessary for human language?* Paper session to be presented at the annual meeting of Jean Piaget Society, San Francisco, CA.

Delgado, J.A.P., & Oblak, M. (2007). The effects of daily intensive tact instruction on the emission of pure mands and tacts in non-instructional settings by three preschool children with developmental delays. *Journal of Early & Intensive Behavior Intervention*, *4*(2), 392–411.

Finn, H.E., Miguel, C.F., & Ahearn, W.H. (2012). The emergence of untrained mands and tacts in children with autism. *Journal of Applied Behavior Analysis, 45*(2), 265–280. doi:10.1901/jaba.2012.45-265

Greer, R.D., & Du, L. (2010). Generic instruction versus intensive tact instruction and the emission of spontaneous speech. *The Journal of Speech-Language Pathology and Applied Behavior Analysis*, *5*(1), 1–19.

Greer, R. D., & Keohane, D.D. (2006). The evolution of verbal behavior in children. *The Journal of Speech-Language Pathology and Applied Behavior Analysis, 1*(2), 111–140.

Greer, R.D., & McDonough, S.H. (1999). Is the learn unit a fundamental measure of pedagogy?. *The Behavior Analyst*, *22*(1), 5–16.

Greer, R.D., & Speckman, J.M. (2009). The integration of speaker and listener responses: A theory of verbal development. *Psychological Record*, *59*(3). 449–488.

Hixon, M.D. (2004). Behavioral cusps, basic behavioral repertoires, and cumulative-hierarchical learning. *The Psychological Record*, *54*(3), 387–403.

Karmali, I., Greer, R.D., Nuzzolo-Gomez, R., Ross, D.E., & Rivera-Valdes, C. (2005). Reducing palilalia by presenting tact corrections to young children with autism. *Analysis of Verbal Behavior, 21*, 145–153.

Lamarre, J., & Holland J.G. (1985). The functional independence of mands and tacts. *Journal of the Experimental Analysis of Behavior*, *43*, 5–19.

Lydon, H., Healy, O., Leader, G., & Keohane, D.D. (2009). The effects of intensive tact instruction on three verbal operants in non-instructional settings for two children with autism. *The Journal of Speech-Language Pathology and Applied Behavior Analysis, 3*(2), 173–184.

Pistoljevic, N., & Greer, R.D. (2006). The effects of daily Intensive tact instruction on preschool students' emission of pure mands and tacts in non-instructional setting. *Journal of Early and Intensive Behavior Intervention*, *3*(1), 103–120.

Rosales-Ruiz, J., & Baer, D.M. (1997). Behavioral cusps: A developmental and pragmatic concept for behavior analysis. *Journal of Applied Behavior Analysis*, *30*(3), 533–544.

Ribeiro, D.M., Elias, N.C., Goyos, C., & Miguel, C.F. (2010). The effects of listener training on the emergence of tact and mand signs by individuals with intellectual disabilities. *Analysis of Verbal Behavior, 26*, 65–72.

Schauffler, G., & Greer, R.D. (2006). The effects of intensive tact instruction on audience-accurate tacts and conversational units. *Journal of Early and Intensive Behavior Intervention*, *3*(1), 121–134.

Skinner, B.F. (1948). *Verbal behavior*. Unpublished manuscript, Williams James Lectures, Harvard University, Retrieved from http://www.bfskinner.org/bfskinner/PDFBooks_files/William%20James%20Lectures.pdf

Sundberg, M.L., San Juan, B., Dawdy, M., & Argüelles, M. (1990). The acquisition of tacts, mands, and intraverbals by individuals with traumatic brain injury. *Analysis of Verbal Behavior, 8*, 83–99.

Turan, Y. (2012). Acceptability ratings of language interventions and reasoning as described by early childhood special education teachers. *Early Child Development and Care*, *182*(10), 1371–1382.

Ward, S. (1999). An investigation into the effectiveness of an early intervention method for delayed language development in young children. *International Journal of Language & Communication Disorders*, *34*(3), 243–264.

BEHAVIORAL DEVELOPMENT BULLETIN

VOLUME 19
NUMBER 1
MARCH 2014

Mothers' and fathers' knowledge of behavioral principles as applied to children: data from a normative sample

Jennifer D. Tiano[1] and Cheryl B. McNeil[1]

ABSTRACT

Research on knowledge of behavioral principles has been conducted with several different groups of individuals (e.g., mothers, undergraduates, direct-care staff, therapists). However, no studies were found comparing maternal and paternal knowledge of behavioral principles. The current study compared knowledge of behavioral principles, as measured by the Knowledge of Behavioral Principles as Applied to Children (KBPAC), for a community sample of 40 mother-father pairs of a young male child. Results indicated that mothers and fathers exhibited similar levels of knowledge. The KBPAC also was correlated with social position, parent report of child behavior problems, and parental education. Implications of these findings are discussed.

KEYWORDS: maternal, paternal, knowledge, behavioral principles

Research has stressed the importance of fathers in child development and suggested that fathers may provide distinctive influences to child behaviors, as compared to mothers (Bagner & Eyberg, 2010; Lamb, 1997; Palkovitz, 1996; Parke & Brott, 1999; Popenoe, 1999). However, fathers continue to be understudied in child development literature. Interestingly, when children's maladaptive behaviors warrant intervention, few fathers actively participate in behavioral parent training (BPT) outcome studies (Budd & O'Brien, 1982; Coplin & Houts, 1991; Tiano & McNeil, 2005). From 1970 to 1981, only 3 studies (13%) utilizing BPT included fathers (Budd & O'Brien, 1982). This rate improved to 35 (37%) BPT studies from 1981 to 1988 (Coplin & Houts, 1991), but decreased to 10 studies (no percentage was specified) from 1989 to 2003 (Tiano & McNeil, 2005).

BPT programs are efficacious treatments for child externalizing behaviors and are based on behavioral principles (e.g., positive reinforcement, punishment, contingencies; Kazdin, 1987; Serketich & Dumas, 1996). Thus, at completion of treatment, parents receiving BPT should exhibit some understanding of behavioral principles. In a study by McLoughlin (1985), nineteen mothers read a manual of behavior management strategies (not behavioral principles) and implemented those strategies with their child's negative behaviors. Findings indicated that mothers' knowledge of behavioral principles increased as a result of utilizing behaviorally-oriented approaches. Similarly, after completion of a five-hour child management training, parents' Knowledge of Behavioral Principles as Applied to Children (KBPAC) scores increased from 48% to 85% (O'Dell, Tarler-Benlolo, & Flynn, 1979). In comparing group parent training and individual family therapy, Pevsner (1982) found that after treatment families receiving group therapy exhibited more knowledge of behavioral principles than those receiving individual therapy families. However, O'Dell et al. (1979) and Pevsner (1982) failed to indicate which parent completed the KBPAC (if only one parent completed the measure) or report scores for both parents. Thus, no research was found that reported maternal and paternal KBPAC scores separately or that evaluated behavioral principles knowledge of mothers and fathers who received BPT.

Recent studies evaluating behavioral knowledge largely have been conducted with non-parental samples and failed to report scores separately for men and women. In particular, no studies were found comparing mothers and fathers on knowledge of behavioral principles in regard to its application to child behaviors. Thus, whether mothers and fathers demonstrate similar levels of knowledge of behavioral principles either prior to or following training in these strategies is unknown. Because BPT is effective in decreasing problem behaviors in children, parents of children with few or minor behavior problems may benefit from the knowledge and skills targeted in BPT (e.g., consistency, understanding of behavioral theories, effective discipline strategies). The current study examined maternal and paternal knowledge of behavioral principles in a community sample.

1 Department of Psychology, West Virginia University. The authors would like to acknowledge T. Lindsey Burrell and Rebecca Grate for their hard work and dedication on this project. The successful completion of this project would not have been possible without their assistance. Correspondence concerning this article should be addressed to Jennifer Tiano, One John Marshall Drive, Department of Psychology/Harris Hall, Marshall University, Huntington, WV 25755. Email: tiano@marshall.edu

Table 1. Demographic characteristics and KBPAC scores of entire sample

Demographic variable	Mean	SD
Parent age[a]	34.24	6.40
Child age[b]	4.65	1.65
Number of children in the home[a]	2.28	.81
Involvement with child[a]	24.55	15.65
Number of hours per week child is in care of others[a]	2.03	1.31
Hollingshead Index[a]	2.56 (upper middle class)	1.09
ECBI intensity scale raw score[c]	103.38	20.19
ECBI problem scale raw score[c]	6.52	5.42
KBPAC score[a]	43.43	13.58
	n	%
Parent race		
Caucasian	79	98.75%
African American	1	1.25%
Child race		
Caucasian	39	97.50%
African American	1	2.50%
Marital status		
Married	76	95.00%
Not married	4	5.00%
Biological parent	76	95.00%

Note. ECBI = Eyberg Child Behavior Inventory (Eyberg & Pincus, 1999). *a* represents $n = 80$. *b* represents $n = 40$. *c* represents $n = 79$.

» METHOD

Participants

Participants included 80 parents (40 mother-father pairs) of a two-to seven-year-old male child. Participants must have been the primary caregivers and lived in the house with the child for the last two years.

Measures

Demographic form. Each mother and father completed a demographic form presenting descriptive information on the parents, target child, and family. Amount of parental involvement from each parent was calculated by the sum of the hours spent engaging in caregiving and play activities on a typical week day and the hours spent engaging in caregiving and play activities on a typical weekend day. See table 1 for demographic information of the entire sample and table 2 for demographic information of each parent.

Hollingshead. The Hollingshead Index (Hollingshead, 1957) is a two-factor index of a social position score derived from an individual's education level and income. A social class score also can be derived from the social position score. The higher the social class or Hollingshead score, the lower the socioeconomic status (i.e., Class I = upper class; Class III = middle class; Class V = lower class).

Eyberg Child Behavior Inventory (ECBI). Each mother and father participant completed an ECBI on the target child. Information obtained from this measure was used as demographic data to describe the behavior of the child sample. The ECBI (Eyberg & Pincus, 1999) is a 36-item questionnaire examining child disruptive behavior as reported by the parent(s). The Intensity scale measures the frequency of child externalizing behaviors on a scale of 1 (Never) to 7 (Always). The Problem scale measures whether the parent perceives each of the listed child behaviors as a problem for that parent. Clinical cutoff scores of 132 (*t*-score = 60; Intensity scale) and 15 (*t*-score = 60; Problem scale) have been suggested by Colvin, Eyberg, and Adams (1999). Good psychometric data have been reported for the ECBI. For example, both scales demonstrated high internal consistency (Intensity = .95, Problem = .92). In addition, both scales have demonstrated discriminative validity; construct validity, and inter-parent agreement (Colvin et al.; Eyberg & Pincus). Finally, the test-retest reliability of the Intensity scale was reported for 12 weeks ($r = .80$) and 10 months ($r = .75$; Funderburk, Eyberg, Rich, & Behar, 2003). See table 1 for ECBI scores of entire sample and table 2 for each parent's ECBI score.

Knowledge of Behavioral Principles as Applied to Children (KBPAC). The original KBPAC (O'Dell, Tarler-Benlolo, & Flynn, 1979) is a 50-item multiple choice questionnaire that evaluates familiarity with behaviorally-oriented strategies as applied to children. The authors were careful to use general language and avoid the use of behavioral vocabulary in this measure. The KBPAC presents scenarios of common child behaviors to which the respondent is to choose the best technique to address the child's actions. The techniques used in this measure include reinforcement, punishment, schedules, shaping, differential attention, extinction, and monitoring behavior. Ten- and 25-item versions of this measure were developed (Furtkamp, Giffort, & Schiers, 1982) to decrease administration time. The current study used the 25-item KBPAC. An example item from this measure is: "Which of the following is the most effective form of punishment in the long run for reducing a child's undesirable behavior?". This shortened version of the KBPAC has demonstrated psychometric data similar to the 50-item KBPAC. In addition, a range of internal consistencies has been reported for this version (Cronbach's $\alpha = .42–.84$; Sturmey, Newton, Milne, & Burdett, 1987). It is important to note that the KBPAC has not been validated with mothers or fathers. Refer to table 1 for KBPAC scores of the sample and table 2 for scores separated by gender.

Table 2. Demographic characteristics and KBPAC scores by gender

	Mother		Father		
	Mean	(SD)	Mean	(SD)	*t*
Demographic variable					
Age	32.43	(5.87)[a]	36.05	(1.02)[a]	−5.858***
Involvement with child	16.89	(5.93)[a]	12.35	(6.12)[a]	−3.688**
ECBI intensity scale raw score	104.85	(21.48)[a]	101.87	(18.94)[b]	.581
ECBI problem scale raw score	5.95	(5.89)[a]	7.10	(4.90)[b]	−1.112
KBPAC percentage	44.86	(13.00)[a]	42.00	(14.15)[a]	1.158

Note. *a* represents $n = 40$. *b* represents $n = 39$. ECBI = Eyberg Child Behavior Inventory (Eyberg & Pincus, 1999). ** $p < .01$. *** $p < .001$.

Table 3. Intercorrelations between demographic variables and knowledge of behavioral principles

	1	2	3	4	5	6	7	8
1. Parent gender	—	-.285*	.356**	.127	.000	.074	-.107	.106
2. Parent age		—	-.220	-.277*	.267*	-.112	.018	.381**
3. Involvement			—	.182	-.366**	.155	.133	.002
4. Hollingshead Index				—	.012	.215	.171	-.262*
5. Child age					—	-.246*	-.047	.325**
6. ECBI intensity scale*						—	.548**	-.313**
7. ECBI problem scale*							—	-.126
8. KBPAC								—

Note. $n = 80$, except * represents $n = 79$. ECBI = Eyberg Child Behavior Inventory (Eyberg & Pincus, 1999). KBPAC = Knowledge of Behavioral Principles as Applied To Children (Furtkamp, Giffort, & Schiers, 1982). *$p < .05$. **$p < .01$.

Procedure

Data for this project were collected in the participants' homes and as part of a larger study. Each caregiver completed paper-and-pencil measures, as well as a videotaped 15-minute interaction with their son. All information was obtained in the presence of the investigator.

» RESULTS

A paired-samples t test was conducted to evaluate whether mothers and fathers differed in their knowledge of behavioral principles. Average scores on the KBPAC were 44.86 ($SD = 13$) for mothers and 42 ($SD = 14.15$) for fathers. Results indicated that mothers and fathers exhibited similar knowledge of behavioral principles, $t(39) = 1.158$, $p = .254$ (see table 2).

Negative correlations were found between knowledge of behavioral principles, Hollingshead Index (social position), $r(79) = -.26$, $p < .05$, and child behavior problems as rated on the ECBI Intensity scale, $r(79) = -.31$, $p < .01$ (see table 3). These correlations suggest that higher knowledge of behavioral principles is associated with higher social class (i.e., lower social position score on Hollingshead) and lower child behavior problems. An additional significant correlation was found between parental education level and knowledge of behavioral principles, $r(79) = .444$, $p < .0001$, suggesting that the higher the education level of the parent, the higher the knowledge of behavioral principles. Interestingly, KBPAC scores did not correlate with level of involvement with the child, $r(79) = -.085$, $p > .05$, but did significantly correlate with the number of years as a parent, $r(79) = .323$, $p < .01$ suggesting that years of parenting experience influences knowledge of behavioral principles as opposed to how involved the parent is with the child.

» DISCUSSION

Mothers and fathers did not differ on their knowledge of behavioral principles as measured by the KBPAC. This finding may be attributed to similar social position scores for mothers and fathers. Education and occupation are used in calculating the Hollingshead social position index. Similar social position scores suggest similar education levels and occupations for parents. In this study, both the Hollingshead Index and education level were positively correlated with the KBPAC. Similar to the findings of Rasnake, Martin, Tarnowsk, and Mullick (1993), the correlation in the current study between education and KBPAC indicates that more educated parents exhibited greater knowledge of behavioral principles than less educated parents. However, it is important to note that the average percentage for parents on the KBPAC was 43% out of 100%. This score is similar to previous research conducted with parents and the KBPAC. Parents in a study by O'Dell, Tarler-Benlolo, and Flynn (1979) obtained an average of 48% on the KBPAC prior to attending child behavior management training.

The mean KBPAC percentage in this study is similar to scores reported for other populations as well. Specifically, various samples of individuals working with populations with developmental disabilities included direct care staff scoring an average of 51% (Furtkamp, Giffort, & Schiers, 1982); professionals including nurses, occupational therapists, psychiatrists, and physiotherapists obtaining 49% (Sturmey, Newton, Milne, & Burdett, 1987); and school staff achieving a mean of 52% (Sturmey et al., 1987). However, community mental health agency therapists' mean KBPAC score of 64% is somewhat higher than the 43% obtained by parents in this study (Herschell, 2004). The majority of therapists (almost 90%) in Herschell's study (2004), however, had masters-level degrees, while parents in the present study reported, on average, completing "some college." These discrepancies in education and scores on the KBPAC between the present study and Herschell (2004) may support the idea that education, particularly education in mental health, increases knowledge of behavioral principles.

Parent scores on the KBPAC were significantly correlated with several additional variables. Interestingly, the older the parent and the child, the more knowledge of behavioral principles the parents exhibited. This finding may be due to parenting experience, especially because higher KBPAC scores in this study were associated with more years as a parent. The older the parent and the child, the more years the parents would have with the child. Thus, parents would have increased experience with parenting practices and more time to try a variety of behavior management strategies as the years pass. This experience with behavior management may lead to an increase in parental knowledge of behavioral principles.

Interestingly, although fathers were less involved with their children than mothers, father involvement did not correlate with KBPAC scores. As previously discussed, years of parenting experience impacts knowledge of behavioral principles. Perhaps this variable is more predictive of a parent's understanding of behavior modification than how much time the parent spends with the child.

Results also indicated that knowledge of behavioral principles is associated with parent report of child behavior problems. More specifically, parents with greater knowledge of behavioral principles reported less externalizing behaviors in their children. This correlation between knowledge and behavior problems also may be influenced by parental experience with managing behavior. It would be expected that as parents gain more experience with implementing discipline techniques and knowledge of behavioral principles, ability to handle child externalizing behaviors would improve, thus decreasing the frequency of behavior problems.

This study found that mothers and fathers of a young male child from a normative sample exhibited similar levels of knowledge of behavioral principles. In addition, knowledge of behavioral principles was correlated with several demographic and parental variables. These findings suggest that at-risk families (i.e., families with low socioeconomic status and parental education and numerous child behavior problems) may have more difficulty with BPT programs and implementing effective discipline techniques than families with few disadvantages. Results of the current study suggest that training parents in these behavioral principles may aid in enhancing the use of strategies to manage child behavior. Instead of simply teaching behavioral parent strategies, clinicians could teach parents the principles behind these techniques to increase understanding of the reasons why these programs are effective, and help program for generalizing parental use of these skills to other situations and behaviors.

Limitations

There are limitations of the study with generalizability of results. With the KBPAC, results of knowledge of behavioral principles with fathers were not found in the literature. This prevents comparison of paternal KBPAC scores in this study with KBPAC scores of other fathers. In addition, few studies have been conducted utilizing the KBPAC with parents. To provide normative data on parental knowledge of behavioral principles, additional studies must be conducted with parents and the KBPAC. The current study also did not evaluate experience with parenting or length of time as a parent, which may impact knowledge of behavioral principles.

Generalizability of results also may be hindered by the demographic characteristics of the present study. The Hollingshead head score of this sample was impacted by the high education level (finishing some college) and occupations of the participants. As a result, the average income for this sample was $66,000. Results obtained from the current sample may not apply to families in higher or lower social positions. Additionally, the overwhelming majority of the sample was Caucasian, limiting the applicability of these findings to various cultures. Only parents of male children were examined in this study to control for child gender effects. Thus, parents with female children may produce different data than parents of male children. Because a community sample of children with few to minor behavior problems as used, data from parents of children with clinical levels of behavior problems may differ from the current findings. Finally, this sample included parents willing to volunteer which may be an indication of level of parental involvement. Thus, this sample may not be representative of most families, or particularly, families referred for BPT.

Future directions

More recent research on the KBPAC has been conducted with populations other than parents, highlighting the need for additional studies examining parental knowledge of behavioral principles. In addition, no studies were found that separately reported paternal and maternal KBPAC scores. Similarly, Tiano and McNeil (2005) found that few studies of parents in behavioral parent training programs collected, reported, or analyzed paternal data independently from maternal data. Thus, future research should obtain, report, and compare maternal and paternal KBPAC scores to provide normative data of behavioral knowledge for mothers and fathers to further determine if knowledge of behavioral principles is correlated with or predictive of completion of BPT programs. ■

REFERENCES

Bagner, D.M., & Eyberg, S.M. (2010). Father involvement in parent training: When does it matter? *Journal of Clinical Child and Adolescent Psychology, 32(4)*, 599–605.

Budd, K.S., & O'Brien, T.P. (1982). Father involvement in behavioral parent training: An area in need of research. *The Behavior Therapist, 5*, 85–89.

Colvin, A., Eyberg, S.M., & Adams, C.D. (1999). Restandardization of the Eyberg Child Behavior Inventory. Retrieved February 4, 2005, from http://www.pcit.org

Coplin, J.W., & Houts, A.C. (1991). Father involvement in parent training for oppositional child behavior: Progress or stagnation? *Child and Family Behavior Therapy, 13*, 29–51.

Eisenstadt, T.H., Eyberg, S.M., McNeil, C.B., Newcomb, K., & Funderburk, B. (1993). Parent-child interaction therapy with behavior problem children: Relative effectiveness of two stages and overall treatment outcome. *Journal of Clinical Child Psychology, 22*, 42–51.

Eyberg, S.M., & Pincus, D. (1999). *Eyberg Child Behavior Inventory and Sutter-Eyberg Student Behavior Inventory: Professional Manual*. Odessa, FL: Psychological Assessment Resources.

Funderburk, B.W., Eyberg, S.M., Rich, B.A., & Behar, L. (2003). Further psychometric evaluation of the Eyberg and Behar rating scales of parents and teachers of preschoolers. *Early Education and Development, 14*, 67–81.

Furtkamp, E., Giffort, D., & Schiers, W. (1982). In-class evaluation of behavior modification knowledge: Parallel tests for use in applied settings. *Journal of Behavior Therapy & Experimental Psychiatry, 13*, 131–134.

Herschell, A.D (2004). *Evaluation of Techniques for Disseminating Parent-Child Interaction Therapy*. (Unpublished doctoral dissertation). West Virginia University, Morgantown, WV.

Hollingshead, A.B. (1957). *Two factor index of social position*. New Haven, CT: Yale University Press.

Kazdin, A.E. (1987). Treatment of antisocial behavior in children: Current status and future directions. *Psychological Bulletin, 102*, 187–203.

Lamb, M.E. (1997). Fathers and child development: An introductory overview. In M.E. Lamb (Ed.), *The role of fathers in child development* (3rd ed., pp. 1–18). New York: Wiley.

McLoughlin, C.S. (1985). Utility and efficacy of knowledge of behavioral principles as applied to children. *Psychological Reports, 56*, 463–467.

Nixon, R.D.V., Sweeney, L., Erickson, D.B., & Touyz, S.W. (2003). Parent-child interaction therapy: A comparison of standard and abbreviated treatments for oppositional defiant preschoolers. *Journal of Consulting and Clinical Psychology, 71*, 251–260.

O'Dell, S.L., Tarler-Benlolo, L., & Flynn, J.M. (1979). An instrument to measure Knowledge of Behavioral Principles As Applied to Children. *Journal of Behavior Therapy and Experimental Psychiatry*, 10, 29–34.

Palkovitz, R. (1996). Parenting as a generator of adult development: Conceptual issues and implications. *Journal of Social and Personal Relationships, 13*, 571–592.

Parke, R.D., & Brott, A.A. (1999). *Throwaway dads: The myths and barriers that keep men from being the fathers they want to be.* Boston: Houghton Mifflin Company.

Pevsner, R. (1982). Group parent training versus individual family therapy: An outcome study. *Journal of Behavior Therapy and Experimental Psychiatry, 13*, 119–122.

Popenoe, D. (1999). *Life without father: Compelling new evidence that fatherhood and marriage are indispensable for the good of children and society.* Cambridge, MA: Harvard University Press.

Rasnake, L.K., Martin, J., Tarnowski, K.J., & Mullick, J.A. (1993). Acceptability of behavioral treatments: Influence of knowledge of behavioral principles. *Mental Retardation, 31*, 247–251.

Serketich, W.J., & Dumas, J.E. (1996). The effectiveness of behavioral training programs to modify antisocial behavior in children: A meta-analysis. *Behavior Therapy, 27*, 171–186.

Sturmey, P., Newton, T., Milne, D., & Burdett, C. (1987). Parallel forms of the Knowledge of Behavioral Principles As Applied to Children Questionnaire: An independent, multi-centered, British replication. *Journal of Behavior Therapy and Experimental Psychiatry, 18*, 223–227.

Tiano, J.D., & McNeil, C.B. (2005). The inclusion of fathers in behavioral parent training: A critical evaluation. *Child & Family Behavior Therapy, 27*, 1–28.

Webster-Stratton, C. (1992). Individually administered videotape parent training: "Who benefits?" *Cognitive Therapy and Research, 16*, 31–35.

Webster-Stratton, C. (2000). Oppositional-defiant and conduct-disordered children. In M. Hersen & R.T. Ammerman (Eds.), *Advanced Abnormal Psychology* (2nd ed., pp.387–412). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

BEHAVIORAL DEVELOPMENT BULLETIN

VOLUME 19
NUMBER 1
MARCH 2014

Using private blog sites to collect interobserver agreement and treatment integrity data

Leah Gongola[1], Lyle E. Barton[2], Robert J. Gongola[3], Rocio Rosales[4], and Andrea Speece[5]

ABSTRACT

Single subject research places an emphasis on extended data collection for interobserver agreement and treatment integrity; however, distributed research teams make this effort difficult. If researchers live too far apart, the opportunity to collectively take data on interobserver agreement and treatment integrity poses a challenge. In this study, private blog sites were utilized to minimize travel distance and distributed research team variables during data collection practices. The use of private blog sites as a technological modality allowed video to be feasibly reviewed throughout the study (i.e., researchers viewed a video from home as opposed to, driving lengthy distances) while offering a superior option in contrast to traditional in vivo practices.

KEYWORDS: interobserver agreement, treatment integrity, behavioral interventions, data collection, research teams, technology

Interobserver agreement (IOA) and treatment integrity are essential components of single subject research. Interobserver agreement refers to the extent that two independent observers are consistent in their reporting of behavioral measurements (Cooper, Heron, & Heward, 2007); while treatment integrity is defined as the degree to which an intervention is implemented as planned (Armstrong, Ehrhardt, Cool, & Poling, 1997) and is essentially a reliability measure of the independent variable (Lane, Bocian, MacMillan, & Gresham, 2004). Behavioral research is vulnerable to violations of treatment integrity (Salend, 1984) with low integrity levels indicating that the treatment being implemented is different or inconsistent from the original intention (Gresham, 2005). Low integrity levels have been noted to decrease intervention effects (Fiske, 2008), thus, justifying the importance of evaluating treatment integrity in educational and residential treatment settings, where many behavior analysts are employed. Further, Vollmer and colleagues (2008) have articulated that failure to reliably collect IOA and treatment integrity measures can be a hazardous practice considering that critical decisions are made for clients based off of reported data. Accuracy in IOA and treatment integrity data is imperative in effort to maximize the decision making process during behavioral treatment (Vollmer et al., 2008).

While single subject research places an emphasis on extended data collection for IOA (i.e., with suggestions of collecting IOA for a range of 25–33% of all sessions) and treatment integrity (i.e., with suggestions indicating these measurements should occur at least as often as those devoted to IOA; Gresham, MacMillan, Beebe-Frankenberger, & Bocian, 2000; Kennedy, 2005; McIntyre, Gresham, DiGennaro, & Reed, 2007); numerous variables may hinder efforts to collect such data in *practice*. For instance, distributed research teams (i.e., researchers separated by geography) may not always have the flexibility, time, or resources to be present throughout the data collection process. If researchers live too far apart and have travel distance as an impending variable, the opportunity to collectively take data on IOA and treatment integrity is challenging. In addition, research teams may struggle with scheduling conflicts and having staff available on-site for in vivo data collection.

When considering the data collection process for researchers, reactivity issues (i.e., the practitioner being observed is aware of the observer's presence; Craig, 2010; Kazdin, 2001) can potentially inflate the traditional levels of practitioner integrity (Fiske, 2008). Direct observation is one of the most frequently reported methods of treatment integrity measurement; however, direct observation is time consuming (Gresham, 1989) and considering the concern with reactivity, can display an unrepresentative depiction of practitioner behavior. By contrast, video cameras can be a continuous presence in the classroom, reducing reactivity for both students and teachers. Additionally, every data collection session can be videotaped without the teacher knowing which sessions will be used to assess IOA and treatment integrity. Thus, inconspicuous observations via video records and private blog sites may serve to reduce reactivity while promoting accuracy in the measurement of treatment integrity.

1 Youngstown State University, 2 Kent State University, 3 Mayfield City Schools, 4 University of Massachusetts Lowell, 5 Proactive Behavior Services, LLC.
Address Editorial Correspondence to: Leah Gongola, Youngstown State University, Beeghly College of Education, Department of Counseling, Special Education, and School Psychology, One University Plaza, Youngstown, Ohio 44555.
Email: lgongola@gmail.com

Table 1. Treatment integrity questions and percentages

Treatment integrity questions	Average percent of treatment integrity for Cole	Average percent of treatment integrity for Rachael
1) Did the practitioner give the participant a choice of two preferred items at the onset of the activity?	100%	100%
2) Did the practitioner preview the work tasks in a “First__then” format?	95%	95%
3) Did the practitioner keep the token economy in clear view throughout the entire session?	100%	95%
4) Did the practitioner keep the visual timer within clear view throughout the session?	100%	100%
5) When the timer was exhausted, did the practitioner immediately (within three seconds) give defined praise accompanied with the token?	100%	86%
6) If the participant displayed a target behavior, did the practitioner immediately reset the timer?	84%	86%
7) If the participant displayed high rates of the target behavior, did the practitioner turn the timer in effort to temporarily remove the intervention?	100%	95%

In effort to strengthen opportunities for IOA and treatment integrity data collection, technological advances (i.e., asynchronous collaborative technologies; Cemile Serce et al., 2011) offer additional modalities beyond that of traditional observation practices. To minimize travel, scheduling, and reactivity concerns while encouraging distributed research team participation, private blog sites (i.e., ones accessible only to individuals specifically invited to view them) may be integrated into data collection practices. Technology offers a superior alternative to obtrusive data collection practices and has the potential to be more cost and time effective than in vivo observation. The use of private blog sites can increase the number of sessions in which researchers can assess IOA and treatment integrity, resulting in more reliable measures overall. The current study evaluated the role of private blog sites in supporting data collection practices during a differential reinforcement of other behaviors (DRO) treatment package. The rationale for using private blogs was that distance barriers and time conflicts would be minimized (Burnett, 2003); therefore supporting IOA and treatment integrity data collection.

» METHOD

Participants

Two children with an autism diagnosis were identified from a sample of students in a public school classroom for students with multiple disabilities. Participants were identified according to the following criteria: (a) a professional diagnosis of autism based upon the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association, 2000), (b) attendance in the classroom for students with multiple disabilities, (c) a current age between eight and nine, (d) and exhibited target behaviors that disrupted or halted the learning process for themselves or others in the classroom setting. Cole was a nine-year-old boy whose target behaviors included inappropriate vocalizations (e.g., “Ba! Ba!”), hair picking, and inappropriate breathing (i.e., blowing from mouth up into his nose or breathing into a cupped hand). Rachael was an eight-year-old girl whose target behaviors included inappropriate vocalizations (e.g., whistling, guttural sounds), hand movements (i.e., up and down, side to side, cupped, or whole hand movement), and scratching classroom materials (i.e., fingers sweep across a surface with the palm facing upwards). For both children, behaviors created social stigmas and impeded their integration with peers (e.g., Cole had gastrointestinal issues and thrush which resulted in a potent smelling breath and for Rachael, service providers in the school had expressed frustration when she harmed their classroom materials via scratching).

Two classroom educational assistants implemented the intervention. One assistant had eighteen years of experience working with students with disabilities and the other had four years of experience. The lead researcher was a doctoral candidate and the research assistant was a graduate student. Both were attending a local university for special education coursework.

Procedure

Treatment integrity sessions. Each child participated in three experimental conditions: baseline, a DRO treatment package, and maintenance. The lead researcher and research assistant were responsible for treatment integrity and IOA data collection throughout all experimental conditions. Prior to beginning the study and once per week throughout, treatment integrity training sessions were provided to classroom staff by the lead researcher. Training sessions included: (a) development and review of operational definitions for each target behavior; (b) discussion and role play of target behaviors; (c) observation and data collection via digital video recordings; and (d) positive and corrective feedback on specific treatment integrity questions (DiGennaro, Martens, & Kleinmann, 2007). The educational assistants viewed video recordings together once per week with the lead researcher and research assistant. During this time, each educational assistant would identify yes or no on the treatment integrity sheet. If components of intervention implementation were below 100%, researchers would provide descriptive feedback with suggestions for how to improve the intervention.

Digital video recording. At the same time as treatment integrity practices, digital video recording with a Canon© ZR950 took place for interobserver agreement training purposes. To begin, the lead researcher and research assistant (i.e., researchers) defined the video recording area by affixing masking tape to the floor as location markers for the student and camera placement, thus assuring consistency in viewing angle and video area. To ensure that researchers gathered data from the exact same video segment, educational assistants were instructed to begin a timer and say the word "Go" to indicate the beginning of the session. Each ten minute observation period was concluded with an auditory beep and the classroom staff's instruction "Stop." This ensured that observations began and ended at the same time.

Digital video recording occurred once per day for both participants. The lead researcher used iMovie©, Apple's video editing software to create ten minute video clips and posted the clips to private and free Google© blog sites (i.e., each participant had a personal site). Consent for the video recording was obtained from educational assistants and the parents of the participants. Individual blogs were created using www.blogger.com and privacy was assured by setting the blog so only invited users (e.g., classroom staff, researchers, and parents) had access to the blog. Invited users were required to create a password prior to obtaining access. The researchers could then log into the private blog sites at a convenient time and independently review the digital video to record the behavioral frequencies. Interobserver agreement was determined by simple agreement (e.g.: small number of occurrences ÷ large number of occurrences × 100 = %) throughout training, baseline, intervention, and maintenance conditions. Baseline data collection began after the researchers had obtained at least 95% agreement during training across all behaviors for each participant.

Basic rotation schedule. Sessions were recorded daily using the video camera. The constant presence of the camera allowed staff and students to habituate to its presence, thereby reducing the likelihood of reactivity. Further, researchers set a basic rotation schedule to ensure that IOA data was collected on Monday, Wednesday, Friday, and then Tuesday and Thursday of the following week. By contrast, treatment integrity data was collected on an opposing rotation schedule (e.g., Tuesday and Thursday of the first week and continually alternating). By applying the basic rotation schedule, data was collected on IOA and treatment integrity on an every other day cycle.

» RESULTS

Interobserver agreement

During the baseline condition, IOA was assessed for 64% of sessions for both Cole and Rachael. During the intervention condition, IOA was assessed for 84% of the sessions for Cole and 70% of the sessions for Rachael. During the maintenance condition, IOA was assessed 66% of the sessions for Cole and 100% of the sessions for Rachael. Observer's records were compared and mean agreement for Cole was 92% during baseline, 96% during intervention, and 93% during maintenance. For Rachael, observer's records were compared and mean agreement was 94% during baseline, 96% during intervention, and 89% during maintenance. During the maintenance phase for Rachael, slight deviations in recordings took place (i.e., the lead researcher recorded three occurrences of inappropriate vocalizations while the research assistant recorded two occurrences of inappropriate vocalizations), which resulted in a deflation in agreement scores. In addition, simple agreement calculations were applied throughout this study. In future applications, a more rigorous method for calculating agreement should be used (e.g., interval-by-interval or exact agreement; Vollmer et al., 2008).

Treatment integrity

In regards to treatment integrity, 44% of observation sessions were evaluated for Cole and 52% of observation sessions for Rachael. Although a basic rotation schedule was used, private blog sites allowed for increased access to video recordings; therefore, increasing the percentage of sessions measured for IOA and treatment integrity. By contrast, a limitation occurred when the research assistant's computer crashed, resulting in a lower percentage of treatment integrity observation sessions for Cole. Although 21st century technology presents an advantage to direct observation practices, technological reliability can present an entirely different problem.

Data collection

In the present study, private blog sites facilitated IOA data collection for greater than the 20 to 33 percent range that is generally recommended (Kennedy, 2005) and also, enabled data collection on treatment integrity. The use of the private blog sites made it feasible for researchers who were distributed geographically to access the data, resulting in increased feedback to staff members and improved precision of treatment implementation. The digital video also made it possible for observers to view clips at their leisure, and as many times as necessary in order to collect accurate information.

Behavioral interventions in school facilities can be maximized when behaviors are well defined and when training and support are provided to classroom staff members (Steege, Davin, & Hathaway, 2001). The convenience and accessibility of digital video on private blog sites allowed for performance feedback to be delivered weekly to classroom staff. This addresses suggestions from previous work that indicates that weekly feedback meetings are important to help maintain adherence in intervention protocols (Eikeseth, 2001). High levels of treatment integrity have been found to facilitate better intervention outcomes than low levels of treatment integrity (Rhymer, Evans-Hampton, McCurdy, & Watson, 2002). In fact, skills can be mastered more quickly when treatment is implemented with increased integrity (Wilder, Atwell, & Wine, 2006).

» DISCUSSION

Ethics and privacy

When considering the use of blog sites to post video of students and clients, researchers and practitioners must be cognizant of obtaining informed consent and also, of maintaining privacy throughout the process. Parents and caregivers should be provided with a consent form explaining the purpose, risks, and benefits of the video and specification that the video will only be viewed by classroom staff and the research team. Permissions must be obtained from the family prior to moving forward with the video and blogging process. In addition, research team members should hold a briefing on ethical practices and how to consistently maintain confidentiality. The meeting should conclude with research team members signing a non-disclosure agreement indicating that video recorded and viewed will not be discussed and that names will be withheld. This visibility from the onset ensures that the family and research team alike, have a solid understanding of the intent of the video and also, that all parties are clear on the expectations for ensuring strong standards of privacy.

Technology

Process of blogging. When beginning the process of blogging, the lead researcher is most frequently delineated the responsibility of blog administrator which includes setting up the blog and distributing invitations to potential members on the site. The blog administrator must ensure that the blog is on a private setting and by invitation only. After electronic invitations have been sent from the blog site to individual email addresses, members create a password and use the password for log in. When put to a private setting, the site will remain secure to members while inaccessible to others that have not been invited.

After the blog site is established, one or two research team members are typically responsible for visiting the location and video recording. With the ease of recent technologies such as smart phones and iPads©, taking video is simplistic and can be effortlessly stored by emailing to oneself and then saving the file to a flash drive. Research team members can then begin posting video directly to the blog site by uploading the video file. The blog administrator should remain the person responsible for accepting new video posts on the blog to ensure that the posts are relevant and of high quality. This blog administrator should consistently maintain control over the ethical nature of the blog.

Convenience. Posting digital video records onto private blog sites maintains security of video while producing permanent products that can be accessed at any time and from any place for data collection purposes. Communication tools such as blog sites avoid the need for researchers to be present for data collection to occur; rather, researchers can post information to team members whenever they are available (Cemile Serce et al., 2011). Past research has suggested that data monitoring should be parsimonious (Vollmer et al., 2008) and with this in mind, collaborative technologies such as blog sites facilitate the simplicity and efficiency by which researchers view and monitor data. An additional consideration is that digital video is both easily managed and avoids problems associated with video tapes (i.e., video tape can stretch and jeopardize the accuracy of data). Using digital video both eliminates this potential for error and permits distal data recording.

Advantages and future directions. Video blogs have become a normalized alternative to the conventional days of working around research team member schedules and then driving lengthy distances to a meeting location. Technology offers an advantage that saves on time while simultaneously producing a real time video product that can be viewed effortlessly. In terms of future directions, research should evaluate the use of video blogs as a technological training tool for families. In this study, parents anecdotally reported being more at ease with applying intervention procedures as a result of viewing daily video of their child. Researchers should assess the use of video blogs for families who need support and modeling in the application of evidence-based practices. This continuity in service delivery from a school or clinical location to the home setting could substantially expedite student progress when all parties are working together. More and more, the use of video is playing a critical role in supporting collaborative efforts to facilitate student progress (Pearson, Chambers, & Hall, 2003).

This exploratory study suggests that the use of 21st century technology (i.e., private blog sites) can be easily used to enable data collection by geographically separated researchers and by researchers with scheduling conflicts. Future research should replicate the effectiveness of this technological modality as well as address potential differential results of in vivo data collection and that from digital video. This study shows that having access to digital video supported the ease of data collection while allowing for systematic evaluation of IOA and treatment integrity during a behavioral intervention. Technological advances present an improvement from current practice in that, researchers can stay home to access their work as opposed to driving lengthy distances and working around scheduling challenges. Using digital video via private blog sites offers a practical and time saving venue in which research can be easily accessed and viewed without sacrificing accuracy of the data. ■

REFERENCES

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.

Armstrong, K., Ehrhardt, K., Cool, R., & Poling, A. (1997). Social validity and treatment integrity data: Reporting in articles published in the *Journal of Developmental and Physical Disabilities*, 1991–1995. *Journal of Developmental and Physical Disabilities, 9*(4), 359–367.

Burnett, C. (2003). Learning to chat: Tutor participation in synchronous online chat. *Teaching in Higher Education, 8*, 247–261.

Cemile Serce, F., Swigger, K., Nur Alpaslan, F., Brazile, R., Dafoulas, G., & Lopez, V. (2011). Online collaboration: Collaborative behavior patterns and factors affecting globally distributed team performance. *Computers in Human Behavior, 27*, 490–503.

Cooper, J., Heron, T., & Heward, W. (2007). *Applied Behavior Analysis* (2nd ed.). Upper Saddle River, NJ: Prentice-Hall.

Craig, A. (2010). Self-administered behavior modification to reduce mail biting: Incorporating simple technology to ensure treatment integrity. *Behavior Analysis in Practice, 3*(2), 38–41.

DiGennaro, F.D., Martens, B.K., & Kleinmann, A.E. (2007). A comparison of performance feedback procedures on teachers' treatment implementation integrity and students' inappropriate behavior in special education classrooms. *Journal of Applied Behavior Analysis, 40*(3), 447–461.

Eikeseth, S. (2001). Recent critiques of the UCLA young autism project. *Behavioral Interventions, 16*, 249–264.

Fiske, K.E. (2008). Treatment integrity of school-based behavior analytic interventions: A review of the research. *Behavior Analysis in Practice, 1*(2), 19–25.

Gresham, F.M. (2005). Treatment integrity and therapeutic change: A commentary on Perepletchikova and Kazdin. *Clinical Psychology: Science and Practice, 12*, 391–394.

Gresham, F.M., MacMillan, D., Beebe-Frankenberger, M., & Bocian, K. (2000). Treatment integrity in learning disabilities intervention research: Do we really know how treatments are implemented? *Learning Disabilities Research and Practice, 15*(4), 198–205.

Gresham, F.M. (1989). Assessment of treatment integrity in school consultation and prereferral intervention. *School Psychology Review, 18*, 37–50.

Kazdin, A.E. (2001). *Behavior modification in applied settings* (6th ed.). Belmont, CA: Wadsworth.

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

Lane, K., Bocian, K., MacMillan, D., & Gresham, F. (2004). Treatment integrity: An essential- but often forgotten- component of school-based interventions. *Preventing School Failure, 48* (3), 36–43.

McIntyre, L.L., Gresham, F.M., DiGennaro, F.D., & D.D. Reed. (2007). Treatment integrity of school-based interventions with children in the Journal of Applied Behavior Analysis 1991–2005. *Journal of Applied Behavior Analysis, 40*, 659–672.

Pearson, S., Chambers, G., & Hall, K. (2003). Video material as a support to developing effective collaboration between teachers and teaching assistants. *Supporting for Learning*, *18* (2), 83–87.

Rhymer, K.N., Evans-Hampton, T.N., McCurdy, M., & Watson, T.S. (2002). Effects of varying levels of treatment integrity on toddler aggressive behavior. *Special Services in the Schools, 18*, 75–82.

Salend, S. (1984). Therapy outcome research: Threats to treatment integrity. *Behavior Modification, 8* (2), 211–222.

Steege, M., Davin, T., & Hathaway, M. (2001). Reliability and accuracy of a performance-based behavioral recording procedure. *School Psychology Review, 30* (2), 252–261.

Vollmer, T.R., Sloman, K.N., & St. Peter Pipkin, C. (2008). Practical implications of data reliability and treatment integrity monitoring. *Behavior Analysis in Practice 1* (2), 4–11.

Wilder, D.A., Atwell, J., & Wine, B. (2006). The effects of varying levels of treatment integrity on child compliance during treatment with a three-step prompting procedure. *Journal of Applied Behavior Analysis, 39* (3), 369–373.

BEHAVIORAL DEVELOPMENT BULLETIN

VOLUME 19
NUMBER 1
MARCH 2014

The effects of intensive tact instruction with young children having speech delays on pure tacts and mands in non-instructional settings: a partial replication

Jeremy H. Greenberg[1], Wendy Tsang[1], and Tracy Yip[1]

ABSTRACT

The present study is a partial replication of the intensive tact instruction tactic. Previous applications of this tactic have demonstrated improvements in the pure verbal operant behaviors of preschool students with autism and speech delays and in middle-school students with special needs (Pistoljevic & Greer, 2006). Tacts, mands, and conversational units have been increased across three non-instructional settings (NIS), before and after the mastery of five categories of pictures using 100 tact learn units. The participants in the present study included two boys and one girl with autism who ranged in age from six to nine years old and attended a private school in Hong Kong. The experimental design was a delayed multiple probe design across participants. All probe sessions were conducted for a cumulative time of 15 minutes including five minutes in each of the three NIS. All three students were observed to emit significantly more tacts after mastering the 100 learn units through the intensive tact instruction. There were collateral effects observed in the number of mands emitted for two of the three students. The present study adds to the external validity of the intensive tact instruction tactic with an older age-range of students.

KEYWORDS: autism, mand, partial replication, tact, verbal behavior

One of the major areas of deficit identified in children diagnosed with autism is their delay in verbal development. Teaching that targets the development of the speaker repertoire becomes an essential part of a child's success in school and beyond. In Skinner's analysis of verbal behavior (1957), mands and tacts are described as two vocal operants (behaviors) that can be controlled by antecedent stimuli. Tacting, in particular, requires a person to identify aspects of one's environment using their own senses. Functionally, it informs another person about what the tacting individual is identifying. Tacting is a verbal operant that is reinforced through social attention. The tact repertoire is critical for the advancement of a fluent speaker repertoire in children with developmental delays (Delgado & Oblak, 2007; Partington, Sundberg, Newhouse, & Spengler, 1994).

There are various studies within the sub-field of applied behavior analysis, verbal behavior analysis that have identified effective procedures in teaching children functional verbal operants. These tactics include: the use of echoic prompts to increase spontaneous mands and tacts (Kodak & Clements, 2009), teaching mands-to-tacts to facilitate rapid acquisition of tacting (Arntzen & Almas, 2002), and providing intensive tact training to increase spontaneous tact, mand, and intraverbal behaviors (Greer, 2002). One disadvantage of the echoic to tact training by Kodak & Clements (2009) was that it produced limited language interaction without a careful transfer of stimulus control from the echoic prompt (vocal antecedent) to the naturally occurring stimuli. In comparison, Greer's use of the intensive tact protocol produced a more rapid result and participants were observed to emit an increased number of verbal operants in their natural settings. The use of the intensive tact instruction procedure on various young learners has been observed. Children who have benefited from this procedure include preschoolers (Pistoljevic & Greer, 2006; Delgado & Oblak, 2007) to middle school aged-students (Schautffler & Greer, 2006) diagnosed with autism, pervasive developmental disorder, emotional problems, and behaviors disorders with developmental delays. All participants were found to increase their number of pure mands and tacts.

In a replication of Pistoljevic & Greer's (2006) study, Delgado & Oblak (2007) used the intensive tacting procedure with three preschool students diagnosed with developmental delays. The results showed that the procedure effectively increased the number of pure mands and tacts emitted in non-instructional settings. In another experiment conducted by Schauffler & Greer (2006), the effects of the intensive tact instruction on the emission of audience-accurate verbalizations were tested on two middle school students. Findings showed a significant increase in the number of

[1]The Children's Institute of Hong Kong Limited.
Correspondence concerning this article should be addressed to: Jeremy H. Greenberg, Ph.D., BCBA-D,The Children's Institute of Hong Kong Limited,19/F Kennedy Town Centre,23 Belchers Street,Kennedy Town, Hong Kong,E-mail: jgreenberg@tcihk.org,Tel: +852 2812 2144

Table 1. Description of three students participating in the study

Student	Gender	Age	Diagnosis/level of verbal capability	Verbal behavior operant verbal behavior analysis (Greer & Ross, 2008)
A	Boy	9.2	Autism Listener/speaker Emergent reader	Mands/tacts Intraverbals Textual responding
B	Girl	6.7	Autism Listener/speaker Emergent reader	Mands/tacts with autoclitic frames Intraverbals Textual responding
C	Boy	8.6	Autism Listener/speaker Emergent reader	Mands/tacts Intraverbals Textual responding

audience-accurate tacts and conversational units for both participants and a decrease in the number of inappropriate tacts for one of the participants. Their study expanded the external validity of the intensive tact protocol tactic by showing effects with an older age range of students and by demonstrating that the tactic can improve other verbal operants that are not directly taught which may suggest a type of adduction.

The purpose of the current study was to replicate the original research findings conducted by Pistoljevic & Greer (2006) on the use of intensive tacting protocol with three, six to nine year-old children diagnosed with autism. This is a much older group of participants than the three preschool students from Schauffler and Greer (2006). The intensive tact protocol had not been applied to children in this age group in previous studies. Delgado & Oblak (2007) did successfully replicate earlier findings with the same preschool aged students. Our study tested the effects of the intensive tact instructions of 100-tact learn units on the number of vocal operants (i.e. mands and tacts) emitted during three non-instructional settings with an older age range of students.

» METHOD

Participants

There were three students who participated in the present study that ranged in age from six to nine years old. The three students were selected for the study because they emitted low numbers of pure tacts within non-instructional settings. Table 1 contains a brief description of each student. Two of the three students also attended a mainstream school part-time, located within the same commercial building where the center-based school was situated. The students' repertoires were assessed using the Assessment of Basic Language and Learning Skills - Revised (ABLLS-R, Partington, 2010).

Setting

The study was conducted in a private not-for-profit, school for children with special needs including autism in Hong Kong Special Administrative Region. The school provides a one to one student to teacher ratio and uses direct special instruction with Applied Behavior Analysis (ABA). All three participants attended a classroom with six students, one head teacher, and six ABA teachers. Most of the long and short term objectives (annual goals) for the participants were derived from the results of the ABLLS-R and were contained in the students' Individualized Educational Program (IEP).

During all probes for pure tacts and pure mands, data were collected in three non-instructional settings: the play area of the classroom upon arrival at school, at the lunch table during lunchtime, and in the play area of the classroom after lunchtime. The play area was located at the back of the classroom and was sectioned off by padded square mats that measured 8' × 5' (244 cm × 152 cm). It was equipped with a shelf holding storybooks and bins of toys on one side of the play area, and a small trampoline on the other side. Lunch was taken at square-shaped wooden tables inside two mainstream classrooms located at the lower level of the school. All of the participants sat at the table for about 25 minutes during lunch. During the tact instruction, participants sat at his/her respective tables in the classroom, next to his/her ABA teachers.

Table 2. Description of tact sets and lists of the categories of two-dimensional stimuli pictures that were taught as pure tacts operants

Categories	Set 1	Set 2	Set 3	Set 4
Instruments	Guitar Harp Organ Xylophone	Tuba Harmonica Flute Cello	Drums Violin Saxophone Piano	Triangle Accordion Clarinet Trombone
Transportation	Bulldozer Sail boat Motorcycle Forklift	Sled Tricycle Crane Ferry	Tractor Escalator Airplane Train	Bicycle Dump truck Helicopter Speed boat
Community Helpers	Photographer Taxi driver Surgeon Crossing guard	Rower Stewardess Basketball player Referee	Painter Ballerina Garbage man Florist	Baseball player Fisherman Lifeguard Scientist
Food	Cashews Asparagus Watermelon Cotton candy	Sushi Donut Coffee Salad	Pasta Beans Bacon Waffle	Bagel Potatoes Pie Grapes
Animals	Crab Starfish Bubble bee Mouse	Dragonfly Squirrel Shark Alligator	Penguin Ants Lizard Fox	Octopus Guinea Pig Turtle Goat

Definition of behavior: the dependent variable

The dependent variables in this study were the number of pure vocal verbal tacts and mands produced during the five-minute probes across three non-instructional settings. According to Skinner (1957), a tact was defined as "a verbal operant in which a response of given form is evoked by a particular object or event or property of an object or event" (p. 81–82). This study specifically targeted "pure tacts," a type of verbal behavior "controlled by non-verbal antecedent stimuli and results in nonspecific generalized conditioned reinforcement" (Rehfeldt, Ziomek, & Garcia, 2006). Pure tacts had a nonverbal antecedent and were in response to objects or events rather than other verbal behaviors or verbal antecedents such as "What is this?" "Pure mands" were also targeted and the number of pure mands was recorded during the same five-minute probes in the non-instructional settings. Skinner (1957) defined a mand as "a verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the functional control of relevant conditions of deprivation or aversive stimulation" (p. 35–36). As was the case for impure tacts, impure mands were not recorded such as mands in response to verbal stimuli, "What do you want?"

Independent variable: the intensive tact procedure

The independent variable in this study was the additional presentation of 100 tact learning units (Albers & Greer, 1991; Greer & McDonough, 1999; Greer, 2002) delivered throughout the six-hour school day. Here, learning units is used instead of the traditional learn unit. The increased number of tact learning units were presented in addition to the students' regularly scheduled instructional subjects and programs based on the IEP. Four sets of 3" × 5" (8 cm × 13 cm) picture cards of stimuli depicting various objects were used. Five categories with four target stimuli in each category were included in each set. The five categories targeted included musical instruments, transportation, food, animals, and community helpers. There were multiple exemplars of each stimuli (at least three) and they were all interspersed in all teaching conditions. The sets of stimuli are listed in Table 2.

During the tact intervention, a correct response was recorded when the participant vocally labeled the target item in the picture accurately and independently within 3 seconds of the presentation of the stimuli. The antecedent for a pure tact operant is non-verbal and consists of an object, event, or in this case, a picture. Positive reinforcement in the form of generalized social praise (i.e. verbal

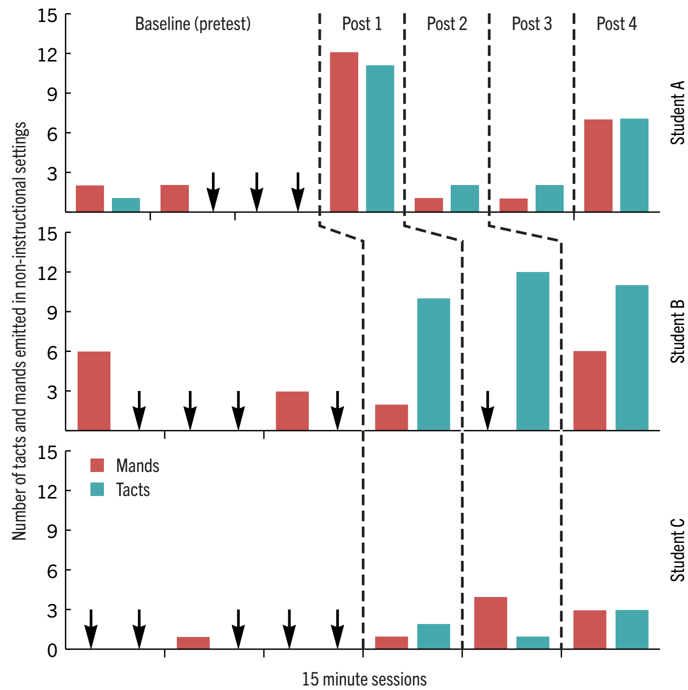

Figure 1. Delayed multiple baseline experimental design across Students A, B, and C's number of tacts and mands emitted across all three non-instructional settings, blocked into 15-minute sessions.

praise such as "Well done", high-fives, tickles) was then presented immediately contingent on a correct response. Responses that deviated from the correct response were omitted, or those that occurred outside of the three-second intraresponse time resulted in the delivery of a simple correction procedure by the teacher. In the simple correction, the target antecedent (picture) was re-presented and accompanied by an echoic prompt.

Upon the outset of instruction, the teacher presented pictures of the four stimuli within all of the five categories. The teacher labeled the target picture whilst the participant was required to echo the target response. Once the echoic responses for the target set of stimuli were completed, the procedure immediately transitioned to independent tacting of the same set of stimuli. Reinforcement or correction operations were then subsequently delivered according to the participant's pure tact responses.

Twenty learning units were presented for each of the five categories within a specific set on a daily basis. The target sets were rotated until 100 tact learning units were presented to the participant. The same sets of stimuli were repeatedly presented until the participant achieved mastery for all four sets of stimuli within the targeted five categories.

Table 3. Interobserver agreement

Student	Baseline	Post-probe condition
A	4 (100%, 100%, 100%, 100%) Mean = 100% Range (100%–100%) % of sessions with IOA = 50%	2 (80%, 100%) Mean = 90% Range (80%–90%) % of sessions with IOA = 25%
B	2 (100%, 100%) Mean = 100% Range = (100%–100%) % of sessions with IOA = 33%	1 (100%) Mean = 100% Range = N/A % of sessions with IOA = 17%
C	1 (90%) Mean = 90% Range = N/A % of sessions with IOA = 33%	2 (100%, 100%) Mean = 100% Range = (100%–100%) % of sessions with IOA = 33%

Data collection

Data were collected in 5-minute intervals during both observation probes and across three different non-instructional settings. Event recording was used to collect data on the number of pure tacts and mands by the participants. A "+" was recorded on the data sheet for correct tacts while a "–" was recorded on the data sheet for incorrect tacts. A timer was used for all three non-instructional settings when data was recorded using direct observation. During the five-minute probes within the play area

Table 4. The number of tacts emitted per minute during the 15-minute sessions for all three students

Condition	Student A	Student B	Student C
Baseline probe 1	.07	.40	.00
Baseline probe 2	.00	.00	.00
Baseline probe 3	.00	.00	.00
Post probe 1	.73	.67	.13
Post probe 2	.13	.80	.07
Post probe 3	.13	.73	.20
Post probe 4	.47	—	—

of the classroom upon arrival at school, the participants were allowed free access to all toys and books located in the play area. During the five-minute probes at lunch time, participants were seated at a table among a minimum of three other typically developing peers whilst eating their lunch. During the five-minute probes within the play area of the classroom after lunch, all toys and books were again available to the participants. Data for each five-minute non-instructional probe were blocked into one 15-minute session for the day consistent with the data collection from the Pistoljevic & Greer (2006) experiment. Data during the intensive tact procedure were collected as responses to learning units. Criterion was achieved when responses were correct with at least 90% accuracy across two consecutive sessions. New sets of stimuli were introduced only after criterion was achieved for the target training sets.

Interobserver agreement

Interobserver agreement was collected by an independent observer who recorded all instances of spontaneous pure tacts and mands emitted by the participants. All utterances produced by the participants were recorded as tally marks marked under "T" if it was a pure tact or under "M" if it was a pure mand. In the baseline condition for student A, there were four observations conducted in the baselines condition all with 100% agreement. For student B, there were two observations conducted in the baseline condition all with 100% agreement. For student C, there was one observation with 90% agreement.

In the post-probe condition for student A, there were two observations conducted that resulted in 80% and 100% agreement with a mean of 90%. For student B, there was one observation conducted that resulted in 100% agreement. For student C, there were two observations conducted that resulted in 100% agreement each. Table 3 shows the results of the inter-observer agreement measurements.

» RESULTS

The results for the three students can be reviewed in Table 4 as the rate of verbal operants per minute. The results are also expressed in Table 5 as the number of tacts emitted across the three non-instructional settings. For student A, there was one tact observed across all three baseline pretests. Student A had a total of four mands observed in baseline. For student B, there were zero tacts observed in baseline and a total of nine mands. Student C was observed to tact zero times in baseline conditions with one mand.

Post probes 1 through 4 were are follows for student A's tact responses: 11, 2, 2, and 7, respectively. Student A's mands were 12, 1, 1, and 7, respectively. Post probes 1 through 3 for student B's tact responses were 10, 12, and 11, respectively. Student B's mands across the three post probe sessions were 2, 0, and 6, respectively. Student C's mands across the three post probe sessions were 1, 4, and 3, respectively. Figure 1 shows the delayed multiple probe design used in the study. Figure 2 shows Student B's tact learning unit data during the acquisition of the tact operants across the sets.

Tact behaviors increased significantly across all three students although more so for students A & B and less so for student C. Mands increased as well across two of the students, A & B but stayed about the same (unchanged) for Student B.

» DISCUSSION

The results of the study showed that the participants emitted an increased number of tact and mand verbal operants during non-instructional settings following the implementation of the intensive tact procedure. The results were similar to the study conducted by Pistoljevic and Greer (2006) and subsequent replication by Delgado & Oblak (2007) where the intensive tact procedure increased the independent verbal operants across all three NIs, compared to baseline measures. However, our results differed from previous studies in that mand operants were observed to increase for two of the students while mands did not change for one of the three students. As the mands were measured as collateral verbal operants and were not directly targeted for increase, there are a number of variables that could have contributed to this difference across the studies. Motivational conditions vary from moment to moment in classroom environments and may have effected the mand behaviors with the student participants.

Table 5. The number of tacts emitted across three non-instructional settings for each of the three student participants

Students		Unpacking	Lunch	Play area
Student A	Baseline	1	0	0
	Baseline	0	0	0
	Baseline	0	0	0
	Post probe 1	5	6	0
	Post probe 2	1	1	0
	Post probe 3	2	0	0
	Post probe 4	2	0	5
Student B	Baseline	2	2	2
	Baseline	0	0	0
	Baseline	0	0	0
	Post probe 1	8	2	0
	Post probe 2	1	0	11
	Post probe 3	2	5	4
Student C	Baseline	0	0	0
	Baseline	0	0	0
	Baseline	0	0	0
	Post probe 1	0	1	1
	Post probe 2	0	0	1
	Post probe 3	1	0	2

Student B did not increase mands in the NIS after the intervention. It may have been the case that the increased number of tacts and resulting reinforcement attained through the generalized social praise by the teachers for correct tacts decreased the motivational conditions for Student B to mand in the post probe condition. The intensive pure tact instruction of novel stimuli served to compensate for prior missing language opportunities. Our study has demonstrated that pure tacts in students ranging in age from six to nine years of age who emit low to zero rates of tacts in NIS can be improved through the use of the intensive tact instruction. The treatment package was effective in increasing the pure tact operants across all three settings for all three student participants. Of note is that the tacts were not of the stimuli in the picture sets. This observation suggests that it's the tact capability that has been induced rather than simple tacting of mastered stimuli.

We considered the treatment a partial replication due to the fact that the stimuli used were similar but not identical to the original studies, the environments were similar but not identical and the students were of a different age range. These variables do not seem to limit or affect the results of the study for tact improvement, however they might be implicated in the different results for the mand operants observed.

Limitations

One limitation for this study was the lack of control of the number of learning units the participants received throughout the day. This was difficult to control as the number of hours in one-to-one setting varied between participants as some of them were integrated into mainstream class settings. Although daily learning unit data is collected for each student daily, it was not reported here in this study. Future studies using the intensive tact protocol should control for learning units presented daily. Interobserver agreement was not collected for the teaching of the tacts and could be included as well in future studies. Another limitation of the current study was that some participants received extra hours of instruction after school. Since the number of learning units overall each day was not held constant across the students, this could have affected the number of mands and tacts emitted by these participants.

Future implications

Future studies may target the long term effects that the intensive tact protocol has on students with and without this type of training. Other procedures such as the echoic to tact training protocols can be compared to this procedure to test their effectiveness and efficiency. The length of sentences, the choice of words, and sentence structures may be tested and compared between the two groups. Tacts with autoclitics may be an improvement on the single word tact responses, for example. Another possible target for future studies may be to increase the number of sets used in the intensive tact protocol. This may lead to further significant increases in the number of vocal operant emitted. Further research is necessary to test other positive effects that the intensive tact protocol may have other verbal operants with other populations of learners. ■

REFERENCES

Albers, A.E., & Greer, R.D. (1991). Is the three-term contingency trial a predictor of effective instruction*? Journal of Behavioral Education*, *1*, 337–354.

Arntzen, E. & Almas, I.K. (2002). Effects of mand-tact versus tact-only training on the acquisition of tacts. *Journal of Applied Behavior Analysis*. *35*(4), 419–422.

Delgado, J.A.P. & Oblak, M. (2007). The effects of daily intensive tact instruction on the emission of pure mands and tacts in non-instructional settings by three preschool children with developmental delays. *Journal of Early and Intensive Behavior Intervention. 4*(2), 392–411.

Greer, R.D. & McDonough, S. (1999). Is the learn unit the fundamental measure of Pedagogy? *Behavior Analyst*, *20*, 5–16.

Greer, R.D. (2002). *Designing teaching strategies*: An applied behavior analysis systems approach. New York: Academic.

Kodak, T. & Clements, A. (2009). Acquisition of mands and tacts with concurrent echoic training. *Journal of Applied Behavior Analysis*. *42*(4), 839–843.

Partington, J.W. (2010). The Assessment of Basic Language and Learning Skills-Revised (The ABLLS®-R). Pleasant Hill, CA: Behavior Analysts, Inc.

Partington, J.W., Sundberg, M.L., Newhouse, L. & Spengler, S.M. (1994). Overcoming an autistic child's failure to acquire a tact repertoire. *Journal of Applied Behavior Analysis. 27*(4), 733–734.

Pistoljevic, N. & Greer, D. (2006). The effects of daily intensive tact instruction on preschool students' emission of pure tacts and mands in non-instructional setting. *Journal of Early and Intensive Behavior Intervention*. *3*(1), 103–110.

Rehfeldt, R.A., Ziomek, M., & Garcia, Y., (2006). Reinforcement contingencies in the mand and tact., *European Journal of Behavior Analysis*, *7*, 125–128.

Schauffler, G. & Greer, D. (2006). The effects of intensive tact instruction on audience-accurate tacts and conversational units. *Journal of Early and Intensive Behavior Intervention*. *3*(1), 121–134

Skinner, B.F. (1957). *Verbal behavior*. Action, MA: Copley Publishing Group.

BEHAVIORAL DEVELOPMENT BULLETIN

VOLUME 19
NUMBER 1
MARCH 2014

Using a tactile prompt to increase instructor delivery of behavior-specific praise and token reinforcement and their collateral effects on stereotypic behavior in students with autism spectrum disorders

Mary E. McDonald[1], Sharon A. Reeve[2], and Erin J. Sparacio[3]

ABSTRACT

This study evaluated the effectiveness of a tactile cue, the Gentle Reminder™, as a prompt to increase instructor use of behavior-specific praise and token reinforcement. First, instructors were told to deliver reinforcement when a student was engaged in behavior that was incompatible with stereotypy. They were then told they would feel a vibration every 10 minutes to remind them to use reinforcement for these behavior. A tactile prompt was then programmed to vibrate every 10 minutes. It was expected that the teacher's use of reinforcement would increase and in turn, this would lead to a reduction in the level of student stereotypic behavior. A multiple baseline design across participants was used to evaluate the effects of the tactile prompt on instructor behavior and the collateral effects on student stereotypic behavior. After implementation of the tactile prompt, instructors' use of reinforcement for behavior incompatible with stereotypy increased systematically across all three instructors. The instructor's use of reinforcement increased more than once every 10 minutes when the tactile cue was implemented. In addition, there was a decrease observed in the level of the students' stereotypic behavior after introduction of the tactile prompt and the instructor's increased use of reinforcement.

KEYWORDS: teacher training, tactile prompt, reinforcement, autism, stereotypic behavior, behavior-specific praise, token reinforcement

Students diagnosed with autism spectrum disorders require specialized intervention by well trained professionals who are able to effectively implement teaching procedures based in applied behavior analysis (Lovaas, 1987). To develop competent teachers who can positively affect their students, it is important that supervisors provide effective training for the teachers (Weiss, 2005). Didactic training alone, however, is not sufficient for building adequate skills in instructional staff (Noell & Witt, 1999). Furthermore, instruction without in-vivo training has been shown to be only minimally effective as a training method (McClannahan & Krantz, 1993).

Instructor training with students with autism spectrum disorders has focused mostly on areas such as discrete trial instruction (Sarokoff & Sturmey, 2004) and functional analyses (Phillips & Mudford, 2008). There is little research, however, detailing effective procedures to train instructional staff to adhere to behavior intervention plans or to consistently apply interventions (Kraemer, Cook, Browning-Wright, Mayer, & Wallace, 2008; Sterling-Turner, Watson, Wildmon, Watkins, & Little, 2001). Instructional staff may require prompting to implement newly learned procedures consistently, thereby maximizing student success (Petscher & Bailey, 2006). A tactile prompt is an unobtrusive, effective option for providing a cue for staff to perform particular skills that they have previously learned. For example, Petscher and Bailey (2006) used a tactile cue as part of a treatment package to increase accurate implementation of a classroom token economy along with instructor self-monitoring. The participants were instructional assistants who had less than 1 year of experience working in a classroom setting.

The current study evaluated the effectiveness of a tactile cue, the Gentle Reminder™, used as a prompt to increase instructor delivery of behavior-specific praise and token reinforcement for behavior incompatible with stereotypy for students with autism spectrum disorder. In turn, it was expected that the increased delivery of reinforcement for behaviors incompatible with stereotypy would, in turn, lead to a reduction in the frequency of student stereotypic behavior.

1 Hofstra University, 2 Caldwell College, 3 The Genesis School/Eden II Programs. Author Note: This research was conducted by Mary E. McDonald, Counseling, Research, Special Education and Rehabilitation Department, Hofstra University, Sharon A. Reeve, Psychology Department, Caldwell College; Erin Sparacio, Plainview, New York. Correspondence concerning this article should be addressed to Mary E. McDonald, Counseling, Research, Special Education and Rehabilitation Department, Hofstra University, Hempstead, NY 11549. Email: Mary.E.McDonald@hofstra.edu

» METHOD

Participants

Three instructors who worked in a school program for students with autism participated. Dana, age 22, worked in the school

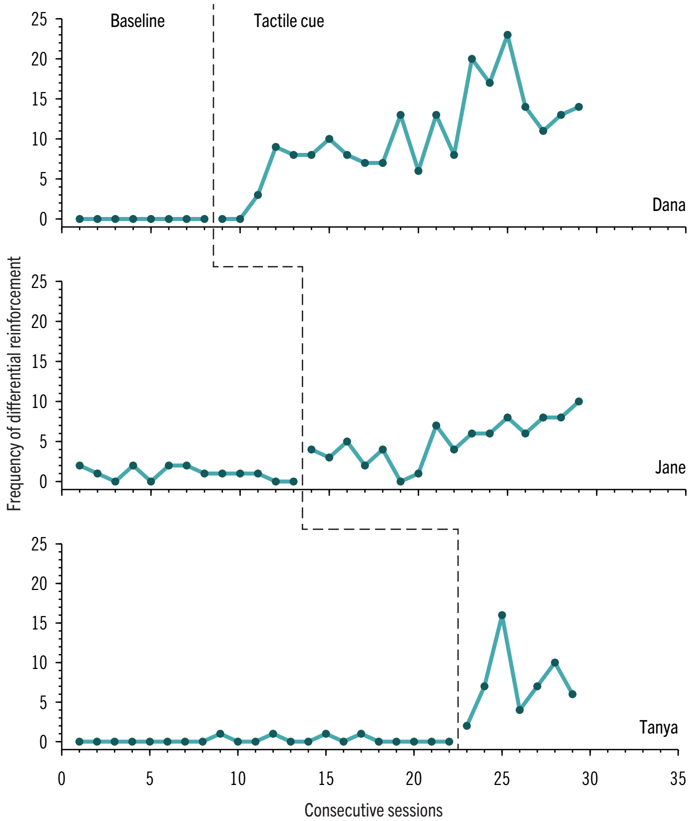

Figure 1. Frequency of reinforcement (behavior-specific praise and token reinforcement) delivery by instructors to student participants across baseline and training sessions.

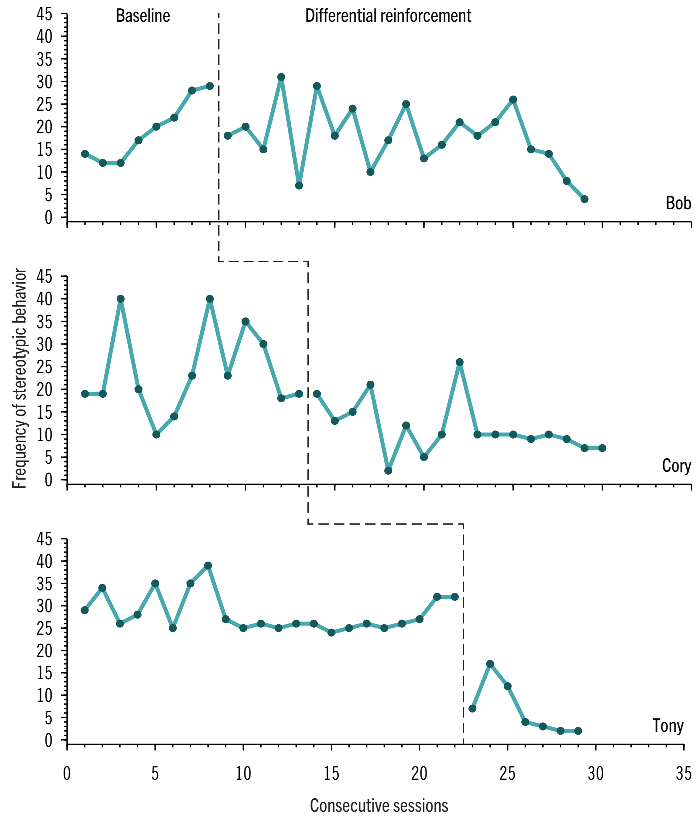

Figure 2. Frequency of stereotypic behavior emitted by student participants across baseline and training sessions.

program for 15 months prior to the onset of the study. Jane, age 20, worked in the school program for 12 months. Tanya, age 20, worked in the school program for 18 months. Instructors were selected for the study because they inconsistently implemented differential reinforcement for appropriate behavior when instructing their assigned students.

In addition, three students diagnosed with autism spectrum disorder participated. Bob, age 7, Cory, age 5, and Tony, age 10, had all attended the school for 3 months prior to the onset of the study. The students were chosen to participate because they engaged in high rates of stereotypic behavior that interfered with their learning. Bob engaged in twisting his hands together, clapping or flapping his hands, or hand gazing. Cory's stereotypic behavior included twisting his hands together, clapping, laying his hands palm up on a staff member, or hand gazing. Tony engaged in rubbing his finger tips together, hand flapping, and twisting his hands together.

For the study, instructors and students were paired as follows: Dana with Bob, Jane with Cory, and Tanya with Tony.

Setting

The study took place in a school program that served students with autism spectrum disorders and was based on the principles of applied behavior analysis. The study was carried out in each of the students' respective classrooms. Each classroom held tables, desks, and chairs for the students and instructor, bookcases, and shelving units containing student curriculum materials.

Materials

A tactile device, The Gentle Reminder™, was used to provide a vibrating tactile prompt to the instructors. Additionally, tokens, in the form of pennies, were used as part of a token economy. Back-up reinforcer choices were selected based on parent and teacher report and consisted of food items, preferred toys, books, and computer games.

Design

A multiple-baseline design across instructors was used to assess whether the tactile cue would increase instructor use of differential reinforcement for the absence of stereotypic behavior. Additionally, a second multiple-baseline design across students was used to assess whether the frequency of student stereotypic behavior decreased as a function of the instructors' increased use of differential reinforcement.

Response definitions and data collection

To be scored as a correct delivery of reinforcement, instructors were required to provide both behavior-specific praise and a token contingent on student behavior incompatible with stereotypy (e.g., hands at sides, hands in lap, hands on a table, sitting up straight, and feet flat on the floor). Behavior-specific praise consisted of the instructor vocally identifying the correct behavior in which the student was engaged (e.g., "Your hands are down, you are sitting nicely."). Tokens delivered were part of a token economy in which students could access their back-up reinforcer for every 10 tokens earned. Instructor delivery of reinforcement was scored as occurring in the presence of the tactile prompt when it was delivered within 2 seconds of the vibration. If reinforcement was delivered at any other time, it was scored as occurring in the absence of the prompt.

Stereotypic behavior was defined individually for each student. Bob's stereotypic behavior included a variety of inappropriate hand movements. These were defined as twisting hands together in a wringing motion other than when washing, drying or applying lotion to hands, clapping hands together with the exclusion of appropriate clapping during a show or when other students were clapping, flapping one or two hands or hand gazing which involved eye orientation toward one or two hands for more than 2 seconds. Tony's stereotypic behavior included inappropriate hand and finger movements. They were defined as rubbing fingertips together (at least 2 movements in the opposite direction), flapping one or two hands or twisting hands together in a wringing motion with the exclusion of washing, drying or applying lotion to hands washing his hands. Cory's stereotypic behavior included inappropriate hand movements. They were defined as twisting hands together in a wringing motion with the exclusion of washing, drying or applying lotion to hands washing his hands, clapping hands together with the exclusion of appropriate clapping during a show or when other students were clapping, laying one or two hands palm facing upward on any part of a staff member's body or hand gazing which involved eye orientation toward one or two hands for more than 2 seconds. To be scored as an instance of stereotypic behavior, each response was required to have at least a 2 second interval between its offset and the onset of the next response.

Procedure

During baseline, instructors engaged in a typical 30 minute teaching session with the student participant in their dyad. The tactile device was worn by the instructor but was not turned on. The instructors were told to provide behavior specific praise and tokens for correct responses by the students for the typical daily instructional materials as well as for behavior incompatible with stereotypy.

During training, the same 30 minute teaching sessions occurred and the tactile device was worn by the instructor. During training, the device was preset to vibrate every 10 minutes for a total of 3 times during the 30 minute session. The instructors were given the same directions provided during baseline but were also told that each time they felt a vibration (tactile cue), they should provide behavior specific praise and token reinforcement if the student was engaged in behavior incompatible with stereotypy at the time the tactile cue occurred.

Interobserver agreement

Interobserver agreement (IOA) data were collected on the frequency of token delivery and behavior specific praise by instructors during 35% of the sessions for both baseline and training. The primary observer was the instructor. The second observer wore a tactile device set to vibrate at the same interval as the instructor's to record when the vibration was delivered. This allowed the observers to record the instructor delivery of reinforcement in both the presence of the tactile cue and in its absence. IOA was computed by dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100. For Dana, IOA for delivery of reinforcement was 100% during baseline and 94% (range 93–98%) during the training phase. For Jane, IOA was 97% (range 95–100%) during baseline and 94% (range 92–100%) during training. For Tanya, IOA was 100% during baseline and 99% (range 98–100%) during training.

IOA data were also collected for the occurrence of stereotypic behavior by the students. For Bob, IOA was 95% (range 90–100%) during baseline and 96% (range 92–100%) during training. IOA for Cory was 92% (range 90–100%) during baseline and 94% (range 92–98%) during training. Tony's IOA during baseline was 99% (range 96–100%) and during training was 98% (range of 92–100%).

» RESULTS

Compared to baseline levels, there was a systematic increase in the delivery of reinforcement in response to the tactile cue by each of the instructors during the training phase. In addition, the use of reinforcement increased in the absence of the tactile cue across all of the instructors. As seen in Figure 1, for Dana, her delivery of reinforcement increased from a frequency of 0 during baseline to a mean of 10 (range 0–23) during training sessions. Jane's delivery of reinforcement increased from a mean frequency of 1 (range of 0–2) during baseline to a mean of 5 (range 0–10) during training sessions. Tanya's delivery of reinforcement increased from a mean frequency of .2 (range 0–1) to a mean of 7.4 (range of 2–16) during training.

There was also a systematic decrease in the students' stereotypic behavior after implementation of the tactile cue and the increased use of instructor reinforcement for behavior incompatible with stereotypy. As seen in Figure 2, Bob's stereotypic behavior gradually decreased from a mean frequency of 19.3 (range 12–29) during baseline to a mean of 17.6 (range 4–31) during training. Cory's stereotypic behavior decreased from a mean frequency of 23.8 (range 10–40) to a mean of 11.5 (range 2–26). Tony's stereotypic behavior decreased from a mean of 28.3 (range 24–39) during baseline to a mean of 6.7 (range 2–17) during training.

» DISCUSSION

In the present study, there was a systematic increase in instructor use of behavior-specific praise and token reinforcement after implementation of the tactile cue. This increase occurred in the presence of the vibration as well as in its absence. These findings are consistent with those obtained by Petscher and Bailey (2006) who found that a tactile cue was an effective method for increasing the delivery of token reinforcement by instructors to their students.

One interesting finding of the study was the increase in instructor reinforcement delivery in the absence of the tactile cue. Had the instructors only responded to the tactile cue, they would have provided tokens and behavior-specific praise a maximum of 3 times throughout the 30 minute session. This was not the case, however, as the instructors delivered reinforcement in the absence of the cue and increased their use of reinforcement greatly. Thus, minimal intrusion by the tactile device was needed to produce major gains in instructor behavior. It would be interesting to determine whether even fewer prompts would have been sufficient to produce similar increases in reinforcement delivery by the instructors.

Consistent with the increased delivery of reinforcement by instructors for behavior that was incompatible with stereotypy, each student's frequency of stereotypic behavior decreased substantially. These data are consistent with the notion that additional prompting may be needed for instructional staff to implement procedures consistently, thereby maximizing student success (Petscher & Bailey, 2006). Thus, the use of the tactile prompt in the present study provides one way in which instructional staff may be taught to more consistently apply behavioral interventions (Kraemer et al., 2008; Sterling-Turner et al., 2001).

One limitation of the current study was that instructor and student behavior were only observed in the same dyad. It would be interesting to determine whether the increased delivery of reinforcement by instructors would generalize to new students. Future studies utilizing the tactile prompt should consider programming and assessing generalization of reinforcement delivery with new student partners as well as across settings. In addition, it may be helpful to add a social validity measure to the study to determine whether instructors rate the intervention as helpful to them, whether they would be likely to use the intervention again, and whether they would recommend the intervention to a peer teacher. Finally, no maintenance data were collected in the present study to determine whether the increased delivery of reinforcement by instructors and the decreased frequency of stereotypic behavior by the students would continue. Although reinforcement delivery did occur in the absence of the vibration cue during training, it would be interesting to determine the effects of systematically fading the device, or by providing probe sessions during which the vibrating cue was not present.

In conclusion, the tactile cue used in the present study was successful in modifying instructor behavior, which led to positive collateral changes in student behavior. Implementing such prompts for instructor behavior requires little effort, and causes minimal disruption and intrusion in the classroom. Additional studies should examine their use for modifying other teacher behavior.

REFERENCES

Kraemer, B.R., Cook, C.R., Browning-Wright, D., Mayer, G.R. & Wallace, M.D.

(2008). Effects of training on the use of the behavior support plan quality evaluation guide with autism educators: A preliminary investigation examining positive behavior support plans. *Journal of Positive Behavioral Interventions, 10*, 179–189.

Lovaas, O.I. (1987). Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of Consulting and Clinical Psychology, 55*, 3–9.

McClannahan, L.E., & Krantz, P.J. (1993). On systems analysis in autism intervention programs. *Journal of Applied Behavior Analysis, 26*, 589–596.

Noell, G.H., & Witt, J.C. (1999). When does consultation lead to effective implementation? Critical issues for research and practice. *Journal of Special Education, 33,* 29–35.

Petscher, E.S., & Bailey, J.S. (2006). Effects of training, prompting and self-monitoring on staff behavior in a classroom for students with disabilities. *Journal of Applied Behavior Analysis, 39*, 215–226.

Phillips, K.J. & Mudford, O.C. (2008). Functional analysis skills training for residential caregivers. *Behavioral Interventions, 23*, 1–12.

Sarokoff, R.A. & Sturmey, P. (2004). The effects of behavioral skills training on staff implementation of discrete-trial teaching. *Journal of Applied Behavior Analysis, 37*, 535–538.

Sterling-Turner, H.E., Watson, T.S., Wildmon, M., Watkins, C., & Little, E. (2001). Investigating the relationship between training type and treatment integrity. *School Psychology Quarterly*, *16*, 56–67.

Weiss, M.J. (2005). Comprehensive ABA programs: Integrating and evaluating the implementation of varied instructional approaches. *The Behavior Analyst Today,* 6(4), 249–256.