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Potential Applications of Behavioral Fluency for Students With Autism

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Curricula for students with autism do not take into account levels of learning such as behavioral fluency. Behavioral fluency addresses accuracy as well as speed of response. We posit that fluency increases the functionality of skills for students with autism and should be systematically programmed into a curriculum. To discuss the application of fluency for students with autism, we present background related to response competence, critical learning outcomes associated with behavioral fluency, and how fluency fits into a hierarchy of learning. We apply the concept of behavioral fluency to individuals with autism and suggest that research continue.

The lifelong consequences of autism create a need for a wide range of effective educational and therapeutic programs. One of the most critical variables in effective education is the curriculum. As a scope and sequence of instruction, a good curriculum designates what students will learn and in what order (Engelmann, 1997). A curriculum identifies the terminal skills the student will display at the end of a program, allowing teachers to program instruction and monitor progress. An effective curriculum-based program for students with autism should result in functional behaviors, age-appropriate skills, and present connections within (e.g., adding basic math facts and later applying that skill to addition facts with regrouping) and across (e.g., a social skill like greeting people and a vocational skill like working at a cash register) curricular domains (Scheuermann & Webber, 2002). Good curricula function like a road map, providing the teacher with clear directions to a final destination. Currently available curricula, however, do not take into account levels of learning such as fluency. We posit that fluency increases the functionality of skills for students with autism and should be systematically programmed into a curriculum.

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BEHAVIORAL FLUENCY DEFINED

In general, the term *fluency* has entered into the vernacular for most people. When asking someone to provide synonyms for *fluency* (e.g., to describe a fluent speaker, dancer, or writer), words such as *smooth, flowing, accurate, graceful, automatic,* and *effortless* may be given. On a descriptive level such words capture the essence of fluency. A student who reads fluently is easily recognized from a student who does not. A child who speaks fluently sounds quite different from a child who has English as his or her second language or is learning to speak. In both cases, descriptors for dysfluent language behavior might include *halting, inaccurate,* and *slow.* Commonalties between words for fluency and dysfluency encompass accuracy and speed at which a person can perform a behavior. Although a number of researchers in education have studied fluency, basic observations supporting behavioral fluency came from an approach called Precision Teaching (PT). Explanations of the PT method fall beyond the scope of this article; however, many fluency articles have their empirical roots in PT.

Although researchers need to continue examining methods and variables responsible for the outcome of the fluency, the evidence base showing the positive effects of behavioral fluency is compelling (Beck & Clement, 1991; Binder, 1996; Johnson & Layng, 1992; Kubina & Morrison, 2000; Maloney, 1998). For example, Haughton (1972) observed that when students could answer basic math facts at about 40 to 50 digits per minute, they could learn more complex problems later in the curriculum sequence. The rate of answering 40 to 50 digit problems correctly, not just getting 100% correct, allowed the students to use those basic math facts fluently with advanced skills predicated on basic math fact fluency (e.g., complex addition—multiple digit problems with regrouping). Across time, individual and entire school performances have shown how fluency enhances student performance.

To discuss the application of fluency for students with autism, we present background related to response competence. Second, we explore critical learning outcomes associated with behavioral fluency and how fluency fits into a hierarchy of learning. Finally, we apply the concept of behavioral fluency to individuals with autism.

LEVELS OF LEARNING

Learning may be characterized as having several levels or stages indicating the degree of competence a student has obtained: acquisition, fluency, maintenance, and generalization (proposed by Alberto & Troutman, 2003). The first level of response competency is the acquisition stage or level that centers on the goal of accuracy (Mercer & Mercer, 2001). Differing levels of response competence means the behavior learned varies in functionality. For instance, a student who can identify eight colors at 100% accuracy may be said to have acquired color labeling. Although the student has attained accuracy, his competence with the acquired task may be questionable. For example, a student who can label eight out of eight colors correctly in 20 sec performs the behavior much more competently than a student who needs 1 min to correctly label the same eight colors.

Fluency means the student is both accurate and fast (Howell & Lorson-Howell, 1990). A student who labels colors fluently does so accurately but also with speed.

Asking a student "What color is this?" will result in an immediate correct response if she or he has attained fluency. The fluency or proficiency level's goal centers on the automatic performance of a skill (Mercer & Mercer, 2001; Wolery, Jones-Ault, & Munson-Doyle, 1992).

The next level of the response competence hierarchy, maintenance, suggests that a behavior will occur for an extended period of time without having to reteach the skill. A student who forgets the answer to a math fact like 1 + 1 = 2 will require additional review. By having to reteach a previously learned skill, the teacher and student lose instructional time that might otherwise be spent on new learning. If multiple skills require reteaching, the student's overall progress is considerably hindered.

At the peak of the hierarchy is generalization, or using a skill in situations different from acquisition. A teacher who had an initial instructional set of triangles could test for generalization by asking the student to identify triangles varying in degrees of shape, color, and spatial orientation (Engelmann, 1997). A skill that shows generalization allows the student to capitalize on the instruction and respond effectively in situations involving novel stimuli. Without generalization a student limits himself or herself to making responses matching the instructional set, a skill sure to encumber the student's future learning progress.

The relationships among the levels of response competence are not independent but interactive. Starting at the acquisition level, a student must firmly establish a response before she or he can attain accuracy and speed, or fluency. For maintenance, or long-term retention, the student must reach the fluency level. Without maintenance, the student will not generalize a skill beyond the initial instruction. An extensive amount of research describes varying curricula and successful approaches to acquisition for students with autism (e.g., Frost & Bondy, 1994; Leaf & McEachin, 1998; Maurice, Green, & Luce, 1996; Sundberg & Partington, 1998). In addition, approaches for producing maintenance and generalization of skills for students with autism exist (e.g., Dunlap, 1984; Lovaas, 2003; Maurice et al., 1996). Although work should continue related to the development of new curricula, attention to the technology of fluency must also be examined. As a recent development in the field of autism, the concept of fluency holds promise as an emerging technology (Weiss, 2001).

LEARNING OUTCOMES ASSOCIATED WITH BEHAVIORAL FLUENCY

As students progress through levels of learning, educators should assess whether the skills attained are functional and learned to a level where they can be used in everyday life. Three learning outcomes are associated with behavioral fluency: retention, endurance, and application. Frequency ranges called performance standards predict these outcomes.

Retention

Retention is the ability to retain information after a period of time during which a person has not had an opportunity for practice (Binder, 1996). Results from behavioral fluency research shows that as students become more accurate and/or attain fluency, they show

high degrees of retention (Berens, Boyce, Berens, Doney, & Kenzer, 2003; Brown, Dunne, & Cooper, 1996; Bucklin, Dickinson, & Brethower, 2000; Ivarie, 1986; Peladeau, Forget, & Gagne, 2003; Shimamune & Jitsumori, 1999). Figure 1 shows a visual representation of retention for a hypothetical student. In Figure 1, each tick mark on the line stands for 1 day. The first *X* on the first tick mark indicates that the student has met his goal and has stopped practicing a target skill. The next *X,* measured 47 days later, demonstrates how well the student has retained the skill. In this example, the student was asked to state the names and corresponding symbols from the periodic table of elements. The student learned the 29 transition metals (e.g., Cadmium—Cd, Nickel—Ni, Silver—Ag); 47 days later the teacher measured how well the student remembered the symbols for the names. If the student reached fluency, he would retain most if not all of the information. If the student did not reach fluency, the 47-day measure would reveal how much the student had retained. To gain fluency, the student must have both accuracy and speed, and, if desired, the student must practice naming the symbols with the names quickly and accurately.

Endurance

Endurance has characteristics similar to athletic stamina. For instance, a runner who has endurance runs at an even pace for a given distance (e.g., 400 m) and does not fatigue. When a student has endurance, he can perform at a steady pace for a given time (Binder, 1996) and is less resistant to distraction (Binder, Haughton, & Van Eyk, 1990). Research suggests students can overcome endurance problems as a result of increasing behavioral fluency (Berens et al., 2003; Binder et al., 1990; Haughton, 1980; Kim, Carr, Templeton, & Bird, 2001; McDowell & Keenan, 2001).

Figure 2 shows two profiles displaying the presence and absence of endurance. In the top line of the figure, each tick mark depicts 1 sec of time and the presence of a response. As shown in Figure 2, each response occurs one after the other in a rhythmic manner. The bottom of the figure shows a response that varies, appears disjointed, and does not proceed in an even manner. Binder et al. (1990) reported research showing the effects of endurance on numeral writing. Students practiced writing at varying time intervals on different days. The intervals ranges were 15 sec, 30 sec, 1 min, 2 min, 4 min, 8 min, and 16 min. Results indicated that students who wrote at a rate of 70 digits per minute showed a

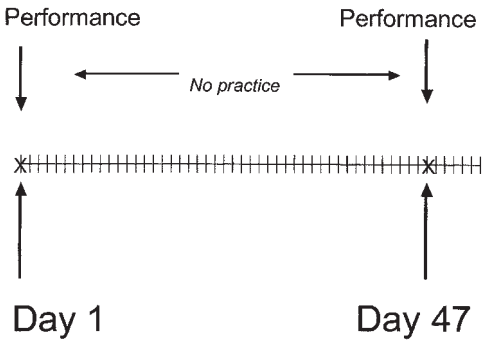

FIGURE 1 A visual example showing retention.

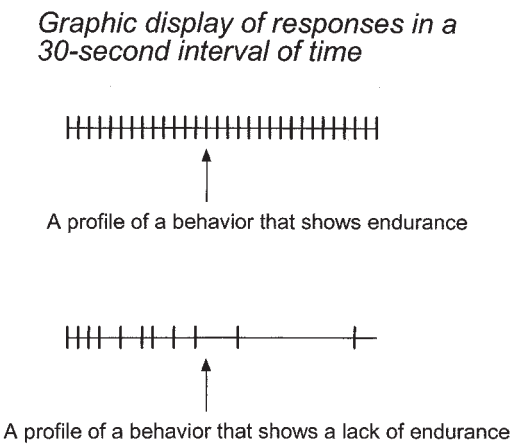

FIGURE 2 Two profiles showing the presence and absence of endurance.

similar performance across the timing intervals. Students who wrote fewer than 70 digits had problems when they attempted to write numerals for longer periods of time. Results from the study illustrated that fatigue, or lack of endurance, prohibited some students from successfully engaging in the writing task.

Application

Application refers to a relationship between component behaviors and a compound behavior. Figure 3 graphically illustrates how two component skills can affect a compound or composite skill. An example of a component skill is handwriting. A composite skill is the integration of multiple component skills such as writing an essay. One of the component skills involved in essay writing is handwriting. Fluent component skills have an effect on a composite skill (Barrett, 1979; Binder, 1996; Haughton, 1972, 1980). When the

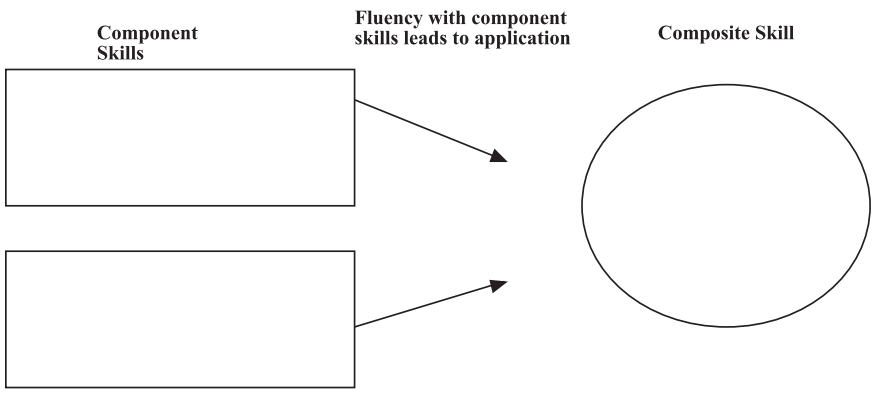

FIGURE 3 A model showing how two element or component skills can affect a compound or composite skill.

components reach fluency, teaching the composite occurs with greater facility (Binder, 1996; Haughton, 1980; Lin & Kubina, 2004). Behavioral fluency studies demonstrate support for the effective application of the components–composite relationship (Berens et al., 2003; Bucklin et al., 2000; Kubina, Young, & Kilwein, 2004; Lin & Kubina, 2004; McDowell & Keenan, 2002; McDowell, Keenan, & Kerr, 2002; McDowell, McIntyre, Bones, & Keenan, 2002; Smyth & Keenan, 2002).

Kubina et al. (2004) conducted a study showing how fluency with component behaviors helped students learn a composite behavior. The three students in the study were second-grade students with specific learning disabilities in reading. The students struggled to spell simple regular words like *mad, run,* and *he*. The intervention focused on building fluency with two component skills of the composite behavior. The component skills included hearing letter sounds and writing the corresponding letter (e.g., hear /h/ and write *h*) and segmenting words into their constituent sounds (e.g., hearing /had/ and saying each phoneme separately /h/ /a/ /d/) or developing phonemic awareness. As the participants became fluent with the two component skills, all three students performed the composite skill spelling regular words with 100% accuracy. The intervention never directly taught students how to spell words but instead only built fluency with the component skills.

Performance Standards

To achieve retention, endurance, and application, teachers and researchers use performance standards or fluency aims. Performance standards have a range of frequencies indicating a low and high end for fluency. Examples of performance standards for fluency include oral reading (i.e., 180 to 200 words per minute), writing answers to basic math facts (i.e., 70 to 90 digits per minute), and writing connected alphabet letters (i.e., 150+ words per minute; Beck & Clement, 1991; G. Freeman & Haughton, 1993a, 1993b). Performance standards serve as a numerical benchmark that predicts the occurrence of retention, endurance, and application (Johnson & Street, 2004). Haughton used the acronym REAPS (i.e., retention, endurance, application, performance standards) to describe the relationship between critical learning outcomes and behavioral fluency (Haughton, 1980; Lindsley, 1995).

BEHAVIORAL FLUENCY FOR STUDENTS WITH AUTISM

Although there is substantial empirical evidence for the use of behavioral fluency, a focused line of study demonstrating fluency and the critical learning outcomes for children with autism does not exist. However, incorporating fluency into the curriculum and other programmatic interventions holds great promise. Fluency may help students learn more and at a higher level. The following section provides examples of potential applications of behavioral fluency for students with autism.

Retention

Many curricula for students with autism focus on accuracy in skill attainment. For example, Taylor and McDonough (1993) broke the curriculum down into beginning, intermediate, and advanced skills. In a section entitled "Pre-academic Skills," the authors listed various matching skills such as matching pictures to identical pictures. With teacher instruction, a student could acquire the skill at a specified level of accuracy (e.g., 90%). However, accuracy will not necessarily result in long-term retainment of the skill.

Fluency, or accuracy plus speed, would require the student with autism to match the pictures very accurately and very quickly. Desired outcomes include that the student not only remembers the skill for long periods of time after instruction has ended but also performs the task with the regnant requirements in the environment. Further, students with behavioral fluency will also have opportunities to participate in activities and, thus, receive positive reinforcement. For example, during group instruction when the teacher holds up a yellow duck and asks, "What color is this duck?" the student who knows the answer will raise his or her hand and have the possibility of being called on and then receive verbal praise from the teacher for providing a correct answer. A student that needs 3 to 5 sec to identify a color will likely not have an opportunity to engage in the reinforcement contingency of providing an answer during group instruction. The potential research applications of fluency and retention extend to any skill and any desired time interval. As shown in Figure 1, an experimenter can insert a different skill and select any time interval and study the long-term retention effects associated with behavioral fluency.

Endurance

Simpson and Zionts (2000) noted that when students with autism become adults, they have a range of employment options open to them. To function in a workplace, a host of skills must reach the fluency level. Take the example of setting silverware in a restaurant. If a person is not fluent, then she or he will also lack endurance. As Figure 2 illustrates, if a person were to set silverware and lack endurance, her or his performance would be characterized by unsteady performance and susceptibility to distraction. Challenging behavior may be attributed to poor endurance. Binder et al. (1990) noted that students lacking endurance also may abandon a task or engage in escape behaviors due to the demands of the task. A lack of endurance could translate into so-called attention problems. Other examinations of endurance may indicate that the students stop or try to escape a skill not because they are uninterested in it but because a lack of endurance precludes the ability to successful engage in the behavior.

Application

As with almost any advanced skill, a number of component behaviors must be fluent. S. Freeman and Dake (1997) described a procedure to help students with autism learn whether they have enough money to purchase an item. The skills involved in the exercise

include using a structured sheet to record an item, the price of an item, and the amount of money the student has. If the person has enough money he or she can purchase the item. Some of the component skills necessary to make the exercise work effectively are handwriting, adding, and subtracting. If the student is slow in any of the components, the composite behavior of determining "Do I have enough money?" will be affected. The critical learning outcome of application is more than task analyzing a composite behavior and analyzing if a student can do it accurately. Behavioral fluency enhances the functionality of the skill.

Any composite skill may be subjected to an experimental investigation of application. Composite behaviors that contain two of more components have an effect on terminal behavior. How fast and accurately a student can perform the component behaviors directly relates to how fast the student can execute the composite behavior. Deficiencies in social skills are very common in students with autism (Volkmar, Carter, Grossman, & Klin, 1997). However, competent use of social skills requires a number of components including recognition of social cues, nonverbal behaviors, the reception and integration of social feedback, and the ability to discriminate social situations (Hazel, Schumaker, Sherman, & Sheldon-Wildgen, 1983). The difference between being accurate but slow versus fluent with a component skill may help advance the understanding and practice of social skill performance.

Performance Standards

Performance standard research could take the form of individually or jointly testing the effects of retention, endurance, and application. For instance, matching objects to identical objects may provide long-term retention, endurance, and application when a student can correctly match objects at a frequency of 10 objects per 10 sec, or 60 objects per minute. Because fluency involves accuracy and time, the resulting performance standards offer a standard measure all students can be compared with—frequency.

Although performance standards for some academic behaviors for students without autism exist (e.g., Beck, Conrad, & Anderson, 1996; Mercer, Mercer, & Evans, 1982), researchers can employ several methods to find performance standards for students with autism. Some of the methods include (a) data gathered from special projects and research, (b) peer fluency data, (c) adult–child proportional formula, and (d) adult fluency data (Binder, 1996; Koorland, Keel, & Ueberhorst, 1990).

CONCLUSION

The research database for behavioral fluency clearly shows positive and substantial effects of behavioral fluency for students with and without disabilities. Although effects have not yet been systematically extended to students with autism, fluency has the potential to produce the critical learning outcomes of long-term retention, endurance, and application for all students with autism. Certainly due caution is always warranted with new lines of research and subsequent practical applications; however, it appears that behavioral fluency has the potential to bring us a step closer to providing maximal learning for students with autism.

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