

Discrete Trial Training in the Treatment of Autism

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Discrete trial training (DTT) is a method for individualizing and simplifying instruction to enhance children's learning. For children with autism, DTT is especially useful for teaching new forms of behavior (e.g., speech sounds or motor movements that the child previously could not make) and new discriminations (e.g., responding correctly to different requests). DTT can also be used to teach more advanced skills and manage disruptive behavior. However, several cautions about DTT are noteworthy: First, the method must be combined with other interventions to enable children to initiate the use of their skills and display these skills across settings. Second, early in treatment, children with autism may require many hours of DTT per week, although controversy exists over precisely how much is appropriate. Third, to implement DTT effectively, teachers must have specialized training. Despite these limitations, DTT is one of the most important instructional methods for children with autism.

Typically developing children continually learn from their environment throughout their waking hours via exploration, creative play, modeling, conversation, and so on (Bredenkamp & Copple, 1997). Unfortunately, children with autism tend to have little skill or inclination to learn in this manner. Moreover, they often fail to understand communicative efforts made by adults attempting to help them learn (Spradlin & Brady, 1999). As a result, these children are likely to experience frustration in teaching situations, and, understandably, they may react to such frustration with tantrums and other efforts to escape or avoid future failures. Therefore, a critical yet difficult task for service providers is to find ways to increase learning opportunities for children with autism and enhance their motivation to learn.

Fortunately, investigators have conducted hundreds of studies on how to accomplish this task and have identified a wide range of effective approaches (Green,

2000). Perhaps the most extensively studied approach is an applied behavior analytic (ABA) procedure called *discrete trial training* (DTT). A discrete trial is a small unit of instruction (usually lasting only 5–20 seconds) implemented by a teacher who works one to one with a child in a distraction-free setting (For simplicity, this article will refer to “teachers” and “children.” However, it should be noted that not only teachers but also professional and nonprofessional therapists, including family members, can implement DTT, and that both children and adults with autism can benefit; Smith, 1993.) Each discrete trial has five parts:

1. *Cue* (technically called a discriminative stimulus): The teacher presents a brief, clear instruction or question, such as “Do this” or “What is it?”
2. *Prompt*: At the same time as the cue, or immediately after it, the teacher assists the child in responding correctly to the cue. For example, the

teacher may take the child's hand and guide him or her to perform the response, or the teacher may model the response. As the child progresses, the teacher gradually fades out and ultimately eliminates the prompt (e.g., guiding the student through less and less of the response) so that the child learns to respond to the cue alone.

3. *Response*: The child gives a correct or an incorrect answer to the teacher's cue.
4. *Consequence*: If the child has given a correct response, the teacher immediately reinforces the response with praise, hugs, small bites of food, access to toys, or other activities that the child enjoys. If the child has given an incorrect response, the teacher says “No,” looks away, removes teaching materials, or otherwise signals that the response was incorrect.
5. *Intertrial interval*: After giving the consequence, the teacher pauses briefly (1–5 seconds) before presenting the cue for the next trial.

Depending on the treatment program in which they are enrolled, children with autism may receive anywhere from a few minutes to several hours per day of DTT, as discussed later in this article. In programs at the high end of this range, children usually spend 2 to 5 minutes at a time in DTT sessions, with 1- or 2-minute breaks between sessions. They generally also receive a 10- to 15-minute

break at the end of every hour and a 1- to 2-hour break in the middle of the day. To maintain children's interest, teachers carefully select reinforcers and implement a diverse set of instructional programs (focusing on communication, academic skills, self-help, play, motor activities, etc.).

Three aspects of DTT may increase children's learning and motivation to learn. First, because each discrete trial is short, children have many learning opportunities (up to 12 per minute). Second, because teachers work one to one with a child, they can tailor instruction to meet his or her individual needs. Third, because DTT has a precise format, it clarifies the teaching situation for the child; specifically, every discrete trial has a definite starting and stopping point, and its components are kept simple (short instructions, salient prompts, etc.). Thus, DTT breaks down "the continuous flow of ordinary adult-child interactions into highly distinctive (discrete) events that are more easily discriminated by the child" (Newsom, 1998, p. 426). In this way, DTT maximizes children's successes and minimizes their failures.

Much research exists on how to select responses to teach in DTT and how best to cue, prompt, and reinforce these responses (Newsom, 1998; Schreibman, 1988; Smith, 1993). Moreover, studies have documented that DTT helps children with autism acquire a variety of skills in important areas such as communication, social interaction, and self-care (Newsom, 1998). In addition, some investigators have reported that when it is applied as part of a comprehensive ABA treatment program, DTT yields major long-term benefits for many children with autism (Smith, 1999), including increases in IQ and decreases in the need for professional services such as special education classrooms (e.g., McEachin, Smith, & Lovaas, 1993).

In addition to DTT, many other ABA methods are effective for children with autism. As pointed out by McClannahan and Krantz (2000), ABA treatment for autism "should not . . . be characterized by any one procedure, such as discrete trial instruction. . . . Although the dis-

crete trial paradigm is unquestionably useful, so are incidental teaching, time delay, peer tutoring, photographic and written activity schedules, script fading, and video modeling procedures" (p. 210). Hence, DTT is one important component of ABA treatment, but it should not be the only component. The present article is intended to elucidate the role of DTT in ABA treatment by describing its main uses; it also includes a discussion of the limitations of DTT, the amount of DTT that children with autism should receive, and the qualifications that teachers need to implement DTT proficiently.

Main Uses of DTT

Studies have indicated that DTT is especially useful for teaching children with autism to add new forms of behavior to their repertoires and to make new discriminations between events.

New Forms of Behavior

"New forms of behavior" are actions that children previously did not and could not perform. For example, many children with autism do not utter the speech sounds needed to say words or do not make the motor movements needed to use signs in sign language. In studies incorporating a scientifically sound design, DTT is the only approach with documented effectiveness for teaching these children to add new speech sounds to their repertoires and combine those sounds into words, syllables, and phrases (e.g., Lovaas, Berberich, Perloff, & Schaeffer, 1966; Young, Krantz, McClannahan, & Poulson, 1994). It is also the best-documented approach for teaching children to make signs in sign language (e.g., Carr & Dores, 1981). In addition, DTT may be the instructional method of choice for teaching a new, subtle motor movement, such as closing fasteners on clothing, writing or drawing, or cutting with scissors (Lovaas et al., 1981), although methods for teaching such behaviors have not been studied as extensively as methods for teaching communication behaviors.

When implementing DTT to teach new forms of behavior, the teacher selects a short, simple cue for the behavior that he or she wants the child to display. For example, the teacher might say, "Do this" while performing an action, to cue the child to perform this action. Immediately after the cue, the teacher prompts the child (e.g., by physically guiding the child to perform the action). In the early stages of instruction, the teacher might reinforce the child for giving an approximation of the action being taught—for example, if the action is clapping, the teacher might reinforce the child for simply putting his or her hands together. However, as the child progresses, the teacher requires closer and closer approximations of the correct action—a procedure called *shaping*. In addition, the teacher gradually fades out the prompts (e.g., provides less and less physical guidance). With systematic shaping and prompt-fading, the child learns to perform the behavior accurately when cued to do so by the teacher. The amount of time required for this teaching varies from a few minutes to several weeks, depending on the behavior and the child. Even when it is relatively lengthy, however, DTT enables children to acquire many new and important forms of behavior that they would otherwise be unable to use. (See Lovaas et al., 1981, for a more detailed description of DTT procedures.)

New Discriminations

Discriminations involve giving different and accurate responses to different cues. For example, if a teacher holds up a doll and asks, "What is it?", the correct response is "doll" and not, for example, "car." Likewise, if the teacher holds up a car and asks, "What is it?", the correct response is "car" (and not "doll"). When implementing DTT to help a child make discriminations, the teacher uses the cuing, prompting, and shaping procedures described above to teach the child one response, such as "doll." Once the child has mastered this response, the teacher uses the same procedures to teach a second response, such as "car." After

mastery of the second response, the teacher alternates between cues for these two responses so that the child learns to discriminate between cues. For example, the teacher may hold up a doll and ask, "What is it?" in one learning trial, then hold up a car and ask, "What is it?" in the next two learning trials, then return to the doll in the following learning trial, and so on. At this stage, the teacher may need to reintroduce prompts in order to help the child respond correctly. The teacher also needs to be on the alert for strategies the child may be using to respond correctly without learning the discrimination. For example, the teacher may inadvertently mouth the correct word, and the child may respond to this action rather than to the presentation of the item. Also, the child may repeat the last response that was reinforced rather than attending to the object the teacher holds up. However, skilled teachers can usually overcome these difficulties so that the child is truly discriminating between cues (see Lovaas, 1977, for more details). Once the child has made this discrimination, the teacher can introduce additional cues one at a time until the child is discriminating among many different ones.

DTT is the best-studied approach for beginning instruction in the following important kinds of discriminations:

Imitation. Imitation is defined as giving a response that is identical to a cue (e.g., clapping when the teacher claps). Many children with autism have few or no imitation skills. DTT is the only teaching method that has been clearly shown to enable such children to imitate actions such as clapping or waving, play activities such as rolling a car, and speech sounds such as "aaah" and "mmm" (Coe, Matson, Fee, Manikam, & Linarello, 1990; Lovaas, Frietas, Nelson, & Whalen, 1967; Young et al., 1994). Teaching these imitation skills is critical because children can learn to perform tasks by watching teachers and others demonstrate them.

Receptive Language. Receptive language involves performing an action in response to a verbal cue (e.g., picking up a doll when the teacher says "doll" and

picking up a car when the teacher says "car"). Almost all children with autism either lack receptive language or are delayed in their development of this skill, relative to other children their age. DTT is the teaching approach with the strongest empirical support for helping children with autism who lack receptive language begin to acquire it (e.g., Lovaas, 1977).

Expressive Language. Expressive language consists of giving a verbal response to a visual cue (e.g., saying "doll" when the teacher holds up a doll and "car" when the teacher holds up a car). As with receptive language, almost all children with autism have no expressive language or are behind other children their age, and DTT is the only approach with data-based evidence of effectiveness for enabling such children to begin learning this skill (Howlin, 1981).

Conversation. Conversation entails giving verbal responses to verbal cues (e.g., answering questions or responding to a statement with another statement on the same topic). With DTT, teachers can instruct many children with autism to start conversing (Hung, 1977; Krantz & McClannahan, 1981).

Sentences, Grammar, and Syntax. Grammar and syntax involve the use of language to describe relations between objects (e.g., which object is bigger) or between elements of a sentence (e.g., who did what to whom). DTT is the most extensively validated approach for advancing children from speaking in single words to using sentences (e.g., Risley, Hart, & Doke, 1972). It has also been used successfully to teach plurals (Baer, Guess, & Sherman, 1972), adjectives (Risley et al., 1972), *yes/no* (Hung, 1980), opposites such as *big/little* and *hot/cold*, prepositions, pronouns, and time relations such as *first/last* and *before/after* (Lovaas, 1977).

Alternative Communication Systems

Because some children with autism have great difficulty acquiring spoken lan-

guage regardless of the instructional approach, investigators have examined how to teach alternative communication systems, especially sign language and picture communication systems. Consistent with the findings for spoken language, DTT is the only method shown to be effective for teaching children their first words and phrases in sign language (Carr & Dores, 1981; Carr, Kologinsky, & Leff-Simon, 1987). DTT also can play a central role in teaching picture communication systems, in which children select a picture to indicate what they want. As a prerequisite for learning such systems, children need to be able to match pictures with the objects that correspond to them (e.g., putting a picture of a cookie with a cookie; Ronski & Sevcik, 1996). Children with autism may require DTT in order to learn to match (Lovaas, Koegel, & Schreibman, 1979). Some of these children also require DTT to proceed from matching to using picture communication systems, though others can learn such systems in a classroom setting if a specially trained aide assists them (Schwartz, Garfinkle, & Bauer, 1998).

Additional Uses of DTT

Expanding Children's Skills

Once children have acquired the forms of behavior and discriminations outlined in the preceding section, teachers often have the choice of either continuing to use DTT or employing other instructional methods. This section presents some common situations in which this choice arises and the alternative methods that might be effective. A subsequent section ("Limitations of DTT and the Need for Other Forms of Instruction") presents considerations that teachers should take into account when making such a choice.

Teachers can implement DTT to expand vocabularies in children with autism who have already acquired some receptive and expressive language (Lovaas, 1977). However, incidental teaching approaches may also be effective (McGee, Krantz, Mason, & McClannahan, 1983; McGee, Krantz, & McClannahan, 1985;

Miranda-Linne & Melin, 1992). In incidental teaching, the teacher sets up environments that encourage the child to initiate activities and then instructs the child in the context of the activities he or she has chosen. Thus, the teacher may put toys in sight but out of reach of the child. In the first step of instruction, whenever the child attempts to gain access to one of the toys, the teacher may say the name of the toy and require that the child repeat the name before receiving the toy. Once the child has mastered this step, the teacher may increase the difficulty of the task by asking a question such as, "What do you want?" rather than saying the name of the object. Subsequently, the teacher may stop saying anything at all and simply look at the child expectantly until the child states the name of the object.

Similarly, once children learn conversational statements, teachers can continue using DTT to teach additional conversational statements (Krantz & McClannahan, 1981; Lovaas, 1977). However, Charlop and Milstein (1989) found that such children could also expand their repertoires of conversational statements by watching videotapes in which models demonstrated these statements. In addition, Krantz and McClannahan (1993) instructed children to read scripts that prompted them to converse with peers. As children progressed, words were gradually removed from the scripts. Eventually, children conversed without the aid of a script.

After children have learned to imitate play activities, teachers can use DTT to develop further play skills. For example, they can request that children imitate a series of two play activities ("Do this and this"), then a series of three activities, and so on (Lovaas et al., 1981). However, investigators have identified other viable instructional approaches. In one study (Carr & Darcy, 1990), children with autism were instructed to observe and imitate an action performed by a typically developing peer. Then, the peer was asked to guide the children with autism through a follow-the-leader game in which the children imitated a series of play activities demonstrated by the peer. In another

study, Stahmer and Schreibman (1992) instructed children with autism to refer to a picture schedule to guide them through a series of play activities without adult supervision. The picture schedule was composed of photographs that illustrated each activity.

DTT and picture schedules are also two feasible approaches for teaching complex daily living skills. For example, DTT can be used to teach children each step involved in setting the table and to perform those steps in sequence (selecting utensils, placing them in the right location on the table, bringing out plates, and so on). However, teaching children to refer to picture schedules may also be an effective method for enabling children with autism to carry out this task (McClannahan & Krantz, 1999)

Management of Disruptive Behavior

Extensive research literature exists on how to reduce the rate of disruptive behaviors displayed by children with autism and how to replace such behaviors with alternative, more adaptive behaviors (Matson, Benavidez, Compton, Paclawsky, & Baglio, 1996). This research has yielded a sophisticated set of methods for modifying children's everyday environments, both to discourage disruptive behavior and to reinforce adaptive behavior. In addition, it has highlighted some applications of DTT for behavior management. For example, as noted in the introduction, children with autism may attempt to escape or avoid almost all teaching situations, as well as any requests that adults make of them. One way to address this problem is for the teacher, during DTT, to request actions that the child is likely to perform successfully (e.g., putting a block in a bucket, sitting down in a chair), reinforce the child for correct responses, and disregard the child's efforts to escape the teaching situation (Carr, Newsom, & Binkoff, 1980; Piazza, Moes, & Fisher, 1996). An alternative to DTT involves attempting to build rapport by following the child's lead (e.g., imitating the child's actions, engaging in activities the child

is familiar with and enjoys; Dawson & Adams, 1984; Koegel, Dyer, & Bell, 1987). However, it is unclear whether the latter approach by itself can significantly reduce escape behavior that occurs in response to teaching efforts or requests. Therefore, many programs combine rapport-building with DTT (e.g., Smith, Donahoe, & Davis, 2000).

Another application of DTT in behavior management is as a method for teaching alternative, adaptive behaviors to take the place of disruptive behaviors. For example, a teacher might use DTT to teach a child to verbally request a desired object or activity, instead of having a tantrum to get it (Carr & Durand, 1985). These alternative behaviors can sometimes be taught in the context of ongoing, everyday interactions (Koegel, Koegel, & Dunlap, 1996), but DTT is also a viable method for teaching such behaviors.

Limitations of DTT and the Need for Other Forms of Instruction

Although DTT has many important uses in the treatment of children with autism, it also has significant limitations. During DTT, children are responding to cues from the teacher; consequently, they may not learn to initiate behaviors in the absence of clear cues. For example, they may use play skills only when asked to do so, not when they see toys. Additionally, in DTT, the teacher sets up a tightly controlled learning environment. Children may not transfer skills acquired in DTT to other environments, such as classrooms or family settings. For example, they may use a skill only if there are no distractions, if they are interacting individually with an adult, or if they are given a particular cue to use the skill. Finally, DTT is highly labor intensive in the sense that teachers work individually with a child and continually provide cues.

Incidental teaching approaches, in which teachers respond to the child's actions rather than vice versa, have proven to be particularly helpful for encouraging children to initiate the use of skills they

have acquired (reviewed by Matson et al., 1996). Both incidental teaching and other instructional approaches, such as peer models, videotapes, and picture schedules, involve a more flexible format than DTT. Thus, these approaches may (a) be more effective than DTT for helping children transfer skills to new settings and (b) impose fewer requirements on teachers to present cues to children.

Because of the utility of DTT for helping children learn skills and the utility of incidental teaching and other approaches for fostering initiation, transfer of skills, and independence from teacher cues, these methods often complement each other. In particular, when instructing children to use new forms of behavior and make new discriminations, teachers might begin with DTT. After the children achieve mastery in DTT, the teachers might switch to other instructional approaches (e.g., incidental teaching). When expanding skills, teachers may follow this same sequence, or, as previously described, they may dispense with DTT and rely on alternative methods. No studies have examined how teachers determine which of these two approaches to expanding skills is preferable. Thus, at present, this determination is more of an art than a science, with the appropriate choice probably depending on the child (how well the child learns in DTT vs. other formats) and the skill (how easy or hard it tends to be for the child with autism to learn).

Amount of DTT

The question of how much DTT children with autism should receive has generated much debate. Unfortunately, however, scant data exist to move this debate forward. As noted in the previous section, children's individual learning styles are likely to be one important factor in determining the appropriate amount of DTT. Skill level is probably another important variable, as children who have already acquired communication, play, and social skills may require less DTT than children who lack those skills.

Age is the factor that has received the most attention. Studies have made clear that DTT is an effective method for teaching new skills to individuals with autism at any age (Newsom, 1998). However, controversy has arisen over whether intensive DTT (15–40 hours per week for 2 or more years) is appropriate for young children with autism. Several studies have indicated that intensive DTT may yield major gains for children with autism who enter treatment at the age of 2 to 3 years (Smith, 1999) and perhaps also for high-functioning children (those having communicative language and full scale IQs above 60) who begin treatment at the age of 4 to 5 years (Eikeseth, Smith, Jahr, & Eldevik, 2001). Reported improvements have included average IQ increases of 20 points, similar increases on other standardized tests, and placement in less restrictive classrooms than are usually offered to children with autism (Smith, 1999). The largest gains have been reported in the program with the most intensive services (40 hours per week; Lovaas, 1987).

Considering these findings, some professionals strongly recommend 40 hours per week of DTT for children with autism who begin treatment prior to the age of 4 or 5 years (e.g., Green, 1996). However, others have argued that because existing studies have had many weaknesses, the reports of large gains may not be valid. Furthermore, it has been suggested that even if intensive DTT does yield large gains, the costs outweigh the benefits, given that the intervention is expensive and potentially stressful for children and their families (e.g., Schopler, Short, & Mesibov, 1989). Additional investigation is necessary to resolve these uncertainties.

Unfortunately, in the absence of definitive studies, many disputes have arisen between families and service agencies, with families requesting intensive DTT and agencies demurring (Feinberg & Beyer, 1998). In this author's judgment, the balance of evidence indicates that intensive DTT is appropriate for most children with autism who enter treatment at age 2 to 3 years, and that this intervention may also be appropriate for

high-functioning children who enter treatment at age 4 to 5 years. However, existing research does not support any firm conclusions.

Regardless of when children with autism begin treatment or how much DTT they receive at that stage, they should require less and less DTT over time. As previously discussed, when children progress in treatment, approaches other than DTT become viable. Indeed, some children may reach the point where they can succeed in classrooms for typically developing children without special assistance (Lovaas, 1987; Smith, Groen, & Wynn, 2000). However, other children continue to require such assistance throughout their schooling, and these children may benefit from continuing to receive DTT. From clinical experience, Smith, Donahoe, and Davis (2000) suggested 10 hours per week as an appropriate amount for most children with an ongoing need for DTT after the age of 5 years, but empirical research is needed to test this suggestion.

Qualifications for Providing DTT

Professionals have distinguished between two levels of proficiency for providing DTT. At the first level, teachers can implement DTT procedures correctly with supervision, but they are not trained to develop DTT curricula for individual children, to instruct new teachers to implement DTT, or to troubleshoot when problems arise (e.g., when a child is making slow progress). At the second level, teachers are trained to carry out all of these responsibilities and thus can supervise children's DTT programs. Studies have indicated that to reach the first level, most teachers need 25 to 60 hours of supervised experience (Koegel, Russo, & Rincover, 1977; Smith, Buch, & Gamby, 2000; Smith, Parker, Taubman, & Lovaas, 1992). To reach the second level, teachers may need a year or more of fulltime, supervised practicum training (Smith, Donahoe, & Davis, 2000) so that they can obtain extensive experience working with different children with au-

tism, become expert not only on DTT but also on other instructional methods, and acquire skills needed to assess children's progress.

More generally, teachers may need to possess these qualifications to supervise any appropriate treatment program for children with autism (whether or not the program emphasizes DTT). Autism is, after all, a complex disorder, and an array of interventions is required to help children with their special learning challenges (Newsom, 1998). Unfortunately, there is a substantial shortage of teachers who have such qualifications, and although professionals are working to alleviate this problem, it is likely to persist for the foreseeable future.

Discussion and Future Directions

The present review has presented DTT as a necessary but not sufficient element of ABA treatment for children with autism. DTT is the only instructional method shown by empirical research to be effective for teaching many new forms of behavior and new discriminations to these children. However, children also require incidental teaching and other instructional approaches to initiate the use of skills they have acquired, transfer those skills to new settings, and reduce their reliance on cues from the teacher.

Future research is unlikely to change this overall conclusion. Given that children with autism need highly individualized, simplified instruction, DTT will probably remain a key component of treatment. Given that DTT creates a tightly controlled environment, other approaches will probably continue to be necessary for encouraging children to transfer skills to other environments and initiate their use.

Nevertheless, as is evident from this review, investigators have much work to do to determine how best to combine DTT with other approaches, how much DTT children should receive, and how to increase the supply of teachers qualified to provide it. Moreover, recent research on child development and on discrimina-

tion learning may reveal ways to enhance DTT (Wilkinson & McIlvane, 1997). Thus, the outlook is favorable for the continued evolution and improvement of DTT, which may substantially benefit children with autism.

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