DECREASING THE INTENSITY OF REINFORCEMENT-BASED INTERVENTIONS FOR REDUCING BEHAVIOR: CONCEPTUAL ISSUES AND A PROPOSED MODEL FOR CLINICAL PRACTICE

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Behavioral interventions that include reinforcement as a treatment component have proven quite effective in decreasing problem behavior in children and individuals with developmental disabilities. These interventions are typically initiated with frequent, immediate reinforcement to increase the likelihood of success and schedules may then be thinned to more clinically manageable schedules to promote generalization and maintenance of treatment effects. Immediate reinforcement can also be delayed to the same effect. However, there are currently no specific procedural guidelines for decreasing the intensity of effective behavioral interventions. The current paper examines several conceptual issues regarding procedures for decreasing the intensity of behavioral interventions and presents clinical and research suggestions.

Behavioral interventions have proven quite effective in decreasing problem behaviors of children, especially those with developmental disabilities (Carr, Coriaty, & Dozier, 2000; Carr, Yarbrough, & Langdon 1997; Watson & Gresham, 1998). Many behavioral interventions used to reduce behavior incorporate reinforcement as a treatment component in the form of differential reinforcement of appropriate behavior (DRA), differential reinforcement of other behavior (DRO) or noncontingent reinforcement (NCR) (Carr, Coriaty, Wilder et al., 2000; LeBlanc, Le, & Carpenter, 2000). In an attempt to increase the likelihood of success, such interventions typically involve frequent and immediate delivery of high-quality reinforcers when treatment is initiated (Hagopian, Fisher, & Legacy, 1994; Miltenberger, 1997). Once the intervention has proven effective, the intensity of the intervention is gradually decreased over time by either reducing the frequency of reinforcement or implementing a delay to reinforcement.

Interventions of decreased intensity are beneficial for several reasons. First, frequent, and immediate delivery of reinforcers often is unmanageable in natural settings (Fisher et al, 2000). For example, a parent may not be able to provide continuous attention for their child during each visit to the doctor or during an important telephone conversation. Second, less labor intensive interventions may result in greater overall treatment integrity. Interventions that are labor intensive or attract undue attention in natural settings are less likely to be implemented consistently than interventions that appear more natural and are easier to implement. Third, less intensive interventions characteristically are more similar to naturally occurring contingencies than highly intensive interventions, promoting generalization of treatment effects to everyday settings (Stokes & Baer, 1977).

Unfortunately, several problems may arise when attempting to decrease the intensity of behavioral interventions. First, treatment gains may be lost as interventions become less intensive. For example, Hagopian, Fisher, Sullivan, Acquisto, and LeBlanc (1998) found that effective functional communication training with extinction interventions failed to remain effective in 60% of cases when schedule thinning or delay to reinforcement was initiated. Second, there are no accepted algorithms or even general strategies that identify specifically how the intensity of interventions should be reduced. The intensity of interventions can be manipulated along several dimensions, including the frequency of reinforcement, the delay of reinforcement, and the characteristics (e.g., magnitude, quality) of the reinforcing events. Researchers have failed to compare the effects of altering these dimensions. Most studies that have systematically examined strategies for reducing the intensity of reinforcement-based interventions for reducing behavior have manipulated the frequency of reinforcement (Lalli, Casey & Kates, 1997; Piazza, Moes, & Fisher, 1996). Even in this area, little evidence exists to guide how quickly we should decrease intensity, or even what the initial intensity of the intervention (i.e., rate of reinforcement) should be. The research that exists has primarily been conducted under highly controlled analogue conditions, making it somewhat difficult to translate findings into useful clinical guidelines for practitioners. Rather than clear guidelines that promote systematic, effective, and efficient methods for decreasing intervention intensity, common lore and best guesses are frequently used in clinical settings.

The purpose of the present manuscript is to consider some issues relevant to reducing the intensity of reinforcement-based interventions and to offer some suggestions for doing so in applied settings. First, we describe clinical variations of schedule thinning and delaying reinforcement and their corresponding behavioral processes. Second, we briefly review the existing literature on efficacy of methods for decreasing the intensity of behavioral interventions. Third, we provide a proposed model for determining how quickly progress can be achieved in individual cases. Finally, we offer suggestions for further research. Because several studies have examined procedures used to reduce problem behaviors in children and individuals with disabilities, attention will be focused on this area. Many of the general issues discussed in this context also are relevant to reducing the intensity of reinforcement-based procedures intended solely to increase appropriate responding.

PROCEDURES FOR DECREASING INTERVENTION INTENSITY

To the best of our knowledge, there are no published formal decision rules for decreasing intensity. The result is that many well-intentioned behavior analysts are left without clear plans for quickly reducing the intensity of their interventions to a level that is appropriate for clients' everyday environments. Thus, many clinical behavior analysts must rely solely on clinical lore and intuition or do not decrease intensity at all. When intensity is decreased, the progression is usually slow and deals solely with frequency of reinforcement. In actuality, as discussed in the next section, interventions may be decreased in intensity along several dimensions. Distinguishing among these dimensions is of practical as well as theoretical significance, and is made easier by use of accurate and consistent terminology.

The term "fading" is frequently used to refer to all procedures for making interventions less intensive and more manageable (e.g. schedule thinning, delaying reinforcement, prompt reduction). This term is appropriate when used to refer to gradual reductions in the frequency or intensity of prompts or other antecedent stimuli, but it is inappropriate when used to describe decreases in the frequency of reinforcement (or punishment) alone (Martin & Pear, 1999; Miltenberger, 1997). "Fading" also is inappropriate when used to refer to procedures that involve increasing delay to reinforcement (or punishment) in the absence of antecedent stimulus manipulations.

"Schedule thinning," or "thinning," is an appropriate term for referring to decreases in the frequency of reinforcement (or punishment) (Cooper, Heron & Heward, 1987; Martin & Pear, 1999). Schedule thinning involves either an increase in the response requirements before delivery of a reinforcer or an increase in the time interval preceding delivery of a stimulus. Common practice involves thinning the schedule by a small increment, then continuing to thin the schedule as long as the intervention remains effective. For instance, a fixed-ratio 1 (FR 1) schedule of reinforcement might be thinned to FR 2, 3, 4, and so on until a terminal value, perhaps FR 25, is achieved. If problems arise, the schedule returns to a previously successful level, a manipulation frequently called "backing up," and is retained at that level until positive effects are again achieved. At that point, thinning begins again. While such practices promote slow steady progress, they do not ensure that the intervention will reach a manageable intensity as rapidly or as efficiently as possible.

A third set of procedures involves systematically increasing the delay to reinforcement. In practice, this often involves gradually introducing a delay or "wait" period between the occurrence of the target response and the delivery of the reinforcer for the response, and then increasing the delay until the procedure can be sustained in the participant's everyday environment.

Attempts to deal with problem behaviors in research settings and in naturalistic environments often combine elements of fading and schedule thinning, and some of them include increasing delay to reinforcement. Nonetheless, it is important to distinguish among the three general techniques for reducing the intensity of interventions. These techniques involve different kinds of environmental manipulations and may differ in their effects. Moreover, they may not be equally appropriate in a given situation and should not be viewed as interchangeable. The following sections deal specifically with schedule thinning manipulations, which are widely used for reducing the intensity of reinforcement-based response-reduction procedures.

Schedule Thinning: Differential Reinforcement of Alternative Behavior

Under a differential-reinforcement-of-alternative-behavior schedule (DRA), reinforcers are delivered dependent on the occurrence of a response that is incompatible with the behavior targeted for reduction. When schedule thinning is incorporated into DRA interventions, an increasing number of occurrences of the targeted appropriate behavior typically must occur before the reinforcer is delivered. The schedule is typically increased from a continuous (FR 1) reinforcement schedule to an intermittent FR or variable-ratio (VR) schedule. For example, if a child exhibited problem behavior in academic work settings, the function-based intervention might involve differential reinforcement of completion of tasks or communication. The intervention might begin with every instance of task completion resulting in access to reinforcers. Gradually the child would have to comply with multiple commands or complete multiple tasks to gain access to reinforcers. Piazza et al. (1996) demonstrate schedule thinning with a DRA procedure to treat the escape-maintained aggressive behavior of a child with autism. Schedule thinning progressed in increments of one until they reached a terminal value of FR 28. The reinforcer in this case was termination of the demand context (a negative reinforcer) and the thinning procedure was quite lengthy but effective.

Hagopian et al. (1998) illustrate another example of this type of schedule thinning with their treatment of escape-maintained problem behavior by establishing a communication response as an alternative behavior. They progressed from an FR 1 to an FR 5 schedule before switching to a VR schedule that more closely approximated contingencies in the natural environment. Under a VR schedule, on average every *n*th response produces the reinforcer, but the number of responses required for reinforcement varies across a prearranged series of values. For example, on average every 10th response is reinforced under a VR 10 schedule, but specific reinforcers might be delivered following as few as 1 or as many as 25 responses. The reader should note that when schedules are thinned by increasing ratio requirements, the time between reinforcers usually increases also, because it take more time to meet the new response requirements.

Procedures that involve thinning schedules by increasing ratio requirements are best used with appropriate behaviors that you want to see occur at moderate to high and steady or increasing rates. A secondary effect might be the decrease or elimination of problematic behavior. Common targets might include completion of chores, compliance with simple directives, exercise for children with weight problems, medication compliance, and completing academic assignments.

Ratio-based thinning procedures should not be used if high rates of the reinforced behavior could cause problems, as is the case with many communication-based interventions. For example, consider a school student who exhibits escape-maintained disruptive behavior during independent seatwork. The student might be taught to engage in an alternative appropriate behavior (e.g., raising a hand to ask for help) when asked to complete work independently. Problem behavior may decrease because hand raising now produces escape and task-related social interactions. While raising a hand to request help is a preferred alternative behavior, it is not desirable to have a child raise her or his hand at a high rate throughout independent seatwork. Here, an increasing ratio schedule in all likelihood would engender a topographically and functionally appropriate behavior that constitutes a problem because of its excessive rate. Interventions meet their doom when children ask repeatedly for things or incessantly perform any of a wide range of behaviors that are highly desirable when less frequent and are annoying when more frequent. It is indeed possible to have too much of a good thing. Additionally, children should not need to ask for help repeatedly before receiving it; however, it is reasonable to expect a child to ask once and then wait (delay to reinforcement) for that assistance while a teacher works with other children.

Schedule Thinning: Time-Based Procedures

Two common interventions that involve increasing time-based schedules are differential-reinforcement-of-other-behavior (DRO) and fixed-time (FT) schedules. In the applied literature, FT schedules are commonly referred to as noncontingent reinforcement (NCR) schedules, or enriched environments. Schedule thinning with DRO procedures involves an increasing interval of time without the occurrence of the target behavior before the reinforcer is delivered. For example, Vollmer, Iwata, Zarcone, Smith, and Mazaleski (1993) initially implemented a DRO 10-s for self-injurious behavior. That is, if 10 seconds passed without the occurrence of self-injury, a reinforcer was delivered. Upon the occurrence of self-injury, a new 10-s interval was initiated. The interval was reset each time self-injury occurred. The length of the DRO interval was gradually increased until 5 min elapsed without self-injury before the reinforcer was delivered.

In general, thinning DRO schedules is possible only in situations where an adult can provide high levels of monitoring for the behavior that is to be decreased. For example, it might be possible to reduce how often an older sibling inappropriately took toys from a younger sibling by reinforcing gradually lengthening intervals during which toys were not stolen. This procedure would be effective only if theft could be detected accurately and DRO intervals could be accurately monitored and reset if needed.

DRO arrangements do not necessarily foster appropriate behavior and are schedules of reinforcement only in the sense of increasing intervals of specified length during which a target behavior fails to occur (Poling & Ryan, 1982). Put differently, they reinforce the *omission*, not *emission*, of behavior. Therefore, although DRO arrangements may be effective in reducing undesired behavior, they must be augmented to produce desired responding. It is noteworthy that DRO arrangements may be used effectively when a strong repertoire of appropriate behavior exists but is not often used in favor of inappropriate behaviors. For example, LeBlanc, Hagopian, and Maglieri (2000) implemented DRO for a man with inappropriate social behaviors who already had an extensive repertoire of appropriate social behaviors.

Under FT schedules (i.e., NCR procedures), a stimulus demonstrated to be a positive reinforcer in another setting is delivered at preset intervals regardless of the occurrence or non-occurrence of behavior. Thinning of FT schedules involves a gradual increase in the interval before presentation of the stimulus. There is no dependency between a target behavior and the presentation of the stimulus. A common initial schedule for NCR is continuous access or near continuous access to the reinforcer. Gradually, the schedule is thinned until stimuli are available only periodically, perhaps every 1-2 minutes or eventually every 10-20 minutes. Hagopian et al. (1994) illustrated the importance of schedule thinning in NCR with attention-maintained problem behavior of quadruplets. NCR was unsuccessful when started at a FT 5-min schedule but was effective when begun with near continuous attention (FT 10-s) gradually thinned until the schedule FT 5-min.

A sizeable number of studies have demonstrated the value of NCR in reducing troublesome behaviors (Carr, Coriaty et al., 2000). Like DRO schedules, FT schedules do not necessarily generate appropriate responding. They appear to reduce undesired behavior through extinction and satiation.

Delay to Reinforcement: The "Waiting" Game

Delay to reinforcement has most often been arranged in the context of DRA schedules. Here, the procedure involves maintaining the original FR 1 schedule of reinforcement and gradually introducing a waiting period between the time of the necessary response and the delivery of the reinforcer. Perhaps the best example is a child who makes a reasonable request that cannot be immediately met. When a child asks at 4:15 to watch an appropriate TV program scheduled for 4:30, the child will preferably ask only once before the reinforcer is delivered and will wait without problem behavior until the reinforcer can be provided. This intervention is desirable to use when you want to see relatively low but steady rates of responding and minimal emotional behavior.

Waiting is very difficult for many people, and thinning schedules by increasing delay to reinforcement is invaluable for teaching this skill. Research suggests that control of behavior with delayed reinforcement is easiest to obtain when the delay is increased very gradually, the magnitude of reinforcement is increased as a function of delay, and care is taken (where possible) to foster rule-governed behavior that is consistent with desired outcomes (e.g., Logue, 1988). Additionally, Fisher et al. (2000) suggest that inserting alternative activities into the "wait" interval facilitates tolerance of delay to reinforcement. Hanley, Iwata, and Thompson (2001) compared several procedures for increasing delays following communication-based interventions. They determined that increasing delays resulted in weakening of the new communication response while adding additional stimulus cues to signal the wait interval resulted in more rapid schedule thinning, maintenance of the new communication response, and low rates of problem behavior.

Procedures for Determining Progression of Schedule Thinning

Knowing which procedures to use to decrease intervention intensity is a first step, but you must also know how much the intensity can be decreased and how quickly this can occur. An intervention that begins at a low intensity may never prove effective and an effective intervention that changes too rapidly can fall apart. There are two typical methods for setting the initial level of intensity and the speed of progression described in intervention research. The first method uses pre-set values and the second method involves mathematical calculations based on ongoing child behavior. Perhaps the most common method is to use the most intense intervention possible (e.g., FR 1, DRO 1-s) and to use small preset increments of increase. This method provides the greatest assurance that the intervention will prove effective, however, it typically presents a longer road to the terminal schedule and may be quite time consuming. As discussed previously, Piazza et al. (1996) illustrated this method by proceeding from an FR 1 to an FR 28 schedule in increments of 1.

Hagopian et al. (1998) illustrate the use of steady slow progression with delay to reinforcement procedures with an individual with problem behavior maintained by access to tangible reinforcers. The initial intervention involved reinforcement for a communication response on an FR 1 schedule with no delay between the communication response and the delivery of the reinforcer. As schedule thinning was implemented, a 5-s delay was inserted between the communication response and the delivery of the reinforcer. This delay was increased by 5-s intervals fourteen times (i.e., to 95 s) and then by 10 s, 15 s, and 30 s until the terminal delay was reached (300 s). With particularly severe and difficult cases, such a slow progression may be necessary to ensure continued success, however, for most cases encountered in outpatient settings procedures that move faster can be used.

The second method involves setting the initial interval based on the average inter-response time (IRT) or rate of behavior during baseline observations and gradually adjusting the schedule based on the average for the most recent intervention sessions. This procedure allows the intervention to begin at a much less intense level, potentially facilitating later decreases in intensity. The drawback is that this method requires constant mathematical calculations and adjustments. These calculations, while easily conducted in laboratory and analogue settings, may prove cumbersome for typical clinicians working with children and their families in outpatient settings. Also, depending on actual IRT distributions, procedures with parameters based on *average* IRTs may prove ineffective, and analyses that are more sophisticated may be required to establish effective treatment parameters. A related procedure for setting the initial would involve calculating the average latency and decreasing that schedule by 50% to create a slightly higher probability of success.

Lalli et al. (1997) illustrated a combination of these two procedures using FT schedules with three children with problem behavior maintained by access to tangible reinforcers. They set their initial level of intensity based on averages during baseline, then systematically increased the interval between reinforcer deliveries by a pre-set interval (i.e., 30 s or 120 s, depending on the child involved) until the terminal level was reached for each individual. They used a criterion of two consecutive successful sessions (e.g., no or little problem behavior) before the schedule was progressed. They also returned to the previous schedule when three consecutive sessions were unsuccessful (i.e., problem behavior equal to or exceeding baseline).

Kahng, Iwata, DeLeon, and Wallace (2000) directly compared procedures for programming FT schedules. In one condition, an arbitrarily selected dense schedule of reinforcement was gradually increased by a fixed time increment. In the second condition, the initial reinforcement schedule was determined by calculating the mean IRT for baseline sessions and gradually adjusting the schedule based on the mean IRT for the most recent intervention sessions. Both schedules were determined to be effective though the adjusting IRT method resulted in slightly quicker progress to the terminal reinforcement schedule.

LeBlanc, Hagopian and colleagues have developed a slightly different procedure (LeBlanc et al., 2000; LeBlanc, Hagopian, Marhefka, & Wilke, 2001) that may prove easily modified for general outpatient clinical use. The procedure is based on a mathematical model with proportional increments in schedules. A series of values, referred to as steps, is established which generally represents a 33 to 50 % increase from the previous value. Early steps generally represent a 50% increase, while later steps represent a 30-40% increase and can be rounded to an easily remembered value (e.g., 115 seconds rounded to 2 minutes). See Table 1 for a sample series of steps that might be used when using an increasing ratio schedule and a sample series of steps for a DRO schedule. The proportional increments allow one to avoid the problems that can occur with a simple "doubling" procedure. Doubling a schedule value is reasonable early in schedule thinning (e.g. FR 1 to FR 2, FR 2 to FR 4), but quickly leads to unworkably large values (e.g. FR 8 to FR 16, FR 16 to FR 32). With the procedure described by LeBlanc et al. (2000; 2001), the steps proceed until the terminal schedule value is achieved. The criterion for increasing the schedule is a 90% or greater reduction from baseline for two consecutive sessions. If problem behavior does not remain at a 90% reduction for two consecutive sessions, the schedule returns to the most recent successful level of intensity.

LeBlanc et al. (2000) demonstrated use of these steps for an increasing DRO schedule in their treatment of inappropriate social behavior in an adult with mental retardation. The initial DRO schedule was set at the mean inter-response time (IRT) during the baseline phase. The initial interval (20 s) was entered as the starting point and nine subsequent steps were established. The initial thinning (step 1) represented a 33% increase in the duration of the DRO interval and the length of the session (600 s) was set as the DRO interval for step 9. All increases ranged from 33% to 100% with an average increase of 45%. At each step, two sessions were required to meet the criterion for success before the next step was implemented.

Recommendations and a Proposed Model

The reader should note that the following recommendations are based on the relevant research and our applied experience; however, this proposed model has not been directly tested in multiple studies. We encourage readers to consider the practices delineated as recommendations based on research and clinical experience rather than documented best practice. In addition, we invite independent investigators and practitioners to evaluate the utility and efficiency of the model or to respond with alternative models.

We make the following recommendations for decreasing intervention intensity when using reinforcement-based procedures to treat problem behavior. First, begin the intervention at a relatively intensive level to promote initial success, a proposal that is supported by Hagopian et al (1994). The initial schedule can be determined by a) selecting the most intense schedule manageable (e.g., Fr-1, 1-s to 5-s delay) or b) determining the schedule by calculating an average IRT or success level from baseline observations (Kahng et al, 2000). Second, determine which method of schedule thinning is appropriate for your intervention. Increasing ratio schedules are valuable when you want to see high rates of behavior (e.g., correctly completed math problems), whereas delay to reinforcement is preferable when you want a behavior to occur once followed by a reasonable wait before the reinforcer is delivered. Third, determine a reasonable terminal goal for the intensity of your intervention based on the age and functioning level of the child. For example, a 10-20 minute wait may be reasonable for a 8-year-old child while a 5 minute wait is appropriate for a younger child or a child with developmental delays. To enhance social validity, determine the terminal schedule value in consultation with the individual who ultimately will use the intervention in a natural setting.

Fourth, establish a series of values or steps between the initial level and proposed terminal level. We recommend approximately 8-12 steps, but the number will vary according to the difference between the initial level and terminal level. Increases of approximately 33 to 50 % from the previous schedule are reasonable, with the initial increments larger than the later increments. For procedures that begin at the highest intensity, the initial steps may have to be 100% increments (e.g., FR 1 to FR 2). These increments avoid the problem of excessive increases associated with doubling procedures and allow calculation of values that are useful in natural environments. Our recommendation includes flexibility to accommodate the purposes of both researchers and clinicians. For example, a researcher in a laboratory setting might choose to set a specific increment (e.g., 50%) throughout all steps in order to specifically investigate the effects of increment magnitude even though 50% increases might create unusual schedule values (e.g., 157-s delay). Clinicians might opt to go with values such as those published here, which have reasonably varying increment values but are easy for parents or teachers to remember (e.g., 30-s, 2-min).

Fifth, allow sufficient exposure to the new level of intervention before proceeding to the next level. We have found that two consecutive exposures during which performance is at an acceptable level is a useful criterion for defining sufficient exposure (LeBlanc et al, 2000; 2001), however this recommendation has not been empirically tested. One exposure would allow quicker progression while additional exposures might be beneficial for certain interventions procedures where greater behavioral variability might be expected (e.g., extinction). Sixth, if success if not achieved at a new level after multiple exposures, briefly return to a previously successful level before trying again. In most cases, this should occur following no more than five unsuccessful exposures. Again, this recommendation has not been empirically compared to other procedures, but has proven useful in clinical practice.

Finally, progress as quickly as possible to the final intervention level by using periodic probes to determine how quickly the intensity reduction can be advanced. After three consecutive steps are successfully completed (e.g., initial level, step 1, step 2, step 3), probe three steps higher (e.g., step 6). If the probe is unsuccessful, return to the most recently successful step (e.g., step 3) and begin slow progression through the three intermediate steps from that point before conducting the next probe (e.g., step 9). If the probe session is successful, immediately probe three additional steps higher. When the progression has reached the halfway point (e.g., 5-minute wait for a goal of 10 minutes), you may chose to probe at the terminal schedule value. We do not recommend conducting probes at the terminal-step prior to the halfway mark because the differences between current schedule and terminal schedule are typically extremely salient prior to that point. See Table 2 for a sample probe procedure. Although the study described below successfully used this model, replications of the model have not yet been published and we encourage readers to evaluate this procedure empirically, as we are currently doing.

LeBlanc et al. (2001) provided an example of the use of this mathematical model and probe procedure while programming delays to reinforcement during functional communication training. Sixteen steps were established that generally represented a 33 to 50% increase from the previous delay interval. The first step represented a 1-s delay and the final delay equaled the length of the entire session length of 10 min. The criterion for increasing the interval was a 90% or greater reduction from baseline for two consecutive sessions. They used a delay reduction (return to previous successful step) if problem behavior did not remain at a 90% reduction for two consecutive sessions. After three consecutive delay steps were successfully implemented (90% or greater reduction from baseline), a probe session three steps higher was conducted to determine if the delay increase could be accelerated. If the probe session was successful, the next probe session (3 additional steps higher) was conducted. If the probe session was unsuccessful, the previous successful level was repeated and the intermediate steps were implemented. This probe procedure allowed rapid progression of schedule thinning. In one condition, the schedule progressed from step 4 to step 14 in only 6 sessions (sessions 46-51) and in another condition from step 1 (no delay) to step 10 in the span of only 4 sessions (sessions 77-80).

Conclusions and Future Directions

Although the model just described has worked rather well for us, it has not been systematically compared to other models. Research is needed in which this model and alternative strategies for reducing the intensity of interventions are directly compared. Specifically, researchers might directly compare schedule thinning with and without the probe procedure to determine if there is additional utility to using probes. Researchers might directly compare the preset values and probes to alternative method such as the shifting mean IRT method illustrated by Kahng et al. (2000). Researchers should also directly evaluate whether failure at a given schedule value should result in a return to a previous value or remain constant. Studies might also examine whether certain participant or client characteristics should impact our decision-making with regard to speed of schedule thinning. There is no support in the literature for differential decision-making but future studies might examine relevant characteristics such as previous history of reinforcement or dimensions of target behavior (e.g., severity, frequency, intensity). Perhaps the most important area for evaluation is the social validity of these procedures. Research should attempt to determine whether clinicians find it acceptable and easy to use values from published tables (such as those provided here) rather than directly computing values based on individuals client performance. In addition, consumers of this model will determine whether the decision criteria and recommendations prove useful in clinical or research practice and allow them to proceed through schedule thinning more rapidly than they have in the past.

Research in analogue settings, such as that conducted by Hanley et al. (2001), may be of initial value in this regard, but studies conducted in participants' natural environment ultimately will be required. Although studies have revealed a great deal about how to reduce problem behaviors using reinforcement-based procedures, most of what we know about how to reduce the intensity of such procedures is based on practical experience, not controlled research. Our current lack of empirical knowledge raises many interesting and potentially important experimental questions. For example, does increasing the magnitude of reinforcement as the inter-reinforcer interval or ratio increases, as illustrated by Piazza et al. (1997), allow for more rapid schedule thinning? If so, what is the best way to increase magnitude? Additionally, research might attempt to determine optimal increment levels under particular conditions. The model suggested above has worked for us, but other increment values might work just as well and result in more rapid thinning. Other general areas worth investigating include strategies for determining terminal schedule values, a topic largely ignored in the literature, and techniques for incorporating rule-governed participant behavior as part of schedule-thinning procedures. Attempts to make use of findings from basic laboratory research in devising procedures for reducing the intensity of interventions is also warranted (e.g., Strohmer, McComas, & Rehfeldt, 2000). In summary, we have attempted to meet two objectives with this paper. If the present manuscript fosters research in any of these areas, we will be delighted. If it is of practical use to behavior analytic clinicians, we will be even happier because both of our objectives will be met.

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Table 1

Sample steps for schedule thinning using DRO intervals or ratio-based schedules.

Step	Interval/Value	% Increase
Initial Intensity: 15 s DRO		
1	30 sec	100%
2	45 sec	50%
3	60 sec	33%
4	90 sec	50%
5	120 sec	33%
6	160 sec	33%
7	230 sec	44%
8	330 sec	43%
9	450 sec	37%
10	600 sec	33%
INITIAL INTENSITY: FR 1		
1	FR2	100%*
2	FR4	100%
3	FR6	50%
4	FR9	50%
5	FR12	33%
6	FR16	33%
7	FR21	33%
8	FR28	33%

* No smaller increment is possible.

Table 2

Hypothetical steps and probe progression for a delay to reinforcement schedule thinning procedure with an initial 1-s delay.

1. After three successful steps, probe three steps higher.
2. If probe is successful, continue to probe three steps higher
3. If prove is unsuccessful, return to the previous successful step

Established Values		Progression of Thinning	
Step	Delay in Seconds	Completed steps	Probes
1	2	1	
2	3	2	
3	5	3	6 (success), 9 (fail)
4	7		
5	10		
6	14	6	
7	22	7	
8	35	8	
9	55	9	12 (success), 14 (success)
10	90		
11	150		
12	300		
13	450		
14	600		