Molar Functional Relations and Clinical Behavior Analysis: Implications for Assessment and Treatment

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The experimental analysis of behavior has identified several molar functional relations that are highly relevant to clinical behavior analysis. These include matching, discounting, momentum, and variability. Matching provides a broader analysis of how multiple sources of reinforcement influence how individuals choose to allocate their time and offers an empirical rationale for reducing problem behavior by increasing adaptive behavior. Discounting highlights the functional relations that affect self-control. Momentum specifies the variables responsible for persistence in challenging situations. Variability characterizes a functional dimension of behavior that is essential for learning and problem solving. These concepts have important implications for clinical practice and research. A selective review of these concepts is presented, and their implications for assessment and treatment are discussed with two goals: to inform basic scientists about the relevance of their work and to invite clinical behavior analysts to broaden the conceptual basis for their work.

Key words: clinical behavior analysis, matching law, discounting, momentum, variability

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For over 50 years, functional relations that have been identified through basic research with humans and other animals have been applied to presenting problems of clinical interest by behavior analysts (see also Lindsley, 2001). This relation between basic research and clinical practice has rested on the assumption that the contextual manipulations used to predict and influence behavior patterns in relatively controlled basic research settings are not different in kind from the types of contextual manipulations that are useful for predicting and influencing clinically relevant behavior patterns in therapy.

Most behavior analysts are familiar with the clinical utility of core functional relations (e.g., reinforcement, punishment, extinction, schedule effects, stimulus control, shaping, and differential reinforcement). These form the most fundamental functional analytic units for clinical work. Basic research, however, has also studied additional more molar functional relations, including match-ing, discounting, momentum, and variability. Unfortunately, the contemporary conceptualizations of clinical behavior-analytic treatments do not reflect the scientific study of these relations. A more thorough understanding of these molar functional relations will facilitate more sophisticated and powerful functional analyses and function-focused interventions.

MOLAR FUNCTIONAL RELATIONS

Most basic operant concepts are molar, in that they characterize processes that are extended in time. For example, reinforcement describes a relation between behavior and its consequences in which, over time, the time spent engaging in that behavior increases. However, it is conventional to speak of functional relations as if they were instances rather than processes. Practitioners may say, for example, that they have reinforced their clients' assertion of needs by complying with requests. Technically, the clients' requests and the therapist's responses may or may not have been part of a reinforced operant. If the clients' requests increase over time and decrease if

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reinforcement is withdrawn or presented independent from the target behavior, then it is a reinforced operant. The molar functional relations reviewed in this paper are not easily characterized by single behavior–environment interactions. Instead, these molar functional relations require the analysis of broad patterns of behavior in context and are understood through an aggregate of events (Baum, 1989).

The remainder of this paper will focus on several of these molar functional relations and how they relate to clinical behavior analysis. This is a selective review, and we chose four molar relations that we have found to be conceptually useful in clinical work. Each of these relations has an accessible base of basic research data with humans and nonhuman animals. The conceptualization of each relation has also received sufficient scrutiny to assume that most of the aspects of these relations will withstand the test of time. It is important to note that throughout the paper we will not distinguish between positive and negative reinforcement. The molar functional relations being reviewed tend to be relevant for both procedures; thus, the more superordinate term *reinforcement* will be used.

The first two molar functional relations we will explore have to do with choice. There are two key features of choice behavior: preference and time allocation. Whenever a choice is made, an individual engages in one pattern of activity (and obtains its accompanying reinforcement) over or to the exclusion of others. However, this preference is not permanent. Our days are filled with multiple opportunities to choose to stop engaging in one activity and start engaging in another. It is of clinical interest to understand the variables that influence preference. How much time a client spends engaging in pleasant activities, relative to all other activities, is also of

clinical interest. Matching is the study of the variables that influence how much time individuals spend engaging in clinically relevant activities.

MATCHING

Matching describes the mathematical relation between the time spent engaging in a type of activity and the rate of reinforcement for that type of activity. More specifically, the time spent engaging in an activity relative to the time spent engaging in all activities in a given situation will be equal to the rate of reinforcement for that activity relative to all sources of reinforcement for that situation. This relation is captured in Equation 1, where R_T (T indicates target) is the time spent engaging in the problematic target behavior pattern and R_e (e indicates extraneous) is the time spent engaging in all other concurrently available activities in that situation. It then follows that r_T is the rate of reinforcement for the target behavior pattern and r_e is the rate of reinforcement for all other concurrently available activities for that situation. Matching research has reliably demonstrated that these two relative proportions remain consistent (Davison & McCarthy, 1988):

$$\frac{R_T}{R_T + R_e} = \frac{r_T}{r_T + r_e}. \quad (1)$$

Matching becomes a more powerful heuristic for clinicians assuming that the overall time spent engaging in activities in a particular situation remains constant. Equation 2 results when the denominator of the left side of Equation 1 is converted to a constant, and the time spent engaging in the target behavior pattern becomes the focus. Equation 2 indicates more efficiently that the time spent engaging in a target pattern of behavior will be equal to the rate of reinforcement for that pattern relative to the total rate of reinforcement

for all activities in that situation:

$$R_T = \frac{kr_T}{r_T + r_e}. \qquad (2)$$

Implications for Assessment

Choice behavior is multiply determined, and clients often have difficulty describing the variables that influence their behavior. Even when they give reasons for being anxious, depressed, or distressed, there is no guarantee that the variables that control the report are the same ones that influence the target behavior patterns of interest. Clinicians can obtain a much better understanding of the contextual variables that influence a presenting problem if they assign clients self-monitoring homework.

The first step in this process is working with clients to clarify what types of activities are part of the problematic behavior pattern. For a substance abuser, this may include time procuring and consuming drugs. Time spent engaging in this pattern of behavior interferes with choosing to engage in other activities that provide access to other reinforcers. For this reason, it is also important to have the individual track the time spent engaging in other activities related to important nondrug reinforcers. The clinician gains a much broader picture of the contingencies that operate in the client's life if the client tracks both the time spent engaging in problematic activities and more adaptive alternatives. The type and breadth of activities worth tracking through self-monitoring will change as treatment progresses.

Implications for Treatment

It is not necessary to be able to account for all activities at all times of the day for matching to inform treatment. Traditional interventions aimed at decreasing problematic tar-get behaviors use the direct application of punishment or extinction procedures. McDowell (1982) specifies how Equation 2 predicts novel indirect ways therapists can manipulate target activity patterns. Matching suggests two additional strategies: To reduce the time spent engaging in a problematic activity (R_T), one can (a) increase the rate of reinforcement for concurrently available response alternatives or (b) increase the rate of free or noncontingent reinforcement in that environment. Both of these strategies increase r_e, and Equation 2 predicts that any intervention that does so will result in a decrease in the problematic activity (R_T).

Numerous studies have illustrated that noncontingent reinforcement can have a general suppressive effect on problematic activity patterns that formerly were instrumental in obtaining reinforcers (Carr et al., 2000; Ecott & Critchfield, 2004). This can be an effective strategy for situations in which alternative reinforcers for more desirable behavior patterns have not been identified. In these situations, noncontingent reinforcement may be the only practical way of increasing r_e. Still, for most clinical presenting problems, the focus of the intervention will be on arranging contingent reinforcement for particular alternative activity patterns. Treatments like behavioral activation specifically arrange contingent reinforcement by assigning clients behavioral homework that increases their engagement in self-identified pleasant events (Lejuez, Hopko, & Hopko, 2001; Lewinsohn, Antonuccio, Breckenridge, & Teri, 1984; Lewinsohn, Munoz, Youngren, & Zeiss, 1992; Martell, Addis, & Jacobson, 2001).

It can be therapeutically useful to have clients self-monitor the time spent engaging in particular alternative activities if they have the skills to self-monitor effectively. Matching provides an explicit rationale for why it is important to target adaptive

behavior in therapy instead of focusing exclusively on problem behavior (i.e., symptom reduction). When alternative activities are identified and monitored in the course of treatment, the therapist and client are able to assess the impact of the reinforcement for these alternative activities on the time allocated toward the problematic behavior.

If intervention programs designed to increase the rate of reinforcement for alternative behaviors (r_e) are unsuccessful, there are three likely sources of this problem. First, reinforcement for the problematic activity (r_T for R_T) may be so large that it is difficult to arrange alternative reinforcers (r_e) of sufficient magnitude to compete with those that maintain the problematic activity (r_T). This is fairly common in chronic substance use and other presenting problems that can be characterized as one source of reinforcement being exceptionally large relative to the reinforcement for other activities. In these situations, it may be necessary to create a therapeutic environment that prevents the individual from accessing the reinforcers that maintain the problem (r_T). Inpatient substance use treatment centers, workshops, retreats, and other training opportunities that remove the clients from their regular environment temporarily fulfill this function. In all of these situations, there are exceptional contingencies in place that either prevent or socially discourage the problematic activity. This provides the opportunity for alternative adaptive activities to encounter relatively higher rates of reinforcement. The challenge of these interventions and workshops is to adequately program for the maintenance of the more adaptive activities once clients return to their regular environment in which reinforcement for the problematic activity (r_T) is available. Matching predicts the greater success of reinforcement-based drug use recovery programs over programs that focus exclusively on stimulus control (see Higgins & Silverman, 1999, for examples).

The second reason interventions that focus on increasing reinforcement for alternative behavior (r_e for R_e) may fail is that the individual lacks the skills necessary to procure relevant reinforcement for alternative adaptive behavior. It is common for clients to report that they are trying to engage in alternative adaptive activities, but that initiation is difficult or responding is being met with extinction or punishment. These variables are often compounded by clients having difficulty identifying situations and opportunities in which the adaptive activity is likely to be reinforced. To resolve these difficulties, at the end of the day clients record the approximate cumulative time spent engaging in alternative activities and at the same time rate the quality of each activity pattern. The quality rating generates a subjective estimate of the effectiveness of the reinforcers that accompany engaging in that activity. Skill barriers to obtaining reinforcement for alternative activities (r_e) may show up in the self-monitoring as little total time engagement in alternative activities. Low quality ratings may be due to ineffective behavior that is met with little or no reinforcement or poor stimulus control. Although ineffective behavior indicates a lack of skills, clients may actually engage in effective behavior at the wrong time or the wrong place. Furthermore, an absence of stimulus control can result in an individual failing to engage in effective behavior when conditions are favorable for responding, as when a socially anxious individual remains withdrawn in the presence of a charitable and interested listener. Thus, ineffective behavior and poor stimulus control both result in suboptimal reinforcement. Self-monitoring that includes daily time and quality estimates provides the therapist with data to assess the need for

skills training and to monitor the impact of skills training. Moreover, as the time allocated to alternative adaptive activities and the quality ratings increase (r_e), a decrease in the time spent engaging in the problematic activity (R_T) is expected.

The third reason interventions that focus on increasing reinforcement for alternative behavior (r_e) may fail is that the client's identification of putative adaptive activities may have been disproportionately controlled by variables related to making a favorable social presentation to the therapist rather than out of consideration for his or her own history with engagement in these activities. This does not necessarily involve deception. The clients themselves often inaccurately identify the contingencies that influence their behavior, and they are just as surprised as the therapist to discover that they are either not engaging more in the alternative adaptive activity or that the quality rating for that activity remains low. Thus, establishing correspondence between verbal statements of preference and actual activity engagement is a key part of therapy. Adopting a collaborative, as opposed to an authoritative, therapeutic stance can facilitate this process.

In contrast to our earlier focus on the decrease of problematic activity patterns, McDowell (1982) also specifies how matching predicts two novel indirect ways of increasing more adaptive behavior. Traditional interventions that aim to increase adaptive behaviors use the direct application of shaping and differential reinforcement for adaptive behavior patterns. Matching suggests two additional strategies. To increase the time spent engaging in more adaptive behavior, therapy can aim (a) to decrease the rate of reinforcement for the target problem activity (r_T) or (b) to decrease the general rate of reinforcement for anything else (i.e., any event that increases r_e). Equation

3 is a simple expansion of Equation 2, and it illustrates how to conceptualize the relation between adaptive behavior patterns (R_A) and the reinforcement rates for adaptive activities (r_A), problematic target activities (r_T), and all other extraneous activities (r_e). Note that the focus of Equation 3 shifts the analysis to a focus on adaptive behavior (R_A) instead of problematic activity patterns (R_T). The relations are still the same:

$$R_A = \frac{kr_A}{r_A + r_T + r_e}. \qquad (3)$$

Although Equation 3 predicts that decreasing the rate of reinforcement for problematic target activities (r_T), and all other extraneous activities (r_e) will increase the time spent engaging in adaptive activities, such interventions are often fraught with problems. Attempts to decrease the value of these reinforcers typically involve extinction or the attempt to degrade the relative value of these reinforcers by arranging concurrent aversive contingencies. Extinction may work adequately in the therapy setting, but the problematic activities can still be met with reinforcement outside the session, rendering any progress temporary at best. Attempts to degrade the relative value of reinforcers for problematic activities tend to utilize two aversive strategies: direct social disapproval (i.e., punishment) and the provision of information as an abolishing operation. Social disapproval as the primary intervention runs the risk of jeopardizing the therapeutic relationship and should only be used sparingly and judiciously, if at all (Kohlenberg & Tsai, 1991, pp. 32–34; Sidman, 1989; Tsai et al., in press). Information-based interventions typically lack the power to truly degrade the value of reinforcers (Laraway, Snycerski, Michael, & Poling, 2003; see also Zettle & Hayes, 1982, pp. 81–82). For example, most smokers have adequate information

relating smoking to a wide variety of health problems. The information about delayed health outcomes is unable to compete with the relatively immediate reinforcing effectiveness of smoking. Thus, although matching provides a means for understanding why information-based interventions often fail, an understanding of additional variables that influence choice behavior will be needed to produce interventions that are more effective. This leads us to the analysis of another dimension of choice behavior: preference as understood in terms of discounting.

DISCOUNTING

Matching characterizes how activity engagement is influenced by relative rates of reinforcement, but discounting characterizes changes in preference patterns. All other things being equal, preference patterns are determined by the size of the outcomes related to the choice alternatives: The larger the outcome, the greater the preference. However, all things are not usually equal, and this presents individuals with dilemmas. Do you pick up fast food on the way home from work or make a healthy home-cooked meal? Do you make an illegal U-turn or drive around the block? Do you escape from the discomfort of awkward or hurtful social situations or do you initiate dialogue to improve interpersonal relationships?

Discounting characterizes how the value of a reinforcer is degraded when some form of inconvenience (e.g., delay, risk, or cost) accompanies it. This is of clinical interest because when important reinforcing outcomes are discounted or otherwise minimized, the resulting pattern of choice behavior can be characterized as impulsive or shortsighted. Impulsivity is a defining characteristic of clinically relevant phenomena such as attention deficit disorder, attention deficit hyperactivity disorder, person-
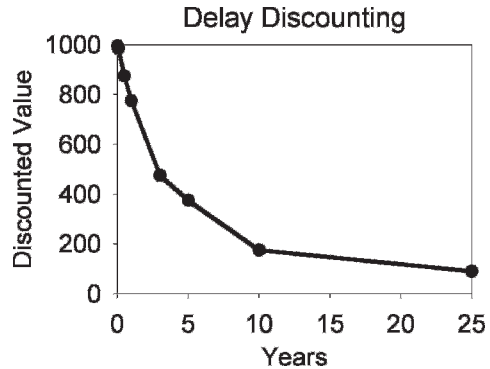

Figure 1.   The minimum median values college students said they would rather receive immediately than wait for $1,000. Each data point represents a different waiting period for which preference was assessed. Most research finds that discounting curves are hyperbolic in shape. Steep curves are indicative of more impulsive responding, and comparatively shallow curves are indicative of greater self-control.

ality disorders, mood disorders, situationally predisposed anxiety disorders, conduct disorders, substance abuse, and eating and other habit disorders (American Psychiatric Association, 2000).

Discounting involves a decrease in the subjective value of an outcome as the delay, risk, or some other associated cost or inconvenience related to that outcome increases. One interesting aspect of the discounting of outcomes is that the decrease in the value of the outcome does not typically follow a linear or rational pattern (Ainslie & Haslam, 1992). Instead, it follows a hyperbolic pattern (Figure 1). Humans and other animals tend to discount outcomes steeply as their associated cost or inconvenience increases (Ainslie, 2001).

The degree of discounting has important implications for how well long-term outcomes relative to alternative impulsive outcomes (e.g., those that are immediately available) influence behavior. The hyperbolic shape of discounting curves captures two important dimensions of clinical presentations: (a) Under most condi-

tions, the larger of two outcomes will be preferred, and (b) under the right conditions, preference will reverse and the smaller of the two outcomes will be preferred when that outcome is immediately available. See Ainslie and Haslam (1992) for further discussion of these features.

Discounting assessments typically involve presenting individuals with a series of hypothetical questions. Answers indicate preference for an immediate amount of money now or a larger amount of money later (e.g., Would you rather have $999 now or $1,000 1 week from now?). The same type of question is repeated, while the amount of money that would be immediately available decreases incrementally. At some point, the individuals change their preference from obtaining a smaller amount of money now to waiting for the larger delayed amount. Several series of these questions are presented, each with a different delay value. Figure 1 illustrates the different delay values used: 1 week, 1 month, 6 months, and 1, 3, 5, 10, and 25 years. An indifference point is plotted for each level of delay. The indifference point represents the minimum value the individual would rather receive immediately than wait for the larger delayed outcome. It is at this point where you could say, for example, that for a particular individual $1,000 available a week from now is equivalent to receiving $800 immediately. Indifference points with large values indicate greater self-control, and indifference points with small values indicate greater impulsivity.

There can be substantial individual variability in the degree to which discounting is observed. Furthermore, discounting can vary in predictable ways with presentations of clinical interest. For example, Vuchinich and Simpson (1998) investigated the relation between patterns of alcohol consumption and the degree of discounting observed on a delay-discounting task almost identical to the one described above. Participants were categorized as light social drinkers, heavy social drinkers, and problems drinkers. They found that problem drinkers' indifference points were much smaller than those of light social drinkers. By preferring only large immediate amounts of money, the light social drinkers would be considered less impulsive than their problem-drinking peers. Studies such as this suggest that monetary delay-discounting tasks may serve as good general measures of self-control or impulsivity. Similar findings have been found comparing opiate abusers with nonabusers (Madden, Petry, Badger, & Bickel, 1997), cocaine-dependent and drug-free controls (Heil, Johnson, Higgins, & Bickel, 2006), smokers and nonsmokers (Baker, Johnson, & Bickel, 1993; Fuchs, 1982), substance abusers with and without antisocial personality disorder (Perry, 2002), gamblers and nongamblers (Holt, Green, & Myerson, 2003), and anxious and non-anxious individuals (Rounds, Beck, & Grant, 2007). All of these studies found that clinical problems are accompanied by greater impulsivity, as measured by discounting tasks.

Implications for Assessment

The majority of discounting research has used monetary discounting tasks. Monetary discounting assessments ask individuals to choose repeatedly between a fixed delayed outcome and a relatively smaller but immediate outcome (e.g., Would you rather have $800 now or $1,000 6 months from now?). The immediate choice alternative is systematically varied until the subject reaches an indifference point. As discussed earlier, Figure 1 illustrates how an indifference point is obtained for several different values of the discounting variable. Most research has investigated the use of hypothetical outcomes, but research investigating the relation between discount-

ing assessments with real versus hypothetical outcomes suggests that human discounting research is not compromised by the use of hypothetical outcomes (see Critchfield & Kollins, 2001, for a review).

Discounting curves can be characterized in ways that will allow them to be treated much like one would treat a score on a conventional psychological assessment instrument. Researchers have identified several ways of mathematically characterizing the shape of discounting curves (e.g., Grace, 1999; Loenstein & Prelec, 1992; Mazur, 1987; Myerson & Green, 1995). Each of the mathematical models can quantitatively summarize individual discounting curves, but these numbers rest on theoretical assumptions regarding what the shape of the discounting curve ought to look like. Myerson, Green, and Warusawitharana (2001) proposed a theory-neutral way of quantifying discounting by computing the area under the discounting curve (AUC). AUC efficiently captures essential features of discounting performance. AUCs can range from 0 to 1, with high values indicating greater self-control and low values indicating greater impulsivity.

Figure 2 presents discounting curves of 2 individuals from the group data presented in Figure 1. The marked differences between the two curves are efficiently captured by their corresponding AUCs. Participants in this study also completed several traditional measures of psychological well-being and distress. The participant with the small AUC reported highly elevated depression and anxiety symptoms and well below average quality of life. Conversely, the participant with the large AUC scored in the normal range for all measures. Initial analyses of the entire data set suggest that measures of psychological distress and well-being correlate with different forms of discounting assessments in predictable ways. In general, greater impul-

sivity (i.e., small AUC) is correlated with greater distress and poorer well-being (Waltz & Follette, 2008).

The majority of human discounting research has used money as the reinforcer of interest and delay or risk as the discounting variable. The curves produced with this generalized reinforcer may provide a somewhat global index of impulsivity, but clinicians are typically interested in how domain-specific reinforcers are discounted. Some research suggests that self-control performance may differ based on the type of reinforcer (Weber, Blais, & Betz, 2002). Researchers have investigated discounting with reinforcers other than money, such as drugs of abuse and food (Odum & Rainaud, 2003), health (Chapman, 1996), social relationships (Jones & Rachlin, 2006), and pornography (Lawyer, 2008). These studies illustrate how clinicians can construct novel discounting tasks related to reinforcing outcomes of interest to individual clients (see Chapman, 1996; Chapman & Elstein, 1995; Critchfield & Kollins, 2001, for ideas on how to construct discounting tasks).

Implications for Treatment

The assessment of discounting performance provides a means of describing an underlying functional dimension that may be responsible for accompanying elevated scores on traditional symptom-focused assessments. A discounting analysis illustrates how the value of a reinforcer is degraded by some inconvenience. When this contributes to clinical distress, improvement can be expected with treatment that successfully increases the relative value of clinically relevant outcomes or decreases the aversive function of the inconvenience variable (for a broader discussion of the contextual manipulations that can influence discounting, see Bickel & Marsch, 2000).

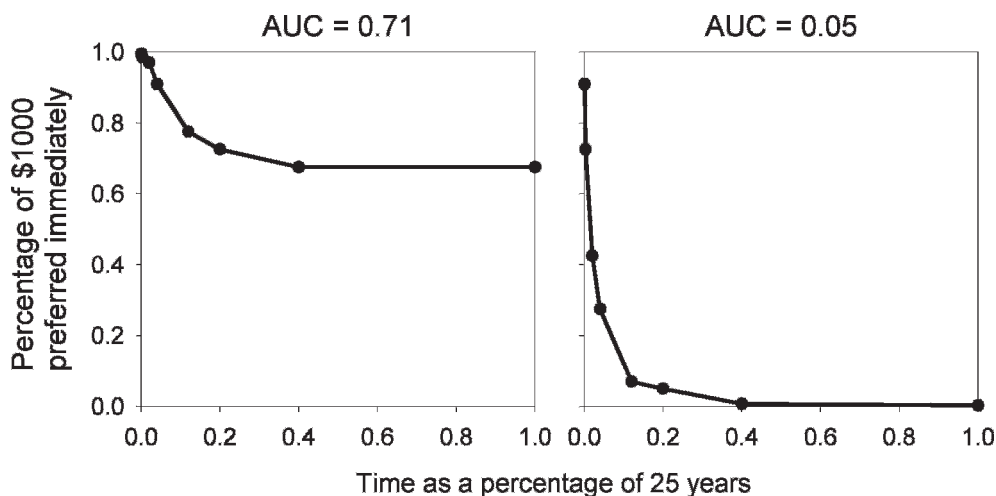When the discounting of important reinforcers is a source of clinical

Figure 2. Discounting curves from 2 participants in a recent experiment. The relatively shallow discounting curve on the left has an area under the curve (AUC) of .71. The steep discounting curve on the right has an AUC of .05. Higher AUC values are associated with greater self-control, and smaller AUC values are associated with greater impulsivity.

distress, therapists will often ask the individual to describe what is so important about that type of outcome. These discussions often challenge the client to broaden the class of events that are related to the putatively reinforcing outcome. This frequently happens when clients enter therapy with very narrow descriptions of the reinforcing dimensions they attend to in interpersonal relationships. As discussed earlier, all things being equal, choice patterns will track larger reinforcing outcomes. To the extent that therapeutic discussions increase the subjective value of interpersonal relationships, this larger outcome should increase the likelihood of choosing to engage in relationship-building activities instead of more impulsive alternatives (e.g., staying home and watching television).

Therapists also often prompt clients to make specific, measureable commitments to choosing patterns consistent with long-term outcomes outside the therapy session as homework. These commitments superimpose a social contingency on the situation, with the intention of increasing the costs for choosing im-

pulsive over long-term outcomes and signaling the availability of therapist approval for engaging in less impulsive activity patterns.

For many individuals, accessing important outcomes requires behavior patterns that are at the limits of or beyond their current repertoire. These suboptimal repertoires are met with correspondingly poor rates of reinforcement. Such a history provides an experiential basis for discounting these outcomes based on risk: Life experience suggests that the outcomes are unlikely. Skills-training interventions can shift discounting by establishing repertoires that increasingly encounter natural reinforcers related to the outcomes of interest. These outcomes will be discounted less as experience demonstrates that they become more probable (i.e., lower risk).

Interventions that focus on increasing distress tolerance should also influence the degree to which the inconveniences that accompany less impulsive outcomes degrade their value. Contemporary behavior-analytic treatments such as acceptance and commitment therapy functionally increase distress tolerance by

teaching individuals a variety of skills to increase persistence in distressing situations (for an elaboration, see Hayes et al., 2007, pp. 69–73).

Rachlin (2000) suggests a naturalistic approach to building soft commitment. This involves the identification of patterns of behavior related to long-term outcomes and measurement of success by the degree to which these patterns persist over long intervals. He considers this type of commitment to be soft because no artificial aversive contingencies have been introduced to control behavior. The aversive control in soft commitment, to the degree it is present, naturally arises from the interruption of a meaningful pattern of activity.

Soft commitment can also be enhanced by successful discrimination and other skills training. This shaping and discrimination training process goes beyond the identification of a broad range of behavioral and reinforcer topographies related to important outcomes. It involves the gradual progression of choice patterns that come under increasing control of temporally extended consequence relations (for further discussion, see Green & Myerson, 1995; Hineline, 1995). In therapy, clients engage in progressively larger patterns of outcome-related behavior and relate these to the outcome of interest. For example, an individual with severe social deficits in want of better relationships may initially work on noticing the impact of eye contact on whether listeners acknowledge that he or she has spoken to them. The next step may involve noticing how variations in intonation and meter are able to sustain a listener's attention longer. This pattern can expand to ever larger units, such as noticing when one is being understood and differentiating between fulfilling relationships characterized by benevolent reciprocity and those focused more exclusively on the needs of the other party.

As patterns become larger, so do the opportunities for contacting reinforcing outcomes. In effect, this increases the overall rate of responding related to less impulsive outcomes as well as the rate of reinforcement. As we will discuss in the next section, pattern building can increase the momentum of self-control.

MOMENTUM

All learning theory textbooks that cover schedules of reinforcement specify that behavior maintained by intermittent reinforcement is more persistent than behavior that is continuously reinforced. It turns out that intermittency is only one of many factors that determine behavioral persistence. Researchers have found that high and low rates of responding decrease (i.e., lose momentum) at different rates when challenging situations are encountered. Behavioral momentum characterizes a behavior pattern's resistance to change when faced with challenging situations. The types of challenging situations basic researchers have used to test the momentum of behavior include extinction by omission, extinction by response-independent reinforcer delivery, preexperimental reinforcer satiation, and presentation of aversive or conditioned aversive stimuli (see Nevin, 1979, for a review).

Momentum is determined by two factors: response rate and the total rate of reinforcement for a given situation (Nevin, 1992). This means that if two behavior patterns have equivalent reinforcement rates, the pattern that occurs at a higher frequency will have greater momentum. Likewise, if two behavior patterns have equivalent rates, the pattern with the higher rate of reinforcement will have greater momentum.

Implications for Assessment

Therapists often devote a lot of energy trying to identify the control-

ling variables for problematic behavior patterns that persist despite their cost to the client. An understanding of behavioral momentum can be helpful in guiding the therapist to interview clients regarding the current and historical variables that may be functionally related to the behavior pattern of interest.

Momentum research suggests that whenever a problematic behavior pattern persists despite unfavorable feedback, that pattern is likely being maintained by a rich schedule of reinforcement. Sometimes the source of this reinforcement is found in the community, as when friends or family members intentionally or inadvertently reinforce the behavior pattern. For example, partners in couples therapy commonly discover that they inadvertently differentially reinforce irritable or escalated behavior. They can do this by only reacting to each other's requests after a high rate or magnitude of emotional responding occurs.

A more insidious set of contingencies results from the verbal community training individuals to serve as an audience for their own behavior. Pliance is one class of rule-governed behavior that has a specific history of reinforcement for complying with a rule (Zettle & Hayes, 1982). If an individual has a rich history of reinforcement for such compliance, clinically relevant rule-governed patterns of behavior may have greater momentum. When a therapist inquires about why a client continues a problematic behavior pattern, the client often replies with a list of rules (e.g., I must do X; other people are supposed to do Y). This suggests that problematic behavior patterns may be influenced by a rich reinforcement history for rule following.

When it appears that a behavior pattern is persisting without observable reinforcement, further assessment is needed. Although the practical contingencies related to the problematic behavior pattern suggest that it should decrease, a history of reinforcement for behaving according to social standards (e.g., religious, cultural) may keep that pattern going. Thus, when therapists ask clients to describe the variables that influence their behavior, therapists should listen for evaluations (e.g., good or bad, right or wrong). Evaluations are similar to pliance-based rule following in that evaluative consistency between behavior patterns and rules can be more important than the other contingencies that may operate in that situation (i.e., social histories set up "being right" or "righteous" as a reinforcer). Most individuals have rich histories of reinforcement for making evaluations or identifying consistency in spurious situations (Hayes, Barnes-Holmes, & Roche, 2001; Skinner, 1957). For example, members of religious traditions may receive social esteem for evaluating particular courses of action as being consistent with (or not) passages of religious texts. This type of evaluative coherence can be another, or even the primary, source of reinforcement that contributes to the momentum of problematic behavior patterns.

One of the important findings in behavioral momentum research is that momentum can be highly context dependent. For example, a husband seeks therapy for anger problems he has when interacting with his wife. A thorough assessment of his social functioning at work (where he spends the majority of his time), with friends, and within session with the therapist indicates that anger problems are rare in these settings. This suggests that relatively high rates of reinforcement for behaving angrily with his wife have resulted in context-dependent momentum. This phenomenon presents particular difficulties for treatment.

Implications for Treatment

Context-dependent momentum presents a challenge for therapy because

therapists can most reliably predict and influence behavior patterns that occur during the session. If the therapy setting is a markedly different context than the one in which the behavior patterns of interest occur, then treatment may produce little to no benefit. This challenges the therapist to replicate as much of the context of the target situation as possible during the session. The challenge for the therapist is to use his or her own repertoire to recreate as much of the target context as possible. The most obvious way to attempt this is via structured role play. Another strategy is to bring part of that context into therapy (e.g., request the husband who jeopardizes his marriage with angry responding to bring his wife to the session). Alternatively, Kohlenberg and Tsai (1991, pp. 63–68) discuss 13 different naturally occurring situations in therapy that provide therapists with opportunities to capitalize on contextual variables that are more common outside therapy (see also Tsai et al., in press).

One global concern for all therapists is whether the skills acquired or refined in therapy will persist outside therapy, where the client's skills may be met with lower rates of reinforcement or even greater challenges. Momentum has general implications for skills training in therapy. If therapists want to increase the likelihood that a trained skills set will generalize and persist in other settings, they need to focus on the rate of responding being trained and the accompanying rate of reinforcement. Most therapists are skilled at providing a rich schedule of reinforcement for the skills being trained in the session. Research on momentum suggests that additional reinforcement (e.g., more general praise for remaining engaged in the training activity or nonspecific therapeutic support) will also increase momentum, even if the supplemental reinforcers are not contingent on a particular behavior (Nevin, Tota, Torquato, & Shull, 1990).

One area in which therapy typically falls short in programming for increased generalization and momentum involves the rate of responding. In therapy, skills training typically involves shaping responding to the rate that is adequate for the target situation. This does not take into account the various variables in the target situation that are likely to challenge the new skill's momentum (e.g., lower rates of reinforcement, extinction, a hostile audience). Furthermore, moderate rates of responding limit contingent reinforcement rates to moderate levels. Behavior analysts who specialize in education have long relied on fluency training to shape virtually automatic, accurate responding with strong momentum (Binder, 1996). Combined, the fluency and momentum research strongly suggests that clients will be able to more broadly generalize targeted skills to momentum-challenging situations if they receive skills fluency training. Fluency training for social skills can produce somewhat rigid rule-governed behavior; thus, it is important that training include contingencies related to variability and contextual sensitivity. This will be the subject of the next section.

The final treatment implication of momentum comes from Mace et al. (1990). They noted that the noncontingent reinforcement procedures often employed in reducing the rate of undesirable activity patterns (see the related discussion in the previous section on matching) can also have the unintended effect of increasing their momentum. This is because the momentum for a class of activities is related to the rate of all forms of reinforcement provided in its presence: response contingent and response independent. Thus, although matching predicts that the rate of responding will decrease when noncontingent reinforcement interventions are used, the momentum re-

search suggests that the benefits of such decreases in response rates may be offset by increased momentum. This may be observed when a client's problematic conversational tangents decrease in the session after receiving unconditional support from the therapist throughout the session. Yet, despite the decrease (i.e., fewer total tangents per session), tangents still occur even though the therapist always redirects the conversation to the original topic. Thus, although the total frequency of tangents decreases, as predicted by matching, the relationship-interfering behavior continues to occur. When matching and momentum research are considered collectively, the best course of treatment is to focus on the differential reinforcement of more adaptive behavior patterns and to reserve noncontingent reinforcement for supplementing the training of adaptive behavior (Plaud & Gaither, 1996).

VARIABILITY

The final molar functional relation reviewed here is variability. All behavior can be characterized in terms of a variability continuum, ranging from complete stereotypy (no variability) to completely random (high variability). The level of variability in a pattern of activity can be functional, as when variations in responding facilitate solving a problem or shaping. Without some level of variability, differential reinforcement and shaping cannot occur. Variability can also be dysfunctional, as when variations in responding prevent behavior from coming under more precise control of particular contextual variables. Variability dimensions can also characterize clinical presenting problems. Individuals who present with depression, impulse control disorders, autism, obsessive compulsive disorder, and dementia may have several skills sets with suboptimal variability. Conversely, individuals presenting with bipolar disorder and attention deficit

hyperactivity disorder may have several skill sets with excessive levels of variability.

Until recently, researchers had assumed that variability was primarily determined by organic variables. Neuringer and colleagues were among the first to demonstrate that when reinforcement is contingent on producing more variable patterns of responding, more variable patterns will emerge (Neuringer, 1986; Page & Neuringer, 1985). Additional research has demonstrated that the response variability of clinical populations known for having low variability in their responding (e.g., individuals with depressed and autistic patterns) can be increased by making reinforcement contingent on the production of more variable patterns of behavior (Hopkinson & Neuringer, 2003; Miller & Neuringer, 2000).

Variability of responding has also been shown to be influenced by the type of reinforcement schedules used to maintain behavior. Generally, more variable response–reinforcer contingencies are accompanied by more variable behavior. Conversely, more regular response–reinforcer contingencies are accompanied by less variable behavior (see Lee, Sturmey, & Fields, 2007, for a review).

Implications for Assessment

It is possible to quantitatively characterize a subject's variability on a computer-based assessment task (see Hopkinson & Neuringer, 2003; Miller & Neuringer, 2000; Stokes & Balsam, 2001, for a description of these programs). These tasks provide a general assessment of an individual's sensitivity to variability-related contingencies. Postassessment interviews could be used to provide therapists with a sense of whether variability was restricted by the use of rules. Other evidence suggests that variability assessments hold promise for documenting the early repertoire-

narrowing effects of dementia (Drossel & Fisher, 2006).

Most clinicians are more interested in assessing the variability of clinically relevant behavior patterns. Researchers have yet to develop a means of formally characterizing the variability of these behavior patterns. For now, clinicians will have to rely on more qualitative means of evaluating variability and take this dimension of behavior into consideration when planning treatment.

Implications for Treatment

Researchers have identified that there is an optimal window during the training process for shaping variable performance (Stokes & Balsam, 2001). If variability training occurs at the beginning of the training process, variability will be poorly maintained over time. If variability training occurs long after training has been established, training will produce only a modest increase in variability. If, however, variability training begins after an initial number of essential exemplars have been trained for the behavior pattern of interest, the behavior will remain relatively more sensitive to variability-based differential reinforcement. This means that treatment should first focus on training a core set of necessary skills. After these are established (but not overtrained), training should focus on increasing the variability of exemplars within the target response class. A history of inadequate support for variability is often observed in social situations. Some individuals have only one or two stories that they can skillfully deliver at social gatherings. These stories are then repeated, although the once-enthralled audience becomes fatigued with repeated deliveries.

When specific exemplars of a target response class are difficult to prompt or the individual's repertoire differs too greatly from the target class, then the therapist needs to differentially reinforce approximations toward functional variability levels. The difficulty of this task lies in specifying the dimensions of behavior patterns in which variability is of interest and the range of responding that will be considered functional. Consider depressed individuals who present for treatment with flat affect. Their verbal and nonverbal behavior will initially lack the variability that helps to maintain most conversations. Most clients will benefit from verbal prompts during the course of variability-focused skills training. For example, individuals can be instructed to vary their tone of voice, increase their eye contact, shift the meter or prosody of their speech, and so on. Such verbal prompts suggest increasing variability in a particular domain of responding or encourage keeping variability within a functional range (e.g., "I really like the way you said that, can you say it again … great … now how might you say the same thing a little bit differently?").

Therapists can include more specific feedback while differentially reinforcing behavior (see Daniels, 1989, pp. 181–191). The easiest way to do this is to specify the dimensions of the response that had a particular impact on the therapist (e.g., "I'm enjoying this conversation. I feel like I get to know you better when you slow the conversation down and stay on one topic."). Some behavior patterns may be so problematic that the therapist will need to directly ask for a different response in hope that the next response will sufficiently vary along a reinforceable dimension (e.g., "I don't know what to make of that. Why don't you try that again but say it totally different. … What I liked about that response was you boiled all of your earlier comments down to one main point.") It is important to frequently vary the form and content of the prompts for more variable behavior. Repeated presentations of the same prompt run

the risk of reducing variability by arranging stereotypic antecedent–behavior–consequence relations (i.e., decreased variability due to schedule effects). Furthermore, lack of variability in prompt presentation can encourage the development of excessive rule governance, which can undermine the variability targeted in training.

When therapists train clients to have more or less variable patterns of behavior, it is also useful to train them to assess their impact on others. This involves two sets of skills: (a) predicting the likely impact of problematic variability on others and noticing the social cues that indicate that this may be the case and (b) identifying situations in which it is appropriate to directly ask others for feedback.

The final consideration for variability-based interventions is to note that the same variables that influence the momentum of other response patterns hold for response patterns in which variability is an important dimension. Thus, if it is important for a particular range of variability to have momentum, part of training should focus on providing high rates of reinforcement for variable response patterns. To accomplish this, initial training should focus on identifying responses within the appropriate range of variability. Thus, once individuals are able to reliably use one effective response, training can shift to generating five or more effective ways to achieve the same interpersonal effect. Once sufficient breadth of variability has been established, fluency training can be used to improve the momentum of the larger functional class. This type of social skills fluency requires individuals to produce variations in responding to repeated presentations of similar antecedents. For example, fluency training can focus on multiple ways of responding to the therapist's initiation of small talk. Other common skills that can benefit from variability

and momentum-focused training include the initiation of difficult conversations and expressions of appreciation or affection.

SUMMARY

Contemporary basic research still has much to offer clinical behavior analysis. Molar functional relations such as matching, discounting, momentum, and variability have broad applicability for understanding clinical problems and for producing behavior change. Our current intervention technologies are only beginning to be understood in terms of these relations. We hope that this review will prompt clinicians to explore the richness offered by basic behavior-analytic research. Clinical behavior analysis can only be as strong as the functional relations used to address clinical problems. Basic researchers are still exploring the frontiers of meaningful behavior–environment functional relations. Current research on matching, discounting, momentum, and variability all have implications for clinical work. There are many additional areas of basic research that have implications for clinical behavior analysis that were not included in the present review (e.g., relational stimulus control, resurgence, emergence, adjunctive behavior, and behavioral economics). The breadth of these areas suggests that the continued synergy between basic research and clinical application in behavior analysis will provide much room for growth and innovation in our field.

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