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RESPONSE LATENCY AS AN INDEX OF RESPONSE STRENGTH DURING FUNCTIONAL ANALYSES OF PROBLEM BEHAVIOR

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Dependent variables in research on problem behavior typically are based on measures of response repetition, but these measures may be problematic when behavior poses high risk or when its occurrence terminates a session. We examined response latency as the index of behavior during assessment. In Experiment 1, we compared response rate and latency to the first response under acquisition and maintenance conditions. In Experiment 2, we compared data from existing functional analyses when graphed as rate versus latency. In Experiment 3, we compared results from pairs of independent functional analyses. Sessions in the first analysis were terminated following the first occurrence of behavior, whereas sessions in the second analysis lasted for 10 min. Results of all three studies showed an inverse relation between rate and latency, indicating that latency might be a useful measure of responding when repeated occurrences of behavior are undesirable or impractical to arrange.

Key words: functional analysis, latency measures of responding

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Research on the assessment and treatment of problem behavior traditionally has used measures that reflect repeated occurrences of behavior, such as rate, duration, or the percentage of intervals during which responding occurs. Measures of response repetition may be undesirable, however, when the target response poses significant risk, as in the case of high-intensity self-injurious behavior (SIB) or aggression. Response repetition might also be difficult to obtain when there are limited response opportunities within a session. When the target behavior alters stimulus conditions such that the response cannot recur, the experimenter's attempts to restore the environment may introduce a source of confounding. For example, responses such as elopement or disrobing can occur only once per session unless a therapist provides additional response opportunities by returning the client to the room or dressing the client, both of which involve the delivery of attention. Finally, some responses (e.g., vomiting) may be physiologically constrained to a degree that precludes their frequent occurrence. When repeated occurrences of behavior are undesirable or impractical to

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arrange, alternative measures of response strength might be necessary.

One dimension of response strength that is not based on response repetition within a session is latency from the onset of a stimulus, such as the beginning of a session, to the first response. Latency measures greatly reduce the number of responses required to assess changes in behavior, and thus might be useful as alternatives to traditional measures based on response repetition. Response latency has been used occasionally in applied research and typically to measure the initiation of adaptive behaviors such as compliance (Ardoin, Martens, & Wolfe, 1999; Belfiore, Lee, Vargas, & Skinner, 1997; Wehby & Hollahan, 2000) or the onset of sleep (Borkovec, Grayson, O'Brien, & Weerts, 1979; Piazza & Fisher, 1991). By contrast, latency as an index of problem behavior has been used rarely and typically as an indicator of treatment effectiveness. In an early example, Liberman, Teigen, Patterson, and Baker (1973) reported increases in latency to the onset of delusional speech during treatment consisting of differential reinforcement (DR) for appropriate speech. More recently, Zarcone, Iwata, Hughes, and Vollmer (1993) and Goh, Iwata, and Kahng (1999) used latency in the context of treatment comparisons. Zarcone et al. compared the effects of momentum and extinction interventions on the latency to SIB maintained by escape from task demands and observed increases in latency only when extinction was in effect. Goh et al. compared the effects of noncontingent reinforcement (NCR), DR, and DR plus blocking on pica and observed sustained increases in the latency to pica during the DR plus blocking condition. Two studies have used latency to problem behavior in the context of assessment. Lalli, Mace, Wohn, and Livezey (1995) showed that several topographies of escape-maintained behavior were members of a response class hierarchy by measuring the latency to each response under varied conditions of reinforcement. More recently, Call, Pabico, and Lomas (2009) measured latency to problem behavior while presenting a series of task instructions to two subjects. They subsequently conducted functional analyses including two demand conditions that contained instructions for which short versus long latencies to problem behavior had been observed previously. Results of both analyses showed higher rates of problem behavior in the short-latency demand condition.

Results of these studies showed that response latency was a useful measure; aside from the Call et al. (2009) study, however, they did not provide any information on whether latency to the first response was predictive of subsequent responding (i.e., response rate). In fact, very little research has examined the relation between response latency and response rate. As an exception, Killeen and Hall (2001) conducted a series of experiments on several dimensions of responding (overall rate, run rate, latency, and probability) to evaluate their utility as measures of response strength. Following exposure to varied reinforcement schedules, pigeons' key-pecking responses were examined during extinction to identify correlations among dependent variables. Although the correlation between overall rate and probability was the highest (suggesting that these were the best measures of strength), results generally showed an inverse correlation between latency to the first response in a trial and subsequent response rate. These findings suggested that response latency might be an adequate measure of response strength.

The purpose of this study was to determine whether response latency could be used as the index of behavior during functional analyses of problem behavior. If so, the use of functional analyses with high-risk and session-terminating behaviors would be more feasible, and the overall efficiency of assessment in general might be improved. Because little is known about latency as a measure of behavior, Experiment 1 consisted of a basic demonstration of the relation between response rate and latency to the first response with simple vocational tasks. Experiment 2 consisted of a retrospective analysis, in which data from functional analyses were compared when graphed as overall session values and as latency to the first response in a session. In Experiment 3, results from pairs of independent functional analyses were compared. Sessions in the first (latency) analysis were terminated subsequent to the first occurrence of the target behavior, whereas sessions in the second analysis lasted for 10 min each.

EXPERIMENT 1: CORRESPONDENCE BETWEEN RESPONSE LATENCY AND RESPONSE RATE

METHOD

Subjects and Settings

Four adult men (Larry, Jack, Dan, and Mickey) who had been diagnosed with developmental disabilities (mild to moderate mental retardation) participated. Three of the four men were able to communicate vocally. The fourth had no vocal communication skills but used limited signs and gestures, and was hearing impaired. Sessions were conducted in therapy rooms that contained all materials necessary to complete the target tasks as well as moderately preferred leisure items, such as magazines or books.

Response Measurement and Reliability

Target behaviors consisted of simple vocational responses (e.g., hole punching, dialing telephone numbers). Operational definitions varied across subjects and included both the criterion for a response and when the response was to be scored (e.g., *dialing* was defined as pressing seven telephone buttons in a particular order; a response was scored when the seventh button was pressed after the first six buttons had been pressed in correct order). Handheld computers were used to collect data on response frequency and latency, and reliability was assessed by having a second observer simultaneously but independently record behavior during a proportion of sessions (range, 20% to 93%). Reliability for frequency data was calculated by dividing each session into consecutive 10-s intervals, dividing the smaller number of responses scored in each interval by the larger number, averaging these fractions, and multiplying by 100%. Reliability for latency data was calculated by dividing the shorter latency (in seconds) by the longer latency and multiplying by 100%. Mean reliability scores across subjects ranged from 94% to 97% for response rate and from 78% to 99% for response latency.

Procedure

The experimenter modeled the target response once prior to the beginning of the first session during the baseline and acquisition conditions but not during the maintenance condition. The model consisted of a single demonstration of the target response with no accompanying instructions, prompts, or consequences. Reinforcers (preferred food items) were not present during baseline but were visible during acquisition and maintenance sessions. Sessions were started 3 s after the model prompt (first session of baseline and acquisition phases only) or 3 s after the subject was seated at the work table. Sessions were 5 min in duration during baseline and acquisition conditions but were terminated during the maintenance condition after reinforcement was delivered for the first response or after 5 min had elapsed in the session, whichever came first. At the end of each session, all session materials were removed, and the subject left the room for at least 3 min. Approximately two to five sessions were conducted per day, 3 to 5 days per week. A multiple baseline design across subjects was used to demonstrate experimental control.

Baseline. The purpose of this condition was to establish a measure of responding in the absence of reinforcement and to determine whether low rates of responding coincided with long latencies to the first response in a session. No consequences were delivered for occurrences of the target response.

Acquisition. The purpose of this condition was to produce an increase in response rate and to determine whether high rates of responding corresponded to short latencies to the first response per session. A small piece of food (selected based on results of a preference assessment) was delivered following each occurrence of a target response.

Maintenance. The purpose of this condition was to determine whether short latencies to the first response were maintained when only one response was allowed to occur. The first response in a session produced delivery of the reinforcer, after which the session was terminated immediately.

Results and Discussion

Results (Figure 1) showed that Larry, Jack, and Dan never emitted any responses during baseline; Mickey emitted only one response during the third session, which occurred 50 s into the session. When reinforcement was delivered during the acquisition condition, Larry, Jack, and Dan immediately began responding at moderate (Larry and Dan) to high (Jack) rates, with uniformly short latencies to the first response. Mickey's responding emerged more gradually and showed an interesting pattern. He emitted no responses during his first acquisition session; thereafter, as his response rate increased, his response latency decreased. All subjects' response latencies remained short during each session of the final maintenance condition (response-rate data are not shown because only one response occurred during each session).

Results of Experiment 1 showed an inverse relation between response rate and latency to the first response, replicating the findings of Killeen and Hall (2001) and extending them to human behavior. In previous applied research on problem behavior in which latency to the first response was used as a dependent variable (e.g., Goh et al., 1999; Zarcone et al., 1993), it was assumed that short latencies were predictive of response maintenance and that long latencies were indicative of extinction. The present data provide some empirical support for this assumption. An unusual feature of Experiment 1 was the inclusion of a maintenance condition in which sessions were terminated following the occurrence of one response. We included this condition to determine whether short latencies would persist under an arrangement approximating that of a functional analysis in which the occurrence of only one response might be tolerated (or observed) in a session. All subjects continued to exhibit short response latencies across a number of sessions, indicating that a history of reinforcement might influence response latency even when contact with the contingency is limited. Thus, data from the maintenance condition suggest the possibility of using response latency as the dependent variable during functional analyses of problem behavior.

It is important to note that the rapid acquisition shown by all subjects may have been influenced by a history of reinforcement for other responses. That is, subjects in Experiment 1 had experience with food reinforcers in other contexts prior to the study, and the presence of the reinforcers in combination with the therapist or session materials might have functioned as a discriminative stimulus. It is possible that individuals without this history of reinforcement for other responses may have acquired the target responses more slowly.

EXPERIMENT 2: RETROSPECTIVE COMPARISON OF RESPONSE RATE AND LATENCY IN FUNCTIONAL ANALYSIS DATA

One way to evaluate correspondence between response rate and latency in the context of a functional analysis of problem behavior would involve examination of assessment data for which both measures already are available. We conducted this type of evaluation in Experiment 2 by comparing rate and latency measures across preexisting sets of functional analysis data.

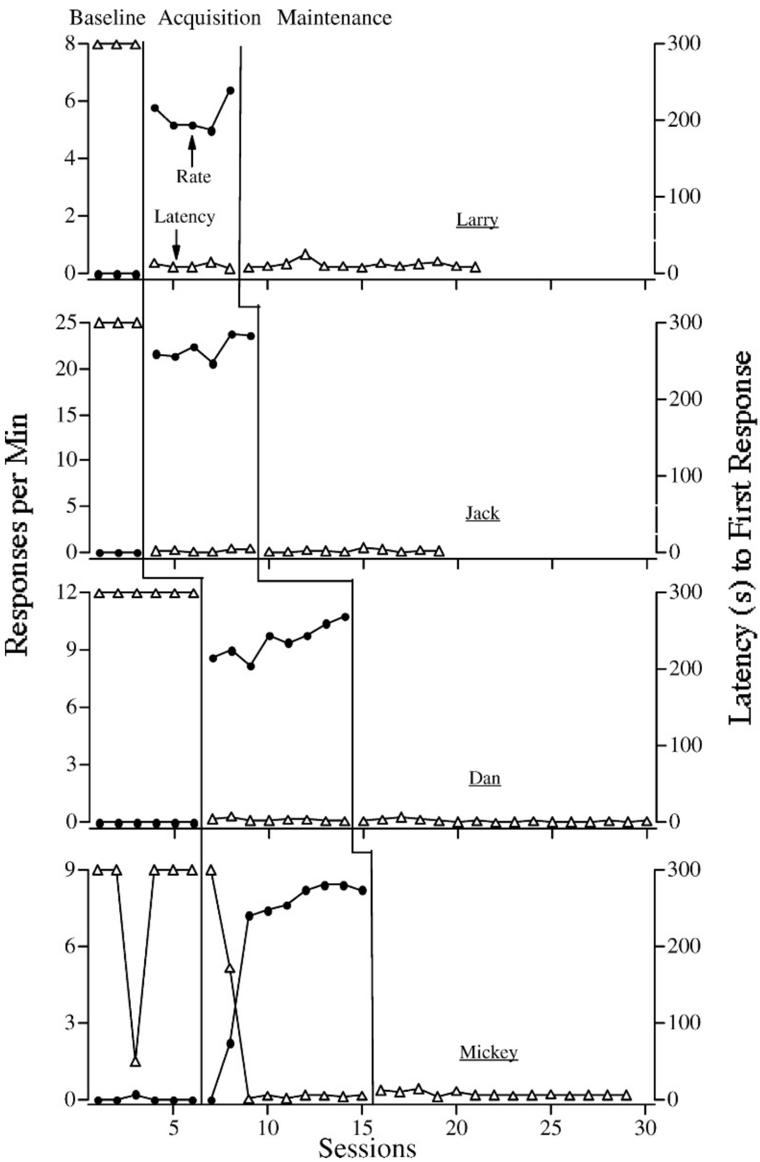

Figure 1. Rate (responses per minute) and latency (in seconds) measures of responding during baseline (BL), acquisition, and maintenance phases of Experiment 1 for Larry, Jack, Dan, and Mickey.

Method

Subjects and Settings

We conducted a record review and selected all functional analysis data for which latency measures were available or could be derived. Data sets were considered complete if they included at least two test conditions and one control condition, with at least three repetitions of each test condition. Thirty-eight data sets met these criteria and were included in the present analysis. Subjects were 37 individuals who had been diagnosed with developmental disabilities and had been referred for assessment and treatment of problem behavior. One individual participated in separate functional analyses for each of two different problem behaviors; both data sets were included in this sample, bringing the total to 38. Thirty-four subjects lived in a state residential facility, and three lived at home with parents or guardians. Sessions were conducted in therapy rooms that contained all necessary materials (e.g., leisure items, demand materials) at the residential facility or at an outpatient treatment center. Trained graduate students conducted all sessions. Data for one subject (Betty) have been presented in previously published articles (Kahng & Iwata, 1999; Lerman, Iwata, Smith, Zarcone, & Vollmer, 1994; Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993a).

Response Measurement and Reliability

Target behaviors were those reported as problematic by caregivers (SIB, aggression, property destruction) and were operationally defined on an individual basis. Sessions were either 10 or 15 min in duration. Trained observers used handheld computers to collect data on target behaviors (either frequency or 10-s partial-interval recording). Reliability was assessed by having a second observer simultaneously but independently record data. Reliability for frequency data was calculated as described in Experiment 1. Reliability for interval data was calculated by dividing the number of intervals containing scoring agreements (on either the occurrence or nonoccurrence of behavior) by the total number of intervals and multiplying by 100%. The proportion of sessions for which reliability was assessed ranged from 13% to 40% across subjects, and mean reliability scores ranged from 88% to 100% across subjects. Reliability was not calculated for the latency scores generated from the raw data.

Functional Analysis

Procedures were based on those described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994). Test and control sessions were alternated in a multielement design. All functional analyses included attention, demand, alone or ignore, and play conditions, with the following exceptions: (a) An alone or ignore condition was not included when the target behavior was aggression, and (b) a tangible condition was included only when caregiver interviews suggested that problem behavior was likely to occur when preferred items were removed or when requests for preferred items were denied. The play condition served as the control condition against which responding in other conditions was compared. Sessions typically were conducted in the following order: alone or ignore, attention, play, tangible (if applicable), and demand. Record review indicated that in several cases specific stimuli, including therapists, colored shirts or tablecloths, and rooms, were correlated with the different conditions in an effort to enhance discrimination; however, this information was not available in all cases.

Attention. At the beginning of each session, the therapist directed the subject to play with the leisure materials in the room, indicated that she "had work to do," and ignored all of the subject's nontarget behavior. Following each occurrence of the target problem behavior, the therapist delivered a brief statement of concern and nonpunitive physical contact (e.g., "Don't do that, you'll hurt yourself" while placing a hand on the subject's shoulder). The tangible condition was similar to the attention condition with the following exception: Access to leisure items was not available during the session except as a consequence for problem behavior.

Demand. Approximately 10 to 15 tasks were identified for use in the session through caregiver interview and informal observation. During each session, the therapist initiated instructional trials using a three-step graduated prompting procedure (instruction, demonstration, physical prompt). Compliance resulted in verbal praise, whereas problem behavior resulted in termination of the instructional sequence.

Alone or ignore. The subject was either alone in the room or at least 2.5 m away from observers, with no access to leisure items or interaction. There were no programmed contingencies for problem behavior during sessions.

Play. The therapist placed preferred leisure items within reach of the subject prior to the start of session and initiated brief social interaction on a fixed-time 30-s schedule throughout the session or more frequently if initiated by the subject. All problem behavior was ignored.

Data Analysis

Two graphs were generated from each of the 38 sets of data. One graph showed either response rate or percentage of intervals in which responding occurred during each session (the response-repetition graph). The second graph showed the latency (in seconds) to the first target response emitted during each session. To generate latency measures from the interval data, we examined raw data streams and set the latency to the first response at the end of the first 10-s interval in which responding was initiated. For example, if the first response was scored during the second 10-s interval of a session, the latency was set as 19 s.

The evaluators included one doctoral level behavior analyst and nine doctoral students in behavior analysis, each with at least 1 to as many as 8 years' experience in interpreting functional analysis data. Identifying information (subject name, target behavior) was removed from all 76 graphs. The 38 latency graphs were presented individually, followed by the 38 response-repetition graphs, all in random order. The graphs were projected onto a screen one at a time to the group of raters, who discussed each graph and reached a consensus about the function of the problem behavior. Shorter response latencies and higher response rates in the latency and response-repetition graphs, respectively, in one test condition (attention, tangible, demand, or alone) relative to the control condition were used to determine maintenance by the reinforcer associated with that condition. Short latencies or high rates in all test conditions, with relatively longer latencies or lower rates in the play condition, were interpreted as maintenance by automatic reinforcement. Correspondence between latency and response-repetition graphs for a given set of data was defined as either (a) higher response rates and corresponding shorter latencies in the same test conditions or (b) undifferentiated patterns of responding in both graphs.

Results and Discussion

A high degree of correspondence was observed between outcomes based on latency and repetition measures. Of the 38 pairs of graphs, 33 indicated maintenance by the same reinforcer; five pairs indicated maintenance by different reinforcers. Because measures of response repetition traditionally have been the index of response strength, instances of noncorrespondence were viewed as instances in which the latency graph was incorrect in indicating the function of behavior.

Figure 2 shows examples of correspondence for behavior maintained by social-positive (Rick, left), social-negative (Albert, center), and automatic (Carrie, right) reinforcement. Rick's higher rates of problem behavior in the attention condition corresponded with relatively short latencies, and his lower rates of behavior in the demand and play conditions typically were associated with longer latencies. Similarly, Albert's higher rates of problem behavior in the demand condition corresponded with relatively short latencies, and his lower rates of problem behavior in the attention, alone, and play conditions corresponded with longer latencies. Finally, Carrie exhibited relatively high rates of problem behavior and short latencies to its first occurrence during all conditions, including the alone condition.

All five instances of noncorrespondence involved problem behavior maintained by positive reinforcement, as indicated by the

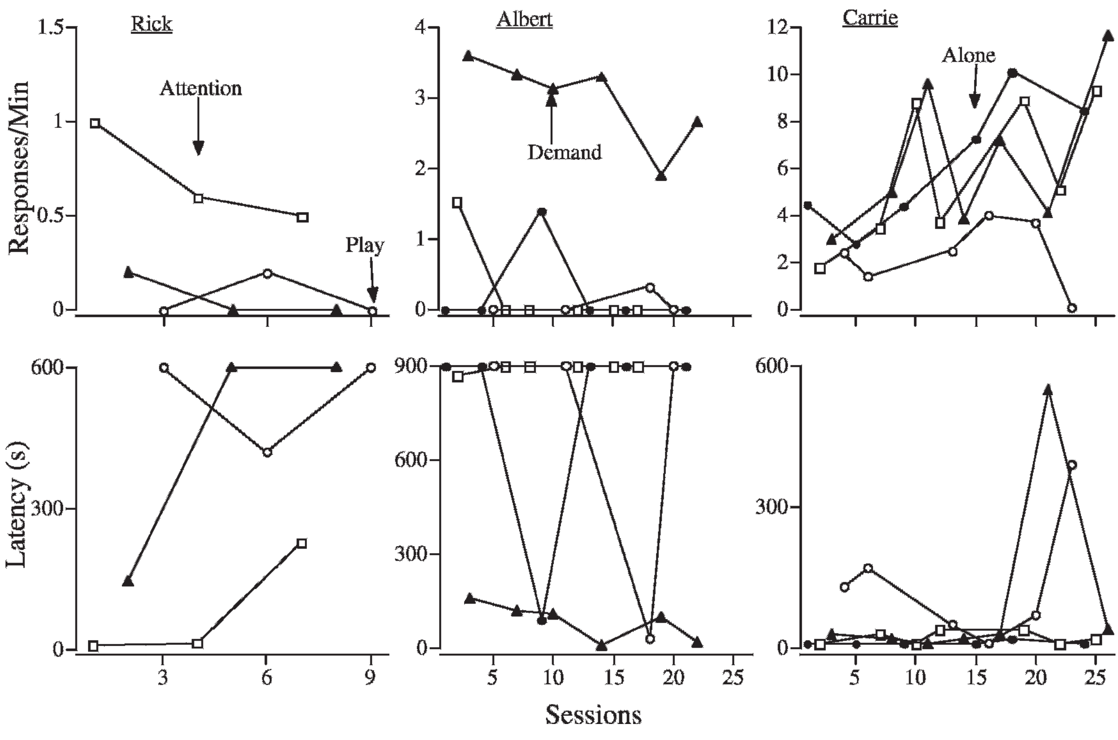

Figure 2. Rate and latency graphs depicting examples of correspondence from Experiment 2 for problem behavior maintained by positive reinforcement (left), negative reinforcement (middle), and automatic reinforcement (right). Top panels show rate data, and bottom panels show latency data.

response-repetition graphs, and two general patterns of noncorrespondence were observed. The latency graphs for two subjects, Ronald and Betty, indicated that problem behavior was maintained by multiple social contingencies (access to tangible items and escape from demands, see Figure 3); latency graphs for the other three subjects indicated that problem behavior was maintained by automatic reinforcement (short latencies to problem behavior across all conditions).

One potential explanation for these patterns of noncorrespondence is unprogrammed stimulus control in irrelevant test conditions, which might influence responding early in a session (accounting for a short latency) but not as the session continued, due to the absence of the relevant reinforcer (accounting for a low overall session rate). To examine this possibility, raw data for individuals who displayed patterns of noncorrespondence were analyzed as minute-by-minute response rates.

Figure 3 shows the data for two subjects who exhibited patterns of noncorrespondence. Ronald's response-repetition graph showed high rates of problem behavior during the tangible condition, whereas his latency graph showed short latencies during both tangible and demand conditions. His within-session pattern of responding showed that problem behavior was maintained throughout tangible sessions. By contrast, problem behavior tended to occur early during demand sessions but typically decreased to low or zero rates by the 3rd minute. Problem behavior occurred at much lower rates and longer latencies during the attention and play sessions, in which items were freely available, and during the alone condition, in which no items or therapists were present. These results suggest that the presence of the

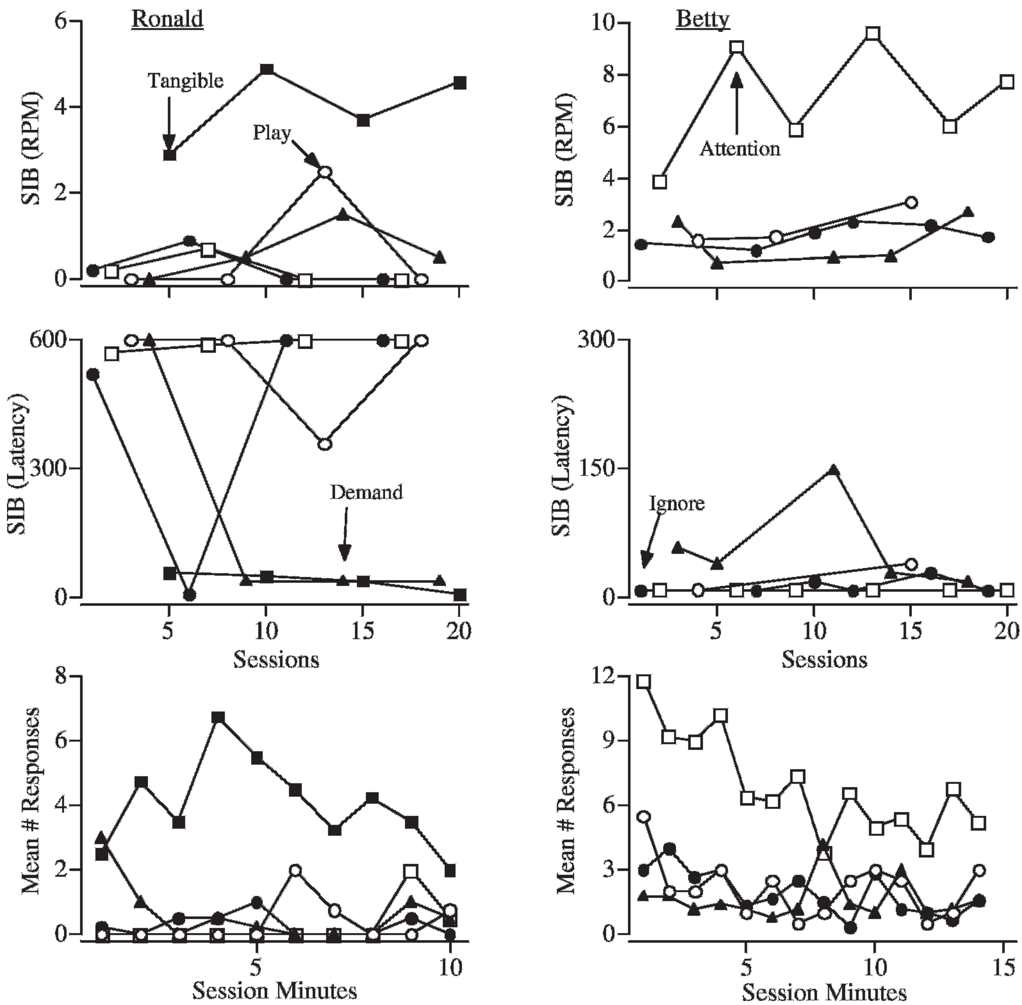

Figure 3. Rate, latency, and within-session analysis graphs for each of two patterns of noncorrespondence observed in Experiment 2. Top panels show rate data, center panels show latency data, and bottom panels show average minute-by-minute within-session data.

therapist might have functioned as a discriminative stimulus for the availability of tangible items. Thus, short latencies to problem behavior were observed during the demand condition; however, response rates were low because exposure to escape as a consequence during the demand condition did not maintain Ronald's behavior throughout the session. One other subject (data not presented) showed the same pattern of noncorrespondence across measures (short latencies in both the demand and tangible conditions but high rates only in the demand condition) and a within-session pattern of responding similar to Ronald's.

Betty's response-repetition graph showed high rates of problem behavior during the attention condition, whereas her latency graph showed short latencies during all conditions. Her within-session graph showed that she engaged in high rates of behavior throughout attention sessions and low but steady rates of behavior throughout play, demand, and ignore sessions. The high rates of behavior during the attention condition demonstrate that behavior was sensitive to attention as a reinforcer; however, it is unclear what factors contributed to the continued occurrences of behavior throughout the play, demand, and ignore conditions. Given that attention was the reinforcer for problem behavior, it is possible that the therapist's presence during play, demand, and ignore conditions might have occasioned attention-maintained behavior. An alternative explanation is that the behavior produced some automatically reinforcing consequences; if that were so, however, higher rates of problem behavior should have been observed during the ignore sessions. In the absence of further manipulations, it is not possible to determine what variables produced Betty's pattern of responding. Two other subjects (data not presented) showed the same pattern of noncorrespondence across measures (short latencies in all conditions but high rates only in the attention condition) and patterns of within-session responding that were similar to Betty's.

EXPERIMENT 3: COMPARISON OF LATENCY AND STANDARD FUNCTIONAL ANALYSES

A limitation of the procedures in Experiment 2 was that, although the latency graphs provided information on the first response that occurred in a session, they provided no indication of how many subsequent responses occurred within that same session. Because the latency data were extracted from sessions that continued for 10 or 15 min rather than ending immediately after consequences were delivered for the first target behavior, several more responses might have occurred within that session, providing additional opportunities for behavior to come under the control of stimuli associated with those session contingencies. Thus, each data point following the first session per condition depicted on the latency graphs reflected a history of repeated exposure to session contingencies, and without those additional exposures, the discriminative stimuli associated with the various reinforcement contingencies might not have acquired control (yielding undifferentiated patterns of responding). This makes it difficult to determine whether functional analyses based on a single exposure to contingencies per session would yield the same results as standard functional analyses. Therefore, the purpose of Experiment 3 was to compare the results of latency functional analyses, during which a single exposure to session contingencies occurred within a session, with the results of standard functional analyses.

Method

Subjects and Settings

Ten individuals who had been diagnosed with developmental disabilities participated. Subject inclusion criteria were that the target problem behavior had been reported to occur at least daily and had been observed at least once during an hour-long observation period prior to the assessment. Sessions were conducted in therapy rooms at a local school, residential facility, or vocational training program. Eight of the 10 subjects had little or no history with the therapists prior to the functional analyses. Two subjects, Shane (data shown in Figure 4) and another for whom the data are not shown, had a prior history with one of their therapists in a different (educational) context. To our knowledge, no subject had experienced a functional analysis, at least not in the 6 months prior to the study.

Response Measurement and Reliability

Target behaviors consisted of behaviors that had been reported as problematic (SIB, aggression, property destruction) and were operationally defined on an individual basis. Data also were collected on therapist behavior, including delivery of attention, instructions, and tangible items, and removal of instruction. Observers used laptop computers to record the frequency of subject and therapist responses. The data-collection program provided real-time data

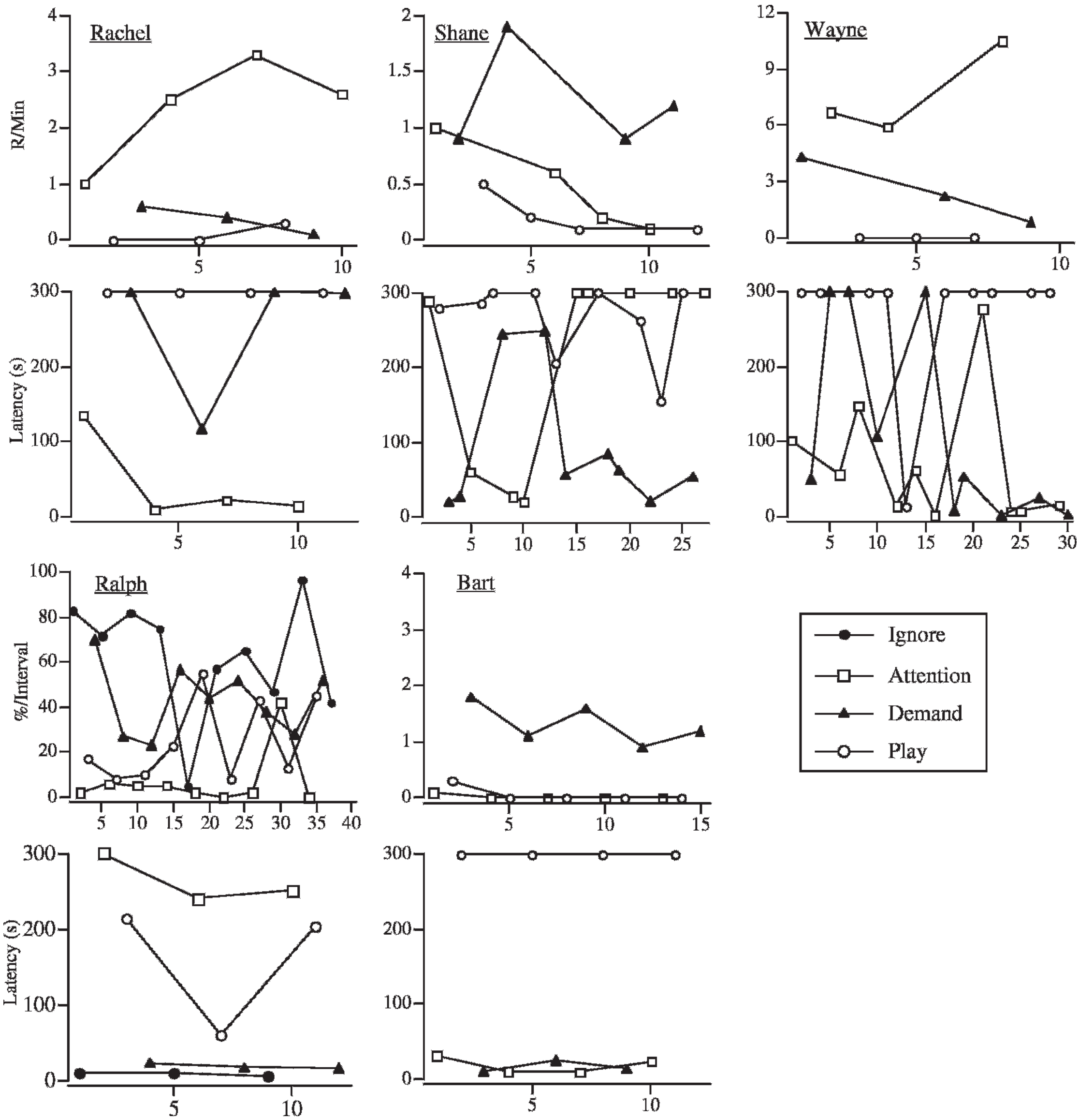

Figure 4. Standard and latency graphs for four patterns of correspondence and one pattern of noncorrespondence observed in Experiment 3. Top panels show data from the standard functional analysis, and bottom panels show data from the latency functional analysis.

streams, such that the raw data reflected the second at which the first target response was scored (in contrast to Experiment 2, in which some latency data were derived from a 10-s partial-interval scoring system). Reliability was assessed during an average of 36% of the sessions and was calculated as described previously for rate, percentage of intervals, and latency measures. Mean reliability (the mean of each subject's reliability scores) was 98% for repetition (rate or partial interval) measures and 91% for latency measures.

Procedure

Assessment conditions were similar to those described for Experiment 2. The latency functional analysis was conducted first, followed by the standard functional analysis. This sequence controlled for possible bias in favor of the latency analysis, which would occur if repeated exposure to session contingencies (in the standard analysis) preceded the latency analysis, during which exposure to session contingencies was limited. Thus, by conducting the latency analysis first, results reflected single-response exposures to test contingencies in a given session, as would be the case had no other assessment been conducted.

Several stimuli were associated with each condition to enhance discrimination in both functional analyses (Conners et al., 2000). First, whenever possible, a different therapist was used for each condition, and each condition was conducted in either a separate room or a separate area of a classroom. Second, each condition was associated with a different-colored shirt worn by the therapist and with a different set of materials available to the subject (e.g., the attention condition may have been conducted by a therapist wearing a red shirt who provided the subject with access to a book and a football). Finally, sessions were initiated (a) when the therapist approached the subject and simultaneously gave a brief instruction or comment (attention, play, and demand conditions) or (b) when the therapist placed the subject in the session room or area (alone or ignore conditions). Prior to attention sessions, the experimenter instructed the subject to play by him- or herself while the therapist worked. Prior to demand sessions, the therapist commented that it was time to work. No instructions were delivered prior to play sessions; the session was started when the therapist sat down next to the subject and delivered some praise (e.g., "nice job brushing the doll's hair"). At least 5 min elapsed between each session, during which the attention, leisure items, and demands were not delivered. The purpose of the break was to enhance session discrimination and to avoid confounding effects that might be introduced if access to potential reinforcers (e.g., attention or preferred items) was immediately available when a session was terminated.

In each functional analysis, conditions were organized in a multielement design in which the sequence was alone, attention, play, and demand sessions, with the play condition serving as the control. Functional analyses were considered complete when (a) differential responding was observed over the course of at least three complete sets of conditions, or (b) 10 complete sets of conditions were conducted. Results of the two functional analyses were compared in the same manner as described for Experiment 2.

Latency Functional Analysis

All session contingencies were the same as described previously; however, session duration was a maximum of 5 min. Attention and escape sessions were terminated immediately following the delivery of programmed consequences for the first instance of a target behavior or when 5 min elapsed, whichever came first. Alone and play sessions were terminated either 1 min after the occurrence of target problem behavior (to minimize inadvertent social consequences for behavior) or when 5 min elapsed, whichever came first. The dependent variable was the latency to the target problem behavior.

Standard (Response-Repetition) Functional Analysis

All procedures were the same as described previously. Sessions were 10 min in duration. The dependent variable was the occurrence of the target behavior, expressed as responses per minute or the percentage of 10-s intervals during which the target response occurred.

Results and Discussion

Table 1 summarizes the results of all independent functional analyses. Correspondence between results of the latency and standard analyses was observed in nine of 10 compari-

Table 1
Outcomes of Independent Latency and Standard Functional Analyses (Experiment 3)

	Latency		Standard	
Subject	Function	No. of responses	Function	No. of responses
Kate	escape	8	escape	33
Rachel	attention	6	attention	108
Gary	escape	3	escape	28
Eric	automatic	29[a]	automatic	398[a]
Wayne	escape and attention	21	escape and attention	304
Isaac	escape	2	escape	28
Shane	escape	18	escape	77
Jay	escape	3	escape	106
Ralph	automatic	11[a]	automatic	779[a]
Bart	escape and attention	7	escape	70

[a] Indicates number of intervals in which responding occurred.

sons. Of these nine subjects, one displayed attention-maintained problem behavior, five displayed escape-maintained problem behavior, one displayed behavior influenced by multiple sources of control (attention- and escape-maintained problem behavior), and two displayed problem behavior maintained by automatic reinforcement. Noncorrespondence was observed for one subject. As another point of comparison, Table 1 shows the actual number of responses that occurred (or number of intervals during which responding occurred) during each subject's latency and standard analyses. Considering only the nine cases of correspondence, the fewest number of responses required to complete the latency analysis was two: Isaac, whose standard analysis required 28 responses (the largest number of responses required to complete the latency analysis was 29 intervals) and Eric, whose standard analysis required 398 intervals. The largest discrepancy between the two assessments was for Ralph (11 intervals of responding during the latency analysis, 779 intervals of responding during the standard analysis). Although observed rarely, several responses may have occurred during a latency functional analysis session (see Wayne's data in Table 1 and Figure 4 for an example of a discrepancy between the number of responses and the number of sessions). Because play and ignore sessions were terminated 1 min after the first instance of behavior, additional responses could occur during the 1-min interval. In addition, more than one response could occur during attention and demand sessions if several responses were emitted in rapid succession.

Figure 4 shows examples of each of the four observed patterns of correspondence, as well as the one pattern of noncorrespondence. In each pattern of correspondence, higher rates of and shorter latencies to problem behavior were observed during the same test conditions of the standard and latency functional analyses, respectively. Rachel's highest rates of behavior and shortest latencies were observed during the attention condition, indicating that her problem behavior was maintained by attention. Shane's highest rates of problem behavior occurred during the demand condition, in which the shortest latencies emerged eventually, indicating that his behavior was maintained by escape. Wayne's highest rates of behavior were observed during the attention condition, and moderate rates also occurred during the demand condition. His latency analysis showed the shortest latencies during the attention condition, and the eventual emergence of short latencies during the demand condition, relative to the control (Sessions 23 to 40). Thus, both of Wayne's functional analyses showed that his behavior was maintained by attention and escape. Ralph's highest levels of and shortest latencies to behavior occurred during the ignore condition, with higher levels and short latencies also during the demand condition, relative to the control. Ralph's raw data indicated that his SIB (scalp rubbing) occurred almost continuously when leisure items were unavailable (during ignore and demand conditions, including during the escape interval of the demand condition) but usually decreased when items were available on a noncontingent basis (during attention and play conditions), except during some later play sessions in which levels of item interaction were low. Thus, it is likely that behavior that occurred during the demand condition was maintained by automatic reinforcement rather than by negative reinforcement (escape). Finally, Bart's standard analysis showed high rates of behavior only in the demand condition, suggesting maintenance by escape; however, his latency analysis showed short latencies to behavior in both the attention and demand conditions, suggesting multiple control. Bart's latency and standard functional analyses provided the only example of noncorrespondence observed in Experiment 3.

GENERAL DISCUSSION

Data on response latency predicted the outcomes of standard functional analyses (Experiments 2 and 3) with a high degree of accuracy while requiring many fewer responses (Experiment 3); as such, the measure offers researchers and clinicians an alternative method for identifying the functions of more severe or difficult-to-assess problem behaviors. Latency functional analyses also might be useful when time constraints are placed on assessment because latency reduces session duration to the first occurrence of a response. More generally, the high degree of correspondence observed between latency to the first response and measures based on response repetition (rate, percentage of intervals) across the three studies reported here indicates that latency may be useful as a dependent variable in a variety of contexts, including assessment and treatment of problem behavior as well as acquisition and maintenance of appropriate behavior. Although results from basic studies suggest that rate and probability share the strongest relation and are likely the best indicators of response strength (Killeen & Hall, 2001), latency to the first response also appears to show a high degree of sensitivity to environmental changes.

A number of responses may be difficult to assess using measures of response repetition. Severe forms of problem behavior, such as SIB that produces immediate tissue damage or aggression directed at vulnerable individuals, may require immediate intervention (response blocking, session termination) to prevent serious injury. Other topographies of problem behavior may be difficult to measure quantitatively because a single instance of behavior precludes its immediate reoccurrence. For example, elopement, disrobing, or certain types of property destruction (breaking furniture or objects) alter the environment in some way to limit the number of response opportunities per session. Finally, responses such as incontinence or vomiting may have physiological constraints such that responding can occur only a limited number of times during a session.

Several innovative procedures have been used to assess behaviors such as those described above. For example, Piazza et al. (1997) measured repeated occurrences of elopement by physically guiding subjects to return to the session room from which they escaped. The strategy was effective in creating multiple response opportunities; however, environmental rearrangements of this type also may introduce a source of confounding (inadvertent attention), which may limit conclusions about the effects of independent variables. Others have approached the assessment of severe problem behavior by conducting functional analyses of behaviors that are different than the target behavior but are presumed to be members of the same response class (e.g., Deaver, Miltenberger, & Stricker, 2001; Smith & Churchill, 2002). Potential advantages of the latency functional analysis over these strategies include the fact that it does not involve the introduction of new contingencies that may influence behavior and it retains a measure of the actual target behavior of interest.

The patterns of noncorrespondence observed in Experiments 2 and 3 illustrate the importance of including procedures to enhance discrimination and to evoke behavior. Conners et al. (2000) showed that pairing unique stimuli (e.g., colored apparel or room assignment) with assessment conditions facilitated discrimination for four of eight subjects. Because our goal was to facilitate discrimination to the greatest extent possible, we used different therapists, presession comments, colored shirts or tablecloths, materials, and in some cases specific session rooms, and it is likely that some combination of these stimuli acquired stimulus control over responding. However, we did not attempt to determine which stimuli may have been the most salient, so it is unclear which arrangements were necessary or sufficient. Future researchers may be interested in empirically determining what stimuli best enhance stimulus control during a functional analysis. In the absence of such information, the most conservative approach may be to include as many discriminative stimuli as possible.

Although discriminative stimuli facilitate differential responding, initial responses have no history with the programmed discriminative stimuli and thus are more likely evoked by establishing operations relevant to the session (e.g., deprivation from attention, exposure to task demands). Therefore, conditions were conducted in a specific sequence that used the content of a previous session as an establishing operation in the subsequent session (Iwata et al., 1994). That is, alone sessions preceded attention sessions, which would likely increase the potency of attention as a reinforcer; similarly, play sessions preceded demand sessions, which would likely increase the salience of a transition from leisure to work, making escape a more effective reinforcer.

Discriminative stimuli and a fixed condition sequence were used in both the latency and standard functional analyses; however, they were especially important in the latency functional analysis, which may have been less accurate otherwise. A typical functional analysis permits repeated exposure to contingencies during each session, such that differences across session types might be readily (or eventually) detected. By contrast, the latency functional analysis permits only a single exposure to a contingency during each session, and thus relies heavily on rapid control by discriminative stimuli and establishing operations to produce differential responding. Thus, the latency analysis may be more prone to false positives than is a standard analysis, as illustrated by Bart's data (Experiment 3). His responding during the latency analysis suggested that his behavior was maintained by both escape and attention; however, further exposure to session contingencies during the standard analysis revealed that his problem behavior was maintained only by escape. Thus, it seems that several exposures to session contingencies were necessary to facilitate differential responding. Therefore, clinicians who rely on latency functional analyses for the purpose of assessment should interpret results cautiously and consider more thorough (albeit lengthy) assessments whenever possible.

On a final note, we must emphasize that response-repetition measures are preferable to latency measures in a number of situations. First, response-repetition measures allow experimenters to conduct additional analyses that may not be possible when only latency measures are available. For instance, examination of within-session response patterns may facilitate the identification of function (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993b). In fact, data sets from Experiment 2 were subjected to this type of analysis, and the resulting information proved to be useful in identifying function in cases of noncorrespondence (see data for Ronald and Betty in Figure 3 as an example of this type of analysis). Second, latency and rate may not always covary, such that latency measures may be poor indicators of response strength. This situation may arise when unprogrammed stimuli evoke an early response that is not maintained under the current contingency (as illustrated in Figure 3). A history of reinforcement for long latencies to the first response may also result in patterns of responding in which latency and rate do not covary. For example, behavior maintained on interval schedules may produce a pattern of responding in which latencies to the first response do not reflect overall response strength. Given the potential limitations of latency as a primary dependent measure, researchers should carefully consider its relative advantages and disadvantages.

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