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# *IDENTIFICATION AND MODIFICATION OF A RESPONSE-CLASS HIERARCHY*

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We evaluated the effects of extinction and negative reinforcement on the latency of response-class members following requests made to a 15-year-old female with moderate mental retardation and autism. A functional analysis showed that the class members (screams, aggression, and self-injury) were escape maintained. Informal observations suggested that these topographies generally occurred in the sequence listed above and therefore may have been hierarchically related. A therapist provided escape from demands contingent on a specific member of the class to determine the effects on the latency of the members' occurrence. Results showed that the latencies occurred in a predictable order. In addition, we expanded the response class to include a vocal response that was functionally equivalent to other members. Findings are discussed regarding the covariation and sequence of response-class members and treatment development.

DESCRIPTORS: response-class hierarchy, response covariation

A response class is defined by the common consequences produced by each member of the class (Catania, 1992). Response-class members can be topographically similar, such as a rat's bar presses (various locations or force), or topographically dissimilar, such as self-injury and aggression (Sprague & Horner, 1992). These topographies have a common effect on the environment, but the probability of their occurrence may not be equal (Baer, 1982). For example, the probabilities of aggression or self-injury being the first member in the response class to occur are different for each response. Baer (1982) suggests that these topographies may substitute for each other and, therefore, may be hierarchically ordered. The hierarchical ordering may be influenced by, but is not limited to, the following: (a) rate of reinforcement, (b) immediacy of reinforcement, (c) response effort, and (d) probability of punishment (Baer, 1982; Mace, 1994).

Several studies have shown that changes in the frequency of one topography can affect the probability of other members of the response class (e.g., Carr & Durand, 1985; Horner & Day, 1991; Lalli, Browder, Mace, & Brown, 1993; Sprague & Horner, 1992). This interdependency among response probabilities has been called *response covariation* (Parrish, Cataldo, Kolko, Neef, & Egel, 1986). When studying response covariation, researchers frequently have focused on reinforcement schedules. In the above studies, the authors evaluated the effects of extinction and functional equivalence training on response covariation (Carr & Durand, 1985; Horner & Day, 1991; Lalli et al., 1993; Sprague & Horner, 1992). These authors conducted pretreatment assessments and found the subjects' problem behaviors to be escape maintained. Based on the assessment findings, the authors taught the moderately to severely delayed subjects verbal responses that were functionally equivalent to their problem behaviors. Each study reported an inverse relationship be-

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tween the trained functionally equivalent response and the other class members (i.e., problem behaviors) for each subject.

The studies cited above show that the probability of a response-class member can be altered by an operation placed on another class member. In the present study, we were interested in the covariation and the ordinal temporal relationships between members of a response class. The dependent variable of interest was the time from a therapist's request to the first occurrence of each response-class member (i.e., latency). Through a functional analysis, we identified a response class consisting of screams, aggression, and self-injury that were escape maintained. Informal observations suggested that these behaviors generally occurred in the above sequence. Therefore, we hypothesized that the latency from a request to the first occurrence of each class member was hierarchically related. The purpose of the present study was (a) to evaluate the effects of extinction and negative reinforcement schedules on response latencies and thus the hierarchical relationship of the class members, and (b) to expand the response class by teaching the subject a response that was functionally equivalent to her problem behaviors.

## METHOD

### *Subject and Setting*

Mary was 15 years old with diagnoses of moderate mental retardation and autism. She was admitted to a hospital inpatient unit for treatment of severe behavior problems. Mary was ambulatory, used adequate fine-motor movement when manipulating leisure materials, and interacted with others using one-word utterances. She typically engaged in problem behavior during personal care routines, activities of daily living (e.g., making her bed), and academic activities.

All sessions were conducted in a dormitory-style room (4.5 m by 6.0 m) that served as Mary's living quarters during her hospitalization. The room was equipped with a full bathroom, a sofa, a table, three to five chairs, and two beds. A therapist and Mary were present during sessions, and observers recorded data from behind a one-way mirror.

### *Dependent Variables and Data Collection*

Mary's target behaviors were (a) *self-injurious mouthing:* insertion of any part of her hand into her mouth; (b) *aggression:* slapping, punching, or kicking others; (c) *screams:* vocalizations above normal conversational volume; and (d) *appropriate vocalization:* saying "no" in response to a therapist's request to do an activity. Screams were recorded with the first occurrence of the vocalization and ended with the absence of the vocalization for three consecutive seconds. Observers used a computerized recording procedure (Repp, Harman, Felce, VanAcker, & Karsh, 1989) for all topographies. The primary dependent measure was response latency, defined as the seconds from a request to the first occurrence of each response. A zero latency was scored if a topography did not occur during a given trial.

A second observer independently collected data during an average of 30% of the sessions equally divided across all phases of the experiment (range across phases, 26% to 39%). Interobserver agreement was determined using the Reliable program (Repp et al., 1989) with a window of ±2 s. Occurrence agreement averaged 84% (range, 70% to 100%) and 81% (range, 75% to 100%) for the onset and offset of screams, 95% (range, 80% to 100%) for aggression, 90% (range, 80% to 100%) for SIB, and 89% (range, 70% to 100%) for appropriate vocalizations. Procedural integrity was monitored for the application of the independent variable (i.e., negative reinforcement contingency). Correct use of the procedure was scored when the therapist stopped instruction within 5 s of the specified response. Procedural integrity was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. Procedural integrity averaged 100%.

*Experimental Designs and Conditions*

A series of functional analysis conditions was presented during 15-min sessions (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). The order of the conditions consisted of four consecutive alone sessions followed by three conditions presented in a multielement design. Three to five sessions were conducted daily. We used a multielement design to evaluate the effects of the extinction, negative reinforcement, and functional equivalence training on the covariation among response-class members during demand conditions. The evaluation consisted of conditions in which the therapist sequentially provided escape contingent on SIB, aggression, and screams, then repeated this sequence, and finally provided escape contingent on an appropriate vocalization.

*Functional analysis.* The functional analysis was conducted as described by Iwata et al. (1982/1994). Reinforcement contingencies in the demand and attention conditions were provided for each occurrence of SIB and aggression; the therapist did not respond to screams. In the demand condition, the therapist presented a request for Mary to make her bed once every 30 s. The therapist responded to SIB and aggression by turning away from Mary (for 30 s) and stating, "Okay, you do not have to make the bed." Contingent on compliance with a request, the therapist provided descriptive praise and the level of assistance necessary (i.e., least-to-most prompt hierarchy). Although the therapist was instructed to end the session if the task was completed, task completion never occurred. The demand condition was designed to evaluate the effects of escape on the rates of SIB and aggression. In the attention condition, the therapist provided Mary with a requested item and diverted his attention from her by reading a magazine. The therapist responded to SIB and aggression by providing disapproving comments. The alone condition was designed to assess the effects of low stimulation on SIB and consisted of placing Mary in a room with a requested item and no adult present. In the control condition, the therapist provided attention for all appropriate interactions, allowed access to requested items, and placed no demands on Mary. The therapist did not respond to screams, aggression, or SIB during this condition.

*Escape contingent on SIB, aggression, or screams.* Procedures in this condition were similar to those in the functional analysis demand condition, with one exception. In sequential conditions, we arranged the negative reinforcement contingency first for SIB, then for aggression, and then for screams. When one topography was negatively reinforced, the remaining two topographies were placed on extinction.

*Escape contingent on appropriate vocalization.* Task instructions were presented as in the functional analysis demand condition. Following the initial instruction, the therapist stated, "Mary, if you do not want to . . ., say 'No.' " The therapist repeated the instruction and the prompt at 30-s intervals until Mary said "no," at which time he provided her with a 30-s break. The therapist did not respond to screams, aggression, or SIB during this condition.

In the above escape conditions, our analyses focused on the first occurrence of each class member after a therapist's request. Therefore, each request was considered as a trial for purposes of data analysis. Sessions continued until a stable pattern of responding to the specific reinforcement contingency was obtained. Session duration ranged from 8.5 min to 55.3 min. Two sessions were conducted daily, with a minimum of 30 min between sessions.

## RESULTS

*Functional analysis.* Occurrences of SIB averaged 74 per hour (range, 24 to 192) in the demand condition. SIB did not occur in the attention or control conditions and occurred only in the first of the alone sessions (Figure 1). Aggression occurred exclusively in the demand

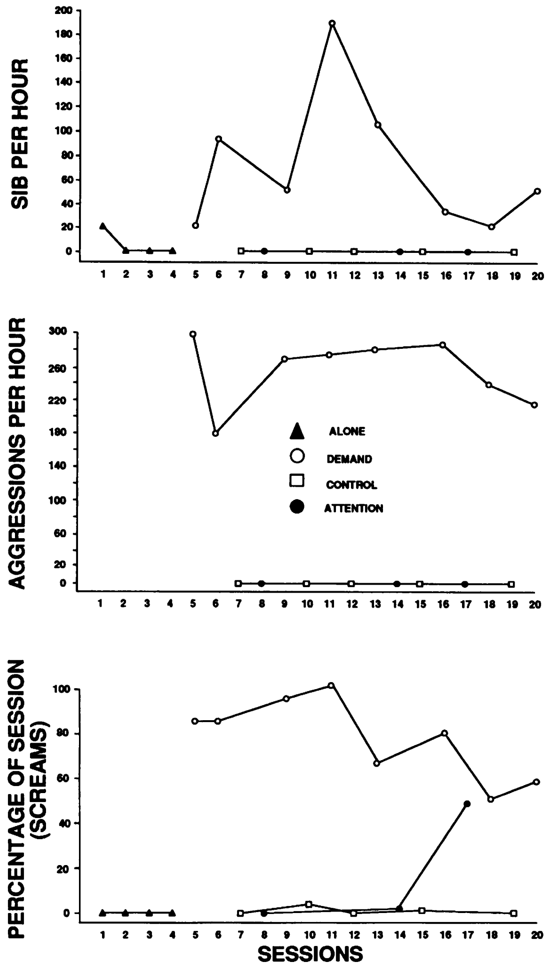


Figure 1. Results of the functional analysis for the response-class members. The top graph shows Mary's SIB, the second graph shows her aggression, and the third graph shows her screams across the various conditions.

condition ($M$ = 250 per hour; range, 174 to 294). Screams occurred most frequently in the demand condition ($M$ = 78% of each session; range, 55% to 100%), occurred infrequently in the attention and control conditions, and did not occur in the alone condition.

*Escape contingent on SIB, aggression, or screams.* Data were analyzed in terms of the latencies (in seconds) to the first occurrence of response topographies after a request from the therapist. In the escape-SIB condition (Figure 2), we predicted that all three topographies might occur in the sequence described above because escape was contingent on the third response in the hierarchy. Results showed the sequence of response latencies to be screams, aggression, and SIB in 14 of the 16 trials. In the two trials not conforming to this pattern, screams and aggression occurred simultaneously (Trials 5 and 14).

In the escape-aggression condition, we predicted that screams would occur first followed by aggression and that SIB might not occur because escape was contingent on a response earlier in the hierarchy. Data from this condition showed that the predicted ordinal positions (i.e., screams → aggression) were observed in 27 of the 35 trials (Figure 2). Of the eight trials in which SIB occurred, seven of the eight occurrences were observed in Trials 1 through 9, with the eighth occurrence in Trial 19. No SIB occurred in the last 16 trials.

In the escape-screams condition, we predicted that only screams would occur because Topographies 2 and 3 were unnecessary to produce escape. In this condition, screams alone occurred during 19 of the 21 trials (aggression occurred in Trials 3 and 8). No topography other than screams occurred after the eighth trial (Figure 2).

In the second escape-SIB condition, the sequence of responses was screams, aggression, and SIB in 14 of the 15 trials (Figure 3). Aggression did not occur in Trial 4. In the second escape-aggression condition, the order of responses was screams and aggression in 15 of the 16 trials (Figure 3). In Trial 7, screams, aggression, and SIB occurred in that order. The second escape-screams condition resulted in screams alone in all 16 trials (Figure 3).

*Escape contingent on appropriate vocalization.* In this condition, we predicted that only the appropriate vocalization would occur because this response served the same function as screams, aggression, and SIB. Results from this condition showed that appropriate vocalization was the only member to occur in 28 of the 36 trials (Figure 3). In Trials 2 and 5, appropriate vocalizations occurred after Mary emitted other topographies. Interestingly, in six trials Mary

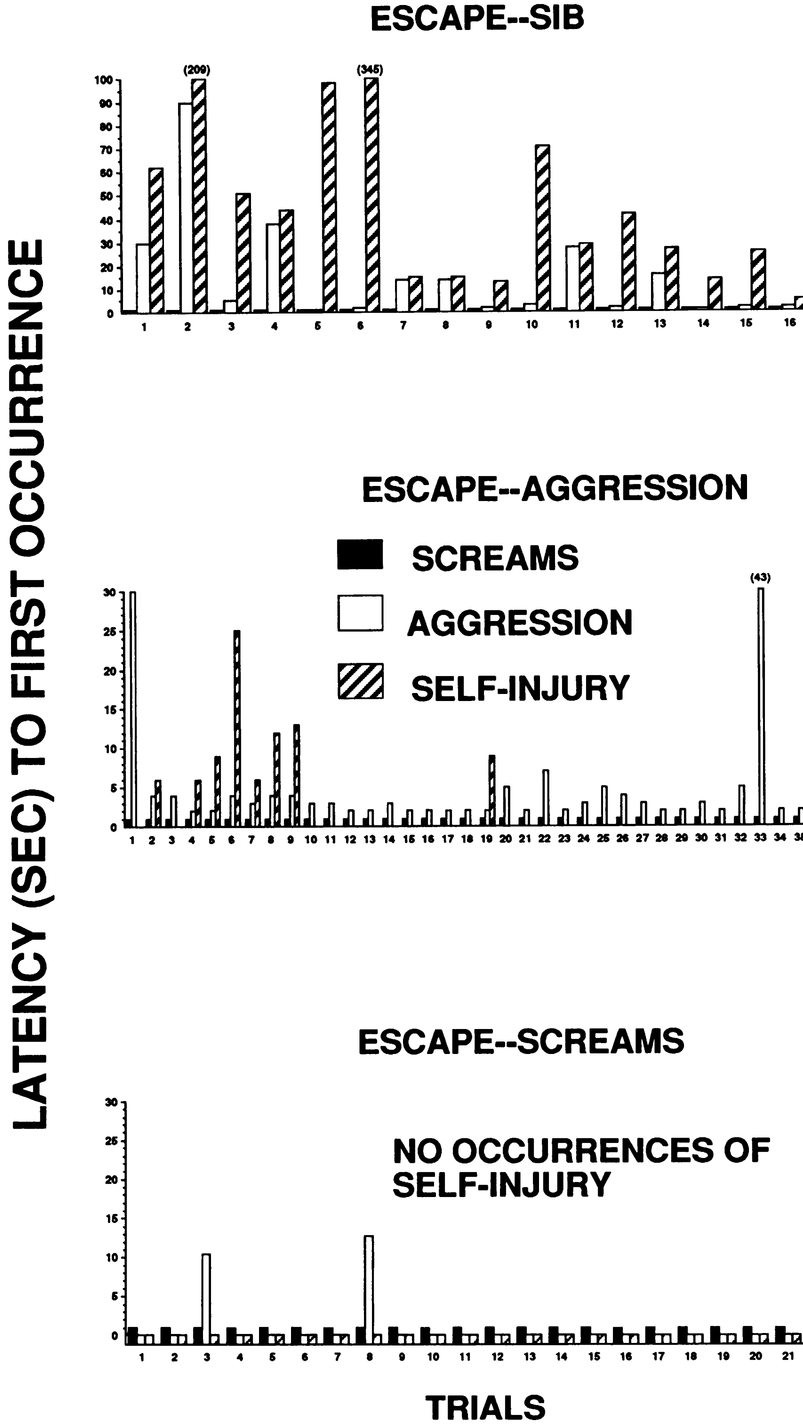


Figure 2. Results of escape contingent on the individual response-class members. The latency to the first occurrence of each topography (in the nearest second) is presented on the ordinate, and the order in which the topographies occurred is presented on the abscissa. A zero latency shows that a topography did not occur during a trial.

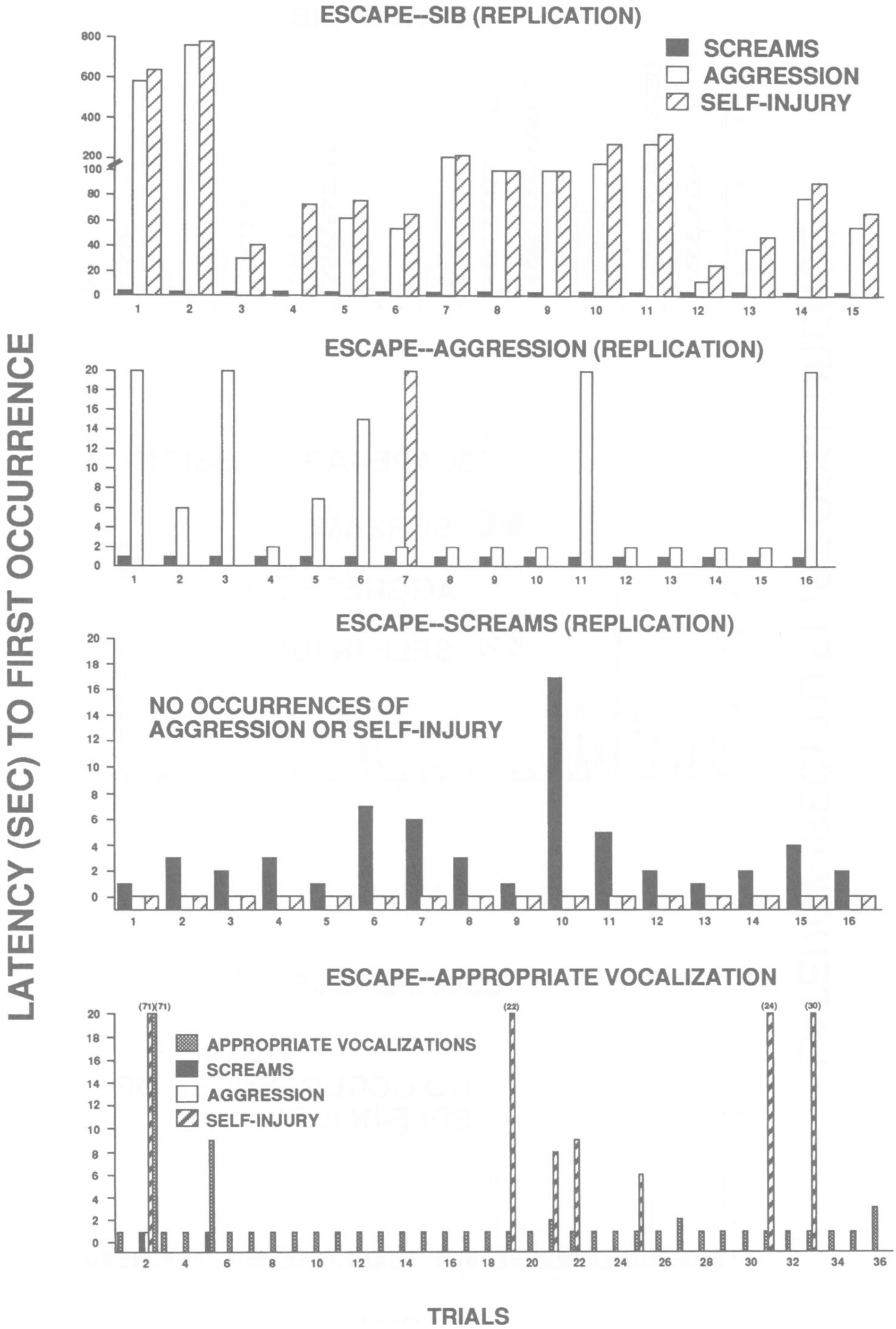


Figure 3. Results of the second condition in which escape was contingent on the individual response-class members and escape was contingent on appropriate vocalization. The latency to the first occurrence of each topography (in the nearest second) is presented on the ordinate, and the order in which the topographies occurred is presented on the abscissa. A zero latency shows that a topography did not occur during a trial.

initially emitted the appropriate vocalization but also engaged in SIB within 5 s to 30 s of the appropriate vocalization.

## DISCUSSION

A functional analysis of our subject's problem behavior showed three distinct topographies that were each functionally related to a common reinforcement contingency. By definition, these behaviors (screams, aggression, and SIB) constituted a response class (Skinner, 1969). During the demand condition of the functional analysis, it appeared that the behaviors often occurred in a sequence beginning with screams, escalating to aggression, and then to SIB. Such a sequence suggested that the response latencies were different for each topography and that these latencies may have been hierarchically related. This hypothesis was tested in a subsequent analysis by applying the escape contingency to only one topography at a time while placing the other two responses on extinction. When escape was applied to the last response in the sequence (SIB), all three topographies were generally observed in their hierarchical sequence. Applying the contingency to topographies earlier in the sequence resulted in the discontinuation of subsequent topographies in the hierarchy. This procedure may provide a methodology for empirically identifying and modifying a response-class hierarchy. Our experimental design, however, did not control for the influence of order effects as a threat to the internal validity of the independent variable.

The results have implications for both theory and clinical applications. At the level of theory, the behaviors belonging to the present response class can be conceptualized as concurrent operants. That is, Mary was free to emit screams, aggression, and SIB any time and in any sequence. As concurrent operants, we can assume that their relative frequency was influenced by the relative rate of reinforcement derived from each topography (Herrnstein, 1970). This assumption was supported when systematic application of escape to only one topography, while placing the other two on extinction, resulted in marked changes in the occurrence of the three target behaviors as the contingency was shifted across behaviors.

Although the sequence of response latencies observed could be due to a history of different reinforcement frequencies for the behaviors, other factors are also possible. For example, differences in reinforcer quality or delays to reinforcement available for concurrent alternatives have been shown to strongly affect response allocation patterns (Neef, Mace, & Shade, 1993; Neef, Mace, Shea, & Shade, 1992). However, in the present study the quality and immediacy of the consequences for the three behaviors remained approximately constant throughout the investigation (i.e., escape from demands occurred within 5 s of the target response). Another plausible influence may have been a difference in the response effort or "cost" associated with the topographies. On logical grounds, screaming appears to be less effortful than aggression, which in turn may require less effort or cost than self-injury. For example, Horner and Day (1991) showed for 1 client that task attempts and aggression were escape maintained. When several trials were required before a break from tasks was allowed, aggression was far more likely than task attempts. However, allowing escape following a single task trial reversed the response probabilities for aggression and task attempts. Thus, the relative effort or efficiency of the two responses to produce escape affected their relative response probabilities. Another possible explanation for the observed sequence may be the probability of producing punishment by each topography. That is, screams may have occurred first in the sequence because they were less likely to produce punishment than aggression was. For example, Sprague and Horner (1992) identified a response class of tantrums (i.e., hitting others or objects, head and body shaking, putting hands to face, screaming) that was escape maintained. When the authors blocked and reprimanded one topography (hitting others), they observed a decrease in the frequency of the targeted topography and an increase in the rates of other response-class members. These findings showed that preventing one topography (while reprimanding attempts) resulted in an increase in the rates of the remaining response-class members. In the present study, we directly controlled only the quality and immediacy of reinforcement; therefore, any plausible explanation for the observed sequence of topographies must be viewed tentatively.

Our definition of response-class hierarchy is conceptually distinct from Premack's formulation of *response hierarchy* and from the definition of a *response chain.* Premack's reinforcement theory indicates that, given an organism's unconstrained opportunity to engage in different behaviors, a hierarchy of relative frequencies or times spent engaging in the behaviors will emerge (Premack, 1959). These relative response probabilities predict whether contingent or restricted access to an activity in the hierarchy will function as a positive reinforcer or punisher, respectively, for other behaviors in the hierarchy. These reinforcement rules were later modified by Allison and Timberlake (1974) to account for the effects of response deprivation on reinforcement relations among behaviors in the hierarchy. A response hierarchy differs from a response chain because in the hierarchy any response can produce the specific reinforcer. By contrast, in a response chain a response in the initial link of the chain produces access to the next schedule of reinforcement rather than the specific reinforcer.

Although the concepts of response-class hierarchy and response hierarchy both rank different topographies along some behavioral dimension, the bases for the hierarchies appear to be different. One difference is that the behaviors that form a response hierarchy typically belong to different response classes. For example, wheel running produces consequences that are different from those produced by bottle licking in rats. The basis for the hierarchical ordering of behaviors may be according to the qualitative differences in the consequences each behavior produces. By contrast, behaviors belonging to a response-class hierarchy share a common effect on the environment. The hierarchical relation among behaviors may be related to differences in the response effort of each topography, the rate or delay to reinforcement produced by each behavior, or the probability of punishment produced by each response. Thus, response-class hierarchies may be conceptualized as a distinct type of concurrent operant.

Empirical identification of a response-class hierarchy also has important clinical implications. First, escalation of episodes of problem behavior is a commonly observed but seldom-researched area. By escalation we mean that comparatively minor topographies of problem behavior are observed first and are later followed by other topographies that are more disruptive or destructive (Baer, 1982). The subject of the present study showed a pattern of escalation that began with screams and escalated to aggression and finally to SIB. By knowing that these three behaviors belong to the same response class and that screaming is likely to escalate to aggression and SIB, interventions can target early behaviors in the sequence to prevent the occurrence of more serious problem behaviors. One intervention consists of shaping appropriate responses that are functionally equivalent to the problem behavior. We shaped the appropriate vocal response during academic instructional periods using mass trials. Then, during escape contingent on appropriate vocalization, the therapist presented a prompt for the vocalization immediately after the task-related request. This procedure prevented the occurrence of aggression or SIB during 78% (28 of 36) of the trials. A possible explanation for the occurrence of problem behavior in the other eight trials may have been Mary's failure to discriminate that the therapist discontinued the task; she frequently walked away from the therapist and, therefore, may not have been paying attention to him when he stopped task-related instructions. An alternative to allowing a subject to completely escape a task contingent on an appropriate vocalization is to require some level of task-related performance before escape is available. For example, Lalli, Casey, and Kates (1995) initially allowed subjects to escape from a task contingent on saying "no" to a therapist's request. Thereafter, escape was contingent on the verbal response plus the specified task performance (i.e., forward chaining). This procedure decreased rates of problem behavior while ensuring that the subjects continued to receive instruction.

In conclusion, the present study represents a preliminary attempt to define and empirically identify a behavioral class whose members have a hierarchy of response latencies. Response-class hierarchies are conceptually distinct from Premack's formulation of response hierarchy, and they constitute a distinct type of concurrent operant that has particular relevance for applied work.

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