Ludwig, T.D. (2002). On the Necessity of Structure in an Arbitrary World: Using Concurrent Schedules of Reinforcement to describe Response Generalization. ***Journal of Organizational Behavior Management,*** 21 (4), 13-38. Version of record published by Taylor & Francis and is available online at: http://www.informaworld.com/ (ISSN: 0160-8061) DOI: 10.1300/J075v21n04_03 [Special Issue of the ***Journal of Organizational Behavior Management*** critiquing Ludwig (2002) included commentaries by Houchins & Boyce (2002), Austin & Wilson (2002), and Geller (2002).]

Keyword: organizational behavior | behavioral assessment

On the Necessity of Structure in an Arbitrary World: Using Concurrent Schedules of Reinforcement to Describe Response Generalization

Timothy D. Ludwig

ABSTRACT
The term response generalization has been poorly defined and has, over many years, been a source of controversy for applied researchers who must grapple with results that show changes in behaviors outside of the response class targeted by their intervention. The present discussion seeks to differentiate response generalization from such terms as response covariation and induction. Instead, response generalization is redefined in the context of response classes and concurrent schedules of reinforcement.

ARTICLE

In Science of Human Behavior, B. F. Skinner (1953) observed that the reinforcement of a response increases the probability of other responses that are similar. The spread of reinforcing effect from one behavior to others has been referred to by Stokes and Baer (1977) as a type of generalization akin to the spread of effect across settings, time, and trainers. Baer, Wolf, and Risley (1968) suggested “a behavioral change may be said to have generality if it proves durable over time, if it appears in a wide variety of possible environments, or if it spreads to a wide variety of related behaviors’ (italics added) (p. 96). However, the use of different behavioral terms to describe generalization of behavior is pervasive in applied literature, often to the detriment of clarity and conciseness. One such term is response generalization. The purpose of this paper is to define the construct of response generalization in the context of response classes and differentiate the term from other phenomena related to the co-occurrence of behavior.

Ludwig and Geller (1991, 1997, 1999a, 1999b, 2000) have used the term “response generalization” to interpret the effects of safety programs which not only increased the behavior targeted by the intervention but also increased other safety-related behaviors that were not targeted by the intervention. The use of this term seemed to be consistent with definitions of response generalization provided by prominent behavior modification texts. For example, Kazdin (2001) refers to response generalization as “changes in behavior or responses other than those that have been trained or developed . . . which occurs (italics added) if a specific response is developed through reinforcement or other procedures and this systematically alters other behaviors that have not been directly trained" (p. 61). Likewise, Martin and Pear (1992) state that response generalization occurs "when a behavior becomes more probable in the presence of a stimulus or situation as a result of a similar behavior having been strengthened in the presence of that stimulus or situation" (p. 155).

However, the use of the term "response generalization" is not wholly agreed upon (see Austin, 2001 and Houchins & Boyce, 2001 in this issue). A seminal publication on generalization by Stokes and Baer (1977) sidestepped the "controversy concerning terminology" (p. 350) and asked the reader to consider a temporary definition of "behavioral" generalization (they did not use the term response generalization). In reality, response generalization may be only one of many descriptions for the co-occurrence of behavior. To group all descriptions under the rubric of "generalization" may not only be ambiguous, but may also have low utility for explaining research results and refining future intervention strategies.

SHARED STRUCTURE: THE RESPONSE CLASS

It is presumed that intervention programs that are associated with response generalization cause a ". . . spread of effect . . . to other responses not included in the reinforced class . . ." (Catania, 1979)." The concept of response classes provides a useful heuristic through which response generalization and it's related concepts can be discussed. It is useful because, in an otherwise arbitrary system of possible behavioral groupings, response classes can accommodate the organization of behaviors through an instrumental and/or functional similarity.

A response may be defined in many different ways. A complete response may be defined as a single neuron pulse in an arm, hand gripping a safety belt, all the movements required in fastening a safety belt, or the execution of an automobile trip without accident or injury (i.e., “safe driving”).
One could include a set of topographically dissimilar behaviors such as turn signal use, driving speed, and/or complete stopping at intersections as part of an overall class of responses resulting in safe driving.
When implementing applied interventions we often do not operate on a specific movement or even on a single behavior, instead we reinforce a class of responses (Catania, 1979). Thus, a “response class” which may be defined as one behavior (consisting of many movements) or as an assortment of behaviors required for a contingency outcome.

The behavioral term operant was used by Skinner (1938) to define response classes in terms of a common effect of behaviors on the environment.
Behaviors that have a common effect on the environment can be described as functionally similar (Keller & Schoenfeld, 1950). “Safetybelt use” can be considered the outcome of many different movements all of which are members of the same response class due to their functional similarity. Sitting in a car seat, reaching across your body, pulling the safety belt back across your body and inserting it into the lock has a collected effect on the environment by securing the safety belt into place.
When safety belt use is reinforced then all the movements that go into safety belt use are also reinforced.

When the response is related to both antecedents and consequences, the correspondence is termed a discriminated operant (Catania, 1979; Johnston & Pennypacker, 1982; Skinner, 1938). A discriminated operant response class only exists in the presence of (or when preceded by) a certain antecedent condition (i.e., a discriminative stimulus) and consequence (e.g., reinforcer). For example, if an individual only comes to a complete stop at a stop sign when a police officer is present to avoid a costly ticket (cf. Herrick et al., 1959), the class of responses used to engage the brake peddle is labeled the discriminated operant.

My students have pointed out to me after collecting driving data in the field that drivers tend to sit up straight in their car seat when they see a police officer. This happens even though one cannot get a ticket for “slouching.” Thus, slouching is not part of a discriminated operant response class that may be operated on when one comes in contact with the discriminative stimuli of a stop light and police officer. Why do these and other driving behaviors change in the face of this stimulus set? One may say, and my students have, that sitting up straight is part of what people consider “safe driving,” along with turn-signal use, safety-belt use, car maintenance, and the like. And it is the unsafe operation of the vehicle that results in the consequence from the police officer. Is some broader, undefined response class (e.g., “safe driving”) also being operated on beyond the discriminative operant (e.g., coming to a complete stop at a stop sign in the presence of a police officer)?

Skinner (1938) observed in The Behavior of Organisms “The three term contingency will obey the laws which apply to it as experimentally treated, but it is not necessarily totally unrelated to the rest of the behavior of the organism" (p. 168).

Structure as Arbitrary

Defining a response class beyond the discriminated operant suggests that a nearly infinite variety of movements and behaviors can be grouped meaningfully into hypothetical structures. Thus, the broader grouping of a response class beyond the discriminated operant is inherently arbitrary because we have no conventional level of analysis whereby a response is always described. The chemistry community has arrived at a level of analysis involving electrons, protons and neurons to describe the structure of atoms. This designation was essential in developing the periodic table made up of 103 combinations of neurons and electrons known as elements. Elements, by definition, are integral structures, not made up of other elements; they are autonomous. To transfer this analogy to behavior would imply that, given the structure of the three-term contingency, we would be able to identify integral patterns of behavior beyond response topography or movements. However, the arbitrary nature of defining response classes makes this impossible. "All description is partial description" (Bower & Hilgard, 1981, p. 178).

Since feasibly any combination of movements and behaviors can be operated upon, or shaped experimentally, Baer (1981) argued any structure of behavior beyond topography and the three-term contingency is arbitrary, not necessary (prerequisite):

> If, in the analytic study of behavior, structures are made, demolished, and remade easily, frequently, and with increasing generality across behaviors, species, and settings, it will be inevitable to ask whether all behavioral structures might be alike in this respect. Experimental structures represent strong cases for this question: we know how they are made and unmade. . . . Thus this strong case is likely to push us toward a null hypothesis: Behavior has no necessary structure other than trivial. (p. 219)

According to Baer's argument (1981) the example of a "safe driving" response class is only hypothetical until operated upon. The designation of a response class is based on effects of experimental operations, essentially viewing a response by its correspondence with environmental antecedents and consequences. This view of the world implies that response classes are a product of natural contingencies acting on the subject and not a reflection of a mediating cognition or skill possessed by the subject.

However, as Baer himself pointed out:

> It is important to remember that in behavioral structures importance is as significant a question as necessity. Some structures of behavior may be quite arbitrary, in terms of the structure of the universe and the laws of behavior, but may be extremely common and urgently important, in terms of the organization of our society and its effects on our behavior. (p. 251)

Indeed, to create an effective, socially valid intervention in applied settings, it is necessary (appropriate) to derive a working structure from which to intervene and measure. This conceptualization of response classes issues a challenge for applied researchers to operationally define a class of responses from the plethora of arbitrary combinations of seemingly functional behavior.

RESPONSE COVARIANCE

When studying humans, many researchers have stressed the need for a broader conception of response class, apart from the basic topographical distinction (e.g., Johnston & Pennypacker, 1980; Wahler, 1975; Wahler & Fox, 1981a; Willems, 1974). Malott, Whaley, and Malott (1997) suggest that a response class can also include behaviors which serve similar functions by producing similar outcomes (see also Miltenberger, 2001). Safety belt use, complete stopping, maintaining a two car-length distance when following, turn signal use, car maintenance can all be logically considered to contribute to the safe operation of an automobile. Such logically derived “schemas” of functionally-similar safe driving behaviors can be investigated more thoroughly through observing covariance between behaviors.

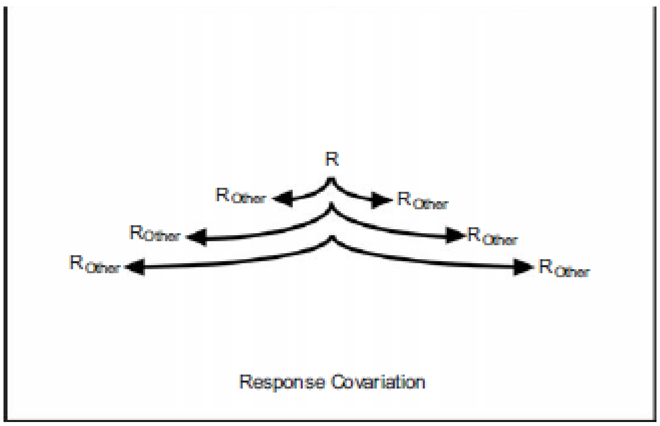
Notable efforts have been made to specify and isolate methodologically the existing interrelationships between behaviors (e.g., Elliott, Huizinga, & Menard, 1988; Ludwig & Geller, 2000; Voelts & Evans, 1982; Wahler, 1975; Wahler&Fox, 1980, 1981a). A first step in deriving a functional response class is to probe for behaviors that are observed to be correlated during a naturalistic baseline period. This can be assessed through the correlation coefficient. However, when many behaviors are observed over relatively long periods of time, factor analysis and cluster analysis (Voeltz & Evans, 1982; Wahler, 1975), as well as regression analysis (Martens & Witt, 1984) can be applied. Pigott, Fantuzzo, and Gorsuch (1987) suggested using a scatterplot to analyze the correlation between baseline and post-baseline observations (for a demonstration of this method see Ludwig & Geller, 2000).

The term response covariance has been used to refer to observed correlations between behaviors (Kazdin, 1982; Pigott, Fantuzzo, & Gorsuch, 1987; Wahler, 1975). When behaviors covary (i.e., change together) the behaviors may (1) be functionally related and operate concomitantly to attain the same outcome, and/or (2) be dependent on one another resulting from response chains or compatibility (as in the matching law). It is important to note that the first explanation is not exclusive of the second explanation.

The terms response covariation and response generalization are often used synonymously. Such a treatment of these terms often is confusing and may be misleading. Response covariation is a descriptive term that merely describes the empirical relationship between observed behaviors. What response covariation describes, as Figure 1 illustrates, are changes in one behavior (labeled as “R”) correlate with changes in other behaviors (labeled as “R_{Other}”) without considering the locus of the change (i.e., the contingency control the responses). On the other hand, changes in non-targeted behaviors via response generalization are the product of contingencies.

Response covariation and response generalization are not exclusive of each other and are not contraindicative. Response generalization can occur in the context of covariation. This is demonstrated in Figure 2 that shows the data from a pizza deliverer from a study reported in Ludwig, Geller, and Clarke (2002). Driver C55's complete stopping and turn signal

FIGURE 1. An Illustrative Model of Response Covariation



use covaried rather consistently during baseline and a group goal setting and feedback phase (as circled at points "A"). This suggests that the driver came to a complete stop on many of the same occasions that he used his turn signal. Then as the driver began to respond to the second intervention phase that offered individualized feedback targeting turn signal use, a corresponding increase in complete stopping also occurred, especially on the occasions when the driver used his turn signal (as circled at point "B").

However, covariation is not necessary for response generalization nor do all covarying behaviors generalize. An example of this occurred in the data reported by Ludwig, Biggs, Wagner, and Geller (2002) whereby turn signal and safety belt use appeared to covary during baseline (as circled at point “A”) in Driver A103. However, as Figure 3 suggests, the increase in turn signal use during a competition intervention was not associated with an increase in safety belt use (as circled at point “B”).

The logical categorizing of behaviors around a common outcome or the observation of behaviors being correlated during naturalistic observations cannot, however, establish conclusively that these behaviors are part of a response class. Such a claim is a causal statement. A response class is defined through its relationship within a three-term contingency. While hypothetical groupings of behaviors may provide useful heuristics for descriptive purposes, such descriptions only describe observed covariation between behaviors. They do not provide a reasonable explana-

FIGURE 2. Cumulative Graph Depicting the Turn Signal and Complete Stopping Occurrences of Driver C55 During Two Goal Setting and Feedback Intervention Phases (Adapted from Database Reported in Ludwig, Geller, and Clarke, 2002)

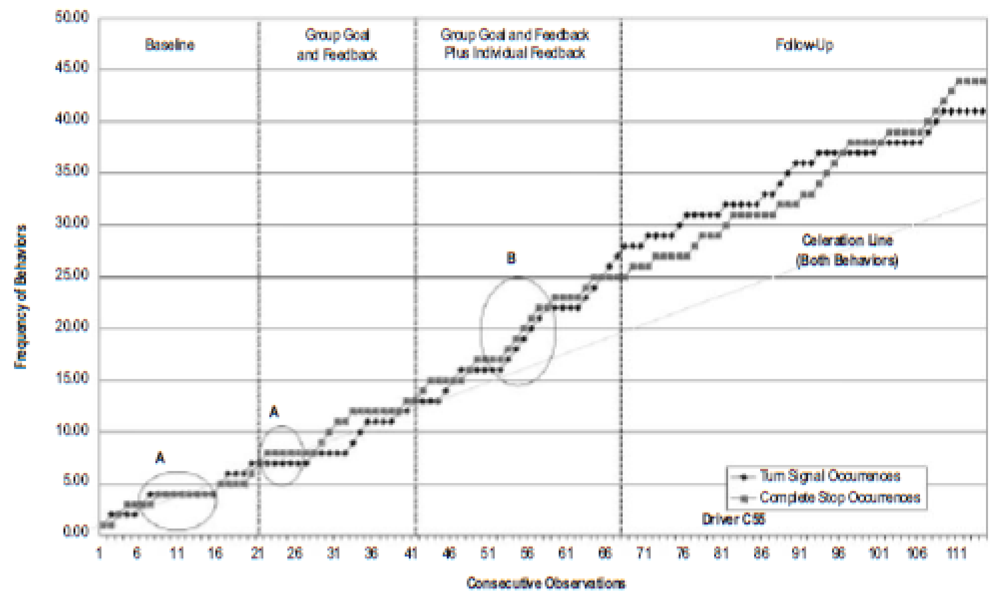
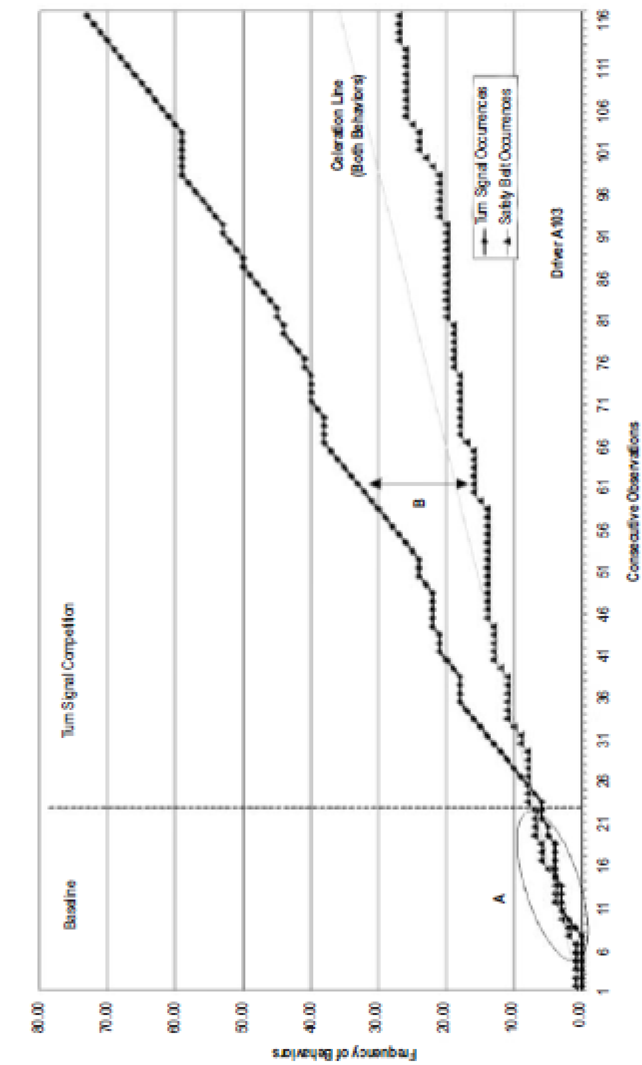


FIGURE 3. Cumulative Graph Depicting the Turn Signal and Safety Belt Occurrences of Driver A103 During a Turn Signal Competition Intervention (Adapted from Database Reported in Ludwig, Biggs, Wagner, and Geller, 2002)



tion as to why response generalization occurs. Response generalization occurs in the presence of contingencies and is a product of contingencies.

RESPONSE GENERALIZATION

An experimental intervention specifies what behavior(s) are in the operated response class as a set of discriminated operants. An operated response class refers to the behavior(s) targeted by the reinforcing contingencies in an intervention being studied experimentally. Using this term will help us distinguish between response classes targeted from a current intervention and response classes occurring naturally or from previous reinforcement events. For example, if we provide a reinforcer in our intervention targeting complete intersection stopping will operate on all movements/behaviors required to bring the vehicle to a stop. In this case complete intersection stops serve as the operated response class. Response generalization refers to changes occurring in behaviors outside of the operated response class concurrent to the intervention operations.

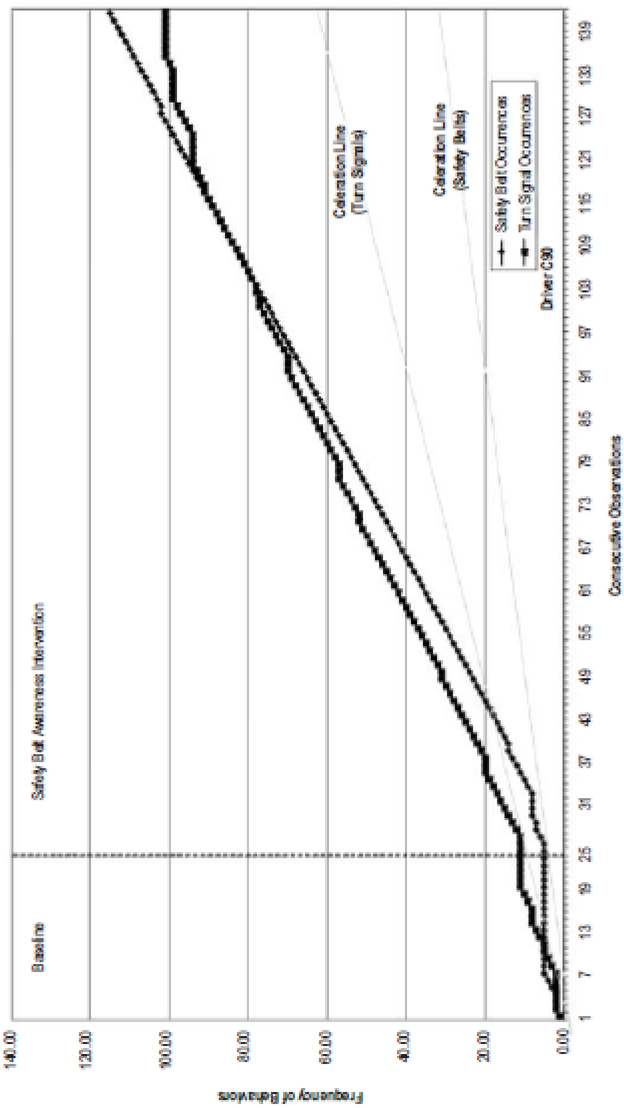
For example, targeting safety belt use in the context of an intervention will operate on all movements functionally capable to produce a fastened belt. However, in the case of Ludwig and Geller (1991, 1999a) turn signal use also increased even though it was not operated on by the intervention (i.e., part of the operated response class specified by the intervention). A graphic example of response generalization in a pizza deliverer, taken from data reported in Ludwig and Geller (1991) appears in Figure 4 showing Driver C90's safety belt use and turn signal use both drastically increasing during an awareness intervention targeting safety belt use.

If we say that response generalization is a product of contingencies we are conceptually challenged by the fact that, by definition, generalized behaviors cannot be a part of the operated response class. We must determine what contingencies are impacting the generalized behaviors. Two explanations are possible: (1) induction and (2) concurrent schedules maintaining other response classes.

Induction

There is a fundamental distinction between induction and differentiation. The initial effect of reinforcement is an increase in responding among many movements, some not directly associated with the reinforcer. This spread to other topographically similar responses is called induction. For example, Catania (1979) presented hypothetical data of rats

FIGURE 4. Cumulative Graph Depicting the Turn Signal and Safety Belt Occurrences of Driver C90 During a Safety Belt Awareness Intervention (Adapted from Database Reported in Ludwig and Geller, 1991)



attaining food pellets contingent on poking its nose through correct slots on a wall with 15 horizontal slots. When reinforcement was contingent on nose-poke through positions 9-12 then, initially, increased responding to other positions not included in the reinforced class was expected. As reinforcement trials continued, the rat's responses become more and more restricted to the particular position(s) of reinforced responses. In turn, non-targeted responses decreased in frequency. The restriction of responding to only the reinforced behavior(s) is called differentiation. According to Catania (1979), induction is the inverse of differentiation.

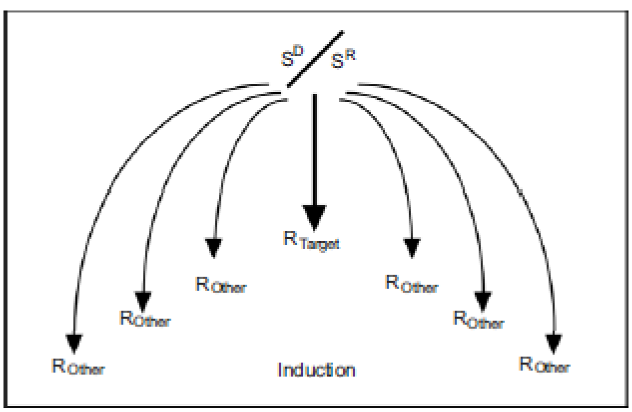
As induction is discussed in learning texts (Catania, 1979; Kimble, 1961) the phenomena is rarely considered past of topographical similarity, temporal similarity, or a comparison of effort across responses. Examples include dogs lifting legs not conditioned to a buzzer-shock (Kellogg, 1939), rats adapting to specific pressures of bar pressing (Skinner, 1938), eyeblink latencies during the interval between the CS and UCS (Boneau, 1958), and across amplitudes of thumb contractions (measured by microvolts) in humans (Hefferline & Keenan, 1963).

Initially, the term "induction" in operant conditioning was influenced by Pavlov's (1927) descriptions of positive and negative induction. Pavlov's use of the term referred to increased (or decreased) responding caused by the ordering of the stimulus. The idea of induction in operant conditioning was also influenced by work done on stimulus generalization and was expected to conform to the notions of generalization gradients and differentiation. As a result, induction was often only considered across some physical continuum of responding such as variations in the presentation of a behavior (e.g., pressure or latency) or across topographically similar movements.

Figure 5 illustrates this conceptualization of induction. An environmental stimulus (labeled "S^D/S^R") results not only in changes within the target behavior (labeled "R_{Target}") but also influences changes in other behaviors (labeled "R_{Other}"). This occurs because the reinforcing stimulus has not been differentiated to just the target response and thus influences other behaviors.

A problem arises, however, when using induction as an explanation for response generalization. Response generalization takes place across functionally similar behaviors and these behaviors are often quite topographically disparate. Functionally similar behaviors often do not conform to some easily identifiable physical continuum. Thus, assuming response generalization is the same as induction, similar to the properties of stimulus generalization (see the argument made by Houchins & Boyce, 2002), may lead to confusion when adapting the concept to the applied setting.

FIGURE 5. An Illustrative Model of Induction



Nevertheless, the use of induction as a metaphor for response generalization may be useful. The implication of induction is that the contingency operations did not differentiate adequately to emit a specific response while omitting other alternatives. If the operations of an intervention program do not adequately differentiate a specific behavior, individuals may fail to discriminate between the target response and other behaviors. Thus, they might emit a variety of behaviors other than the target behavior.

In fact, it is possible that changes in nontargeted behaviors that are attributed to response generalization could be otherwise due to researchers' failure to demonstrate tight control over all aspects of the antecedents and consequences offered in the intervention. Indeed, Stokes and Baer (1977) seemed to agree with this conceptualization when they called for the use of "loose training" and "indiscriminable contingencies" in their suggestions regarding how to increase generalization across settings, subjects, trainers, time, and behaviors. Therefore, an expanded conceptualization of induction may indeed explain the results of some studies showing a spread of effect to other behaviors (see the argument made by Austin, 2001, in this issue).

However, there are a few data-driven arguments that require us to go beyond simply considering response generalization as a failure to control the critical variables sufficiently:

1. Attempts to gain tighter control over intervention operations in order to differentiate the target behavior can result in no decreases in the amount of response generalization (Ludwig & Geller, 2000).

Differentiation can be accomplished by making sure the intervention does not errantly specify some other behaviors as part of the operations. Such procedures that we have used in field settings include meetings with the intervention deliverers (often managers) instructing them not to mention any other behaviors than those targeted during intervention meetings or during regular interactions (Ludwig & Geller, 1991, 1997), conducting post-intervention surveys of participants asking if other behaviors had been mentioned during the time period in questions (Ludwig & Geller, 1991, 1997, 2000), videotaping intervention procedures to determine that no references were made to other behaviors (Ludwig & Geller, 1991, 1997; Ludwig, Geller, and Clarke, unpublished) study, or conducting the intervention via memos (Ludwig, 2000) that were specific to only the single behavior targeted by the intervention thereby nullifying any superfluous contact made with participants.

Differentiation can also be accomplished by making the contingencies more specifically related to the targeted behavior (e.g., via tangible rewards for correct responding). For example, studies that use individualized feedback and rewards for a specific behavior (Ludwig, Biggs, Wagner, & Geller, 2002) to further differentiate the target behavior resulted in no decreases in the amount of response generalization. This hypothesis regarding differentiation and response generalization warrants further planned studies and empirical evidence in order to verify this argument.

2. A “loose training” explanation would assume that all changes in other behaviors would occur in the same direction as the intended target of the intervention or at least with the same desired effect (e.g., increase in safety belt use associated with a decreased, but desirable, frequency of speeding). Thus, the use of induction as a metaphor does not account for changes in non-targeted behaviors in the opposite direction of the targeted behavior. Janssen (1994) found that when hard-core nonusers of safety belts were forced to buckle-up, they drove faster, followed more closely behind vehicles

in front of them, changed lanes at higher speeds, and braked later when approaching obstacles. Ludwig and Geller (1999b) showed a decrease in safety-belt use after deliverers received turn-signal policies. Geller, Casali, and Johnson (1980) found that as safety-belt in-

ducement interventions became more intrusive and controlling,

people were more likely to defeat the system by either sitting on a buckled safety belt or completely disconnecting the system. Ludwig and Geller (2000) equated these results to be examples of countercontrol.

To demonstrate possible examples of countercontrol at an individual level Figures 6 and 7 show data taken from pizza deliverers during two different studies (Ludwig & Geller, 1997; Ludwig et al., 2002, respectively). Driver C49's complete stops and turn signal use, shown in Figure 6, covaried somewhat during baseline (circled as point "A"). However, as the driver experienced the assigned goal setting and feedback targeting complete stopping his turn signal use drastically declined (noted as point "B" showing separation from the celeration line) to only a few occurrences over the rest of the study. Likewise, Driver A74's turn signal use and complete stops, shown in Figure 7, seemed to covary during baseline (circled as point "A"). When a competition intervention that rewarded high turn signal use was implemented, Driver A74 ceased coming to a complete stop for the next 25 observations while he used turn signal almost every occurrence (circled as point "B").

In a study designed to show that an intervention can be programmed to demonstrate either a desirable or undesirable change in nontargeted behaviors, Ludwig and Geller (1997) showed a decrease in turn-signal use when deliverers were assigned a goal to increase their complete stopping at intersections. However, when deliverers were allowed to participate in the same complete stopping intervention turn signal use increased. These findings suggest that an explanation other than loose training is in order. Certainly more research is needed to replicate these studies and confirm this assertion.

Concurrent Schedules

A response class is defined through its association with a three-term contingency. In an experimental study, a group of behaviors can be directly reinforced in an operated operant class under the control of the experimenter. However, in the real world, there are contingencies that influence groups of behaviors concurrent with and often independent of an experimental intervention. For example, traffic laws can reinforce or punish nearly all meaningful driving behaviors with similar S^Ds (e.g., presence of a police officer) and consequences (traffic tickets). Indeed, behaviors often are associated through shaping sometime in the person's

FIGURE 6. Cumulative Graph Depicting the Turn Signal and Complete Stopping Occurrences of Driver C49 During an Assigned Goal Setting and Feedback Intervention (Adapted from Database Reported in Ludwig and Geller, 1997)

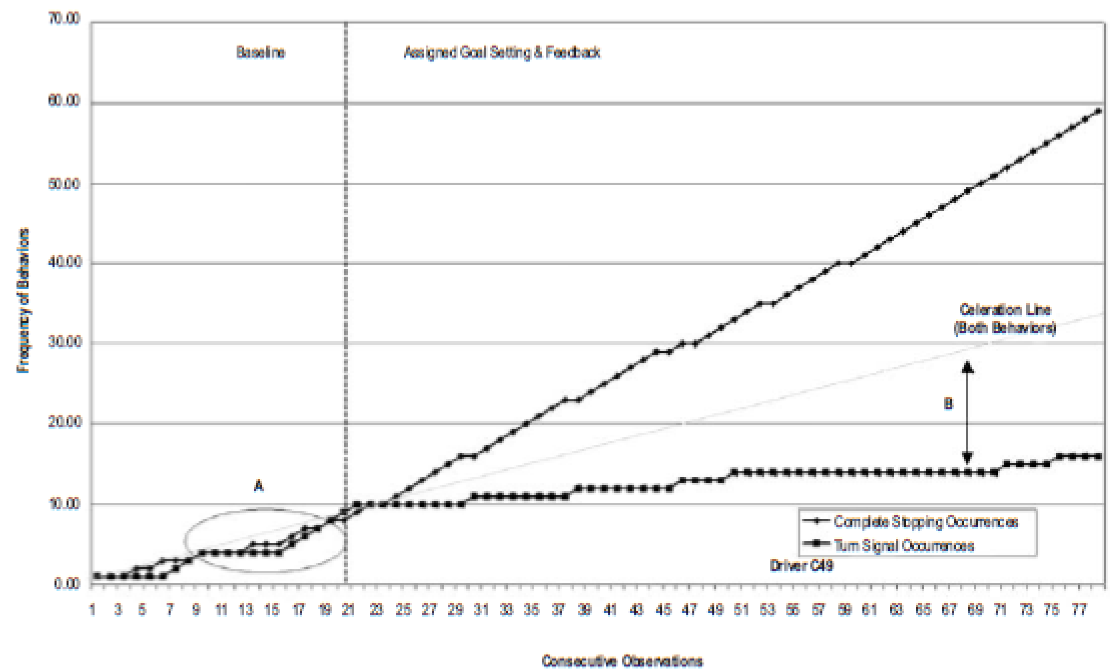
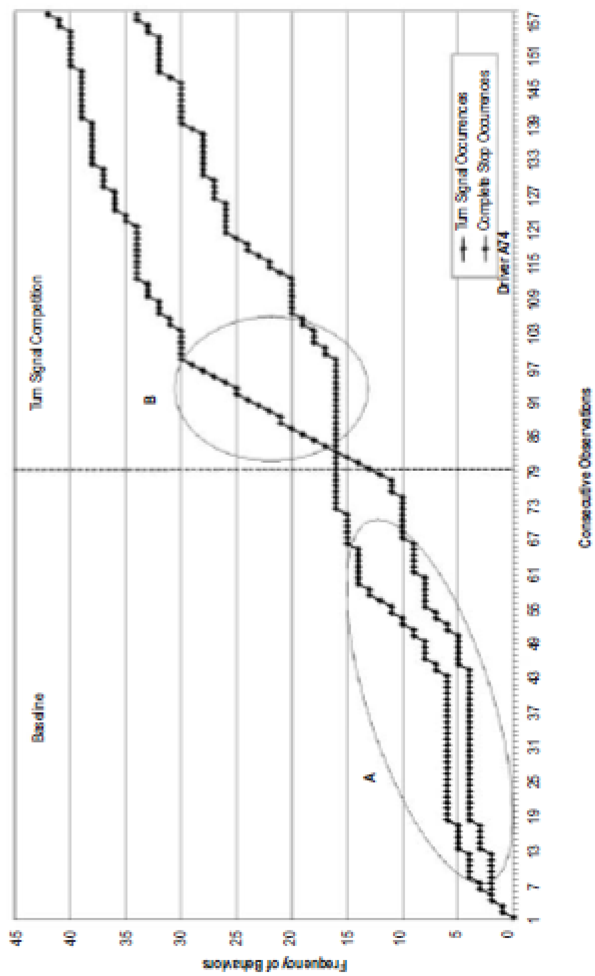


FIGURE 7. Cumulative Graph Depicting the Turn Signal and Complete Stopping Occurrences of Driver A74 During a Turn Signal Competition Intervention (Adapted from Database Reported in Ludwig, Biggs, Wagner, and Geller, 2002)



past (e.g., driver training classes) and/or may be presently operated upon by means of other contingencies in the environment (e.g., traffic laws). These factors may create groupings of behaviors reflecting response classes already operated upon in the environment (Elliott, Huizinga, & Mernard, 1988). However, the response classes formed by environmental contingencies often fall outside of the operated response classes determined by our intervention operations.

When trained together, such as during driver training courses or driver's license exams, behaviors may become associated as a response class. Baer (1981) suggests,

> Our experience with behavior, when positive, is that behavior is always available to be shaped into any reasonable form and brought under the control of any reasonable stimulus, and that this can be done with more than one behavior at a time, so that behaviors acquire interdependencies. (p. 219)

If these prior environmental associations exist then we may have the basis for predicting generalization across behaviors beyond the arbitrary guess suggested by Stokes and Baer (1977) when they suggested we simply "train and hope."

Behaviors that have some type of functional attribute in common are more likely to generalize than novel combinations of behaviors (Carr, 1988; Kimble, 1961). Behaviors that have been associated sometime in a person's past can be said to have functional similarity based on that past reinforcer. Although these associations can differ from one person to the next (Wahler, 1975), a case can be made for people having common learning histories as dictated by their societal, cultural, or family membership. Certainly the majority of people in the United States and other first-world countries undergo common driver training courses to become licensed to drive.

Likewise, it can be expected that societal and other environmental factors (e.g., physics) also operate at any given time to shape and maintain behaviors. For example, our society maintains a set of laws that reinforce driving behaviors consistent with the safe operation of a vehicle. Indeed, driving behaviors may be continuously, negatively reinforced by legal (i.e., tickets), social (being yelled at), or physical (damage to car or self) consequences (Ludwig & Geller, 2000).

Rule Governed Behavior. A number of researchers (Malott, 1992) have suggested that the shaping of behavior (past or present) establishes rules describing the correct behaviors to be emitted in certain contexts and their relationship with a contingency, essentially defining the response class. Rules themselves are not discriminative stimuli (i.e., signaling the occasion when a certain response will be followed by a consequence). Instead rules alter the function of other stimuli and designate them as discriminate stimuli (Blakely & Schlinger, 1987; Schlinger & Blakely, 1987). Therefore, rules (a) specify contingencies, (b) describe performance, (c) and designate discriminate stimuli. Agnew and Redmon (1992) also argued that rules alter the function of consequences.

Cerutti (1989) noted that “few drivers would survive learning to stop at red traffic lights if the discrimination could only be negatively reinforced by avoiding collisions” (p. 262). Instead, rules specify the discriminated control of the traffic light over stopping behaviors. Cerutti used the term instructed response class to describe the correspondence between antecedents, behaviors, and consequences specified by instructions. This can be compared with the operated response class specified by its direct association with an intervention contingency.

What is important for our discussion is that a rule need not stipulate only a single behavior as part of the response class it influences. Instead, when developed over an individual's lifetime of experiences with societal (including work-related) or environmental consequences, rules stipulate a number of similar behaviors that are functionally related. Therefore, if members of a population engage in common rule-governed behavior (based on common learning histories; Wanchisen & Tatham, 1991), then it is expected that the behaviors relevant to a rule will correlate and may change when interventions consistent with the rules get enacted.

Response Generalization and Concurrent Schedules. Whether a set of behaviors act as a response class via concurrent schedules of contingencies or via previous shaping and rule governed behavior, the basis for response generalization is established. When we deliver our experimental interventions we often do so in the context of these concurrent schedules; our interventions do not occur in a vacuum (although for experimental reasons we may often wish they did).

If the contingencies that we deliver as part of our intervention are compatible with these concurrent schedules operating on the same behavior(
s), the concurrent schedule(s)' effect on its response class may be strengthened. The resulting effect may be similar to that described in Figure 8. The contingency enacted by the intervention (labeled as "SD/SR: Intervention Schedule") will directly influence the targeted behavior(s) (labeled as "R_{Target}") or operated response class (point "A"). If the intervention

operations are compatible with other contingencies and/or rules (labeled as "S^D/S^R: Concurrent Schedule") then it may prompt or otherwise activate these concurrent schedules (point "B"). Thus, all members of the concurrent schedule's response class (labeled as "R_{Other}") will be influenced thereby changing along with the targeted behavior (point "C").

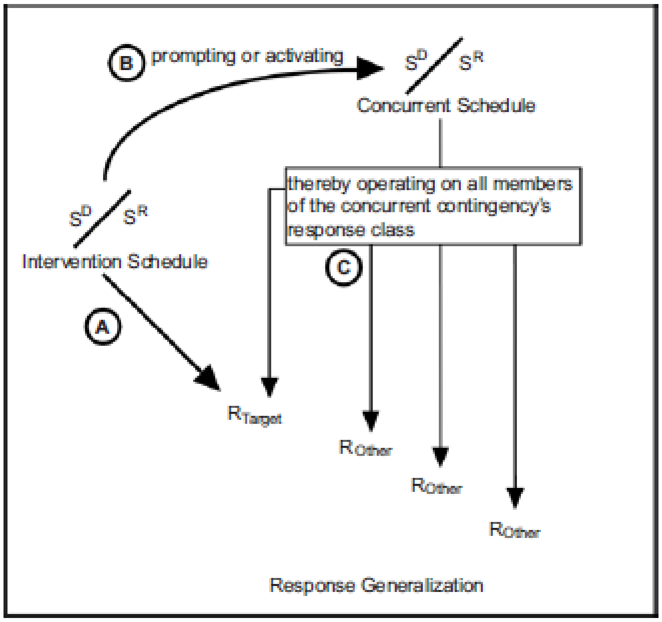
In the context of a Behavior Change Taxonomy, Ludwig and Geller (2000) argued that interventions involving individuals can provide a context that promotes response generalization. Involvement and ownership in an intervention process may contribute to the activation of concurrent schedules and/or rule-governed behaviors because individuals are given an opportunity to verbalize their previously-held rules. For example, in a couple of our studies (Ludwig & Geller, 1991, 1997; Ludwig, Geller, & Clarke, unpublished), we asked deliverers why it is a good idea to engage in the targeted behavior. To answer this question they often referred to legal (i.e., tickets), social (being yelled at), or physical (damage to car or self) consequences. These same consequences pertain to driving safety behaviors other than that targeted by the intervention. Even though these other behaviors were not mentioned during the discussion, their relationship with these common verbalized consequences may have supported concurrent schedules and/or rule-governed behavior in the context of the intervention. Therefore, when interventions were high in involvement, targeting one behavior also activated a number of rule-governed behaviors as well, some of which we systematically observed. The high-involvement interventions reported in Ludwig and Geller (1991, 1997) and in Ludwig, Geller, and Clarke (unpublished) were all associated with response generalization.

In contrast, some of our interventions (Ludwig, Biggs, Wagner, & Geller, 2002; Ludwig & Geller, 1997) focused on external consequences such as assigned goals, managerial surveillance, or individual competition. In these cases, the target behavior was instrumental in attaining the direct external consequences. For example, deliverers were following managerial mandates (Ludwig & Geller, 1997, 1999b), or competing for a reward (Ludwig et al., 2002). In these situations, no behavior other than the target behavior was reinforced by the external consequences.

In Ludwig et al. (2002) no systematic response generalization was observed. In the two Ludwig and Geller studies (1997 and 1999b) non-targeted behaviors decreased during the intervention.

Countercontrol. It is likely the contingencies delivered by the intervention either were not associated with other concurrent schedules/
rules or were incompatible with those concurrent
contingencies/rules. As a result, concurrent contingencies/rules associated

FIGURE 8. An Illustrative Model of Response Generalization



with other safe driving behaviors were not activated. The resulting effect may be similar to that described in Figure 9. The contingency enacted by the intervention (labeled as "S^D/S^R: Intervention Schedule") will directly influence the targeted behavior (point "A"). If the intervention operations are incompatible with other contingencies (labeled as "S^D/S^R: Concurrent Schedule") and/or rules then it may replace these schedules (point "B") at least in the context of the intervention. Thus, in the context of the intervention operations members of the concurrent contingency response class (labeled as "R_{Other}") will no longer be maintained thereby decreasing while the targeted behavior is maintained by the intervention (points "C"). It is important to note that these decreases in other behaviors probably only take place in the presence of the intervention's S^Ds and that concurrent contingencies resume control of these behaviors when not in the presence of the intervention context.

The above scenario is understandable in the context of the pizza delivery business. Assuming individual driving behavior was maintained via concurrent contingencies and/or rules before being employed, pizza deliverers were required to incorporate new behaviors in their capacity as a pizza deliverer. For example, from the start, they were taught to review a map before beginning their trip, run to their car, and keep their car running when going to a customer's door. It is doubtful the deliverers engaged in these behaviors previously or, for that matter, while driving during their free time. These behaviors are obviously associated with rules specific to their job. We suggest that when an intervention offers rules specific to the job, as mandated by the manager or by "top-down" contingencies, then the behavior is governed by job-specific contingencies.

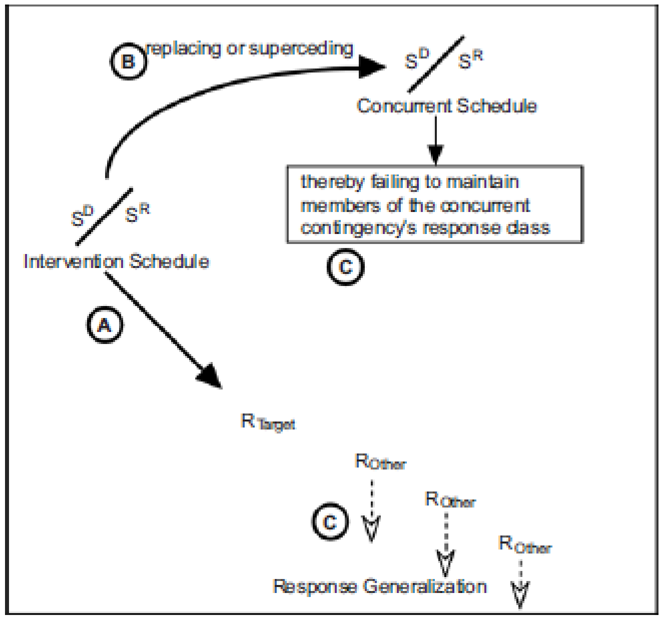
Certainly, much more research is needed to determine whether this model of response generalization is valid. Such a model of response generalization can be empirically tested. Using a yoking procedure in a multiple baseline design, one group (i.e., the yoked group) could receive an intervention which pairs two behaviors (e.g., A & B), of interest, another group could receive an intervention targeting only behavior A, and a third would remain as a control. After a return to baseline, all three groups could receive an intervention targeting only behavior A. If the yoked group shows concurrent changes in both behaviors (e.g., A & B), while the others show significantly less changes in behavior B, then response generalization has been demonstrated. Conversely, if the other non-yoked groups show changes in both behaviors, then one can conclude that both behaviors are members of the operated response class.

CONCLUSIONS

According to Baer (1981) any behavior can be associated with any other behavior given the right three term contingency. Thus, any association between behaviors is arbitrary, not predetermined. Thus, before participating in an intervention a person may bring a nearly infinite combination of previously associated behaviors. We argue that humans experience common contingencies from shared societal and physical environments. Because of this many of us share common associations between behaviors functionally related to past or current contingencies. We can investigate these common associations though naturalistic probes for response covariation.

Response generalization “works” when the intervention not only impacts the targeted behavior (i.e., operated response class) but also acti-

FIGURE 9. An Illustrative Model of Response Generalization Describing Undesirable Change in Non-Targeted Behaviors



vates these environmental contingencies. This, in turn, may also influence members of the concurrent schedule(s)' response class(es) and result in changes in behaviors, similar to, but not directly targeted by the intervention.

Such a conceptualization challenges the research community to cease viewing response generalization as simply and primarily a function of induction. This will allow us to go beyond a "train and hope" (Stokes & Baer, 1977) strategy and more deliberately program for desirable generalization.

REFERENCES

Austin, J., & Wilson, K. G. (2001). Response-response relationships in organizational behavior management. Journal of Organizational Behavior Management, 21, 31-53.

Baer, D. M. (1981). The imposition of structure on behavior and the demolition of behavioral structures. Nebraska Symposium on Motivation, 29, 217-254.

Blakely, E., & Schlinger, H. (1987). Rules: Function-altering contingency-specifying stimuli. Behavior Analyst, 10, 183-187.

Bower, G. H., & Hilgard, E. R. (1981). Theories of learning (5th Ed.). Englewood Cliffs, NJ: Prentice-Hall.

Catania, A. C. (1979). Learning. Englewood Cliffs, NJ: Prentice-Hall.

Cerutti, D. T. (1989). Discrimination theory and rule-governed behavior. Journal of the Experimental Analysis of Behavior, 51, 259-276.

Cohen, P. S., & Looney, T. A. (1984). Induction by reinforcer schedules. Journal of the Experimental Analysis of Behavior, 41, 354-353.

Day, H. M.,&Horner, R. H. (1989). Building response classes: A comparison of two procedures for teaching generalized pouring to learners with severe disabilities. Journal of Applied Behavior Analysis, 22, 223-229.

Geller, E. S., Casali, J. G., & Johnson, R. P. (1980). Seat belt usage: A potential target for applied behavior analysts. Journal of Applied Behavior Analysis, 13, 669-675.

Hawward, S. C., & Everett, P. B. (1975: as cited in Geller et al., 1982). A failure of response cost feedback to modify car driving behavior. Paper presented at the Midwestern Association of Behavior Analysis meeting, Chicago, Illinois.

Houchins, N., & Boyce, T. E. (in press). Response generalization in behavioral safety:

Fact or fiction? Journal of Organizational Behavior Management, 21, 3-11.

Kazdin, A. E. (1982). System substitution, generalization, and response covariation: Implications for psychotherapy outcomes. Psychological Bulletin, 91, 349-365.

Keller, F. S., & Schoenfeld, W. N. (1950). Principles of psychology. New York: Appleton-Century-Crofts.

Ludwig, T. D., Biggs, J., Wagner, S.,&Geller, E. S. (in press). Using public feedback and competitive rewards to increase the Safe Driving Behaviors of Pizza Deliverers. Journal of Organizational Behavior Management.

Ludwig, T. D., & Geller, E. S. (2000). Intervening to improve the safety of delivery drivers: A systematic behavioral approach. monograph. Journal of Organizational Behavior Management, 19, 1-124.

Ludwig, T. D., & Geller, E. S. (1999a). Behavior change among agents of a community safety program: Pizza deliverers advocate community safety belt use. Journal of Organizational Behavior Management, 19(2), 3-24.

Ludwig, T. D., & Geller, E. S. (1999b). Behavioral impact of a corporate driving policy: Undesirable side-effects reflect countercontrol. Journal of Organizational Behavior Management, 19(2), 25-34.

Ludwig, T. D., & Geller, E. S. (1997). Assigned versus participatory goal setting and response generalization: Managing injury control among professional pizza deliverers. Journal of Applied Psychology, 82 (2), 253-261.

Ludwig, T. D.,&Geller, E. S. (1991). Improving the driving practices of pizza deliverers: Potential moderating effects of age and driving record. Journal of Applied Behavior

Analysis, 24, 31-44.

Ludwig, T. D., Geller, E. S., & Clarke, S. W. (2000). Using publicly-displayed feedback to increase turn-signal use: Examining a spread of effect to safe stops and safety-belt use. Manuscript in preparation.

Malott, R. W. (1992). A theory of rule-governed behavior and organization behavior management. Journal of Organizational Behavior Management, 12 (2), 45-65.

Malott, R. W., Whaley, D. L.,&Malott, M. E. (1997). Elementary principles of behavior. Upper Saddle River, NJ: Prentice-Hall.

Martens, B. K., & Witt, J. C. (1984). Assessment and prediction in an ecological system: Application of the general linear model of the response-class concept. Journal of Behavior Assessment, 6, 197-206.

Pavlov, I. P. (1927). Conditioned reflexes. (tr. G.V. Anrep) London: Oxford University Press.

Pavlov, I. P. (1955). Selected works. Moscow: Foreign Language Publishing House.

Pigott, H. E., Fantuzzio, J., & Gorsuch, R. L. (1987). Further generalization technology: Accounting for natural covariance in generalization assessment. Journal of Applied Behavior Analysis, 20(3), 273-278.

Rogers-Warren, A.,&Warren, S.F. (1977). Ecological perspectives in behavior analysis.

Baltimore, MD: University Park Press.

Schlinger, H., & Blakely, E. (1987). Function-altering effects of contingency-specifying stimuli. The Behavior Analyst, 10, 41-45.

Skinner, B. F. (1938). The behavior of organisms: An experimental analysis. Englewood Cliffs, NJ: Prentice-Hall.

Skinner, B. F. (1953). Science and human behavior. New York: Macmillan.

Skinner, B. F. (1957). Verbal behavior. Englewood Cliffs, NJ: Prentice-Hall.

Stokes, T. F., & Baer, D. M. (1977). An implicit technology of generalization. Journal of Applied Behavior Analysis, 10(2), 349-367.

Stokes, T. F.,&Osnes, P. G. (1989). An operant pursuit of generalization. Behavior Therapy, 20, 337-355.

Voeltz, L. M., & Evans, I. M. (1982). The assessment of behavioral interrelationships in child behavior therapy. Behavioral Assessment, 4, 131-165.

Wahler, R. G. (1975). Some structural aspects of deviant child behavior. Journal of Applied Behavior Analysis, 8, 27-42.

Wahler, R. G., & Fox, J. J. (1980). Solitary toy play and time out: A family treatment package for children with aggressive and oppositional behavior. Journal of Applied

Behavior Analysis, 13, 23-39.

Wahler, R. G., & Fox, J. J. (1981a). Response structure in deviant child-parent relationships: Implications for family therapy. Nebraska Symposium on Motivation, 29,1-46.

Wanchisen, B. A., & Tatham, T. A. (1991). Behavioral history: A promising challenge in explaining and controlling human operant behavior. The Behavior Analyst, 14, 139-144.

Warren, S. F., Baer, D. M., & Rogers-Warren, A. (1979). Teaching children to praise: A problem in stimulus and response generalization. Child Behavior Therapy, 1, 123-137.

Willems, E. P. (1974). Behavioral technology and behavioral ecology. Journal of Applied Behavior Analysis, 7, 151-165.