

*MAKING LIFE EASIER WITH EFFORT:
BASIC FINDINGS AND APPLIED RESEARCH ON
RESPONSE EFFORT*

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Early basic research showed that increases in required response effort (or force) produced effects that resembled those produced by punishment. A recent study by Alling and Poling determined some subtle differences between the two behavior-change strategies, but also confirmed that increasing required effort is an effective response-reduction procedure with enduring effects. In this paper we summarize basic research on response effort and explore the role of effort in diverse applied areas including deceleration of aberrant behavior, attention deficit hyperactivity disorder, oral habits, health care appointment keeping, littering, indexes of functional disability, and problem solving. We conclude that renewed interest in response effort as an independent variable is justified because of its potent effects and because the political constraints imposed on punishment- and reinforcement-based procedures have yet to be imposed on procedures that entail manipulations of response effort.

DESCRIPTORS: response effort, response force, response requirement, punishment

“Life is hard and then you die.” A primary goal of applied behavior analysis is to render the first half of this bumper sticker slogan untrue, or at least less true (Baer, Wolf, & Risley, 1968). A logical candidate for research focused on this goal is response effort, yet the relevant literature is surprisingly limited and involves mostly basic research. In this paper we present a brief review of basic research on response effort as an independent variable, highlighting a recent *JEAB* paper by Alling and Poling (1995). We then review applied research in some diverse areas, specify applied implications for others, and advocate increased research exploring the applied benefits of effort-based interventions. We conclude with a brief discussion of types of effort and suggestions for future research.

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BASIC RESEARCH ON
RESPONSE EFFORT

Approximately 50 years ago, several studies investigated the effects in nonhumans of increasing the physical effort required to emit a designated operant response (e.g., Mowrer & Jones, 1943; Skinner, 1938, 1950; Solomon, 1948). Basic studies of response effort (or force) as an independent variable appeared occasionally in the intervening years. In brief, those studies demonstrated that (a) response rates decrease as force requirements increase (Adair & Wright, 1976; Chung, 1965; Mowrer & Jones, 1943; Skinner, 1950), (b) increasing the force requirement in the second component of a two-component chain schedule decreases response rates in the first component (Miller, 1970), (c) extinction is more rapid as force requirements increase (Capehart, Viney, & Hulicka, 1958; Mowrer & Jones, 1943), (d) subjects will escape from situations that require particularly effortful responding (Miller, 1968a, 1968b), and (e) sub-

jects prefer lower effort responding to higher effort responding (Perone & Baron, 1980). These findings have led some investigators to suggest that increasing the effort required to obtain reinforcement is similar to adding an aversive consequence (i.e., arranging punishment) for the response (e.g., Blough, 1966; Chung, 1965; Miller, 1968b, 1970; Solomon, 1948).

The extent to which increasing minimum force requirements produces effects similar to those of punishment was addressed in a recent study that altered lever-press force requirements for rats responding under multiple fixed-ratio (FR) schedules of food delivery (Alling & Poling, 1995). The first experiment arranged an FR 15 in both components, maintained a constant force requirement (0.25 N, or 25 g) in one component, and varied force requirements in the other component (i.e., 0.25, 0.50, 1.00, or 2.00 N). The second experiment also arranged multiple FR 15 schedules and maintained the 0.25-N force requirement in one component. The force requirement in the other component was sometimes increased from 0.25 to 2.00 N for five consecutive responses at the beginning, middle, and end of each ratio. The third experiment reduced the number of required responses in each component from 15 to 5 to 1 while varying force requirements in one component (from 0.25 to 2.00 N) and keeping them constant (0.25 N) in the other. In all experiments, as required response force increased, response rates characteristically decreased, whereas interresponse times and postreinforcement pause times typically increased. These findings agree with those of prior investigations and suggest that the effects of increasing response effort resemble those of punishment in some respects.

In three noteworthy respects, however, the effects of increasing response force differed from those of punishment. One difference is that response suppression produced by mild punishment (e.g., low-intensity shock) often diminishes over time (Azrin, 1956, 1959, 1960; Hake & Azrin, 1963; Rachlin, 1966), but no such

recovery of responding occurred when response force was increased. Also, adding punishment to one component of a multiple schedule frequently leads to rate increases in the other unpunished component (punishment contrast) (e.g., Azrin, 1956; Lattal & Griffin, 1972). Comparable effects were not observed with increases in response force. Finally, the suppressive effects of punishment under FR schedules are strongly influenced by the point in the schedule at which the punishment is arranged; earlier introduction produces greater suppression (Dardano, 1970; Dardano & Sauerbrunn, 1964). In contrast, Alling and Poling found that the rate reductions associated with increased force requirements differed little, regardless of whether the increase was arranged at the beginning, middle, or end of the FR.

INCREASED RESPONSE EFFORT AS AN APPLIED INTERVENTION

The basic research reviewed above indicates that increasing required effort is an effective response-reduction procedure with enduring effects. Manipulating response effort may, in some cases, be a viable alternative to other behavior-change techniques used in applied settings, and may have certain advantages relative to those alternatives, especially punishment. A few studies, selectively reviewed below, have demonstrated that manipulating response effort can be useful for modifying troublesome human behaviors. Moreover, there appears to be growing recognition of the potential importance of response effort as a determinant of human behaviors. For example, recent articles on response efficiency (Horner & Day, 1991; Mace, Neef, Shade, & Mauro, in press; Neef, Shade, & Miller, 1994) have emphasized that behavior is always imbedded in an economic matrix that involves its costs and benefits, which are based on response effort as well as reinforcer rate, quality, and delay. Manipulating any of these variables, including effort, may be effective in producing

desired rates and temporal patterns of responding.

Effort-Based Alternatives to Punishment

One of the most divisive issues in psychology in recent years is the controversy over punishment procedures that employ response-contingent aversive stimulation (Mulick, 1990). Although there are radical constituents of the nonaversive position who appear to oppose any application that has a reductive effect on human behavior (cf. Mudford, 1995), most people seem to accept effective response-deceleration interventions that

- (a) do not involve the delivery of physical pain, (b) do not produce effects that require medical attention, and (c) are subjectively judged to be within typical norms of how people in our society should treat each other. (Horner, 1990, pp. 166–167)

Aberrant behavior in individuals with delays.

Although critics of punishment are probably opposed to its use with any population, the focus of their criticisms has mostly been on individuals with intellectual delays who exhibit severe behavior problems (Mulick, 1990). A small number of studies have shown that increasing required response effort can be an effective alternative to punishment in programs for these persons. For example, Van Houten (1993) demonstrated that placing 0.68-kg weights on the wrists of an adolescent boy with developmental delays and autistic features essentially eliminated self-injurious face slapping. Van Houten noted that “the instant reduction in self-injury, following the application of the weights, suggested that they may have reduced face slaps primarily through the increased response effort required” (p. 198). Interestingly, he made no mention of basic studies that have documented the rapid and enduring rate reductions associated with increasing required response effort.

In other studies, behavior has been reduced not by increasing the effort associated with the target response but by making an effortful re-

sponse contingent upon the occurrence of the target response (cf. Miller, 1970). For example, changing from a simple to a more difficult task contingent upon tantrums reduced them to near-zero levels in an institutionalized 9-year-old girl (Sailor, Guess, Rutherford, & Baer, 1968). As a second example, mild exercise contingent upon aggressive behavior reduced it to near-zero levels in 2 boys with severe disabilities (Luce, Delquadri, & Hall, 1980). As a third example, brief contingent arm movements were more successful than reinforcement procedures in reducing aggression and self-biting in an 11-year-old boy with severe disabilities (Luiselli, 1984).

These studies demonstrate the potent influence that response-contingent increases in response effort can have on inappropriate behavior in individuals with disabilities. Moreover, the procedures used appear to fit Horner’s (1990) criteria for acceptable response-reduction interventions. None of the procedures caused pain or required medical attention, nor did they contrast with societal norms. For instance, coaches often require disobedient players to run laps, and drill instructors make misbehaving recruits do push-ups. Future research, however, should investigate ways to decrease the seeming arbitrariness of the effortful responses that are required contingent on undesired behavior (cf. Sailor et al., 1968). Also, it is important to recognize that extremely effortful responding may, in a functional sense, be aversive, insofar as organisms will respond to escape or avoid situations in which effortful responding is required (Miller, 1968a, 1968b).

Hyperactivity in children. Response-reduction procedures based on increased effort could also reduce misbehavior in children with normal intellectual development. For example, one of the most reported, discussed, and treated problems in children is attention deficit hyperactivity disorder (ADHD) (Friman & Christophersen, 1983). A hallmark of the condition is high-rate switching between activities, which leads teachers to respond with interventions that range

from verbal disapproval to classroom expulsion and medical referral. An early (and unfortunately isolated) demonstration of the applied benefits of increased response effort showed that requiring preschool children to complete a "switching task" prior to moving from one activity area to another substantially reduced the number of switches the children made (Jacobson, Bushell, & Risley, 1969). Whether similar benefits could be obtained for children with ADHD by manipulating response effort is a question worthy of investigation.

Oral habits in children. Another example involves an even more common problem, prolonged pacifier and thumb sucking in children. One method for treatment involves application of an aversive taste solution to the thumb or pacifier (Friman, Barone, & Christophersen, 1986). Although highly effective, aversive taste treatment is also controversial (Friman, Barone, & Christophersen, 1987; MacKenzie, 1987). An early uncontrolled case study described how gradually shortening pacifiers reduced their use, presumably because of the increased effort necessary for children to hold the pacifiers in their mouths (McReynolds, 1972). Further study of similar interventions is warranted.

Other Effort-Based Interventions

Not all interventions involving changes in effort can be categorized as an alternative to punishment. For example, decreasing the effort associated with an appropriate response may increase its frequency and thereby decrease the rate of an inappropriate alternative. There are other possibilities. In the section that follows, we provide examples of effort-based interventions whose effects resemble processes other than punishment.

Broken health care appointments. Broken health care appointments are a notorious problem in medicine. Between 10% and 30% of health care appointments are broken, and patients obviously cannot benefit from health care that is not received (Barron, 1980). Among the reasons identified for broken appointments are

several that involve the effort of keeping them. A small series of studies showed that by mailing a reminder and a parking pass to make remembering the appointment and parking at a pediatric clinic easier, broken appointments were decreased approximately 20% (Friman, Finney, Rapoff, & Christophersen, 1985; Friman, Glasscock, Finney, & Christophersen, 1987; Ross, Friman, & Christophersen, 1993). Although these results were obtained in one site with idiosyncratic conditions, the effort of responding is a generic variable, universally present in human behavior. Keeping a health care appointment involves a chain of responses, each requiring effort and each presenting opportunities for reduction thereof. For example, clinics are sometimes difficult to find; therefore, clearer directions would reduce the effort needed to attend them. Occupying children during long waiting times at pediatric clinics is often difficult. Reducing waiting times or supplying child play areas could reduce the effort needed to manage the children and thereby increase appointment keeping.

Littering. Littering is an enormous, costly, and unsightly problem in the United States. A common strategy for attempting to reduce littering is to threaten to fine those who are caught. Reducing the effort necessary for litter control may be an effective alternative intervention. As an example of this strategy, a recent series of studies showed that reducing response effort by increasing proximity to ashtrays at four separate entrances to a university medical school substantially increased the extent of their use (Friman, 1995). Similarly, a recent study showed that increasing container proximity increased recycling of office paper from 28% to above 85% (Brothers, Krantz, & McClannahan, 1994).

The research on manipulating response effort to improve litter control is sparse but promising and, consistent with the theme of this paper, shows that manipulating response effort has applied implications for a widespread, important problem.

Indexes of functional disability for the aged or ill. The importance of measuring physical disability increases with each life-extending medical breakthrough. As persons live longer, the number of disabling conditions (e.g., chronic diseases, age-related infirmities) increases (Feinstein, Josephy, & Wells, 1986). Measurements of functional disability are critical to compensation determinations, program planning, residential options, critical care estimates, and changes in status for these persons. There are currently more than 1,000 "clinimetric" indexes available for use in assessing various dimensions of disability (Feinstein, 1982; Feinstein et al., 1986; Feinstein, Wells, Joyce, & Josephy, 1985). A common omission in these indexes is a measure of patient effort or collaboration with others. Yet both variables can dramatically influence the degree of an individual's disability. For example, the helpful presence of another person during mundane tasks of daily life (e.g., dressing) substantially reduces the effort required for task completion and thereby reduces related disability. As a second example, some people with angina may bring on an attack merely by walking to the store. If they rode a motorized cart, however, their trip probably would be symptom free. As a third example, a person with infirm legs would require much less effort to pursue the tasks of daily living in a ranch-style house than in a multistory dwelling. Other related examples are numerous (see White, Paine-Andrews, Mathews, & Fawcett, 1995), yet related measures are typically unaccounted for in disability assessments. Feinstein et al. (1986) conjecture that the reason effort and collaboration are so frequently omitted from disability assessments is a prevailing belief that they are complex psychological phenomena that are difficult to measure, interpret, and incorporate into strictly physical ratings. Yet patient effort and collaboration are readily observable and therefore measurable variables. They are also much easier to interpret than variables such as motivation that are often included in disability indexes (Feinstein et al., 1986). In-

corporating measures of response effort into indexes of functional disability is a task that is well suited to the commitments and methods of applied behavior analysis (Baer et al., 1968). The task is important and timely because of the dramatic increase in physical disability in the industrialized world.

There are several other examples of effective procedures in the applied literature that could be construed in terms of response-effort manipulations (e.g., Blank, 1985; Chapman, Smith, & Layden, 1971; Epstein, Miller, & Webster, 1976; Schulman, 1986; Stuart & Davis, 1976; Van Houten, Nau, & Merrigan, 1981). Whether it is profitable to conceptualize them in this fashion is, however, an important issue that merits consideration.

CONCLUDING COMMENTS

Laboratory studies of response force or effort characteristically involve a manipulandum (e.g., lever or key) with clearly specified physical requirements for successful operation. With such arrangements, four distinct types of force can be measured and manipulated: (a) isotonic forces, (b) isometric forces, (c) forces proportional to displacement, and (d) forces proportional to velocity (for discussion of these forces, see Fowler, 1987; Notterdam & Minz, 1965). In the study by Alling and Poling (1995), as in most other studies with nonhumans, response effort was defined and measured in simple physical units (i.e., Newtons). Such precise quantification of effort is difficult in applied settings, although some exceptions are evident. For example, Schulman (1986) reduced speeding by making it harder to operate the gas pedal of an automobile at speeds above the legal limit, and the exact operating characteristics of the pedal at various speeds were specified precisely. Less precision was possible in a study by Van Houten (1993), who compared rates of self-injury under conditions in which wrist weights were and were not used with a self-injurious adolescent. Nonetheless, the increased effort in this

study is clearly physically similar to the increased effort in the study by Alling and Poling (1995), and the comparability of the independent variables in the two investigations is evident.

In other studies that we have considered, however, effort was manipulated in a rather different way. For example, in a study that required youths to solve math problems, Neef et al. (1994) indicated that

Response effort refers to the relative ease with which problems from the respective sets of problems could be completed, as determined by pretest performance on samples of problems ranging from 1-digit addition and subtraction to 4-digit multiplication and division with regrouping operations. Problems completed at the highest rate with the highest accuracy and confirmed by the classroom teacher as "review" or "fluency" targets were designated as low effort. Problems that were completed at a lower rate with at least 50% accuracy and that were confirmed by the teacher as "acquisition" or "mastery" targets were designated as high effort. (p. 578)

Here, rate and accuracy of responding, rather than response force, defined effort. In other studies, effort was indexed in terms of duration or probability of responding; a response that did not occur when a person was not required to perform it was assumed to be effortful. For instance, Luiselli (1984) demonstrated that requiring a boy to engage in arm movements contingent on aggressive or self-injurious behavior reduced those responses. The arm movements almost never occurred in the absence of the intervention, hence, requiring their emission increased response effort. Although this analysis is reasonable, an equally tenable explanation can be made in terms of the Premack principle (Premack, 1959): Forcing an organism to engage in a lower probability behavior contingent on a higher probability behavior punishes (i.e., re-

duces the rate of) the higher probability behavior.

Whether anything is gained by construing the study by Luiselli (1984) in terms of a response-effort manipulation is open to debate. Moreover, the extent to which results from laboratory studies in which response effort is indexed in terms of physical units of force will generalize to situations in which effort is measured in other ways remains to be determined. The results of several applied studies, summarized previously, are consistent with the findings of Alling and Poling (1995) and earlier basic research that increasing response force produces rapid and enduring decreases in behavior. Important tasks for future research include determination of the range of procedures that can be meaningfully considered to involve response-effort manipulations in basic and applied settings and delineation of similarities and differences in the effects of those procedures. Renewed interest in response effort as an independent variable appears to be justified because of the scope of its potential applications (as indicated by the diverse examples described above). It is also justified because the political constraints imposed on punishment- and reinforcement-based procedures, due to an imbalance between effectiveness and social validity (cf. Bernstein, 1990; Mulick, 1990), have yet to be imposed on procedures that entail manipulations of response effort. Finally, it is justified because, for many persons, life is hard, and increased study of response effort just might make it a little easier.

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