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Punishment and Its Putative Fallout: A Reappraisal

Rafaela M. Fontes, Timothy A. Shahan

Utah State University

Abstract

In his book *Coercion and Its Fallout* Murray Sidman argued against the use of punishment based on concerns about its shortcomings and side effects. Among his concerns were the temporary nature of response suppression produced by punishment, the dangers of conditioned punishment, increases in escape and avoidance responses, punishment-induced aggression, and the development of countercontrol. This paper revisits Sidman's arguments about these putative shortcomings and side effects by examining the available data. Although Sidman's concerns are reasonable and should be considered when using any form of behavioral control, there appears to be a lack of strong empirical support for the notion that these potential problems with punishment are necessarily ubiquitous, long-lasting, or specific to punishment. We describe the need for additional research on punishment in general, and especially on its putative shortcomings and side effects. We also suggest the need for more effective formal theories of punishment that provide a principled account of how, why, and when lasting effects of punishment and its potential side effects might be expected to occur or not. In addition to being necessary for a complete account of behavior, such data and theories might contribute to improved interventions for problems of human concern.

Keywords

punishment; conditioned punishment; escape-avoidance; countercontrol; induced aggression

Murray Sidman's exceptional scientific contributions to the field of behavior analysis are widely recognized (e.g., Ahearn, 2011; Arntzen, 2010; Holth & Moore, 2010; Johnson et al., 2020; McIlvane, 2011). Among his many contributions, Sidman's research has had a noteworthy impact on the understanding of aversive control (e.g., Sidman, 1953a, 1953b, 1966, 1989, 2000). Despite his extensive research in this area, Sidman firmly opposed the use of methods based on aversive control (i.e., coercion), advocating instead for the use of positive reinforcement (Delprato, 1995; Sidman, 1993, 2011). His opposition to the use of coercive methods was especially clear in his book *Coercion and its fallout* (Sidman, 1989/2000), where he referred to negative reinforcement and punishment as the two major categories of coercive control. According to Sidman (1989/2000), negative reinforcement and punishment work in a complementary manner because a stimulus punishing a response also should increase behavior removing or avoiding that stimulus (i.e., negative

Correspondence concerning this article should be addressed to Rafaela Fontes (rafaelafontes@hotmail.com) or Timothy Shahan (tim.shahan@usu.edu), Department of Psychology, 2810 Old Main Hill, Logan, UT 84322-2810.

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reinforcement; e.g., Crosbie, 1998). This interdependence between punishment and negative reinforcement was noted by Sidman as one disadvantage of the use of coercive control, with the other being the dangerous side effects of such practices.

It appears that Sidman's opposition to the use of aversive control and, more specifically to the use of punishment, may have impacted how punishment is viewed and used by both basic and applied behavior analysts (e.g., Ahearn, 2011; Holth, 2010). There has been an apparent decrease in interest in studying punishment, leaving several empirical and theoretical gaps in the literature (see Critchfield & Rasmussen, 2007; Horner, 2002; Lerman & Vorndran, 2002; Lydon et al., 2015; Todorov, 2001, 2011). However, a similar decrease has not necessarily been observed with negative reinforcement (e.g., Baron & Galizio, 2005, 2006; Magoon & Critchfield, 2008; Sidman, 2006; Thompson & Iwata, 2005).

Although *Coercion and its fallout* (Sidman, 1989/2000) was focused broadly on the coercive nature of both punishment and negative reinforcement, the present paper focuses on Sidman's concerns about the use of punishment. Sidman questioned the effectiveness of punishment in controlling behavior based on the transitory nature of the response suppression produced and he alerted his readers to the side effects of its use. Among these side effects were the dangers of conditioned punishment, an increase in escape and avoidance responses during punishment, the occurrence of punishment-induced aggression, and the development of countercontrol strategies.

Sidman's (1989/2000) concerns are reasonable and highlight important aspects to be considered when using punishment. Despite his concerns and critiques, Sidman did not deny the relevance of punishment research and the need for a better understanding of punishment effects (Holth, 2010). Accordingly, the goal of the present paper is to revisit Sidman's arguments about the shortcomings and side effects of punishment and examine empirical data that corroborate or contradict these arguments. We hope that such a review improves our understanding of punishment and help to inform discussions about whether, when, and how punishment might be employed, and perhaps help to renew empirical and theoretical interest in punishment.

What is punishment and how does it work?

In *Coercion and its fallout* Sidman defines punishment as follows:

We define reinforcers, positive or negative, by their special effect on conduct; they increase the future likelihood of actions they follow. But we define punishment without appealing to any behavioral effect; punishment occurs whenever an action is followed either by a loss of positive or a gain of negative reinforcers. This definition says nothing about the effect of a punisher on the action that produces it. It says neither that punishment is the opposite of reinforcement nor that punishment reduces the future likelihood of punished actions. (Sidman, 1989/2000, p. 45)

This definition was first proposed by Thorndike (1932) and adopted by Skinner (1953). According to this definition, reinforcement and punishment are assumed to be inherently different. Punishment refers to a procedure, while reinforcement is functionally defined,

referring to both the procedure and a behavioral process (e.g., Holth, 2010; Sidman, 1993, 2011).

Other underlying assumptions are included in this procedural definition of punishment. First, this definition assumes there is no symmetry between reinforcement and punishment, thus they affect behavior through different mechanisms (e.g., Carvalho Neto et al., 2017; Carvalho Neto & Mayer, 2011; Holth, 2005). Second, defining punishment as a procedure and not a process implies that punishment does not have a direct effect on behavior. Instead, the response suppression observed during punishment is assumed to result from other indirect processes, such as an increase in the frequency of other unpunished responses (i.e., escape and avoidance), or the occurrence of unconditioned emotional responses (e.g., freezing) that are incompatible with the punished response (Hineline, 1984; Schuster & Rachlin, 1968). Thus, punishment is only effective in reducing behavior to the extent that it increases the frequency of competing unpunished responses (Dinsmoor, 1954; 1955; Hineline, 1984; Solomon, 1964).

A different definition of punishment was proposed by Azrin and Holz (1966), suggesting that punishment is a consequence (e.g., removal of an appetitive stimulus or presentation of an aversive stimulus) that reduces the probability of the behavior that produces it. This definition has been the most commonly used and accepted one (e.g., Hineline & Rosales-Ruiz, 2013; Holth, 2010; Lerman & Vorndran, 2002; Mallpress et al. 2012; see Sidman, 2006 for discussion). Here, punishment is defined functionally, similar to reinforcement, and punishment and reinforcement are considered symmetrical processes having similar effects on behavior, but in opposite directions (Hake & Azrin, 1965). Furthermore, the Azrin and Holz (1966) definition does not attribute the effects of punishment to any observable or hypothesized competing response (Carvalho Neto et al., 2017; Holth, 2005).

The widespread use and acceptance of the Azrin and Holz (1966) definition, however, is not an indication of this definition being superior to the one defended by Sidman (1989/2000, 2006, 1993, 2011). Although the functional definition has the advantage of acknowledging punishment as a behavioral process similar to reinforcement, attaching the definition of punishment to its effects on behavior is not necessarily indicative of any conceptual improvement (Holth, 2005, 2010). Functional definitions have been criticized for their circularity because the function of a stimulus is identified by its effects on behavior while simultaneously being used to at least implicitly explain the occurrence of that behavior (Holth, 2010; Sidman, 2006; Staddon, 1993). Conversely, concerns about the functional definition proposed by Azrin and Holz (1966) are also not an indication that the procedural definition defended by Sidman (1989/2000) is superior. Defining punishment as a mere procedure that impacts behavior indirectly disregards it as a valid method of behavior control and can mistakenly confound the effects of punishment with the effects of negative reinforcement. However, the decision about the appropriate definition of punishment (and reinforcement) requires a deeper discussion about the conceptual framework upon which behavior analysis is built (e.g., Gallistel, 2005; Gallistel et al., 2001; Killeen, 1988; Shahan, 2017; Staddon, 1993; Timberlake, 1988), a discussion we will not take up here.

One potential way to place both the definition of punishment and the potential mechanisms by which it has its effects on firmer footing is via consideration of formal quantitative models of punishment. To be of any utility, such models must make explicit how punishment has its effects. The two different definitions of punishment described above roughly correspond to two separate quantitative models of punishment based on the matching law (Herrnstein, 1961, 1970). According to the competitive-suppression model (Deluty, 1976), punishers delivered for one option decrease allocation to that option by *increasing* the relative value of a competing option such that,

$$\frac{B_1}{B_2} = \frac{(R_1 + P_2)}{(R_2 + P_1)} \quad (1)$$

where B_1 and B_2 are the response rates, R_1 and R_2 are the reinforcement rates, and P_1 and P_2 are the punishment rates for each of two options. By suggesting that the effects of punishment are mediated indirectly by its effects on other responses, such a model is conceptually akin to Sidman's definition noted above. In contrast, the direct-suppression model (de Villiers, 1980; Farley, 1980) suggests that reinforcement and punishment are symmetrical processes and that punishers for one option decrease allocation to that option by directly *decreasing* the relative value of the punished option in a manner that it is opposite in direction (i.e., sign) from reinforcement such that

$$\frac{B_1}{B_2} = \frac{(R_1 - P_1)}{(R_2 - P_2)} \quad (2)$$

where all terms are as in Equation 1.

Direct comparisons of these models have provided overwhelming empirical evidence in favor of the direct-suppression model (de Villiers, 1980; Farley, 1980; Farley & Fantino, 1978). Thus, punishment might best be understood and defined as having a direct suppressive effect on behavior that is the opposite of reinforcement, as suggested by Azrin and Holz (1966). However, both models sometimes fail to provide accurate quantitative predictions about the effects of punishment on behavior (e.g., Critchfield et al., 2003; Rasmussen & Newland, 2008). In addition, Klapes et al. (2018) have shown that modern versions of both models based on the generalized matching law (Baum, 1974) perform no better quantitatively with punishment data than simpler versions of the generalized matching law that completely omit any role for punishment. Thus, despite the superiority of the direct-suppression model in many circumstances, something remains amiss with its quantitative foundations. Resolving whatever it is that remains amiss with the direct-suppression model could have important implications for the definition of punishment and for our understanding of how it has its effects.

In short, there is still no clear or easy answer to the question of how punishment should be defined or how it works. There remains considerable room for debate about both the appropriate definition and the best conceptual/theoretical account of punishment. Our view is that an increase in empirical and theoretical effort directed at generating a more complete quantitative account of punishment is required before a robust and truly acceptable definition of punishment will emerge. Nevertheless, an inability to provide an acceptable definition or

clear understanding of how punishment works does not prevent assessing the putative shortcomings and side effects of the use of punishment with which Sidman was concerned.

Putative Shortcomings and Side Effects of Punishment

Response Suppression is Temporary

A shortcoming of the use of punishment-based interventions discussed by Sidman (1989/2000) is the fact that response suppression produced by punishment is transitory. According to Sidman:

After a period of suppression, the activity gradually recovers; the animal ends up pressing the lever as rapidly as ever, even though it still gets shocked every time. [...] The longer the animal stopped, the hungrier it became; the positive reinforcement for pressing the lever eventually became more powerful than the punishment. (Sidman, 1989/2000, p. 72–73).

Indeed, response recovery after continuous exposure to constant punishment is a robust finding and has been demonstrated with different species such as pigeons (e.g., Azrin, 1960a), rats (e.g., Storms et al., 1963), squirrel monkeys (e.g., McMillan, 1967), and humans (e.g., Azrin, 1958); with different punishing stimuli such as shocks (e.g., Rachlin, 1966), bar slap (e.g., Skinner, 1938), and noise (e.g., Azrin, 1958); and with different punishment intensities (e.g., Azrin, 1960a; Azrin & Holz, 1961; Rachlin, 1966). Studies showing response recovery during punishment have reliably demonstrated that response suppression is greater when punishment is first introduced, and response rates typically recover following continuous exposure to a constant punishment intensity (e.g., Azrin, 1959a, 1960a, 1960b; Azrin & Holz, 1961; Hake et al., 1967; Rachlin, 1966). Furthermore, response rates typically recover to baseline levels or higher with the removal of the punishment contingency (e.g., Azrin, 1960a; Azrin & Holz, 1961).

Conversely, complete response suppression without response recovery during punishment or after the suspension of the punishment also has been reported (e.g., Appel, 1961, 1963; Storms et al., 1962), suggesting that punishment can result in lasting response suppression. For example, response recovery is less likely with high punishment intensities than with low punishment intensities (Azrin, 1958, 1959b, 1960a; Azrin & Holz, 1961). Furthermore, Storms et al. (1962) demonstrated complete and persistent response suppression even when removal of the punishment contingency was followed by increases in food deprivation.

These contradictory results suggest that the degree of response suppression and the transitory effects of punishment can be impacted by other variables. Punishment intensity appears to be the main factor impacting response suppression and recovery during punishment (e.g., Azrin, 1958, 1960a; Azrin & Holz, 1966). Whenever the punishment intensity (e.g., shock voltage) is severe enough to suppress behavior completely, no response recovery is observed (e.g., Appel, 1961, 1963; Storms et al., 1962; Hake et al., 1967). The degree of response suppression and recovery also differs across strains (e.g., Storms et al., 1963), species (e.g., Appel, 1961, 1963; Azrin, 1959a, 1960a, Hake et al., 1967), and punishing stimuli. For example, shocks usually produce greater suppression than loud noise (e.g., Azrin, 1958; Azrin & Holz, 1966). Shocks also produce greater and faster response

suppression than timeout from positive reinforcement (i.e., negative punishment; e.g., Holz et al., 1963; McMillan, 1967). Contrary to the abrupt initial suppression commonly observed with punishment by shock, studies using timeout have shown that the frequency of the punished behavior increases upon the introduction of timeout, and gradually decreases with continuous exposure to the timeout condition (e.g., Brantner & Doherty, 1983; Bostow & Bailey, 1969; Harris, 1985; Holz et al., 1963; McMillan, 1967; Smith, 1981). Furthermore, direct comparisons have shown less response recovery and more lasting response suppression with timeout than with shocks (McMillan, 1967).

Although some of the variables impacting response suppression and response recovery during punishment have been identified, it remains unclear why response recovery happens in the first place. According to Sidman (1989/2000), response recovery occurs due to competition between punishment and reinforcement. Because decreases in response rates commonly are correlated with decreases in obtained reinforcement rates, the animal gets hungrier and the value of the reinforcer overcomes the aversiveness of the punisher. Although this not an unreasonable account of response recovery, it is limited for three reasons. First, the amount of hunger is typically controlled in such experiments with supplemental food after the session. Second, this explanation does not account for the results from Storms et al. (1962) showing no response recovery with increased deprivation; nor does it explain instances of a lack of recovery after the suspension of punishment (e.g., Appel, 1961, 1963; Hake et al., 1967) or the difference in the degree of recovery between different punishing stimuli (e.g., McMillan, 1967). Lastly, if changes in response suppression during punishment are to be explained by the competition between reinforcement and punishment, rules about how organisms make trade-offs between reinforcers and punishers are necessary. Without a quantitative description of how the values of the reinforcers and punishers change over time, this explanation remains speculative.

A potential alternative explanation for response recovery during punishment is based on habituation. Habituation is defined as a reduction in responsiveness to a stimulus following repeated or prolonged exposure to that stimulus (Rankin et al., 2009; Thompson & Spencer, 1966). In the context of punishment, the reduction in responsiveness would refer to a decrease in the suppressive efficacy of a punishing stimulus. Studies of habituation suggest that higher rates of stimulus presentation and prolonged exposure to a constant stimulus can speed and enhance habituation to that stimulus (McSweeney et al., 1996; Thompson, 2009). Habituation also develops faster and is more pronounced in the presence of a weaker stimulus, and rarely occurs in the presence of a strong stimulus (Rankin et al., 2009; Thompson, 2009). Furthermore, the presentation of a new or stronger stimulus commonly results in recovery of the habituated response (i.e., dishabituation; Rankin, et al., 2009; Thompson, 2009).

The studies reviewed above share several characteristics that highlight the potential role of habituation in response recovery with punishment. First, punishment was presented at high rates (i.e., fixed ratio [FR] 1; Azrin, 1960a, 1960b; Azrin & Holz, 1961; Hake et al., 1967; Rachlin, 1966; Storms et al., 1963), which results in faster habituation. Second, response recovery was observed in the presence of weak punishment (e.g., Azrin, 1959a, 1960a, 1960b, Azrin & Holz, 1961), but not in the presence of intense punishment (e.g., Appel,

1963; Azrin, 1959b; Hake et al., 1967; Storms et al., 1962). Third, dishabituation (i.e., recovery of the habituated response) was observed when increases in punishment intensity following response recovery resulted in resuppression of the punished response (e.g., Azrin, 1960a; Azrin & Holz, 1961; Rachlin, 1966). Further evidence of habituation to punishment also is provided by studies showing that preexposure to the punisher or gradual increases in punishment intensity increase resistance to punishment (e.g., Banks, 1966a, 1966b, 1976; Baron & Antonitis, 1961; Campbell & Cleveland, 1977; Cohen, 1968), and by studies showing that decreases in punishment efficacy are prevented by using varied rather than constant punishers (e.g., Charlop et al., 1988).

The notion that habituation might impact the degree of response suppression and response recovery during punishment could provide important insights about differences in punishment effects across species and stimuli. Because habituation is an adaptive learning mechanism, the speed of habituation, and the stimuli to which organisms habituate depend on the evolutionary history of the species (Eisenstein et al., 2001). Thus, different species and even different individuals within the same species can show different levels of responsiveness to the same stimulus (e.g., Biedeweg et al., 2011; Blumstein, 2016).

The idea that habituation can impact operant conditioning is not new. McSweeney and colleagues have argued that the reinforcing efficacy of a stimulus is affected by habituation to repeated presentation of that stimulus during the operant session, resulting in changes in response rates across session time (e.g., McSweeney et al., 1996; McSweeney & Murphy, 2009; McSweeney & Roll, 1998; McSweeney & Swindell, 2002). It seems reasonable that a similar process may occur during punishment. If the response recovery observed in punishment studies might result from habituation to the punisher, the transitory effects of punishment should not be considered grounds for challenging the effectiveness of punishment in general.

In conclusion, the studies reviewed above suggest that the transitory effects of punishment noted by Sidman (1989/2000) are real. However, those transitory effects are likely not specific to punishment and depend on several aspects of the environment and of the contingency. This is true for all variables controlling behavior; thus, it should not be taken as an intrinsic disadvantage of punishment (Johnston, 1972).

Conditioned punishment

One side effect of punishment discussed by Sidman (1989/2000) was conditioned punishment and its role in the generalization of punishment effects to the environment in which punishment is delivered. According to Sidman,

Whenever we are punished, more and more elements of our environment become negative reinforcers and punishers. We come more and more under coercive control and we rely more and more on countercoercion to keep ourselves afloat. [...] That is why conditioned punishment is a “toxic” side effect of punishment. Environments where we are punished become punishing themselves and we react to them as to natural punishers. (Sidman, 1989/2000, p. 89)

Studies of conditioned punishment have investigated the suppressive effects of stimuli associated with a punisher using two procedures: discriminated punishment and conditioned suppression (Church et al., 1970). In discriminated punishment experiments, only responses in the presence of a specific stimulus are followed by the punisher. Thus, the punisher is contingent on both the response and the antecedent stimulus (i.e., discriminative stimulus; Church et al., 1970). In conditioned suppression experiments, a neutral stimulus is paired with an unconditioned aversive stimulus (i.e., punisher), thus acquiring aversive properties through classical conditioning. The suppressive effect of the conditioned stimulus is demonstrated when response-independent presentation of the conditioned stimulus results in suppression of an operant response that was never previously followed by the unconditioned aversive stimulus.

A discriminative stimulus associated with the delivery of response-dependent punishment can function as a conditioned punisher for other responses. For example, Davidson (1970) trained rats on a multiple schedule of reinforcement and showed that the discriminative stimulus associated with the punished component functioned both as a punisher and as a negative reinforcer when presented dependent on responding during the unpunished component. Using a similar procedure, Weisman (1975) demonstrated that the discriminative stimulus for the punished component functioned as a punisher, but only while it continued to be associated with the delivery of the unconditioned punisher. In a related study, Hake and Azrin (1965) demonstrated that the conditioned stimulus from a conditioned suppression procedure also can function as a conditioned punisher when presented dependent on a response. Pigeons were trained on a conditioned suppression procedure where a tone was paired with shock. When the tone was used as a conditioned punisher delivered contingent on key pecking, suppression of key pecking was then observed. The suppressive efficacy of the tone was a function of the intensity of the shock with which the tone was paired. Furthermore, the tone was only effective as a conditioned punisher while the tone-shock contingency was maintained. Taken together, the results of these studies suggest that discriminative or conditioned stimuli associated with punishment can in fact become punishers themselves. However, these stimuli are only effective in suppressing operant responses while the contingency between the stimuli and the original punisher is maintained.

Generalization of the effects of conditioned punishers also has been investigated. For example, Honig and Silvka (1964) reinforced key pecking in the presence of seven different key colors and superimposed response-dependent punishment on the schedule of reinforcement for one of the colors. Punishment effects generalized to all colors initially; however, a U-shaped inhibitory generalization gradient developed with continued training. Furthermore, response rates returned to baseline levels on the removal of the punishment contingency (see Honig, 1966 and Carman, 1972 for similar findings). Brush et al. (1952) also trained pigeons to key peck in the presence of a discriminative stimulus and reported similar generalization gradients for pigeons tested after reinforcement only and for pigeons tested after key pecking was suppressed by punishment in the presence of the same discriminative stimulus. These results suggest that the generalization process for punishment is similar to that of positive reinforcement.

The suppressive effects of conditioned punishers have been compared between conditioned suppression and discriminated punishment procedures. For example, Orme-Johnson and Yarczower (1974) trained separate groups of pigeons on each procedure and reported greater response suppression with conditioned suppression than discriminated punishment. Furthermore, conditioned suppression effects generalized to stimuli associated with the unpunished baseline, while discriminated punishment effects did not (see Hunt & Brady, 1955 and Hoffman & Fleshler, 1965 for similar results; but see Hoffman & Fleshler, 1961 and Church et al., 1970 for different results). Additionally, greater resistance to extinction of punishment (Hoffman & Fleshler, 1965; Hunt & Brady, 1955) and greater emotional responses (Hunt & Brady, 1955) also have been demonstrated with conditioned suppression than with discriminated punishment.

These findings suggest that the suppressive effects of a conditioned punisher are directly related to the contingency between the conditioned and unconditioned punishers. Once this contingency is broken, the conditioned punisher loses its punishing efficacy. Furthermore, the contingency between the response and the delivery of the punisher (conditioned or unconditioned) also seems to play an important role in the degree of response suppression and generalization of the suppressive effects. This suggests that the “aversiveness” of the punishing stimulus, as measured by the degree of response suppression and emotional responses produced by the punisher, is impacted by the organism’s control of the punisher.

In conclusion, the studies reviewed above support Sidman’s argument that stimuli correlated with presentation of unconditioned punishers can become punishers themselves. However, those stimuli are only effective as conditioned punishers while correlated with unconditioned punishers, and do not necessarily acquire lasting effects of the unconditioned punishers with which they are associated. Furthermore, the generalizability of conditioned punishment effects is reduced with continued training, contradicting Sidman’s argument that more exposure to punishment results in greater generalization of response suppression. Thus, it appears that these concerns of Sidman are not supported by empirical evidence. Instead, the “toxicity” of the conditioned punishment side effect seems to be greatly impacted by the animal’s control of the punishment delivery and the information conditioned punishers provide about the contingency.

Furthermore, contrary to Sidman’s concerns about conditioned punishment, in applied settings the establishment of conditioned punishers commonly is described as a desirable side effect of punishment (e.g., Brantner & Doherty, 1983; Johnston, 1972; Lerman & Vorndran, 2002). However, few applied studies have addressed these effects. There is some evidence that verbal cues paired with the delivery of an unconditioned punisher can acquire conditioned punishing functions (e.g., Dorsey et al., 1980; Lovaas & Simmons, 1969), though it remains unclear under which conditions those conditioned punishers result in response suppression during treatment. For example, verbal warnings are usually presented before the imposition of response-dependent timeout from positive reinforcement (e.g., Harris, 1985; MacDonough & Forehand, 1973; Wilson & Lyman, 1983). However, the effectiveness of verbal warning or other stimuli associated with the onset of the timeout as a conditioned punisher has yet to be investigated (Brantner & Doherty, 1983; Everett et al., 2010; Harris, 1985).

Applied studies also have provided evidence that response suppression obtained with punishment-based interventions, such as timeout, can generalize to other nontarget undesirable behavior (e.g., Brantner & Doherty, 1983; Firestone, 1976; Lovaas & Simmons, 1969). Again, such effects are generally described as a desirable side effect. However, generalization of the suppressive effects of punishment to other, desirable behavior also has been reported (e.g., Lerman et al., 2003; Mayhew & Harris, 1978). These mixed results have prevented a clear understanding of the conditions under which desirable and undesirable generalization of punishment effects occur in applied settings, thus highlighting the importance of more research on this potential side effect of punishment (e.g., Lydon et al., 2015; Matson & Taras, 1989).

Increase in escape and avoidance behavior

Sidman (1989/2000) considered punishment and negative reinforcement as complementary processes, suggesting that the difference between them relies on the temporal relation between the presentation of the aversive stimulus (i.e., negative reinforcer or punisher) and the occurrence of behavior. Given the intrinsic connection between punishment and negative reinforcement, the second side effect of punishment (and conditioned punishment) discussed by Sidman was an increase in escape and avoidance behavior. According to Sidman,

Punishers, whether things, places, events, or people, suppress actions that produce them but also generate escape as one of their side effects. A victim of punishment who can turn it off, or can somehow get out of the situation, will do so. (Sidman, 1989/2000, p. 93)

The notion that punishment increases escape and avoidance is directly related to the procedural definition of punishment discussed above (Sidman, 1989/2000) suggesting that punishment only has an indirect effect on behavior by increasing the frequency of competing responses (Carvalho Neto et al., 2017; Church, 1963; Holth, 2005). This competing response hypothesis states that behavior suppression observed during punishment is due to 1) unconditioned emotional responses elicited by the punisher that compete with the punished response (e.g., Estes, 1944, Estes & Skinner, 1941), or 2) increases in the frequency of operant responses that are negatively reinforced by the removal of the punisher or conditioned punishers (e.g., Dinsmoor, 1954, 1955, 1977, 2001; Millenson & MacMillan, 1975; Sidman, 1993, 2000).

The contribution of unconditioned emotional responses to response suppression during punishment has been demonstrated by studies on conditioned suppression and by experiments using response-independent punishers. Given the lack of dependency between the response and the punisher in both procedures, the obtained response suppression is attributed to emotional responses elicited by the punisher that compete with the positively reinforced operant behavior (e.g., Annau & Kamin, 1961; Estes & Skinner, 1941; Hunt & Brady, 1955; Orme-Johnson & Yarczower, 1974). This competing emotional response hypothesis has been challenged by studies showing greater response suppression with response-dependent than response-independent punishment (e.g., Azrin, 1956; Camp et al., 1967; Schuster & Rachlin, 1968). If unconditioned emotional responses were responsible for response suppression during punishment, equal suppression should occur in both conditions.

The greater suppression obtained with response-dependent punishment thus suggests that punishment has a suppressive effect regardless of the occurrence of emotional responses (Church, 1963; Schuster & Rachlin, 1968).

The hypothesis that response suppression during punishment results from increases in competing operant responses (i.e., avoidance and escape) also has been extensively investigated. For example, Millenson and McMillan (1975) arranged reinforcement dependent on 10 s of bar holding with rats and showed that the average hold time was greater than 10 s during baseline but considerably shorter than 10 s when punishment was superimposed on the schedule of reinforcement. Failures to complete the response requirement (i.e., 10-s hold) during punishment were interpreted as avoidance responses that prevented the delivery of punishment.

Furthermore, Azrin, Hake, et al. (1965) and Arbuckle and Lattal (1987) investigated the effects of the availability of a specific avoidance response on behavior suppression during punishment with pigeons. In Azrin, Hake, et al., an FR1 punishment schedule was superimposed on different schedules of reinforcement for pecking the main key. Each peck on a second key (i.e., avoidance response) started an interval during which responses on the main key were not punished. Increases in punishment intensity increased the frequency of avoidance responses, and avoidance responses were maintained even when responding on the avoidance key decreased obtained reinforcement rates. Furthermore, more resistance to punishment occurred when the avoidance response was unavailable than when it was available. However, because the avoidance response allowed the animals to continue responding on the main key in the absence of punishment, increases in avoidance responding did not decrease the frequency of main-key responses, but only decreased the frequency of main-key responses that were punished. Thus, the relation between punishment and negative reinforcement in that study was not entirely clear.

Arbuckle and Lattal (1987) also superimposed punishment on a schedule of key-peck reinforcement. During some of the punishment conditions, the punisher could be avoided if responses were spaced by a minimum inter-response time (IRT). Response rates and shock rates were lower in all conditions in which the IRT avoidance contingency was in effect than in an initial no-avoidance condition. Furthermore, response rates decreased as the length of the IRT required to avoid shocks increased. In a subsequent re-exposure to the no-avoidance condition, response rates decreased even further than during any of the IRT conditions, and shock rates remained relatively low. These results suggest that the effects of a punisher might be augmented indirectly by negative reinforcement, however, they do require interpreting the absence of responding (i.e., pausing) as an increase in active avoidance. Obviously, such an interpretation introduces some potential interpretive issues related to differentiating response rate decreases resulting from direct effects of punishment versus indirect effects of increases in pauses between the punished response.

Taken together, these findings suggest that negative reinforcement might play a role in response suppression during punishment, supporting the complementary relation between punishment and negative reinforcement. However, none of the studies reviewed above provided evidence that increases in escape and avoidance responses are *necessary* for

punishment to effectively suppress behavior, as proposed by the competing response hypothesis (see Dunham, 1971; Rachlin & Herrnstein, 1969; Schuster & Rachlin, 1968 for discussion), unless one considers the lack of responding as an avoidance response. The competing response hypothesis also has been challenged by empirical data demonstrating suppression during punishment without increases in specific avoidance responses. For example, Leitenberg (1965a, 1967) compared the effects of punishment in the presence and absence of an escape response with rats and reported greater suppression when punishment was delivered in the absence of an escape response than when an escape response was available.

In application, the occurrence of escape and avoidance responses can be one of the main reasons for the inefficacy of punishment-based interventions (Nelson & Rutherford, 1983; Wilson & Lyman, 1983). For example, timeout from positive reinforcement has been shown ineffective in reducing problem behavior when escaping from timeout is possible or other sources of reinforcement are available during the timeout (e.g., Solnick et al., 1977). Thus, establishing contingencies to prevent escape, such as blocking or return to timeout are commonly recommended (e.g., Donaldson & Vollmer, 2011; Quetsch et al., 2015; Riley et al., 2017).

Therefore, although the relation between punishment and negative reinforcement discussed by Sidman seems clear, there is not enough empirical evidence to confirm that punishment increases competing responses, nor that such an increase in competing responses is the mechanism underlying response suppression during punishment. Instead, the findings above suggest that the consequence of a response can impact how organisms allocate their behavior across other available options. Superimposing punishment on one of many available responses may impact how an organism weighs the consequences associated with all options and how it allocates its time across options (e.g., Baum, 1973, 2010, 2012; Baum & Rachlin, 1969). Thus, the relation between punishment and competing responses would be better understood by acknowledging that punishment may have both a suppressive effect on the punished response and a facilitative effect on other options (e.g., Carvalho Neto et al., 2017; Spradlin, 2002). Therefore, changes in response allocation during punishment would be more appropriately described as resulting from changes in the relative values of the options. Indeed, because they are based on the matching law, both quantitative models of punishment described above necessarily suggest that punishment impacts the *relative values* of both punished and non-punished options.

Punishment-induced aggression

Another side effect of punishment discussed by Sidman (1989/2000) was an increase in aggressive behavior following the presentation of a punisher. As he stated,

Coercive practices can bring counterattack against individuals and against the groups [...] It is easy to see how aggression could become a new way of life for the formerly subservient. The very success of the counteraggression can set into motion a self-perpetuating buildup of an aggressive way of life. (Sidman, 1989/2000, p. 211–212)

Sidman's concern was not only with punishment-induced aggression, but also with the persistence and perpetuation of such responses. This was considered an especially dangerous side effect because the aggression may be misplaced toward an organism that is not the one imposing the punishment and trigger aggressive reactions in the attacked organism.

In fact, several studies have demonstrated that presentations of response-independent aversive stimuli do result in aggressive responses in the form of attack toward another animal (e.g., Azrin et al., 1963; Myer & Benninger, 1966; Ulrich & Azrin, 1962) or toward inanimate objects (e.g., Azrin, 1970; Azrin et al., 1964). Attack and fight responses have been demonstrated with response-independent presentation of different aversive stimuli, such as shocks (e.g., Azrin et al., 1967; Ulrich et al., 1964), preheated floor (e.g., Ulrich & Azrin, 1962), and tail pinches (e.g., Azrin, Hake & Hutchinson, 1965). Furthermore, this effect has been replicated with several species, such as rats (e.g., Myer & Benninger, 1966; Ulrich & Azrin, 1962), mice (Azrin, 1964; Ulrich, 1966), squirrel monkeys (e.g., Azrin et al., 1963), hamsters (e.g., Ulrich & Azrin, 1962), and cats (e.g., Ulrich et al., 1964).

Studies investigating aggressive responses with the presentation of response-independent aversive stimuli have shown that the probability of such responses depends on both environmental and organismic variables (Azrin, 1964; Ulrich, 1966). Among the environmental variables, the frequency of aggression increases with the frequency (Ulrich & Azrin, 1962), intensity (Ulrich & Azrin, 1962; Ulrich et al., 1964), and duration (Azrin, Ulrich, et al., 1964) of the aversive stimulus. However, this function is reversed at more extreme intensity and duration of shocks, and aggressive responses seem to decrease when shocks are severe enough to produce escape and physical reactions (Azrin, 1964; Azrin et al., 1964; Azrin, Ulrich, et al., 1964; Ulrich, 1966; Ulrich & Azrin, 1962). Aggressive responses also are more common immediately after the presentation of the aversive stimulus (e.g., Azrin et al., 1968; Azrin et al., 1964; Hutchinson et al., 1971); in smaller chambers where the animals were physically close compared to chambers with a larger floor area (e.g., Ulrich & Azrin, 1962), and among food-deprived animals compared to free-fed animals (e.g., Cahoon et al., 1971). Among organismic variables, aggressive responses elicited by response-independent aversive stimuli vary among different strains of the same species. For example, attack responses are observed less frequently with Wistar rats than with other rat strains (Ulrich, 1966; Ulrich & Azrin, 1962). Differences across species have also been reported. For example, no aggressive response is observed with guinea pigs (e.g., Azrin, 1964; Ulrich, 1966; Ulrich & Azrin, 1962). Furthermore, pigeons and monkeys typically attack an inanimate object in the absence of another living being, although rats rarely do so (Ulrich, 1966; Ulrich & Azrin, 1962). Variables such as castration, age, and social conditions in the home cage also have been shown to impact the frequency of aggressive responses (e.g., Hutchinson et al., 1965; Ulrich, 1966).

In applied studies using response-dependent punishment, punishment-induced aggression has been reported with physical punishment (e.g., Mayhew & Harris, 1978) but not with some other punishers such as timeout from positive reinforcement (e.g., Bostow & Bailey, 1969; Risley, 1968). The occurrence of other emotional responses, such as crying and temper tantrums, have been reported anecdotally with the use of seclusion timeout (e.g., Azrin & Wesolowski, 1974; Sachs, 1973). However, reductions of such emotional responses

also have been reported to accompany the reduction of the problem behavior during timeout and other punishment-based interventions (e.g., Matson & Taras, 1989; van Oorsouw et al., 2008).

Although elicitation of aggression by aversive stimuli is a robust and reliable finding (Azrin, 1964; Ulrich, 1966), the evidence just reviewed does not suggest that aggression is a *necessary* collateral effect of punishment. In the experiments reviewed above, the aversive stimulus was delivered response-independently, thus not meeting the definition of punishment as a procedure (i.e., presentation of an aversive stimulus following a specific response) or as a process (i.e., reduction of a response that produces an aversive stimulus).

Countercontrol

The final undesirable punishment side effect discussed by Sidman (1989/2000) was the development of countercontrol. Sidman stated that,

If punishees are confined or restricted and cannot get away, the coercion will inevitably produce one of its most prominent side effects, countercontrol. If people cannot escape or avoid, they will find another way to deflect punishments and threats of punishment; they will learn how to control their controllers. (Sidman, 1989/2000, p. 214)

Countercontrol was extensively discussed by Skinner (1953, 1971, 1974) and is defined as operant behavior in response to social aversive control that results in extinction or punishment of the punishing agent's behavior. Countercontrol can have different topographies such as overt aggression, passive resistance, or escape from the agent imposing the punishment. Therefore, countercontrol is considered a serious and socially relevant side effect of aversive control (Ornelas, 2018).

Basic research with nonhumans on countercontrol is nonexistent. According to Sidman (1989/2000), the lack of studies on countercontrol in laboratory research is a result of the highly controlled environments where such research is conducted. The isolation of the experimental setting prevents the animals from countercontrolling the experimenter. Thus, countercontrol has been discussed as an exclusively human side effect of social aversive control (e.g., Delprato, 2002; Mace, 1994; Miller, 1991; Sidman, 2000; Skinner, 1953, 1974).

Instances of countercontrol with humans in different social situations have been described in the literature. Carey and Bourbon (2004, 2006) described several examples of countercontrol by students observed in schools in several countries. The authors noted that some students described their behavior, such as cheating on an exam or missing class, as countercontrol against their teachers. Countercontrol has also been discussed during behavior modification as a form of resistance from the client to comply with the treatment (e.g., Mace, 1994; Miller, 1991; Seay et al., 1984). Examples of countercontrol have also been described in experimental studies with humans. For example, Boren and Colman (1970), using a token economy with psychiatric patients, reported that when patients were fined a few tokens for staying in bed instead of attending a morning meeting, attendance dropped from 70% to 0%.

During informal observations, the authors mentioned hearing some of the participants ordering others not to attend the morning meetings as a form of rebellion.

However, in all the situations described above, countercontrol was used as a post hoc explanation for unexpected conduct observed during investigation of other topics. Most work on countercontrol has been conceptual, and the variables that impact the probability, frequency, and topography of countercontrol have not been thoroughly investigated empirically. It is also unknown how countercontrol may affect the behavior of the punishing agent and the probability of punishment in the future (Mace, 1994). To the best of our knowledge, the only experimental study attempting to evoke countercontrol was conducted by Ornelas (2018) using a simulated work environment. During the experiment, aversive verbal statements were used to evoke countercontrol from the participants. However, the results were inconclusive about the relevant variables involved in countercontrol. First, the aversive statements were given at the beginning of the experimental session and no aversive stimulus was dependent on the participant's behavior. Thus, the procedure did not meet the definition of countercontrol as a strategy to deflect punishment and control the punishing agent. Second, the results did not show any evidence of what the experimenter considered as countercontrol by the participants. In conclusion, nearly nothing is known about this potential side effect of punishment

Conclusion and future directions

Sidman's opposition to the use of aversive control, and more specifically to the use of punishment, was clear in his writings (e.g., Sidman, 1993, 2000, 2011). Although his concerns are reasonable and highlight important aspects to be considered when using any form of behavior control, the literature reviewed above suggests a lack of strong empirical support for the notion that these shortcomings and side effects are ubiquitous, long-lasting, or specific to punishment. The transitory nature of response suppression produced by punishment does not appear to be an inherent issue with punishment and depends on many aspects of the environment and the contingency. In addition, although stimuli associated with unconditioned punishers can indeed become punishers themselves, such effects are not indiscriminately generalized to other stimuli present and do not necessarily persist once the contingency is suspended. Similarly, increases in escape and avoidance can be observed during punishment, but the occurrence of such responses is not necessary for punishment to suppress responding. Increases in aggressive behavior in the presence of aversive stimulation have also been shown to be a reliable effect; however, it is not necessarily or exclusively a result of punishment procedures. As with conditioned punishment effects, the occurrence of punishment-induced aggression seems to be impacted by the organism's control of the punishment delivery. Lastly, although anecdotal examples of countercontrol have been described in the literature, countercontrol has not been empirically investigated and it remains unclear when or how such behavioral strategies might develop.

The lack of undesirable side effects associated with the use of punishment has also been noted in the applied literature (e.g., Brantner & Doherty, 1983; Harris, 1985; Johnston, 1972; van Oorsouw et al., 2008). Indeed, the use of punishment-based interventions typically has been related to increases in positive behavior (e.g., Bostow & Bailey, 1969; Firestone, 1976;

van Oorsouw et al., 2008; Risley, 1968). For example, Matson and Taras (1989) reviewed 382 applied studies employing different punishment procedures during interventions with individuals with developmental disabilities and concluded that the results reviewed did not provide evidence supporting the occurrence of undesirable side effects. Instead, the majority (93%) reported positive side effects during punishment interventions, such as increases in social behavior and responsiveness to the environment. Furthermore, the severity of the undesirable side effects, to the extent that they occur, was considered less harmful than the target behavior to be treated by punishment (Matson & Taras, 1989).

Given the considerations above, one wonders if opposition to the use of punishment might reflect a more general cultural tendency to regard its use as inherently bad. Such a view of punishment could be one of the reasons for the apparent decline in punishment research over the years (e.g., Bland et al., 2018; Johnston, 1991). Thus, the first step to renew the interest in punishment as a scientific topic is to acknowledge that aversiveness is not intrinsic to punishment but instead is contextually dependent (Leitenberg, 1965b; Perone, 2003). As noted by Perone (2003), the distinction between positive reinforcement and aversive control can be a matter of perspective, and every situation can be interpreted in terms of positive reinforcement or aversive control. As Sidman (1989/2000) noted, the use of deprivation to increase the efficacy of positive reinforcers might also be considered coercive. Thus, such concerns should not be taken as a reason to avoid seeking a better understanding of punishment (Vollmer, 2002).

Regardless of how one feels about Sidman's (1993, 2000, 2011) and others' (e.g., Skinner, 1953, 1974) view of punishment, punishment-based procedures are effective in reducing the behavior of several species, in both basic and applied settings (see Lerman & Vorndran, 2002 for a review). Indeed, punishment is a valuable method in the treatment of problem behavior, and is commonly used in such settings (e.g., Hagopian et al., 1998; Hanley et al., 2005; Lerman & Vorndran, 2002; Lydon et al., 2015; Matson & Taras, 1989; Risley, 1968; Thompson et al., 1999). However, much remains unknown about punishment and its potential side effects. These empirical and theoretical gaps emphasize the need for more research on punishment (e.g., Horner, 2002; Johnston, 1991; Todorov, 2001, 2011). The potential benefits of an increased understanding of punishment and its potential side effects could be manifold.

First, an improved understanding of punishment and its putative side effects could help shine an empirical light on preconceptions about the "dangerousness" of punishment. As noted above, there is a lack of strong empirical support for many of the putative shortcomings and side effects of punishment. In cases where those side effects do occur, many questions remain unanswered. For example, it is unclear under what circumstances punishment generalizes to other stimuli present during its presentation and if punishment effects generalize with unconditioned punishers besides shock. Much also remains unknown about the interactions between punishment and reinforcement. Better understanding such interactions could improve our understanding of decision-making processes more generally by providing information about how organisms make trade-offs between different types of consequences. Understanding such trade-offs could provide important information about potential side effects of punishment. As one example, it is unknown if the availability of

other sources of positive or negative reinforcement impacts the frequency of punishment-induced aggression. Lastly, the complete lack of research on countercontrol makes clear the need for additional research on this potential side effect of punishment before it is considered in arguments against the use of punishment.

Second, additional research on punishment could contribute to the development of a well-grounded quantitative theory of punishment. As discussed above, both the competitive-suppression and direct-suppression models have failed to adequately account for punishment data. Furthermore, to the extent that punishment side effects do occur, a good quantitative theory of punishment should provide a principled account of how, why, and when they occur. As just one example, response recovery is a robust and reliable phenomenon that needs to be accounted for by a quantitative model of punishment. If habituation indeed plays a role in response recovery during punishment, a theory of punishment will need to incorporate a formal account of habituation in order to predict the conditions under which recovery should be expected to occur.

Furthermore, a science of behavior cannot be complete without understanding how aversive consequences contribute to behavior control (e.g., Johnston, 1991; Magoon & Critchfield, 2007; Vollmer, 2002). Punishment is a biological, behavior-regulation mechanism critical for learning to stop engaging in maladaptive behavior (e.g., Todorov, 2011; Vollmer, 2002). Regardless of whether or not one believes that punishment should ever be a part of explicitly arranged contingencies, it will always be a part of natural ones. Thus, it is critical that punishment be effectively integrated into more general formal theories of behavior. But for that to happen, the amount of rigorous data related to punishment and its potential side effects needs to increase substantially. Not only would such data and theories be valuable in their own right, but they could also meaningfully improve applications to problems of human concern.

Finally, our call for increased empirical and theoretical work on punishment should not be misconstrued as a disregard for concerns about the use of punishment on ethical and humanitarian grounds. Nor should this call for additional research be mistaken as an argument for more widespread use of punishment-based practices. Instead, our goal in highlighting empirical and theoretical gaps in the literature is to emphasize the need for a more complete understanding of punishment and its putative pitfalls before adopting or abandoning its use.

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References

- Ahearn WH (2011). Sidman on Aversive Control. *European Journal of Behavior Analysis*, 12(1), 327–329. 10.1080/15021149.2011.11434380

- Annau Z, & Kamin LJ (1961). The conditioned emotional response as a function of intensity of the US. *Journal of Comparative and Physiological Psychology*, 54(4), 428–432. 10.1037/h0042199 [PubMed: 13683658]
- Appel JB (1961). Punishment in the squirrel monkey *saimiri sciurea*. *Science*, 133(3445), 36–36. 10.1126/science.133.3445.36 [PubMed: 13683864]
- Appel JB (1963). Punishment and shock intensity. *Science*, 141(3580), 528–529. 10.1126/science.141.3580.528-a [PubMed: 14013457]
- Arbuckle JL, & Lattal KA (1987). A role for negative reinforcement of response omission in punishment? *Journal of the Experimental Analysis of Behavior*, 48(3), 407–416. 10.1901/jeab.1987.48-407 [PubMed: 16812501]
- Arntzen E (2010). Comments on Sidman's "Remarks". *Behavior and Philosophy*, 38, 173–177. 10.2307/41806303
- Azrin NH (1956). Some effects of two intermittent schedules of immediate and non-immediate punishment. *The Journal of Psychology: Interdisciplinary and Applied*, 42, 3–21. 10.1080/00223980.1956.9713020
- Azrin NH (1958). Some Effects of Noise on Human Behavior. *Journal of the Experimental Analysis of Behavior*, 1(2), 183–200. 10.1901/jeab.1958.1-183 [PubMed: 16811219]
- Azrin NH (1959a). Punishment and recovery during fixed-ratio performance. *Journal of the Experimental Analysis of Behavior*, 2(4), 301–305. 10.1901/jeab.1959.2-301 [PubMed: 13795413]
- Azrin NH (1959b). A technique for delivering shock to pigeons. *Journal of the Experimental Analysis of Behavior*, 2, 161–163. 10.1901/jeab.1959.2-161 [PubMed: 13795411]
- Azrin NH (1960a). Effects of punishment intensity during variable-interval reinforcement. *Journal of the Experimental Analysis of Behavior*, 3, 123–142. 10.1901/jeab.1960.3-123 [PubMed: 13795412]
- Azrin NH (1960b). Sequential effects of punishment. *Science*, 131, 605–606. 10.1126/science.131.3400.605 [PubMed: 13795414]
- Azrin NH (1964). Aggressive responses of paired animals. Paper read at Symposium on Medical Aspects of Stress Walter Reed Institute of Research, Washington, D.C.
- Azrin NH (1970). Punishment of elicited aggression. *Journal of the Experimental Analysis of Behavior*, 14, 7–10. 10.1901/jeab.1970.14-7 [PubMed: 4988590]
- Azrin NH, Hake DF, Holz WC, & Hutchinson RR (1965). Motivational aspects of escape from punishment. *Journal of the Experimental Analysis of Behavior*, 8(1), 31–44. 10.1901/jeab.1965.8-31 [PubMed: 14266507]
- Azrin NH, Hake DF, & Hutchinson RR (1965). Elicitation of aggression by a physical blow. *Journal of the Experimental Analysis of Behavior*, 8(1), 55–57. 10.1901/jeab.1965.8-55 [PubMed: 14266511]
- Azrin NH, & Holz WC (1961). Punishment during fixed-interval reinforcement. *Journal of the Experimental Analysis of Behavior*, 4, 343–347. 10.1901/jeab.1961.4-343 [PubMed: 13863579]
- Azrin NH, & Holz WC (1966). Punishment In Honig WK (Ed.), *Operant behavior: Areas of research and application* (pp. 380–447). Englewood Cliffs, NJ: Prentice-Hall.
- Azrin NH, & Hutchinson RR (1967). Conditioning of the aggressive behavior of pigeons by a fixed-interval schedule of reinforcement. *Journal of the Experimental Analysis of Behavior*, 10(4), 395–402. 10.1901/jeab.1967.10-395 [PubMed: 6067961]
- Azrin NH, Hutchinson RR, & Hake DF (1963). Pain-induced fighting in the squirrel monkey. *Journal of the Experimental Analysis of Behavior*, 6(4), 620. 10.1901/jeab.1963.6-620 [PubMed: 14055963]
- Azrin NH, Hutchinson RR, & Hake DF (1966). Extinction-induced aggression. *Journal of the Experimental Analysis of Behavior*, 9(3), 191–204. 10.1901/jeab.1966.9-191 [PubMed: 16811286]
- Azrin NH, Hutchinson RR, & Hake DF (1967). Attack, avoidance, and escape reactions to aversive shock. *Journal of the Experimental Analysis of Behavior*, 10(2), 131–148. 10.1901/jeab.1967.10-131 [PubMed: 4962063]
- Azrin NH, Hutchinson RR, & Sallery RD (1964). Pain-aggression toward inanimate objects. *Journal of the Experimental Analysis of Behavior*, 7(3), 223–228. 10.1901/jeab.1964.7-223 [PubMed: 14143908]

- Azrin NH, Rubin HB, & Hutchinson RR (1968). Biting attack by rats in response to aversive shock. *Journal of the Experimental Analysis of Behavior*, 11(5), 633–639. 10.1901/jeab.1968.11-633 [PubMed: 5749187]
- Azrin NH, Ulrich RE, Hutchinson RR, & Norman DG (1964). Effect of shock duration on shock-induced fighting. *Journal of the Experimental Analysis of Behavior*, 7(1), 9–11. 10.1901/jeab.1964.7-9 [PubMed: 14120153]
- Azrin NH, & Wesolowski MD (1974). Theft reversal: An over-correction procedure for eliminating stealing by retarded persons. *Journal of Applied Behavior Analysis*, 7, 577–581. 10.1901/jaba.1974.7-577 [PubMed: 4443324]
- Banks RK (1966a). Persistence to continuous punishment following intermittent punishment training. *Journal of Experimental Psychology*, 71(3), 373–377. 10.1037/h0023016 [PubMed: 5908817]
- Banks RK (1966b). Persistence to continuous punishment and nonreward following training with intermittent punishment and nonreward. *Psychonomic Science*, 5(3), 105–106. 10.3758/BF03328303
- Banks RK (1976). Resistance to punishment as a function of intensity and frequency of prior punishment experience. *Learning and Motivation*, 7, 551–558. 10.1016/0023-9690(76)90005-9
- Baron A, & Antonitis JJ (1961). Punishment and preshock as determinants of bar-pressing behavior. *Journal of Comparative and Physiological Psychology*, 54(6), 716–720. 10.1037/h0040066 [PubMed: 13865142]
- Baron A, & Galizio M (2005). Positive and negative reinforcement: Should the distinction be preserved? *The Behavior Analyst*, 28(2), 85–98. 10.1007/BF03392107 [PubMed: 22478443]
- Baron A, & Galizio M (2006). The distinction between positive and negative reinforcement: use with care. *The Behavior Analyst*, 29(1), 141–151. 10.1007/BF03392127 [PubMed: 22478461]
- Baum WM (1973). Time allocation and negative reinforcement. *Journal of the Experimental Analysis of Behavior*, 20(3), 313–22. 10.1901/jeab.1973.20-313 [PubMed: 16811709]
- Baum WM (1974). On two types of deviation from the matching law: bias and undermatching. *Journal of the Experimental Analysis of Behavior*, 22(1), 231–242. 10.1901/jeab.1974.22-231 [PubMed: 16811782]
- Baum WM (2010). Dynamics of choice: A tutorial. *Journal of the Experimental Analysis of Behavior*, 94, 161–174. 10.1901/jeab.2010.94-161 [PubMed: 21451746]
- Baum WM (2012). Rethinking reinforcement: allocation, induction, and contingency. *Journal of the Experimental Analysis of Behavior*, 97(1), 101–124. 10.1901/jeab.2012.97-101 [PubMed: 22287807]
- Baum WM, & Rachlin HC (1969). Choice as time allocation. *Journal of the Experimental Analysis of Behavior*, 12, 861–874. 10.1901/jeab.1969.12-861 [PubMed: 16811415]
- Biedenweg TA, Parsons MH, Fleming PA, & Blumstein DT (2011). Sounds scary? Lack of habituation following the presentation of novel sounds. *PloS One*, 6(1), e14549 10.1371/journal.pone.0014549 [PubMed: 21267451]
- Bland VJ, Cowie S, Elliffe D, & Podlesnik CA (2018). Does a negative discriminative stimulus function as a punishing consequence? *Journal of the Experimental Analysis of Behavior*, 110(1), 87–104. 10.1002/jeab.444 [PubMed: 29926923]
- Blumstein DT (2016). Habituation and sensitization: new thoughts about old ideas. *Animal Behaviour*, 120, 255–262. 10.1016/j.anbehav.2016.05.012
- Boren JJ, & Colman AD (1970). Some experiments on reinforcement principles within a psychiatric ward for delinquent soldiers. *Journal of Applied Behavior Analysis*, 3(1), 29–37. 10.1901/jaba.1970.3-29 [PubMed: 16795235]
- Bostow DE, & Bailey J (1969). Modification of severe disruptive and aggressive behavior using brief timeout and reinforcement procedures. *Journal of Applied Behavior Analysis*, 2, 31–37. 10.1901/jaba.1969.2-31 [PubMed: 16795199]
- Brantner JP, & Doherty MA (1983). A review of timeout: A conceptual and methodological analysis In Axelrod S, Apsche J (Eds.), *The effects of punishment on human behavior* (pp. 87–132). New York: Academic Press.

- Brush FR, Bush RR, Jenkins WO, John WF, & Whiting JW (1952). Stimulus generalization after extinction and punishment: an experimental study of displacement. *Journal of Abnormal Psychology*, 47(3), 633–640. 10.1037/h0055188 [PubMed: 12980764]
- Cahoon DD, Crosby RM, Dunn S, Herrin MS, Hill CC, & McGinnis M (1971). The effect of food deprivation on shock elicited aggression in rats. *Psychonomic Science*, 22, 43–44. 10.3758/BF03335929
- Camp DS, Raymond GA, & Church RM (1967). Temporal relationship between response and punishment. *Journal of Experimental Psychology*, 74(1), 114–123. 10.1037/h0024518 [PubMed: 6032563]
- Campbell PE, & Cleveland CT (1977). Persistence following intermittent punishment and continuous reinforcement: Between and within subjects. *Bulletin of the Psychonomic Society*, 9(3), 183–185. 10.3758/BF03336968
- Carey TA, & Bourbon WT (2004). Countercontrol: A new look at some old problems. *Intervention in School and Clinic*, 40(1), 3–9. 10.1177/10534512040400010101
- Carey TA, & Bourbon WT (2006). Is Countercontrol the Key to Understanding Chronic Behavior Problems? *Intervention in School and Clinic*, 42(1), 5–13. 10.1177/10534512060420010201
- Carman JB (1972). Generalization of activity following discriminative punishment training. *Psychonomic Science*, 28, 19–21. 10.3758/BF03328649
- Carvalho Neto MB, & Mayer PCM (2011). Skinner e a assimetria entre reforçamento e punição. *Acta Comportamental*, 19, 21–32.
- Carvalho Neto MB, Mayer PCM, & Ferreira PA (2017). Simetrias e assimetrias entre reforçamento e punição: Uma proposta taxonômica. *Acta Comportamental*, 25(1), 73–84.
- Charlop MH, Burgio LD, Iwata BA, & Ivancic MT (1988). Stimulus variation as a means of enhancing punishment effects. *Journal of Applied Behavior Analysis*, 21(1), 89–95. 10.1901/jaba.1988.21-89 [PubMed: 3372404]
- Cherek DR, & Pickens R (1970). Schedule-induced aggression as a function of fixed-ratio value. *Journal of the Experimental Analysis of Behavior*, 14(3), 309–311. 10.1901/jeab.1970.14-309 [PubMed: 5530984]
- Church RM (1963). The varied effects of punishment on behavior. *Psychological Review*, 70, 369–401. 10.1037/h0046499 [PubMed: 14049776]
- Church RM, Wooten CL, & Matthews TJ (1970). Discriminative punishment and the conditioned emotional response. *Learning and Motivation*, 1(1), 1–17. 10.1016/0023-9690(70)90123-2
- Cohen PS (1968). Punishment: the interactive effects of delay and intensity of shock. *Journal of the Experimental Analysis of Behavior*, 11, 789–799. 10.1901/jeab.1968.11-789 [PubMed: 16811324]
- Critchfield TS, & Rasmussen ER (2007). It's aversive to have an incomplete science of behavior. *Mexican Journal of Behavior Analysis*, 33, 1–6.
- Critchfield TS, Paletz EM, Mac Aleese KR, & Newland MC (2003). Punishment in human choice: Direct or competitive suppression? *Journal of the Experimental Analysis of Behavior*, 80, 1–27. 10.1901/jeab.2003.80-1 [PubMed: 13677606]
- Crosbie J (1998). Negative reinforcement and punishment In Lattal KA & Perone M (Eds.), *Handbook of Research Methods in Human Operant Behavior* (p. 163–189). New York: Plenum Press.
- Davidson RS (1970). Conditioned punishment and conditioned negative reinforcement on a multiple schedule. *Psychonomic Science*, 20, 163–165. 10.3758/BF03335652
- de Villers P (1980). Toward a quantitative theory of punishment. *Journal of the Experimental Analysis of Behavior*, 33, 15–25. 10.1901/jeab.1980.33-15 [PubMed: 16812158]
- Delprato DJ (1995). Beyond Murray Sidman's Coercion and its fallout. *Psychological Records*, 45, 339–347. 10.1007/BF03395146
- Delprato DJ (2002). Countercontrol in behavior analysis. *The Behavior Analyst*, 25(2), 191–200. 10.1007/BF03392057 [PubMed: 22478386]
- Deluty MZ (1976). Choice and the rate of punishment in concurrent schedules. *Journal of the Experimental Analysis of Behavior*, 25, 75–80. 10.1901/jeab.1976.25-75 [PubMed: 16811898]

- Deweese J (1977). Schedule-induced biting under fixed-interval schedules of food or electric-shock presentation. *Journal of the Experimental Analysis of Behavior*, 27(3), 419–431. 10.1901/jeab.1977.27-419 [PubMed: 16812004]
- Dinsmoor JA (1954). Punishment I: The avoidance hypothesis. *Psychological Review*, 61, 34–46. 10.1037/h0062725 [PubMed: 13134415]
- Dinsmoor JA (1955). Punishment II: An interpretation of empirical findings. *Psychological Review*, 62, 96–105. 10.1037/h0041258 [PubMed: 14357531]
- Dinsmoor JA (1977). Escape, avoidance, punishment: Where do we stand? *Journal of the Experimental Analysis of Behavior*, 28, 83–95. 10.1901/jeab.1977.28-83 [PubMed: 16812016]
- Dinsmoor JA (2001). Stimuli inevitably generated by behavior that avoids electric shock are inherently reinforcing. *Journal of the Experimental Analysis of Behavior*, 75(3), 311–333. 10.1901/jeab.2001.75-311 [PubMed: 11453621]
- Donaldson JM, & Vollmer TR (2011). An evaluation and comparison of time-out procedures with and without release contingencies. *Journal of Applied Behavior Analysis*, 44(4), 693–705. 10.1901/jaba.2011.44-693 [PubMed: 22219523]
- Dorsey MF, Iwata BA, Ong P, & McSweeney TE (1980). Treatment of self-injurious behavior using a water mist: initial response suppression and generalization. *Journal of Applied Behavior Analysis*, 13(2), 343–353. 10.1901/jaba.1980.13-343 [PubMed: 7380756]
- Dunham PJ (1971). Punishment: Method and theory. *Psychological Review*, 78, 58–70. 10.1037/h0030304
- Eisenstein EM, Eisenstein D, & Smith JC (2001). The evolutionary significance of habituation and sensitization across phylogeny: A behavioral homeostasis model. *Integrative Physiological & Behavioral Science*, 36, 251–265. 10.1007/BF02688794
- Estes WK (1944). An experimental study of punishment. *Psychological Monographs*, 57, 1–40. 10.1037/h0093550
- Estes WK & Skinner BF (1941). Some quantitative properties of anxiety. *Journal of Experimental Psychology*, 29(5), 390–400. 10.1037/h0062283
- Everett G, Hupp S, & Olmi D (2010). Time-out with Parents: A Descriptive Analysis of 30 Years of Research. *Education and Treatment of Children*, 33(2), 235–259.
- Farley J (1980). Reinforcement and punishment effects in concurrent schedules: A test of two models. *Journal of the Experimental Analysis of Behavior*, 33, 311–315. 10.1901/jeab.1980.33-311 [PubMed: 16812169]
- Farley J, & Fantino E (1978). The symmetrical law of effect and the matching relation in choice behavior. *Journal of the Experimental Analysis of Behavior*, 29, 37–60. 10.1901/jeab.1978.29-37 [PubMed: 16812038]
- Firestone P (1976). The effects and side effects of timeout on an aggressive nursery school child. *Journal of Behavior Therapy and Experimental Psychiatry*, 6, 79–81. 10.1016/0005-7916(76)90050-1
- Flory R (1969). Attack behavior as a function of minimum inter-food interval. *Journal of the Experimental Analysis of Behavior*, 12(5), 825–828. 10.1901/jeab.1969.12-825 [PubMed: 16811405]
- Gallistel CR (2005). Deconstructing the law of effect. *Games and Economic Behavior*, 52, 410–423. 10.1016/j.geb.2004.06.012
- Gallistel CR, Mark TA, King AP, & Latham PE (2001). The rat approximates an ideal detector of changes in rates of reward: implications for the law of effect. *Journal of Experimental Psychology. Animal behavior processes*, 27(4), 354–372. 10.1037/0097-7403.27.4.354 [PubMed: 11676086]
- Gentry WD (1968). Fixed-ratio schedule-induced aggression. *Journal of the Experimental Analysis of Behavior*, 11(6), 813–817. 10.1901/jeab.1968.11-813 [PubMed: 5750925]
- Hagopian LP, Fisher WW, Sullivan MT, Acquisto J, & LeBlanc LA (1998). Effectiveness of functional communication training with and without extinction and punishment: a summary of 21 inpatient cases. *Journal of Applied Behavior Analysis*, 31(2), 211–235. 10.1901/jaba.1998.31-211 [PubMed: 9652101]

- Hanley GP, Piazza CC, Fisher WW, & Maglieri KA (2005). On the effectiveness of and preference for punishment and extinction components of function-based interventions. *Journal of Applied Behavior Analysis*, 38(1), 51–65. 10.1901/jaba.2005.6-04 [PubMed: 15898474]
- Hake DF, & Azrin NH (1965). Conditioned punishment. *Journal of the Experimental Analysis of Behavior*, 8(5), 279–293. 10.1901/jeab.1965.8-279 [PubMed: 14342363]
- Hake DF, Azrin NH, & Oxford R (1967). The effects of punishment intensity on squirrel monkeys. *Journal of the Experimental Analysis of Behavior*, 10, 95–107. 10.1901/jeab.1967.10-95 [PubMed: 16811311]
- Harris KR (1985). Definitional, parametric, and procedural considerations in timeout interventions and research. *Exceptional Children*, 51(4), 279–288. [PubMed: 3882433]
- Herrnstein RJ (1961). Relative and absolute strength of response as a function of frequency of reinforcement. *Journal of the Experimental Analysis of Behavior*, 4(3), 267–272. 10.1901/jeab.1961.4-267 [PubMed: 13713775]
- Herrnstein RJ (1970). On the law of effect. *Journal of the Experimental Analysis of Behavior*, 13, 243–266. 10.1901/jeab.1970.13-243 [PubMed: 16811440]
- Hineline PN (1984). Aversive control: A separate domain? *Journal of the Experimental Analysis of Behavior*, 42(3), 495–509. 10.1901/jeab.1984.42-495 [PubMed: 16812404]
- Hineline PN, & Rosales-Ruiz J (2013). Behavior in relation to aversive events: Punishment and negative reinforcement In Madden GJ, Dube WV, Hackenberg TD, Hanley GP, & Lattal KA (Eds.), *APA Handbooks in Psychology®: APA Handbook of Behavior Analysis*, Vol. 1. *Methods and Principles* (p. 483–512). Washington, DC: American Psychological Association.
- Hoffman HS, & Fleshler M (1961). Stimulus factors in aversive controls: the generalization of conditioned suppression. *Journal of the Experimental Analysis of Behavior*, 4(4), 371–378. 10.1901/jeab.1961.4-371 [PubMed: 13908107]
- Hoffman HS, & Fleshler M (1965). Stimulus aspects of aversive controls: the effects of response contingent shock. *Journal of the Experimental Analysis of Behavior*, 8(2), 89–96. 10.1901/jeab.1965.8-89 [PubMed: 14269567]
- Holth P (2005). Two definitions of punishment. *The Behavior Analyst Today*, 6, 43–47. 10.1037/h0100049
- Holth P (2010). A Research Pioneer's Wisdom: An Interview with Dr. Murray Sidman. *European Journal of Behavior Analysis*, 11(2), 181–198. 10.1080/15021149.2010.11434342
- Holth P, & Moore J (2010). Preface to special section: Murray Sidman's "Remarks". *Behavior and Philosophy*, 38, 113–115. 10.2307/41806292
- Holz WC, Azrin NH, & Ayllon T (1963). Elimination of behavior of mental patients by response-produced extinction. *Journal of the Experimental Analysis of Behavior*, 6(3), 407–412. 10.1901/jeab.1963.6-407 [PubMed: 13961498]
- Honig WK (1966). The role of discrimination training in the generalization of punishment. *Journal of the Experimental Analysis of Behavior*, 9(4), 377–384. 10.1901/jeab.1966.9-377 [PubMed: 5961506]
- Honig WK, & Slivka RM (1964). Stimulus generalization of the effects of punishment. *Journal of the Experimental Analysis of Behavior*, 7(1), 21–25. 10.1901/jeab.1964.7-21 [PubMed: 14120134]
- Horner RH (2002). On the status of knowledge for using punishment a commentary. *Journal of the Experimental Analysis of Behavior*, 35(4), 465–467. 10.1901/jaba.2002.35-465
- Hunt HF, & Brady JV (1955). Some effects of punishment and intercurrent anxiety on a simple operant. *Journal of Comparative and Physiological Psychology*, 48(4), 305–310. 10.1037/h0042529 [PubMed: 13252162]
- Hutchinson RR, Ulrich RE, & Azrin NH (1965). Effects of age and related factors on the pain-aggression reaction. *Journal of Comparative and Physiological Psychology*, 59(3), 365–369. 10.1037/h0022046 [PubMed: 14313775]
- Hutchinson RR, Azrin NH, & Hunt GM (1968). Attack produced by intermittent reinforcement of a concurrent operant response. *Journal of the Experimental Analysis of Behavior*, 11(4), 489–495. 10.1901/jeab.1968.11-489 [PubMed: 4970464]

- Hutchinson RR, Renfrew JW, & Young GA (1971). Effects of long-term shock and associated stimuli on aggressive and manual responses. *Journal of the Experimental Analysis of Behavior*, 15(2), 141–166. 10.1901/jeab.1971.15-141 [PubMed: 16811496]
- Johnson C, Iversen I, Kenyon P, Holth P, & de Souza DG (2020). Murray Sidman: A life of giving. *Journal of Applied Behavior Analysis*, 53(3), 1290–1298. 10.1002/jaba.718 [PubMed: 32399994]
- Johnston JM (1972). Punishment of human behavior. *American Psychologist*, 27(11), 1033–1054. 10.1037/h0033887
- Johnston JM (1991). What can behavior analysis learn from the aversives controversy? *The Behavior Analyst*, 14(2), 187–196. 10.1007/BF03392569 [PubMed: 22478098]
- Killeen PR (1988). The reflex reserve. *Journal of the Experimental Analysis of Behavior*, 50(2), 319–331. 10.1901/jeab.1988.50-319 [PubMed: 16812564]
- Klapes B, Riley S, & McDowell JJ (2018). Toward a contemporary quantitative model of punishment. *Journal of the Experimental Analysis of Behavior*, 109, 336–348. 10.1002/jeab.317 [PubMed: 29509286]
- Leitenberg H (1965a). Response initiation and response termination: analysis of effects punishment and escape contingencies. *Psychological Reports*, 16, 569–575. 10.2466/pr0.1965.16.2.569 [PubMed: 14285873]
- Leitenberg H (1965b). Is time-out from positive reinforcement an aversive event? A review of the experimental evidence. *Psychological Bulletin*, 64, 428–441. 10.1037/h0022657 [PubMed: 5323024]
- Leitenberg H (1967). Punishment training with and without an escape contingency. *Journal of Experimental Psychology*, 74(3), 393–399. 10.1037/h0024728 [PubMed: 6052618]
- Lerman DC, Kelley ME, Vorndran CM, & Van Camp CM (2003). Collateral effects of response blocking during the treatment of stereotypic behavior. *Journal of Applied Behavior Analysis*, 36(1), 119–123. 10.1901/jaba.2003.36-119 [PubMed: 12723875]
- Lerman DC, & Vorndran CM (2002). On the status of knowledge for using punishment implications for treating behavior disorders. *Journal of Applied Behavior Analysis*, 35, 431–464. 10.1901/jaba.2002.35-431 [PubMed: 12555918]
- Lovaas OI, & Simmons JQ (1969). Manipulation of self-destruction in three retarded children. *Journal of Applied Behavior Analysis*, 2(3), 143–157. 10.1901/jaba.1969.2-143 [PubMed: 16795215]
- Lydon S, Healy O, Morán L, & Foody C (2015). A quantitative examination of punishment research. *Research in Developmental Disabilities*, 36C, 470–484. 10.1016/j.ridd.2014.10.036 [PubMed: 25462507]
- Mace FC (1994). Basic research needed for stimulating the development of behavioral technologies. *Journal of the Experimental Analysis of Behavior*, 61(3), 529–550. 10.1901/jeab.1994.61-529 [PubMed: 16812734]
- MacDonough TS, & Forehand R (1973). Response-contingent time out: Important parameters in behavior modification with children. *Journal of Behavior Therapy and Experimental Psychiatry*, 4, 231–236. 10.1016/0005-7916(73)90079-7
- Magoon MA, & Critchfield TS (2008). Concurrent schedules of positive and negative reinforcement: differential-impact and differential-outcomes hypotheses. *Journal of the Experimental Analysis of Behavior*, 90(1), 1–22. 10.1901/jeab.2008.90-1 [PubMed: 18683609]
- Mallpress DE, Fawcett TW, McNamara JM, & Houston AI (2012). Comparing pleasure and pain: the fundamental mathematical equivalence of reward gain and shock reduction under variable interval schedules. *Journal of the Experimental Analysis of Behavior*, 98(3), 355–367. 10.1901/jeab.2012.98-355 [PubMed: 23144510]
- Matson JL, & Taras ME (1989). A 20 year review of punishment and alternative methods to treat problem behaviors in developmentally delayed persons. *Research in Developmental Disabilities*, 10(1), 85–104. 10.1016/0891-4222(89)90031-0 [PubMed: 2648505]
- Mayhew GL, & Harris FC (1978). Some negative side effects of a punishment procedure for stereotyped behavior. *Journal of Behavior Therapy and Experimental Psychiatry*, 9(3), 245–251. 10.1016/0005-7916(78)90036-8
- McIlvane WJ (2011). Comments on Sidman's Remarks Series. *European Journal of Behavior Analysis*, 12(1), 339–341. 10.1080/15021149.2011.11434384

- McMillan DE (1967). A comparison of the punishing effects of response-produced shock and response-produced time out. *Journal of the Experimental Analysis of Behavior*, 10, 439–449. 10.1901/jeab.1967.10-439 [PubMed: 4963564]
- McSweeney FK, Hinson JM, & Cannon CB (1996). Sensitization–habituation may occur during operant conditioning. *Psychological Bulletin*, 120(2), 256–271. 10.1037/0033-2909.120.2.256
- McSweeney FK, & Murphy ES (2009). Sensitization and habituation regulate reinforcer effectiveness. *Neurobiology of Learning and Memory*, 92(2), 189–198. 10.1016/j.nlm.2008.07.002 [PubMed: 18674628]
- McSweeney FK, & Roll JM (1998). Do animals satiate or habituate to repeatedly presented reinforcers? *Psychonomic Bulletin & Review*, 5, 428–442. 10.3758/BF03208818
- McSweeney F, & Swindell S (2002). Common processes may contribute to extinction and habituation. *Journal of General Psychology*, 129(4), 364–400. 10.1080/00221300209602103
- Millenson JR & MacMillan ASC (1975). Abortive responding during punishment of bar holding. *Learning and Motivation*, 6, 279–288. 10.1016/0023-9690(75)90028-4
- Miller LK (1991). Avoiding the countercontrol of applied behavior analysis. *Journal of Applied Behavior Analysis*, 24(4), 645–647. 10.1901/jaba.1991.24-645 [PubMed: 16795762]
- Myer JS, & Baenninger R (1966). Some effects of punishment and stress on mouse killing by rats. *Journal of Comparative and Physiological Psychology*, 62(2), 292–297. 10.1037/h0023690 [PubMed: 6008014]
- Nelson CM, & Rutherford RB (1983). Timeout revisited: guidelines for its use in special education. *Exceptional Education Quarterly*, 3(4), 56–67. 10.1177/074193258300300412
- Orme-Johnson DW, & Yarczower M (1974). Conditioned suppression, punishment, and aversion. *Journal of the Experimental Analysis of Behavior*, 21(1), 57–74. 10.1901/jeab.1974.21-57 [PubMed: 16811734]
- Ornelas MA (2018). Evaluation of an experimental procedure to evoke countercontrol. [Master’s thesis, California State University, Fresno]. Fresno State Digital Repository.
- Perone M (2003). Negative effects of positive reinforcement. *The Behavior Analyst*, 26(1), 1–14. 10.1007/BF03392064 [PubMed: 22478391]
- Quetsch L, Wallace N, Herschell A, & McNeil C (2015). Weighing in on the time-out controversy: An empirical perspective. *Clinical Psychologist*, 68, 4–19.
- Rachlin H (1966). Recovery of responses during mild punishment. *Journal of the Experimental Analysis of Behavior*, 9, 251–263. 10.1901/jeab.1966.9-251 [PubMed: 16811293]
- Rachlin H, & Herrnstein RJ (1969). Hedonism revisited: On the negative law of effect In: Campbell BA & Church RM (Eds.), *Punishment and Aversive Behavior* (pp. 83–109). New York: Appleton-Century-Crofts.
- Rankin CH, Abrams T, Barry RJ, Bhatnagar S, Clayton DF, Colombo J, Coppola G, Geyer MA, Glanzman DL, Marsland S, McSweeney FK, Wilson DA, Wu CF, & Thompson RF (2009). Habituation revisited: an updated and revised description of the behavioral characteristics of habituation. *Neurobiology of Learning and Memory*, 92(2), 135–138. 10.1016/j.nlm.2008.09.012 [PubMed: 18854219]
- Rasmussen EB, & Newland MC (2008). Asymmetry of reinforcement and punishment in human choice. *Journal of the Experimental Analysis of Behavior*, 89, 157–167. 10.1901/jeab.2008.89-157 [PubMed: 18422016]
- Reynolds GS, Catania AC, & Skinner BF (1963). Conditioned and unconditioned aggression in pigeons. *Journal of the Experimental Analysis of Behavior*, 6(1), 73–74. 10.1901/jeab.1963.6-73 [PubMed: 13986427]
- Richards RW, & Rilling M (1972). Aversive aspects of a fixed-interval schedule of food reinforcement. *Journal of the Experimental Analysis of Behavior*, 17(3), 405–411. 10.1901/jeab.1972.17-405 [PubMed: 16811597]
- Riley AR, Wagner DV, Tudor ME, Zuckerman KE, & Freeman KA (2017). A survey of parents’ perceptions and use of time-out compared to empirical evidence. *Academic Pediatrics*, 17, 168–175. 10.1016/j.acap.2016.08.004 [PubMed: 27856291]

- Risley TR (1968). The effects and side effects of punishing the autistic behaviors of a deviant child. *Journal of Applied Behavior Analysis*, 1(1), 21–34. 10.1901/jaba.1968.1-21 [PubMed: 16795157]
- Sachs DA (1973). The efficacy of time-out procedures in a variety of behavior problems. *Journal of Behavior Therapy and Experimental Psychiatry*, 4(3), 237–242. 10.1016/0005-7916(73)90080-3
- Seay MB, Suppa RJ, Schoen SF, & Roberts SR (1984). Countercontrol: An Issue in Intervention. *Remedial and Special Education*, 5(1), 38–45. 10.1177/074193258400500108
- Schuster R, & Rachlin H (1968). Indifference between punishment and free shock: Evidence for the negative law of effect. *Journal of the Experimental Analysis of Behavior*, 11, 777–786. 10.1901/jeab.1968.11-777 [PubMed: 16811322]
- Shahan TA (2017). Moving beyond reinforcement and response strength. *The Behavior Analyst*, 40(1), 107–121. 10.1007/s40614-017-0092-y [PubMed: 31976956]
- Sidman M (1953a). Avoidance conditioning with brief shock and no exteroceptive warning signal. *Science*, 118(3058), 157–158. 10.1126/science.118.3058.157 [PubMed: 13076224]
- Sidman M (1953b). Two temporal parameters of the maintenance of avoidance behavior by the white rat. *Journal of Comparative and Physiological Psychology*, 46(4), 253–261. 10.1037/h0060730 [PubMed: 13096610]
- Sidman M (1966). Avoidance behavior In Honig WK (Ed.), *Operant behavior: Areas of research and application* (pp. 448–498). New York: Appleton-Century-Crofts.
- Sidman M (1989). Avoidance at Columbia. *The Behavior Analyst*, 12(2), 191–195. 10.1007/BF03392496 [PubMed: 22478032]
- Sidman M (1993). Reflections on behavior analysis and coercion. *Behavior and Social Issues*, 3(1–2), 75–85. 10.5210/bsi.v3i1.199
- Sidman M (2000). *Coercion and its fallout*. Boston: Authors Cooperative (Original work published 1989)
- Sidman M (2006). The distinction between positive and negative reinforcement: some additional considerations. *The Behavior Analyst*, 29(1), 135–139. 10.1007/BF03392126 [PubMed: 22478460]
- Sidman M (2011). Can an understanding of basic research facilitate the effectiveness of practitioners? Reflections and personal perspectives. *Journal of Applied Behavior Analysis*, 44(4), 973–991. 10.1901/jaba.2011.44-973 [PubMed: 22219551]
- Skinner BF (1938). *The behavior of organisms*. New York: Appleton-Century-Crofts.
- Skinner BF (1953). *Science and human behavior*. New York/London: Free Press/Collier MacMillan.
- Skinner BF (1971). *Beyond freedom and dignity*. New York: Knopf.
- Skinner BF (1974). *About behaviorism*. New York: Knopf
- Smith DE (1981). Is isolation room time-out a punisher? *Behavioral Disorders*, 6(4), 247–256. 10.1177/019874298100600407
- Solnick JV, Rincover A, & Peterson CR (1977). Some determinants of the reinforcing and punishing effects of timeout. *Journal of Applied Behavior Analysis*, 10, 415–424. 10.1901/jaba.1977.10-415 [PubMed: 144719]
- Solomon RL (1964). Punishment. *American Psychologist*, 19, 239–253. 10.1037/h0042493
- Spradlin JE (2002). Punishment: A primary process? *Journal of Applied Behavior Analysis*, 35, 475–477. 10.1901/jaba.2002.35-475 [PubMed: 12555921]
- Staddon JER (1993). The conventional wisdom of behavior analysis. *Journal of the Experimental Analysis of Behavior*, 60, 439–447. 10.1901/jeab.1993.60-439 [PubMed: 16812706]
- Storms LH, Boroczi G, & Broen WE Jr. (1962). Punishment inhibits an instrumental response in hooded rats. *Science*, 135(3509), 1133–1134. 10.1126/science.135.3509.1133 [PubMed: 13917529]
- Storms LH, Boroczi G, & Broen WE (1963). Effects of punishment as a function of strain of rat and duration of shock. *Journal of Comparative and Physiological Psychology*, 56, 1022–1026. 10.1037/h0043165 [PubMed: 14100939]
- Thompson RF (2009). Habituation: a history. *Neurobiology of Learning and Memory*, 92(2), 127–134. 10.1016/j.nlm.2008.07.011 [PubMed: 18703156]

- Thompson RH, & Iwata BA (2005). A review of reinforcement control procedures. *Journal of the Experimental Analysis of Behavior*, 38(2), 257–278. 10.1901/jaba.2005.176-03
- Thompson RH, Iwata BA, Conners J, & Roscoe EM (1999). Effects of reinforcement for alternative behavior during punishment of self-injury. *Journal of Applied Behavior Analysis*, 32, 317–328. 10.1901/jaba.1999.32-317 [PubMed: 10513027]
- Thompson RF, & Spencer WA (1966). Habituation: A model phenomenon for the study of neuronal substrates of behavior. *Psychological Review*, 73(1), 16–43. 10.1037/h0022681 [PubMed: 5324565]
- Thorndike EL (1932). Reward and punishment in animal learning. *Comparative Psychology Monographs*, 8, 4, 65.
- Timberlake W (1988). The behavior of organisms: Purposive behavior as a type of reflex. *Journal of the Experimental Analysis of Behavior*, 50(2), 305–317. 10.1901/jeab.1988.50-305 [PubMed: 3057104]
- Todorov JC (2001). Quem tem medo de punição? *Revista Brasileira de Terapia Comportamental e Cognitiva*, 3(1), 37–40. 10.31505/rbtcc.v3i1.304
- Todorov JC (2011). Quem tem medo de controle aversivo? *Acta Comportamentalia*, 19(4), 5–7.
- Ulrich RE (1966). Pain as a cause of aggression. *American Zoologist*, 6, 643–662. 10.1093/icb/6.4.643 [PubMed: 6009829]
- Ulrich RE, & Azrin NH (1962). Reflexive fighting in response to aversive stimulation. *Journal of the Experimental Analysis of Behavior*, 5(4), 511–520. 10.1901/jeab.1962.5-511 [PubMed: 13995319]
- Ulrich RE, Wolff PC, & Azrin NH (1964). Shock as an elicitor of intra- and inter-species fighting behavior. *Animal Behaviour*, 12(1), 14–15. 10.1016/0003-3472(64)90095-8
- Ulrich R, Wolfe M, & Dulaney S (1969). Punishment of shock-induced aggression. *Journal of the Experimental Analysis of Behavior*, 12(6), 1009–1015. 10.1901/jeab.1969.12-1009 [PubMed: 4982672]
- van Oorsouw WM, Israel ML, von Heyn RE, & Duker PC (2008). Side effects of contingent shock treatment. *Research in Developmental Disabilities*, 29(6), 513–523. 10.1016/j.ridd.2007.08.005 [PubMed: 17945467]
- Vollmer TR (2002). Punishment happens: some comments on Lerman and Vorndran's review. *Journal of Applied Behavior Analysis*, 35(4), 469–473. 10.1901/jaba.2002.35-469 [PubMed: 12555920]
- Weisman RG (1975). Stimulus control by response-dependent shock in discriminated punishment. *Bulletin of the Psychonomic Society*, 5, 427–428. 10.3758/BF03333289
- Wilson DR, & Lyman RD (1983). Time-out in the treatment of childhood behavior problems: Implementation and research issues. *Child & Family Behavior Therapy*, 4(1), 5–20. 10.1300/J019v04n01_02
- Wolf M, Risley T, Johnston M, Harris F, & Allen E (1967). Application of operant conditioning procedures to the behavior problems of an autistic child: A follow-up and extension. *Behaviour Research and Therapy*, 5(2), 103–111. 10.1016/0005-7967(67)90004-6 [PubMed: 6025711]