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What is an Extinction Burst?

Kristal Huffman
kristalhuffman5@gmail.com

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Kristal Huffman

Rollins College

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Abstract

This paper will explore the effects of extinction, specifically the extinction burst. Extinction is known to be an effective and necessary process in decreasing specific behaviors (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990). During this process, side effects might occur and the extinction burst is one of those side effects. Extinction bursts might be a problematic side effect, especially during treatment of severe behavior. This paper will explore the extinction burst in detail as well as how the term is used in both the basic and applied literature. Next, an investigation of the extinction burst as a technical term and multiple definitions of the extinction burst will be evaluated. Last an evaluation of an adjusted definition for extinction burst will be considered.

Keywords: Extinction, extinction burst

Introduction

Extinction involves the termination of a contingency and the elimination of the functional reinforcer, ultimately resulting in the reduction of a behavior (Cooper, Heron, & Heward, 2007). Skinner was one of the earliest investigators of extinction (e.g., Skinner, 1938). Following Skinner's initial investigations, basic researchers continued to investigate extinction, creating a solid foundation of literature describing the extinction process and extinction-related effects. Years later, as the understanding of extinction developed, applied researchers began to employ extinction as a treatment for problem behavior in children. Extinction has been demonstrated to be effective in decreasing a variety of different behaviors including, but not limited to, aggression (e.g., Lerman, Iwata, & Wallace, 1999), self-injurious behavior (SIB; e.g., Goh & Iwata, 1994; Iwata et al., 1990), and property destruction (e.g., Bowman, Fisher, Thompson, & Piazza, 1997). Furthermore, research has demonstrated that in some cases, extinction is a necessary component to achieve abolishment of a behavior (e.g., Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc 1998; Saini, Fisher, & Pisman, 2017).

Extinction is an effective treatment because its primary effect is the elimination of a target response (Iwata et al., 1990; Pace, Iwata, Cowdery, Andree, & McIntyre. 1993; Anderson & Long, 2002). However, achieving this ultimate outcome might evoke side effects along the way. One frequently discussed side effect of extinction is the so-called "extinction burst" in which a temporary increase in responding (i.e., "burst") is observed at the onset of extinction (Cooper et al., 2007). Extinction bursts may be problematic in treatment contexts because this effect may prolong the extinction process, as therapists "work through a burst." Another concern might be the safety risks posed to the individual and others if target behavior exhibiting a burst is severe. Furthermore, if therapists or caregivers are unable to continue extinction due to a burst,

more restrictive treatment components may be added (e.g., punishment in the form of restraint), or treatment might be abandoned altogether.

Unfortunately, despite the importance of this effect and the extensive basic research literature investigating extinction as a behavioral process, few systematic data on the extinction burst exist (Lattal, St. Peter, & Escobar, 2013). A few studies within the applied literature have investigated the prevalence of extinction bursts (Lerman & Iwata., 1995; Lerman et al., 1999), and potential methods of mitigating bursts (e.g., Zarcone et al., 1993). However, this invites the question of why there is a discrepancy between the basic and applied literature on this topic, if a such a discrepancy exists. This paper will start by exploring extinction in general, and the extinction burst in particular, across the basic and applied literature. Next, research-examining factors that affect extinction bursts will be discussed. Subsequently, there will be a consideration of the extinction burst as a technical term. In this section, definitions of the extinction burst will be critically examined. Finally, discussed revised definition of the extinction burst will be proposed.

Literature Review

Defining Extinction

Cooper et al. (2007) stated extinction is the most-misused term in ABA. As defined in the text, the term refers to “when reinforcement of a previously reinforced behavior is discontinued” (p. 457). As a result of this procedure, the targeted behavior decreases in the future. One misuse of the term stated by Cooper et al. is using extinction to refer to any decrease in behavior. The authors explain that extinction might be referred to when any behavior decreases, regardless of the procedures used (e.g., time-out or physical restraints). Assuming any decrease in behavior is due to extinction might hinder the individual’s treatment plan and disregard any other

environmental phenomena occurring at the time (e.g., outside reinforcement, medications, environmental changes).

A second misuse of this term occurs when individuals confuse forgetting and extinction. Forgetting involves target behaviors being weakened by the passage of time. During this period the person does not have the chance to emit the specific behavior. In comparison to extinction, withholding reinforcement weakens the target behavior. This might impact the results of treatment due to the inability to effectively abolish the behavior.

A third misuse of this term occurs when individuals confuse response blocking and sensory extinction. Response blocking consists of blocking the individual from engaging in the target behavior. The difference between response blocking and extinction is that during extinction, the individual typically is allowed to engage in the behavior but this specific behavior will not contact reinforcement. During response blocking, the behavior is blocked from occurring at all. By confusing response blocking for extinction, the abolishing effects of extinction might not appear, ultimately misrepresenting the results.

A final misuse of the term occurs when individuals confuse non-contingent reinforcement (NCR) and extinction. NCR and extinction are both procedures used to eliminate target behavior, however, these processes operate differently. The difference between NCR and extinction is NCR diminishes behavior by changing the motivating operation (i.e., via an abolishing operation [AO]) and extinction diminishes behavior by changing the consequences for the response. Confusing these procedures with extinction might impact the implementation of extinction and might provide researchers and practitioners with inaccurate results.

Types of extinction. There are three forms of extinction procedures that are implemented based on the consequence previously maintaining the behavior. One form of procedural

extinction is extinction of behavior maintained by positive reinforcement. This form of extinction occurs when a response no longer produces the positive reinforcer (e.g., attention, access to tangible items) that previously maintained the behavior (Cooper et al., 2007). For example, planned ignoring is the extinction procedure implemented when an individual's behavior is maintained by attention. Planned ignoring consists of not responding to an individual while they are engaging in the targeted (i.e., inappropriate) behavior. For example, Williams (1959) assessed the termination of a maintaining reinforcer by placing the problem behavior on extinction. The subject of the study was a child who engaged in tantrums (i.e., screaming, crying) maintained by parental attention during bedtime. During this extinction procedure, the parents placed the child in bed and left the room. When the child began to scream, the parents did not return to the room as they did in the past. Thus, planned ignoring was implemented and the tantrum was not reinforced. After implementing extinction, the child's tantrums slowly decreased and ultimately were eliminated.

The second form of extinction is the extinction of behavior maintained by negative reinforcement, in which the response ceases to produce termination of an aversive stimulus (Cooper et al., 2007), also known as "escape extinction." This procedure is implemented by not allowing the individual to escape aversive stimuli. Thus, the individual contacts the extinction contingency (i.e., that the response will no longer produce negative reinforcement). One procedure associated with this form of extinction is reissuing instructions (e.g., "broken record prompting"). Anderson and Long (2002) described an experiment involving multiple topographies of problem behavior (i.e., aggression, self injurious behavior [SIB], and disruptions) that were placed on extinction during task situations (e.g., matching to sample, receptive language, and independent work). The authors used escape extinction, which consisted

of repeatedly prompting the subject to complete the presented task, even if problem behavior occurred. This procedure produced significant decreases in problem behavior when tasks were presented.

A third form of extinction is the extinction of behavior maintained by automatic reinforcement, which consists of the removal of sensory consequences presumed to maintain the automatically reinforced behavior, or “sensory extinction” (Cooper et al., 2007). Such sensory consequences could consist of stimuli (produced without social mediation) that smell, taste, look, sound, and feel good, as well as situations in which the movement itself feels good (Rincover, 1981). Accordingly, because presumed consequences for automatically reinforced behaviors are diverse, the procedures for sensory extinction are as well. For example, sensory extinction for hand mouthing might involve placing mittens on the subject (Mazaleski, Iwata, Rodgers, Vollmer, and Zarcone, 1994), whereas sensory extinction for head hitting might involve placing a helmet on the subject (Kuhn, DeLeon, Fisher, and Wilke, 1999). Deaver, Miltenberger, and Sticker (2001) used sensory extinction as an intervention to decrease hair twirling in a toddler. The authors removed the presumed sensory consequence by placing mittens on the child’s hands. Placing the mittens blocked the child from twirling their hair and ultimately extinguished the behavior, presumably because the behavior no longer contacted the sensory-reinforcing contingencies.

Effects of Extinction

As previously discussed, the terminal effect of extinction is the elimination of responding, and thus extinction is an effective procedure for decreasing problem behavior. However, extinction has also been shown to evoke several alternative effects (a.k.a. “side

effects”), including extinction-induced variability, extinction-induced aggression, and extinction bursts.

Extinction-induced variability. One generative side-effect of extinction described in the literature is extinction-induced variability (Lattal et al., 2013). Morgan and Lee (1996) examined response variability using extinction and differential reinforcement of low rates of responding (DRL). The authors compared results of two experiments evaluating the effects of reinforcing undergraduate students for engaging in key pressing sequences on a computer keyboard. A DRL schedule was used to reinforce keying in the correct sequence rather than emitting multiple guess responses. Following the DRL condition, the authors placed the response on extinction (i.e., the participant did not earn any points for keying in the correct sequence). During this phase, most of the participants engaged in variable key-typing responses. These results demonstrated greater response variability when extinction was implemented, relative to DRL.

It is worth noting that although the term “side effect” might have a negative connotation, side effects of extinction are not necessarily bad. For example, Neuringer (2002) discussed the positive effects of extinction-induced variability. First, extinction-induced variability could induce learning by allowing the individual to emit multiple responses in different situations. Second, behavioral variability can help individuals behave more effectively when faced with a problem. Being able to emit multiple responses based on the problem presented might help the individual adapt to their environment and engage in problem solving. When discussing extinction-induced variability, Grow, Kelly, Roane, and Shillingsburg (2008) also described that “when appropriate behaviors are placed on extinction, other desirable behaviors may emerge” (p. 16-17). These authors not only examined extinction-induced variability as side effect, but also discussed how the effect might be beneficial when looking for replacement behaviors in a

treatment context.

For these reasons, extinction-induced variability has also been of interest to applied researchers. Grow et al. (2008) investigated 1) whether an appropriate response would emerge during extinction of problem behavior and 2) if the new (i.e., emergent) response would be maintained by the same consequence as problem behavior. The authors conducted a functional analysis (FA) to determine the function of problem behavior in three children with autism and then placed these behaviors on extinction. During the extinction condition, problem behavior no longer resulted in the consequences that maintained the behavior (i.e., access to toys). However, the first alternative response (i.e., “don’t” and “no”) emitted was reinforced. During baseline, problem behavior occurred at high rates. During extinction, problem behavior decreased and the alternative response increased. The results of this study demonstrate the variability in responding produced by extinction. By placing a response on extinction, the experimenters were able to assess a functionally alternative response as well as reinforce a more appropriate response. Thus, Grow et al. used the variability in responses that occurred during extinction to facilitate reinforcement of an alternative response.

Extinction-induced aggression. A second side effect that might accompany extinction is extinction-induced aggression. Azrin, Hutchinson, and Hake (1966) observed a sudden increase in aggression when implementing repeated cycles of extinction and reinforcement. After teaching pigeons to peck a response key for food, the authors placed key-pecking behavior on extinction. During the extinction phase, the pigeons engaged in increased aggression towards nearby (restrained) pigeons. It is possible this effect is related to extinction-induced variability (see previous section). Extinction-induced aggression might be considered a form of extinction-induced variability in which the responding evoked is “aggressive” in topography. Labeling this

newly emerging behavior as extinction-induced aggression or extinction-induced variability may depend on the experimenter's definition of aggression.

Extinction-induced aggression effects have been observed in human subjects as well. Kelly and Hake (1970) examined extinction-induced aggression in nine human subjects. Each subject was given the choice between pushing a button and punching a cushion to terminate a tone during the experiment. The different topographies of terminating the tone (e.g., if the button was pressed lightly or punched forcefully) imitated natural aggression during the experiment. After the reinforcement phase, escape extinction was implemented. During this time, seven of the nine subjects had increased rates of punching vs. pushing the button to terminate the tone. These results suggest, even in human subjects, exposure to extinction might evoke aggression.

In their review of clinical data sets, Lerman et al. (1999) defined extinction-induced aggression as “an increase in aggression during any of the first three treatment sessions above that observed during all of the last five baseline sessions or all of baseline if it was briefer than five sessions” (p. 3). In this article, authors looked at 41 SIB treatment evaluation data sets. Of these data sets, about half (i.e., 50%) showed an extinction burst or extinction-induced aggression. Extinction bursts, which will be discussed in the next section, occurred more often than extinction-induced aggression. However, the authors noted both side effects of extinction were less likely to occur when the treatment was combined with alternative procedures (i.e., NCR, differential reinforcement, or antecedent manipulations).

Extinction bursts. In addition to previously described extinction effects, many studies have reported the so-called “extinction burst.” This effect is the primary topic of this paper and as such will be considered in more depth. Cooper et al. (2007) defined an extinction burst as “an initial increase in frequency of responding when an extinction procedure is initially

implemented” (p. 695, glossary). For example, subjects in Repp, Felce, and Barton’s (1988) study showed an increase or “burst” of responding when extinction was implemented to decrease self-injury and stereotypy across three subjects. Iwata et al. (1990) also observed extinction bursts during their experiments. The authors conducted three studies to examine correlations between the environmental stimuli present and SIB. When escape extinction was implemented, the subjects engaged in an initial increase of SIB (i.e., extinction burst), however, ultimately the researchers saw elimination of SIB all together during extinction.

Early Research Describing Extinction Bursts

In seminal investigations of extinction, Skinner (1938) discussed the “extinction curve.” Keller and Schoenfeld (1950) also noted a similar curve at the onset of extinction. The authors also observed that when a response previously received continuous reinforcement was placed on extinction, response rate temporarily increased. This effect was described by Keller and Schoenfeld as a “burst.”

A study was also conducted by Antonitis (1951) to assess effects of extinction with albino rats. Reinforcement was provided when the rats completed a response chains, consisting of leaving the feeding area, completing a specific amount of nose thrusts responses, and returning to the feeding area. Following that phase, the authors implemented extinction of the response chains. Results showed an increase in nose thrusts during the first day of extinction, which was described as a “burst.”

Ratner (1956) also looked at the effects of extinction and described an extinction burst in his experiment on dipper approaching and bar pressing in 72 male rats. Ratner implemented five phases: adaptation (water deprivation), dipper training, bar training, interpolated extinction of dipper approaching, and extinction testing. During the extinction of dipper approaching, the rats

were divided into three groups: click (a click would sound when the dipper was presented), no-click, and a control group. During extinction testing the dipper was available, however, it did not contain any water. Unsystematic responding was observed across the groups during extinction; however, an extinction burst occurred in the control group. Results also showed significant increases in bar presses, almost tripling, when extinction was implemented.

Later, Anger and Anger (1976) also observed an increase in responding when implementing extinction during a study conducted with pigeon subjects. Sequences of key pecking were reinforced, then placed on extinction. During this condition, three of the pigeons exhibited an increase in responding half way through the extinction phase, followed by a decrease in responding. The authors noted responding during the first extinction were significantly higher than the final extinctions. This might indicate a possible burst, however, the authors' graphs do not include baseline data, making it difficult to make this determination.

Though these, and several other, early investigations of extinction describe effects we might today label "extinction bursts," little research has been conducted systematically evaluating the extinction burst as a subject of study in its own right (Lattal et al., 2013). Furthermore, the above articles do not use the term "extinction burst," but rather, describe responding that appears to fit the definition of an extinction burst without using the term, specifically. Further comparison of basic and applied analysts' use of the term "extinction burst" will be considered later in the paper. However, we will now turn to the research that has investigated variables affecting the extinction burst.

Reducing Extinction Bursts

One hypothesis is that extinction bursts occur due to the sudden change in reinforcement contingencies accompanying the abrupt transition from reinforcement to extinction. If this is the

case, one way to reduce extinction bursts might be making the transition to the terminal treatment contingencies more gradual, via such techniques as instructional fading and schedule thinning.

Instructional fading consists of “fading in” (i.e., gradually increasing) a predetermined number of demands each session to increase compliance and decrease any side effects of the extinction procedure. For example, Zarcone et al. (1993) compared the therapeutic effects of instructional fading with and without extinction with three subjects who engaged in high rates of SIB. During instructional fading, SIB remained low and escape extinction was implemented contingent on SIB. Instructional fading was successful in decreasing SIB, however, the low rates of behavior did not maintain without extinction. Thus, extinction may be a necessary component to reduce behavior, and instructional fading may be necessary to reduce the extinction-burst side-effect of the procedure.

Hagopian, Toole, Long, Bowman, and Lieving (2004) compared schedule thinning and extinction. Specifically, they compared two techniques for thinning alternative reinforcement schedules (e.g., dense-to-lean and fixed lean) for subjects with severe problem behavior. The dense-to-lean schedule consisted of reinforcement being provided on dense schedules (e.g., fixed ratio [FR] 1), followed by systematic schedule thinning to leaner schedules (e.g., FR 1 and 1 min of extinction). The fixed-lean condition involved reinforcement being provided on a lean schedule (e.g., 1 min FR 1 and 9 min of extinction) from the outset of treatment. During the fixed-lean schedule, decreases in problem behavior was achieved quicker than during the dense-to-lean schedule, however, there were more brief instances of recovery during schedule thinning. Thus, though the schedule thinning procedure took longer to achieve the terminal treatment goal, the risk of extinction bursts was reduced. Thus the authors suggest that schedule thinning should

be used if minimizing the likelihood of extinction bursts is a serious concern (e.g., when problem behavior is severe).

Another technique used to decrease extinction bursts might be antecedent manipulations such as limiting exposure to the establishing operation (EO). Fisher et al. (2018) evaluated differential exposure to EO's during functional communication training (FCT) as a way to mitigate extinction bursts. The authors hypothesized that minimizing the exposure to the EO might decrease the likelihood of an extinction burst. In the limited EO condition, the functionally-reinforcing item was restricted only for the amount of time it took to provide a prompt for the communication response. During the extended EO condition, the therapist restricted the item for an extended duration, individually determined for each subject based on responding in the FA (e.g., 40 seconds). More extinction bursts occurred during the extended EO condition relative to the limited EO condition, suggesting that the level of the EO is an important factor affecting the likelihood of extinction bursts.

Defining the Extinction Burst

To examine the definition of the term “extinction burst,” a search was conducted of all studies containing the phrase “extinction burst” published in the Journal of Applied Behavior Analysis (JABA) and the Journal of the Experimental Analysis of Behavior (JEAB). The Figure depicts search results as a function of time, beginning in 1964 and ending in 2018. During this time, nine articles in JEAB and 75 articles in JABA used the term “extinction burst.” Definitions of extinction bursts that appeared in these studies are shown in Table 1. If the term appeared in the article but was not defined, or if the definition referenced a prior definition, this reference was not included in the table. Specially, across both journals, 13 out of 84 articles provided definitions for the term “extinction burst.” Many of the articles included in the review excluded a

precise definition for the effect or cited previous authors (e.g., Farmer & Schoenfeld, 1964; Lerman & Iwata, 1995).

While several definitions (i.e., 4 of 13) describe an extinction burst as an increase in response frequency or rate, the most common descriptive phrase used is simply an “increase in responding/behavior[s]” (7 out of 13 definitions), and it is unclear to which dimensions of behavior (e.g., duration, intensity, etc.) this descriptor may apply. Table 2 shows definitions of the extinction burst from behavior analysis textbooks. Because textbooks present established literature in aggregate, one might expect greater consistency with respect to how the extinction burst is defined in textbooks, relative to individual articles. Most of the definitions (i.e., 4 of 6) describe extinction bursts as an increase in frequency, duration, or magnitude of a behavior that was previously reinforced and is now not being reinforced. However, the definitions also vary in how they approach response topography, temporal locus of the burst, and measurable dimensions of responding. *Behavior Modification* (Miltenberger, 2008) and *Principles of Behavior* (Malott & Suarez, 2004), both mention the initial increase in responding as well as an emotional response that may follow the removal of reinforcement. While most of the definitions refer to response topography, temporal locus of the effect, multiple measurable dimensions of behavior, or some combination of these, definitions from two books were vague in that their definitions did not include any of these qualities.

Looking across definitions provided in both tables, differences in criteria for extinction bursts were found in three main areas: the temporal locus of the burst, the magnitude of the burst, and topography of the burst. These variations among the definitions will now be discussed.

When do extinction bursts occur? Cooper et al. (2007) defined an extinction burst as “an increase in frequency of responding when an extinction procedure is initially implemented,”

(p. 695). Later, Lerman and Iwata (1995) defined an extinction burst as “an increase in the level of responding in any of the first three treatment sessions above all of the last five sessions from the previous phase” (p. 93). The main difference between these two definitions is when the increase in responding must occur in order for it to “count” as an extinction burst. According to the definition by Cooper et al. an extinction burst could occur at any point during extinction, whereas Lerman and Iwata relegate the extinction burst to only the first three treatment sessions. Comparably, Iwata et al. (1990) defined extinction bursts as a simple “initial burst in responding.” Without consistent criteria defining the temporal locus of extinction burst relative to the onset of extinction, an increase in responding at any point during an extinction phase (e.g., 50 sessions into extinction) may be labeled as an “extinction burst.” This is potentially problematic because such vague criteria may make it difficult for experimenters to discriminate between an extinction burst and phenomena that cause behavior to return following prolonged extinction (i.e., resurgence, reinstatement, renewal, spontaneous recovery). In applied contexts, over-generalization of the term “extinction burst” might lead therapists and researchers to mistakenly attribute increased behavior to an expected extinction process, rather than other environmental variables (e.g., contextual changes in the case of renewal; ratio strain of appropriate behavior, in the case of resurgence), to the detriment of treatment.

What is the magnitude of a burst? Lerman and Iwata’s (1995) definition was also relatively stringent in that the definition includes criteria defining the size of increase in responding that must occur for the event to be labeled a “burst.” Specifically, the authors labeled the event a burst only if responding increased above the previous five baseline data points. Four of the studies noted in Table 1 (Goh & Iwata, 1994; Lerman et al., 1999; Reed et al., 2004; Podlesnik, Bai & Elliff, 2012) refer to baseline in their definitions. In single-case designs,

extinction effects, like other independent variable effects, are judged relative to the immediately preceding baseline (Cooper et al., 2007). Furthermore, the relative language of “increase” requires a comparison point (e.g., increased relative to baseline). Including specific criteria for the magnitude of extinction bursts relative to the immediately preceding baseline may help experimenters and therapists distinguish between bursts and responding that is simply resistant to extinction.

Does a burst involve changes in frequency only? As previously discussed, most definitions of the extinction burst examined by this review stated that the effect is characterized by an increase in responding. However, three of these definitions (Iwata et al., 1990; Lerman & Iwata, 1995; Lerman et al., 1999) focus on the effect with respect to changes in repeatability (i.e., response frequency or rate) do not take into account changes in other measurable dimensions of responding that may also be described as an extinction burst. Six out of the twelve publications in Table 1 included multiple measurable dimensions of responding in their definitions, including intensity, frequency, and duration. For example, Cooper et al. (2007) definition included frequency, intensity, and duration. The other six definitions simply state extinction bursts are an increase in responding, failing to elaborate on the topography of these responses.

The vague description of “increase in responding” could be potentially problematic if this lack of specificity leads to overgeneralization of the term. For example, imagine a therapist providing treatment for an individual engaging in aggression. During extinction, the client begins engaging in aggressive responses of longer duration (e.g., prolonged forceful grabbing rather than quick grabbing responses). Would this “increase in responding” count as a burst? Depending on which definition the therapist uses, the answer to this question could be yes (e.g., Cooper et al., 2007) or no (e.g., Lerman & Iwata, 1995).

Furthermore, the inclusion of multiple measurable dimensions in the definition of the extinction burst has implications for how bursts are distinguished from other extinction-related effects. Taking the prior example, imagine that the client also began engaging in novel topographies of responding (e.g., pinching, biting) during extinction that were captured by the operational definition of aggression, but had not yet been observed by the therapist. Applying a vague definition of the extinction burst might cause the therapist to label this effect a burst, when this effect was truly extinction-induced variability.

Prevalence of Extinction Bursts

While extinction bursts are often presented as a normal effect that occurs early in the course of the extinction process (e.g., Cooper et al., 2007; Lattal et al., 2013), research on the prevalence of the effect suggest more conservative estimates of prevalence. Lerman and Iwata (1995) assessed 113 sets of extinction data to determine how frequently extinction bursts occur. These data sets were found through online databases (i.e., Psychinfo, Current Contents, & Psychological abstracts), behavioral journals, and literature on treatment reviews. Each data set was included only if 1) the target response was aberrant behavior 2) treatment was effective 3) baseline data was collected 4) maintaining reinforcers were withheld during the transition into the intervention 5) data sets were displayed session-by-session and 6) differential reinforcement was included along with extinction. In this study, the authors defined an extinction burst as an increase in responding during any of the first three treatment sessions and when responding appears above the last five baseline sessions. Only 27 out of 113 data sets (24%) were characterized as exhibiting an extinction burst. The results also indicated extinction bursts were more prevalent when extinction was implemented alone (i.e., without a reinforcement component like differential reinforcement).

A few years later, Lerman et al. (1999) investigated multiple side effects of extinction (i.e., extinction-induced aggression & extinction bursts) by looking at their own data sets between 1989 and 1997. The authors collected data sets from 41 clinical cases and determined the percentage of cases in which extinction bursts occurred. Out of the 41 cases, 16 cases (39%) showed response bursting. Overall, extinction bursts were the highest in cases where behavior was maintained by social negative reinforcement.

Extinction is commonly used in basic experiments; however, there is not a comparable review to Lerman and Iwata (1995) or Lerman et al. (1999) of basic research data. However, an unpublished study by Katz and Lattal (2018) examined the prevalence of extinction bursts within a single, basic operant study. The authors defined extinction bursts as “transient increase in response rate at the onset of extinction” (though the authors’ presentation also noted similar definitional issues discussed earlier in the present review). Three pigeons were exposed to eight cycles of autoshaping (1 session), VR 20 reinforcement (5 sessions), and extinction (8 sessions). No extinction bursts effects were observed at the whole-session level of analysis. However, when the data were analyzed at the within-session level (i.e., minute-by-minute) extinction bursts were observed sporadically (1/8, 3/8, & 2/8 cycles of extinction for each of the three pigeons, respectively). This suggests the level of analysis may be an important factor in detecting the occurrence of extinction bursts, particularly in basic research settings.

Apart from this one (unpublished) study, basic researchers appear to have largely neglected the topic of extinction bursts, whereas applied researchers appear more interested in the topic. The following section will compare and contrast the treatment of the concept of the extinction burst in basic and applied settings.

Reconciling the Extinction Burst Literature

To examine the use of the term across basic and applied behavior analysis, the studies found in the search of the literature describe above were analyzed according to their respective journal. The Figure depicts the use of the term “extinction burst” search results as a function of time, beginning in 1964 and ending in 2018. As seen in the Figure, the term was rarely used in either journal before 1990. Only one article (Farmer & Schoenfeld, 1964) referenced the term “extinction burst” between the JEAB’s first issue in 1964 and 1980. To the author’s knowledge, this was the first use the term in a published article. There was an increase in the use of the term during the 1990’s that continued into the 2000’s, especially in applied research. Throughout its existence, JABA published a total of seventy-five articles referencing the term “extinction burst,” whereas JEAB published nine. This supports the observation that the term appears to have “taken off” to a greater extent within applied behavior analysis. Some suggestions for this discrepancy between basic and applied subfields will now be considered.

Procedural differences. Extinction bursts might not be observed as frequently in basic experiments as they are in applied experiments due to how basic researchers conduct their experiments. Basic researchers typically set their apparatus to a fixed duration (e.g., 1 hr) or until the subject reaches a set reinforcement criterion (e.g., 60 obtained reinforcers). During this time, researchers use operant chambers and computers to record data, which allows them to leave the experiment until the sessions is terminated. In contrast, applied researchers typically use in-vivo data collection. This might allow applied researchers to see the fluctuations (i.e., frequency, magnitude, and/or variability) in behavior throughout the conditions, making within-session changes in behavior more salient to the observer. Thus, extinction burst effects might not be as salient to basic researchers, relative to applied researchers.

Furthermore, basic researchers often aggregate data and report in whole-session data points rather than within-session data points. Katz and Lattal (2018) showed extinction burst effects occurring at the within-session level whereas the whole-session level did not show these effects. Thus, the lack of observed extinction effects may be an artifact of data analysis conventions, rather than a difference in prevalence across fields.

Underutilization of the term. Basic researchers may not use the term “extinction burst,” however, as previously discussed, many basic research studies do describe extinction-burst-like effects (e.g., Ratner, 1956; Anger & Anger, 1976). For example, multiple studies included in this review report an increase, burst, or curve in responding followed by a decrease in responding (if not complete extinction) of the response (e.g., Antonitis, 1951; Bullock, 1960; Jacquet, 1972). This invites the question of whether basic researchers are simply under-utilizing the term. While it is expected that prior to Farmer and Shoenfeld’s (1964) introduction of the phrase, basic researchers would not use this term specifically, the fact that the term had not yet been coined cannot account for the large discrepancy in recent basic and applied research (see Figure). It is possible that the term gained more weight in an applied context due to the clinical significance of bursts (e.g., danger to clients), whereas basic researchers might view the effect as a transition state. In his seminal textbook, Sidman (1960) observed that transitory phenomena are often neglected in steady-state, single-case research, and extinction bursts may be one example of this trend.

Overgeneralization of the term Another reason for the discrepancy between the applied and basic fields when referring to extinction bursts might be because applied researchers are over-applying the term. Anecdotally, individuals working in applied contexts frequently use the term “extinction burst” during their experiments and during practice. This may be a stimulus

control issue, in which applied researchers might be “over-generalizing” by imprecisely labeling alternative side effects as extinction bursts. Specifically, terms like extinction-induced variability and extinction-induced aggression might be mislabeled as extinction bursts if applied researchers are simply using the term to describe any increase in responding that occurs when implementing extinction. This may be addressed by discrimination training, to teach individuals to discriminate between extinction-induced variability, extinction-induced aggression, and extinction bursts.

However, another potential reason for over-generalization (if it is occurring) may be the lack of a precise definition. As seen in Table 1 and 2, multiple qualified behavior analysts, like Durand and Carr (1991), describe extinction burst as an increase in responding, but fail to clarify any more specific criteria for the phenomenon. On the other hand, Goh and Iwata (1994), Lerman and Iwata (1995), and Lerman et al. (1999) do include specific criteria in their definitions. The absence of consistency with respect to the definition sets up researchers and practitioners alike to misinterpret extinction bursts. When following a vague definition like “an increase in responding,” behavior analysts could mistakenly label any variability in responding during extinction as an “extinction burst.”

The above suggestions are merely some hypotheses to account for the verbal behavior of behavior analysts with respect to extinction bursts, however, these explanations invite empirical investigation. Examining how basic and applied researchers use the term “extinction burst” would be beneficial for our field, because it could close the gap between applied and basic literature it may be particularly important to learn more about the variables governing how Board Certified Behavior Analysts (BCBA) use “extinction bursts.” Understanding how current BCBA use the term might illuminate the need for additional training to help future BCBA discriminate between extinction bursts and other extinction-related effects, and might help

practitioners better implement treatments for their clients (i.e., implementing escape extinction, planned learning, and other extinction-related interventions as well as what to do if a different side effect occurs during extinction).

Toward a New Definition of the Extinction Burst

The definition of any term aids in creating a conceptually systematic structure for how people apply the term in research and practice. Just as behavior analysts provide operational definitions for the behaviors of clients, we need to be just as precise in defining our terms. As discussed at length in this manuscript, the definition for an extinction burst is vague and variable across peer-reviewed articles and books.

A new definition for the extinction burst is needed. It should reconcile differences in the definition provided across multiple articles and books, taking into account the current state of the extinction literature. The revised definition should include specific criteria for the temporal locus of a burst and what changes in responding constitute a burst, taking into consideration that extinction bursts may be observed at different levels of analysis (e.g., within- and across-sessions). This will allow researchers and therapists to differentiate extinction bursts from other extinction related side effects (e.g., extinction-induced aggression, extinction-induced variability) and relapse phenomena (e.g., resurgence, reinstatement, renewal, spontaneous recovery). Thus, the following definition is proposed.

Extinction bursts are an increase above baseline levels, observed at any level of analysis, in the measured dimension of the target response within one or more of the 1st three extinction sessions.

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Table 1*Comparison of extinction burst definitions used in articles.*

Author	Year	Definition	Qualities
Farmer & Schoenfeld	1964	The “missing” of reinforcement is followed by several other rapid responses	None
Carr & Kologinsky	1983	Sudden increase in response rate produced when reinforcement for a behaviors is first withdrawn	None
McGonigle et al.	1987	An increase in responding in the first treatment phase compared to baseline	Temporal locus
Iwata et al.	1990	Initial bursts of responding	None
Durand & Carr	1991	Increase in behaviors following the removal of reinforcement	None
Goh & Iwata	1994	A temporary increase in SIB above its baseline rate, persistence in responding, or the occurrence of other undesirable behaviors	Magnitude
Lerman & Iwata	1995	Defined as an increase in the level of responding in any of the first three treatment sessions above all of the last five sessions from the previous phase	Temporal locus, Magnitude
Lerman et al.	1996	Initial increases in response frequency	None
Lerman et al.	1999	An increase in responding during any of the first three treatment sessions above that observed during all of the last five baseline sessions	Temporal locus, Magnitude
Lerman et al.	2002	An initial increase in responding during extinction	None
Reed et al.	2004	Increase in initial responding during treatment that were greater than baseline levels of responding	Magnitude
Grow et al.	2008	Increase in the level of responding in any of the first three treatment sessions above all of the last five session from the previous phase	Temporal locus, Magnitude
Podlesnik et al.	2012	An increase in target responses rates during extinction above baseline levels	Magnitude

Table 2*Comparison of extinction burst definitions used in articles.*

Book title	Year	Definition	Qualities
Applied Behavior Analysis	2007	A temporary increase in frequency, intensity or duration of the target response	Multiple measureable dimensions
Behavior Modifications	2008	Increase in frequency, duration or intensity of the unreinforced behavior during the extinction process	Multiple measureable dimensions
Behavior Modification	2008	Involved an increase in the unreinforced behavior of the occurrence of novel (and sometimes emotional) behaviors for a brief period is a nation reaction to the termination of reinforcement	None
Operant Extinction	2013	Response rates in the first three sessions of extinction exceeding rates in the last five sessions in the previous phase	Temporal locus, Magnitude
Performance Management	2014	A temporary increase in the frequency of behavior when the behavior no longer produced the reinforcer.	None
Principles of Behavior	2004	Initial increase in the response frequency, magnitude, or intensity, especially if that response has an “emotional” or aggressive component	Multiple measureable dimensions

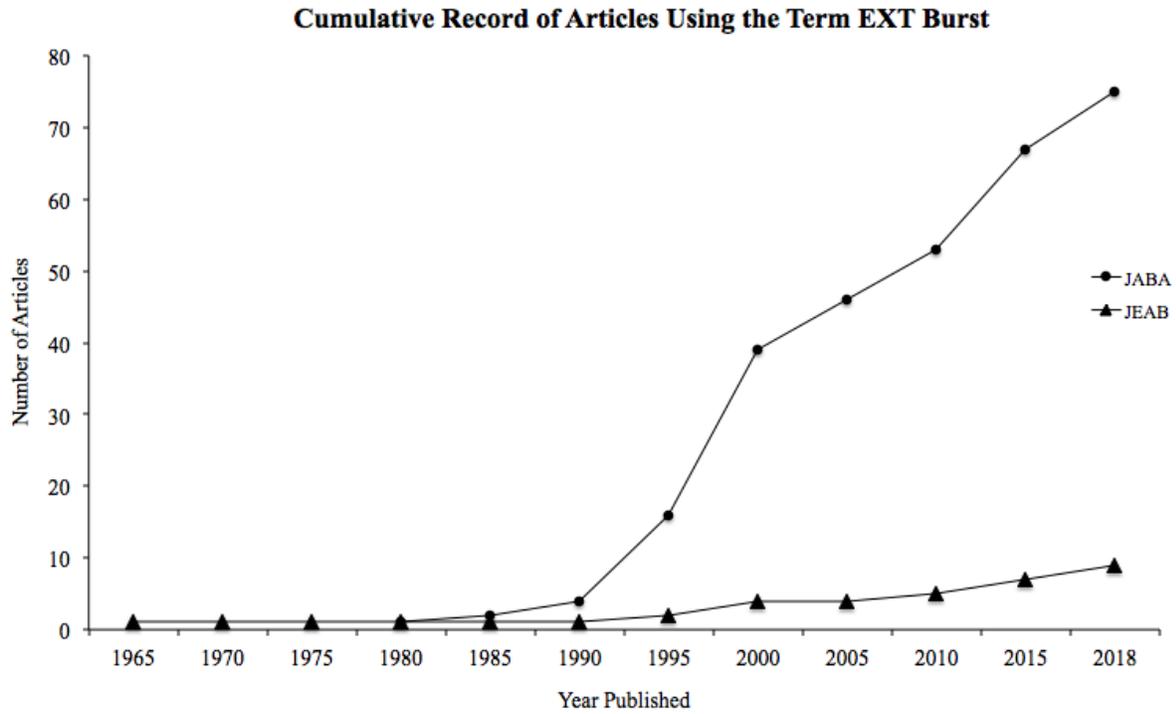


Figure. This graph depicts a cumulative record of the usage of the term “extinction burst.” Articles who used the term are displayed on the Y-axis and the year the articles were published on the X-axis.