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SIX REASONS WHY APPLIED BEHAVIOR ANALYSTS SHOULD KNOW ABOUT RESURGENCE

SEIS RAZONES POR LAS CUALES LOS ANALISTAS CONDUCTUALES APLICADOS DEBEN DE SABER SOBRE EL RESURGIMIENTO

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Abstract

To date, the majority of resurgence studies have occurred in controlled contexts with nonhuman subjects. However, understanding resurgence has implications for application. In this article, I outline six reasons why applied behavior analysts should know about resurgence. These reasons are the generality of the phenomenon, the diversity of responses that resurge, the extent to which procedures parallel common clinical treatment, the likelihood of particular topographies resurging, the extent to which clinicians might want resurgence, and the ways that clinicians can structure reinforcement histories to affect resurgence. Although we have a growing body of knowledge about the conditions under which resurgence occurs, further research is needed to determine the generality of existing studies to clinical contexts. In the meantime, clinicians should plan for resurgence when working with their clients.

Keywords: functional communication training, problem behavior, behavioral history, resurgence, treatment

Resumen

A la fecha, la mayoría de los estudios sobre resurgimiento han ocurrido en contextos controlados con sujetos no humanos. No obstante, entender el resurgimiento tiene

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implicaciones para la aplicación. En este artículo, esbozo seis razones por las cuales los analistas conductuales aplicados deben de saber sobre el resurgimiento. Estas razones son la generalidad del fenómeno, la diversidad de las respuestas que resurgen, la medida en la que los procedimientos son paralelos al tratamiento cínico común, la posibilidad de que topografías particulares resurjan, la medida en la que los clínicos pudieran desear el resurgimiento y las formas en las que los clínicos pueden estructurar las historias de reforzamiento para afectar el resurgimiento. A pesar de que tenemos un cuerpo de conocimientos creciente de las condiciones bajo las cuales ocurre el resurgimiento, se requiere de más investigación para determinar la generalidad de los estudios existentes a los contextos clínicos. Mientras tanto, los clínicos deben de considerar el resurgimiento cuando trabajan con sus clientes.

Palabras clave: entrenamiento en comunicación funcional, conducta problema, historia conductual, resurgimiento, tratamiento

The term resurgence refers to a procedure, outcome, and process by which previously suppressed responding recurs following discontinuation of reinforcement for an alternative response. The typical resurgence procedure involves three phases. During the first, a target response is reinforced, resulting in increased or maintained rates of target responding. During the second, the target response is placed on extinction and reinforcers are delivered for engaging in an alternative response. This decreases rates of target responding and increases and maintains rates of alternative responding. During the third, all responses are placed on extinction. This shift to extinction for both responses transiently increases target responding—the outcome labeled resurgence. Resurgence as a process is often identified when a shift to extinction increases target responding relative to target–response rates during the alternative–reinforcement phase.

Although the first studies of resurgence occurred in the 1950s (Carey, 1951), resurgence has received more attention in recent years and could now be conceptualized as a well–established phenomenon in the basic experimental literature. Resurgence has been found across several species, response topographies, and first– and second–phase reinforcement schedules. Yet, most of this research has occurred in controlled experimental contexts with nonhuman subjects (hereafter, "basic" research). It is only in the last decade that resurgence has been a focus of research using socially significant problems and populations . Yet, there are substantial implications of the experimental resurgence literature for the assessment and treatment of socially significant problems.

This article describes six reasons why applied behavior analysts should know about resurgence. For each of the reasons, I describe the findings identified in basic research, and applied research when applicable. I use these findings to highlight implications for

socially significant problems, including potential avenues for future applied research. The review of the literature is not meant to be exhaustive, but rather selective, highlighting issues related to resurgence that may be important to applied behavior analysts.

1. Resurgence is a robust and generalizable phenomenon

Resurgence has been demonstrated across a wide array of subjects, settings, responses, and initial reinforcement schedules. Perhaps the earliest study in the operant tradition demonstrating the phenomenon of resurgence was conducted by Carey (1951), who examined recurrence of previously reinforced lever pressing (either single or double presses, depending on condition) of rats during extinction. Since Carey's study, resurgence has been demonstrated with rats (e.g., Sweeney & Shahan, 2013a; Bouton & Schepers, 2014; Winterbauer & Bouton, 2012) pigeons (e.g., Cançado & Lattal, 2011; da Silva, Maxwell, & Lattal, 2008; Doughty, da Silva, & Lattal, 2007), hens (Cleland, Foster, & Temple, 2000), Siamese fighting fish (da Silva, Cançado, & Lattal, 2014), and humans (e.g., Bruzek, Thompson, & Peters, 2009; Doughty, Cash, Finch, Holloway, & Wallington, 2010; Reed & Clark, 2011). Resurgence has occurred across multiple response topographies, including nose poking (Sweeney & Shahan, 2013b), lever pressing (e.g., Bouton & Schepers, 2014; Podlesnick, Jimenez–Gomez, & Shahan, 2006; Winterbauer & Bouton, 2012), key pecking (e.g., Podlesnick & Kelley, 2014; Sweeney & Shahan, 2013a), treadle pressing (e.g., Doughty et al., 2007; Lieving & Lattal, 2003), ring swimming (da Silva et al., 2014), button pressing (e.g., Marsteller & St. Peter, 2012; McHugh, Procter, Herzog, Schock, & Reed, 2012), caregiving (Bruzek, Thompson, & Peters, 2009), play behavior (Reed & Clark, 2011), manding (Hoffman & Falcomata, 2014), and problem behavior (Lieving, Hagopian, Long, & O'Connor, 2004; Marsteller & St. Peter, 2014; Wacker et al., 2013) . Other dimensions of the operant, such as the temporal pattern of responding, can also resurge (Cançado & Lattal, 2011). Resurgence occurs when the initial reinforcement schedule was based on number of responses (ratio schedules) or the first response after a particular period of time (interval schedules; e.g., Winterbauer, Lucke, & Bouton, 2013). It occurs when the alternative–reinforcement procedure consists of reinforcement of a number of responses, the first response after a period of time, or even the absence of target responding without an explicit alternative behavior (da Silva et al., 2008). Previously reinforced responses resurge when the originally trained response is extinguished before the start of alternative reinforcement (e.g., Cleland et al., 2000; Hoffman & Falcomata, 2014) and when alternative reinforcement begins immediately after the initial reinforcement phase (e.g., Cancado & Lattal, 2011; Marsteller & St. Peter, 2014).

In other words, resurgence has been demonstrated across a range of variables. In each case, the initially reinforced response, which was reduced or eliminated in the

alternative–reinforcement phase, recurs during increased exposure to extinction. Because of the variety of conditions across which resurgence has occurred in controlled experimental evaluations, it seems likely that resurgence would occur across an equally wide range of socially significant situations. In fact, resurgence already has been demonstrated in socially significant contexts. Severe problem behavior displayed by individuals with disabilities resurges when treatments based on differential reinforcement are discontinued or when reinforcement rate is reduced (e.g., Hoffman & Falcomata, 2014; Lieving et al., 2004; Marsteller & St. Peter, 2012; Volkert, Lerman, Call, & Trosclair–Lasserre, 2009; Wacker et al., 2013). Despite this early evidence that the robust resurgence findings from the laboratory are likely to be replicated with socially significant problems, more research in this area is needed to empirically demonstrate the utility of evaluating resurgence in nonlaboratory contexts. For example, the bulk of the research to date on resurgence of socially significant problems has focused on a small segment of the population: individuals with intellectual or developmental disabilities who engage in chronic or severe challenging behavior. The extent to which resurgence occurs with other forms of socially significant behavior and with typically developing humans in nonlaboratory contexts has not yet been established.

2. Resurgence doesn't just occur with simple operant responses

Applied behavior analysts often deal with structurally complex responses (like vocal language) or series of responses (such as response–class hierarchies). Many of the resurgence experiments cited above evaluated easily measured and clearly defined single operant responses with a short duration, like key pecks or lever presses (hereafter, "simple" operants). Although there is a robust literature demonstrating resurgence with such operants, more complex operants also recur when extinction is in effect. Resurgence of more complex operants was shown as early as Carey's (1951) initial operant resurgence experiment. Some rats initially received food for single lever presses, but others received food for double presses. The other response (single or double) was reinforced in the second phase. When both responses were placed on extinction, the initially reinforced response sequence recurred. Reed and Morgan (2006) demonstrated similar resurgence of response sequences, but used three–response sequences across two levers.

Resurgence also occurs with complex human responses, including caregiving responses (Bruzek et al., 2009), complex play sequences (Reed & Clark, 2011), and response–class hierarchies (Lieving et al., 2004). For example, Bruzek et al. evaluated chains of caregiving responses, such as rocking, feeding, and playing with a baby doll. They selected a particular target response for each phase (the topography selected

varied across participants), and reinforced that response by terminating a recorded infant's cry when the participant engaged in the target response. The participants increased rates of reinforced responding during the first two phases of the experiment. When extinction was in place for all responses (there was no way for the participants to terminate the crying), the initially reinforced response recurred. Notably, participants spent more time engaging in the initially reinforced topography than a topography that was not reinforced during the experiment, suggesting that the increase was due to resurgence rather than extinction–induced variability. Similarly, Reed and Clark (2011) trained two different complex sequences of play behavior for children with autism during the first two phases of the resurgence procedure. The initially reinforced play sequence recurred when all responses were placed on extinction. In sum, not only simple operants but also chains of responses are likely to recur when socially significant behavior contacts extinction.

Resurgence also occurs during the treatment of response–class hierarchies. Response–class hierarchies are said to occur when several different forms of behavior are maintained by the same reinforcer, and tend to occur in a fixed sequence that often is associated with response effort or severity. Low–effort responses are likely to occur early in the hierarchy; if these responses do not produce a reinforcer, more effortful responses are emitted. Lieving et al. (2004) showed that resurgence occurred when particular responses in a response–class hierarchy were placed on extinction. One participant, Christine, engaged in property destruction, aggression, and self–injurious behavior as part of a response–class hierarchy maintained by access to preferred items. The experimenters initially reinforced property destruction, the first form of responding in the hierarchy. During the second phase, property destruction no longer resulted in access to items, but other forms of problem behavior continued to be reinforced; rates of aggression increased and rates of property destruction decreased. When both aggression and property destruction were placed on extinction during the third phase, rates of property destruction increased relative to the previous phase, suggesting resurgence of that behavior. Thus, resurgence occurs not only with complex responses but also socially significant responses that interact in response–class hierarchies.

Resurgence of complex operant responses has important implications for application. Applied behavior analysts rarely deal with an isolated form of behavior, and rarely are the response topographies associated with problem behavior and appropriate alternative behavior similar. Applied behavior analysts should be vigilant about the potential resurgence of complex responses, including response sequences, complex relations between responses, and response–class hierarchies.

In particular, resurgence of response–class hierarchies may account for "novel" forms of behavior that emerge during treatment packages that involve an extinction component. For example, assume that you are an applied behavior analyst working

with a client who has been referred for the assessment and treatment of inappropriate statements. You conduct a functional analysis of inappropriate statements and demonstrate that those statements are maintained by attention from adults. You then begin to implement functional communication training, during which you place inappropriate statements on extinction and begin to reinforce appropriate requests for attention. Caregivers initially implemented your treatment consistently, but, over time, they become less vigilant about attending to requests, thus exposing your client to extinction. When this occurs, you might expect inappropriate statements to recur. However, your client might also begin to engage in other, more severe forms of problem behavior, like property destruction or aggression. The emergence of these responses also might be instances of resurgence, if the responses are part of a response–class hierarchy that never emerged during your initial assessment and intervention because you targeted the least effortful (most probable) form of problem behavior.

The likelihood of resurgence across a wide variety of complex, socially significant responses remains to be empirically established. However, the literature suggests that such resurgence is likely. Unfortunately, predicting resurgence of response–class hierarchies and other complex behavior may be difficult, particularly when only lower–effort responses (such as vocalizations in the example above) are targeted for assessment and intervention. A barrier to demonstrating resurgence with response–class hierarchies in applied research is that such responses may not have been explicitly associated with reinforcer delivery during the experiment. That is, the development of the hierarchy likely occurred during an extra–experimental context and defining the members of the hierarchy or functional response class a priori may be difficult. For example, aggression resurged with clients referred for the treatment of aggression even when the aggressive responses were never reinforced during the experiment (Hoffman & Falcomata, 2014). These extra–experimental histories complicate analyses of resurgence because it becomes more difficult to distinguish between resurgence, extinction–induced variability, and other extinction–induced side effects (like extinction–induced aggression). Thus, the extent to which complex response sequences and hierarchies resurge may be best answered with basic and translational research studies, which can employ responses with known behavioral histories and can include "control" responses to account for variability and other side effects of extinction.

3. The experimental preparation used to study resurgence is eerily similar to treatment procedures common in applied behavior analysis

As described above, resurgence is commonly studied using a three–phase procedure consisting of reinforcement for one response, reinforcement of an alternative response, and then extinction of all responses. This three–phase procedure may closely

replicate common phases used in the treatment of problem behavior. During the first phase, the clinician attempts to identify the function of the behavior using functional–analysis procedures (e.g., Iwata, Dorsey, Slifer, Bowman, & Richman, 1994). This typically involves reinforcement of the problem behavior and no programmed consequences (extinction) for appropriate requests —a clear parallel to the first phase of the typical resurgence procedure, which involves reinforcement for a response that is later extinguished. Even if clinicians forgo a formal functional analysis, the problem behavior presumably is being maintained by extant reinforcement contingencies before treatment is implemented.

The second phase of a clinical case often involves reinforcing an appropriate alternative response with the reinforcer identified during the functional analysis while placing the problem behavior on extinction. Much like the second phase of a resurgence procedure, rates of an alternative response increase because they now produce the same reinforcer that was previously maintaining problem behavior. Rates of problem behavior decrease following exposure to the extinction contingency. As with studies of resurgence, the second (treatment) phase typically continues until rates of initially reinforced (problem) behavior are suppressed and rates of alternative responding stabilize.

At this point in the treatment process, the clinician faces several options. Often, effective interventions start with rich reinforcement schedules, including reinforcement of every response. To be practical for caregivers, clinicians must thin the reinforcement schedule before the treatment can be clinically useful. Schedule thinning necessarily involves increasing the client's exposure to brief periods of extinction as the requirements to earn a reinforcer are increased. When schedules are thinned rapidly, the client may be exposed to sufficient amounts of extinction for resurgence to occur. Resurgence has occurred during rapid schedule thinning in both controlled laboratory experiments (e.g., Lieving & Lattal, 2003) and treatment evaluations for children with disabilities (Volkert et al., 2009). Both Lieving and Lattal (2003) and Volkert et al. (2009) reduced reinforcement rates twelvefold from the second to the third phases of the experiments. Despite differences in experimental arrangements (including species, responses, setting, and reinforcers) and schedule types (interval or ratio), some resurgence occurred following schedule thinning in both studies. Further research determined that resurgence of problem behavior occurred, albeit to a lesser extent, even when reinforcement rates were minimally reduced (Marsteller & St. Peter, 2012). Thus, procedures used to promote clinical utility of our treatments may resemble the third phase of the resurgence procedure.

There is yet another way that post–treatment clinical procedures may resemble the third phase of a typical resurgence procedure. For clinical treatments to have long–term impacts, caregivers are trained to implement the procedures throughout the day.

However, caregivers often implement those procedures inconsistently. Caregivers may frequently fail to implement reinforcement procedures to promote appropriate responding (e.g., Codding, Feinberg, Dunn, & Pace, 2005), resulting in extinction for all responses. These treatment integrity failures may result in the recurrence of previously treated problem behavior (Marsteller & St. Peter, 2012).

4. The form of the responses taught might matter

The typical resurgence procedure involves reinforcement for an alternative response in the second phase. In many laboratory studies of resurgence, the form of the alternative response is similar or identical to the initially trained response. For example, the initially reinforced response might be pecking the center key in an operant chamber, and the alternative response might be pecking the right key (e.g., Sweeney & Shahan, 2013a). This arrangement differs from the parallel resurgence procedure during the treatment of problem behavior, in which case the topography of the initially reinforced response (the problem behavior) and the alternative response (often, a socially appropriate request) typically differ substantially.

The topographical similarity between the initial and alternative responses may affect the extent to which resurgence occurs. In a series of experiments, Doughty et al. (2007) systematically varied the type of reinforcement procedure and the topography of the response targeted in the alternative–reinforcement phase. During the initial phase of Experiment 5, the experimenters reinforced pecking the right key using a multiple schedule with two components that were identical except for the key color. During the second phase, pecking the left key was reinforced in one component but pressing a treadle was reinforced in the other component. Both second–phase components included extinction for pecking the right key. This procedure allowed the experimenters to directly compare resurgence following reinforcement of a topographically similar or topographically distinct response. Extinction was in effect for all responses during the third phase. During the extinction phase, resurgence occurred more rapidly and to a greater extent in the component previously associated with reinforcement of treadle pressing than in the component previously associated with alternative key pecking.

Doughty et al.'s (2007) results suggest that clinicians should consider the response topographies selected as replacement behavior during differential–reinforcement procedures. The speed and extent to which resurgence occurs may be reduced when the problem behavior and alternative response are similar in topography. Distinct topographies across initial and alternative responses may be more likely to result in resurgence. However, identifying alternative responses that are topographically similar to problem behavior may prove challenging for applied behavior analysts, although

perhaps not impossible in all cases. For example, some instances of problem behavior are problematic only because of the force of the response—yelling can be replaced with conversational volumes and hitting can be replaced with polite taps to the shoulder. However, other forms of behavior (e.g., self–injury) may be more difficult to replace with a topographically similar response.

Although the topographical similarity of initial and alternative responses has varied across studies, there are few direct comparisons of topographically similar or distinct responses within the same experiment. Additionally, the reduced resurgence obtained by Doughty et al. (2007) may have been caused by differential persistence of the alternative response rather than the topographical similarity or difference. In other words, it remains possible that resurgence was reduced because right–key pecking persisted to a greater extent in extinction than did treadle pressing, and that the persistence of alternative responding competed with the reemergence of the initially reinforced response.

Future applied studies could directly compare the extent to which topographically similar or distinct responses recur when alternative reinforcement is discontinued. Such studies, coupled with additional laboratory work, could clarify the extent to which the topography of the response strongly influences resurgence. Until such studies are conducted, clinicians should consider selecting an alternative response that requires the least effort possible to emit. Low–effort responses may be more likely to persist than effortful responses when reinforcement is discontinued, thus potentially competing with recurrence of problem behavior.

5. There might be situations under which resurgence is desirable (that is, in which we want to promote resurgence)

The examples of resurgence in application described above focus primarily on recurrence of problem behavior following successful treatment. However, resurgence may occur with any kind of initially reinforced response; the effect is not isolated to socially undesirable responses. There may be some situations in which resurgence is desirable. For example, resurgence of previously successful solutions to problems may be important or necessary when the most recently reinforced approaches fail (Epstein, 2015, *this issue*; Lattal & St. Peter Pipkin, 2009).

Even when treating problem behavior, it may be possible to arrange the treatment environment so that resurgence of another appropriate response occurs before resurgence of problem behavior. Hoffman and Falcomata (2014) reinforced two different requests (mands) for items across the first two phases of a resurgence procedure with three children who engaged in problem behavior maintained by access to items. When extinction was put in place for all responses, the initially trained mand recurred for all three participants. Although problem behavior also resurged during the extinction

phases, all three participants engaged in the initially trained mand before engaging in problem behavior.

Similar sequential mand training might be useful when clinicians are concerned that one form of mand may not be consistently reinforced. For example, although there are several benefits to teaching the use of sign language as mands, novel listeners who are unfamiliar with sign language may be unable to reinforce the mands when they occur. Thus, teaching an alternative form of communication, such as the use of gestures or picture cards, before teaching sign, may result in reemergence of a previously reinforced form of appropriate communication when the more recently reinforced forms of communication contact extinction.

6. Resurgence may be differentially likely depending on the client's reinforcement history

We are learning more about the historical conditions that are likely to produce resurgence. A growing body of evidence suggests that the reinforcement rate and response rates that occurred during response–dependent reinforcement phases affect the probability and magnitude of resurgence, with more frequent reinforcers or higher response rates yielding increased likelihood or rate of resurged behavior. For example, Sweeney and Shahan (2013b) obtained greater target response reduction during the second phase when the alternative–reinforcement rate was high rather than being consistently low or gradually thinned. During extinction, however, components associated with low or thinned reinforcement rates produced considerably less resurgence than did the component previously associated with a high reinforcement rate. Schepers and Bouton (2015) found more resurgence following exposure to rich reinforcement schedules than to leaner reinforcement schedules. This effect occurred regardless of whether reinforcement rate was altered through traditional thinning (that is, from a rich reinforcement schedule to a leaner reinforcement schedule) or with a "reverse thinning" procedure, in which the schedule started lean and gradually became richer over time. One potential limitation of these studies, however, is that reinforcement rate and response rate often co–vary. Thus, it is unclear whether increased resurgence is due to increased reinforcement rate, increased response rate, or both (see Cançado, Abreu–Rodrigues, & Alo, 2015, *this issue*; Fujimaki, Lattal, & Sakagami, 2015, *this issue*; and da Silva et al., 2008 for further discussion of implications of response rate and reinforcement rate on resurgence).

The finding that rich reinforcement rates may be likely to produce resurgence is important for application because most differential–reinforcement procedures, including functional communication training, typically start with rich schedules in the hopes of promoting high response rates. Guidelines for implementing functional communica-

tion training recommend frequent prompting and reinforcement of the alternative response (Tiger, Hanley, & Bruzek, 2008). Unfortunately, such rich schedules of reinforcement may be likely to produce resurgence when the treatment is challenged. Schedule thinning may be one way to reduce the likelihood of resurgence during sudden treatment discontinuation (extinction for all responses), but at least some resurgence may occur every time the schedule is thinned, particularly if the thinning process occurs in a context previously associated with reinforcement for the target behavior (e.g., Marsteller & St. Peter, 2012; Sweeney & Shahan, 2013b; Winterbauer & Bouton, 2012).

To combat resurgence associated with rich reinforcement schedules, Mace et al. (2010) suggested starting treatment with a rich schedule in a contrived context, and gradually thinning reinforcement rate in that context, before introducing treatment in the natural environment. When Mace et al. (2010) implemented these procedures, first with nonhumans and subsequently with human participants, they found less resurgence when differential reinforcement was introduced in a contrived context than in a context previously associated with reinforcement of the problem behavior. Changing contexts may be a useful strategy because resurgence has been shown to be related to the presence of signals or discriminative stimuli that have been previously associated with reinforcement (Kincaid, Lattal, & Spence, 2015). Resurgence also may occur to a lesser extent when DRA is initially implemented with a leaner schedule rather than a rich one (Sweeney & Shahan, 2013b). However, implementing DRA with an initially lean schedule may reduce the extent to which, or rate at which, problem behavior is suppressed during the intervention. This may not be acceptable in all circumstances.

Introducing delays to reinforcement, as suggested by Fisher, Thompson, Hagopian, Bowman, & Krug (2000), also may reduce resurgence following initially rich reinforcement schedules. Introducing delays to reinforcement may make procedures more manageable while maintaining rich reinforcement schedules. For example, Fisher et al. (2000) gradually increased the delay to reinforcer delivery from 0 s to 30 s while maintaining a continuous reinforcement schedule (each communicative response resulted in a reinforcer, albeit at a delay in some phases). Although rates of requests decreased as the delay to reinforcement increased, problem behavior remained virtually eliminated. Thus, delays to reinforcement may provide one way to decrease obtained reinforcement rate without inducing resurgence. To date, the extent to which delays to reinforcement influence resurgence has not been examined. This is a promising area of future investigation, as several applied studies have successfully used this method to reduce reinforcement rate while maintaining low rates of problem behavior (e.g., Fisher et al., 2000; Hanley, Iwata, & Thompson, 2001). Notably, however, some applied studies have still reported recurrence of problem behavior when delays were introduced (e.g., Fisher et al.). Thus, the conditions that maintain low response rates when delays are introduced are unclear.

Although there is mounting evidence to suggest that richer rates of reinforcement are more likely to produce resurgence during extinction, the evidence for this effect is not uniform. For example, Reed and Clark (2011) taught three groups of children with autism to engage in a variety of play sequences. The groups differed based on the duration of response–dependent reinforcement and reinforcement rate during the initial training phases, with different groups receiving a variable–ratio (VR) 4 schedule for 60 min, a VR 4 schedule for 30 min, or a VR 2 schedule for 30 min. Resurgence of previously reinforced play sequences varied as a function of the duration and schedule, but was the inverse of what one would predict from the studies described above: the greater the number of reinforcers delivered, the smaller the resurgence effect. The reason for the differences between the evaluation by Reed and Clark (2011) and other studies showing a positive relation between previous reinforcement rate and resurgence is unclear. To date, the study by Reed and Clark is the only published evaluation explicitly examining differences in response–dependent reinforcement rates on resurgence with human participants. Further research with humans and socially significant behavior is needed to determine how reinforcement rate impacts resurgence during treatment contexts.

The duration of reinforcement history may also affect the likelihood or extent of resurgence. Long histories of reinforcement for the target response may make that response more likely to recur when alternative–reinforcement conditions are disrupted (e.g., Winterbauer et al., 2013). To date, the relation between the duration of reinforcement history for the target response and the extent to which resurgence occurs has not been thoroughly examined with human participants. Reed and Clark (2011) varied duration of reinforcement history and reinforcement rate with children with autism and found that reinforcement rate was a better predictor of resurgence than was time in training. In contrast, Doughty et al. (2010) identified a positive relation between duration of reinforcement history and amount of resurgence with college students responding in match–to–sample human–operant task. Given that clients referred for the treatment of problem behavior are likely to have long and varied reinforcement histories for that response, further evaluation of the duration of reinforcement history with human subjects is warranted.

There may be a negative relation between the duration of the reinforcement history for alternative responding and the extent to which resurgence occurs (e.g., Cleland et al., 2000; Leitenberg, Rawson, & Mulick, 1975; Sweeney & Shahan, 2013b; Wacker et al., 2013). Sweeney and Shahan (2013b) demonstrated that resurgence of keypecking decreases as the second, alternative–reinforcement phase increases in duration, and the likelihood and extent to which resurgence occurs decreases following repeated exposures to extinction without an intervening history of reinforcement for the target response. Wacker et al. (2013) found similar outcomes with children who engage in

problem behavior; overall levels of resurgence decreased in repeated extinction probes following continued implementation of a treatment based on functional communication training.

Finally, there is mixed evidence regarding the extent to which histories with different schedule types produce differential resurgence. Winterbauer et al. (2013) found greater resurgence of lever pressing with rats following VR schedules than following yoked–interval schedules, even though the reinforcement rate across the schedules was equated. In contrast, Lastinger and St. Peter (2015) found the opposite effect with human participants engaging in simple operant responses: more resurgence occurred following a fixed–interval history than a fixed–ratio history. However, Lastinger and St. Peter did not control for reinforcement rate, which may have influenced their outcomes. Given the prevalence of interval schedules in the nonhuman evaluations of resurgence, and the near–exclusive use of ratio schedules in applied studies, further evaluation of the extent to which different schedule types or reinforcement rates produce resurgence seems warranted.

Conclusion

Resurgence has several applied implications, and should be considered by behavior analysts changing socially significant behavior. Although much is yet to be discovered about the boundary conditions that result in resurgence, we already know that resurgence occurs following several different kinds of reinforcement histories, during different extinction–like disruptors, and across multiple species. Resurgence may be particularly important to consider in the treatment of problem behavior, as the traditional three–phase resurgence procedure closely resembles situations in which problem behavior is assessed, treated, and then the treatment is extended or challenged. Additionally, resurgence may be more likely when the topography of the initially reinforced response and alternative response differ, as is often the case during the use of functional communication training as an intervention for problem behavior. Yet, eliminating an explicit alternative response (for example, through the use of differential reinforcement of other behavior (DRO) or response–independent reinforcement) is not sufficient to eliminate resurgence when that treatment is challenged. The rich reinforcement schedules so common in initial treatment or skill acquisition procedures actually may be more likely to result in treatment relapse than are schedules with lower reinforcement rates. In other words, the procedures most commonly recommended and used by applied behavior analysts, particularly during the treatment of problem behavior, are also the procedures that are likely to result in behavioral resurgence.

Despite the implications of resurgence for clinical treatments, there are currently few studies examining resurgence with socially significant behavior. Of the studies

reviewed in this article, only 11 were conducted with human participants, and only 8 targeted socially significant behavior (Hoffman & Falcomata, 2014; Lieving et al., 2004; Mace et al., 2010; Marsteller & St. Peter, 2012; Marsteller & St. Peter, 2014; Reed & Clark, 2011; Volkert et al., 2009; Wacker et al., 2013). Seven of these 8 studies (all but Reed and Clark, 2011) assessed resurgence following the treatment of problem behavior, and evaluated the extent to which problem behavior recurred during treatment disruption. Continued research on the conditions necessary to produce or mitigate resurgence following successful treatment of problem behavior is warranted. To date, all studies have demonstrated resurgence of problem behavior following sudden treatment discontinuation, suggesting that such an outcome is likely unless clinicians program for procedures that reduce the likelihood of recurrence. Four such methods of mitigating effects of treatment disruption have received some empirical support: teaching multiple alternative responses (Hoffman & Falcomata, 2014), using response–independent reinforcement schedules (Marsteller & St. Peter, 2014), changing the context during alternative reinforcement (Mace et al., 2010), and extending the alternative–reinforcement phase (Wacker et al., 2013). Future studies could extend these findings by identifying alternative methods for mitigating resurgence effects or exploring the boundaries of these four established methods. For example, how many alternative responses are necessary? How rich does the response–independent reinforcement schedule need to be? Is there a critical necessary duration of the alternative reinforcement phase?

Future studies also might examine the extent to which resurgence of appropriate behavior can be programmed to occur. Although Reed and Clark (2011) demonstrated resurgence of play sequences with children with autism, they did so under controlled laboratory conditions with arbitrarily selected play sequences. In other words, although Reed and Clark targeted a socially signification problem and population, their findings may have limited overall social validity or applicability to other situations. Authors have speculated that resurgence may be an important aspect of problem solving (e.g., Lattal & St. Peter Pipkin, 2009), but this outcome has not yet been clearly demonstrated in the empirical literature (but see Epstein, 2015, *this issue*). Future studies could evaluate resurgence of socially significant appropriate behavior (in the absence of problem behavior), such as academic responding or problem–solving strategies.

Finally, further research is needed on the reinforcement histories that produce or exacerbate resurgence. The existing literature suggests that there may be complex interactions between variables such as reinforcement rate, duration of the history, and response rate or patterning during the history. These complex interactions may have led to different outcomes across studies that were designed to evaluate the same historical variables. Because clients enter typically seek treatment after long and varied reinforcement histories have been established, a clear understanding of historical in-

fluences on resurgence will be necessary for clinicians to predict the conditions under which behavior is likely to recur.

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