THE EFFECTS OF LAG SCHEDULES AND MULTIPLE RESPONSE ALTERNATIVES ON RESPONSE RESURGENCE

by

Ashley Bagwell

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Approved by:

Dr. Joel Ringdahl, Chair

Dr. Johnathan Baker

Dr. Ruthanne Rehfeldt

Graduate School

Southern Illinois University Carbondale

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The mitigation of response resurgence is a topic which has garnered recent attention due to its importance in a clinical setting. The present study examined the mitigation of response resurgence in a human operant study using a computer program to teach multiple response alternatives using a Lag 3 schedule of reinforcement. Of the six undergraduate students who participated in this study, three came under the control of the programmed contingencies. All three of these participants demonstrated higher rates of resurgence in the component which simulated a single response alternative when compared to the component which simulated a multiple response alternative. Areas for future study are discussed.

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CHAPTER 1

INTRODUCTION

Despite the many proven techniques for addressing disruptive and often dangerous behaviors exhibited by individuals over a wide range of functioning levels, many clinical studies have demonstrated an inconsistency with which the effects of these techniques maintain over time and across settings (Wacker et al., 2011). This phenomenon of inconsistency is often attributed to a concept termed resurgence. There exists a scarcity of studies regarding means of mitigating resurgence in both applied and operant settings, but the studies which do exist lend support to the concept and suggest that there may be methods of avoiding or at least dampening its effects.

Resurgence was first termed by Epstein and Skinner (1980) in a study that demonstrated the re-emergence of key pecking exhibited by pigeons after a period of extinction. More specifically, key pecks were shaped via a moving dot in the first condition. In the second condition, reinforcement was instead delivered on an interval schedule and key pecks were completely extinguished. In the last condition, food reinforcement was no longer delivered and experimenters saw the resurgence of key pecking at high rates. This study by Epstien and Skinner does not exactly conform to the more often used three-phase model later outlined by Lieving and Lattal (2003), but the demonstration of resurgence is robust and represents one of the earliest empirical demonstrations of the resurgence phenomenon, preceded only by Leitenberg, Rawson and Bath (1970) and Leitenberg, Rawson, and Mulick (1975), which focused on the effects of alternative reinforcement contingencies with rats.

In the first phase of the Lieving and Lattal (2003) model of resurgence, the target response results in reinforcement. In the second phase, target response is extinguished and an alternative response is reinforced. In the final phase, both responses are placed on extinction. Work conducted by Epstein (1983, 1985) demonstrated the resurgence phenomenon again in pigeons using a model, which more closely resembles the previously mentioned phases (wing flaps were used as the alternative response in phase two). It was further demonstrated that the responding was not a form of emotional behavior, such an increase in general responding, due to a lack of responding on an available control key.

The studies conducted by Epstein (1983, 1985) were used as the foundation for the Lieving and Lattal (2003) study, which lead to the developmental of the previously mentioned three-phase model. Lieving and Lattal sought to identify the variables responsible for controlling the magnitude, occurrence, repeatability of resurgence within individual organisms. Still working with pigeons, experimenters were able to replicate the findings of Epstein thereby demonstrating that resurgence is not dependent on dense schedules of reinforcement prior to the final extinction condition. They were also able to reliably repeat the resurgence phenomenon within-subjects, albeit with inconsistent magnitudes, independent of whether extinction resulted in zero or near-zero rates of responding. Finally, and perhaps most significantly with regard to clinical implications, the authors found that with increasingly intermittent schedules of reinforcement, extinction effects associated with long periods without reinforcement could produce resurgence. They assert that, “the variables that have been shown to engender greater persistence and resistance to change" are most likely to influence resurgence (Lieving and Lattal, 2003).

Within an applied setting, these findings, while fascinating on the operant level, can carry more weight in terms of the implications they place on the identification and treatment of problem behavior in clinical populations. Lerman and Iwata (1996) identified the clinical use of extinction specifically as an area where resurgence must be considered. Resurgence is conceptualized as an indirect effect of extinction and Lerman and Iwata suggested that current research across a variety of areas, resurgence included, is insufficient to support a comprehensive understanding of extinction and its effects in clinical settings. Given the efficacy of numerous treatments that rely heavily on an extinction component, understanding the mechanisms underlying resurgence becomes imperative. Fortunately, there a small but growing number of studies that have endeavored to apply the work done previously to clinical settings. Volkert, Lerman, Call, and Trosclair-Lasserre (2009) extended the work done by Lieving and Lattal (2003) to a clinical population, arguing that the three-phase procedure described by Lieving and Lattal could be analogous to the poor, if not nonexistent, treatment integrity seen in the implementation of interventions by caregivers.

Volkert et al. (2009) examined resurgence during a functional communication training (FCT) procedure. One of the most common treatments for problem behavior (see, Tiger, Hanley, & Bruzek, 2008 for a review), FCT is a form of differential reinforcement during which the problem behavior is systematically placed on extinction and a communicative response is differentially reinforced. Mace and Roberts (1993) attributed inconsistencies in the maintenance of the effects of FCT when implemented by caregivers to poor treatment integrity. This explanation was later supported by a number of studies. Shirley, Iwata, Kahng, Mazaleski, and Lerman (1997) found that extinction was a necessary component of FCT and that inconsistency in the implementation of the extinction component could result in continuing occurrences of problem behavior. Hagopian, Fisher, Sullivan, Acquisto, and LaBlanc (1998) found that a FCT with extinction procedure was effective for the majority of 21 participants, but that the addition of delay-to-reinforcement fading procedures resulted in relapse of problem behavior or otherwise reduced treatment efficacy for approximately half of the participants.

The Volkert et al. (2009) study was able to systematically replicate the effects observed in the Hagopian et al. (1998) study, as well as in several other studies that looked specifically at problem behavior during periods of non-reinforcement during FCT implementation. Fisher, Thompson, Hagopian, Bowman, and Krug (2000), in an investigation targeting the facilitation of tolerance of delayed reinforcement, found that reinforcer delay fading was associated with an increase in certain topographies of problem behavior (e.g. masturbation and head rolling). Hanley, Iwata, and Thompson (2001) demonstrated that increasing delays to reinforcement, when used singularly, lead to the extinction of the desired alternative response as well as the resurgence of SIB at relatively low but variable rates. Finally, Hagopian, Toole, Long, Bowman, and Lieving (2004) compared dense-to-lean and fixed-lean schedules of reinforcement as fading components for FCT and saw initial increases in the rate of problem behavior in both conditions. Viewed through the lens of resurgence theory, Volkert et al. conducted a series of experiments which systematically replicated the Lieving and Lattal (2003) study with five children diagnosed with autism or developmental disabilities exhibiting self-injury, aggression, or disruption, thereby providing one possible explanation for this recurring theme.

In the first experiment, Volkert et al. (2009) implemented FCT until the subject's behavior met two criteria across three consecutive sessions: a) the targeted alternative response was emitted without experimenter prompting at a minimum rate of half the average baseline rate of the problem behavior, and b) problem behavior was reduced by at least 80% from baseline levels. Participants then moved into the FCT maintenance condition which lasted for a minimum of ten sessions. After responding achieved stability and problem behavior remained at an 80% reduction from baseline across three sessions, the extinction condition began. This condition tested for resurgence by discontinuing the delivery of reinforcement for the alternative response. Resurgence was defined using the criterion outlined by Lieving and Lattal (2003) which stated that problem behavior had to occur at a rate higher than that observed during the FCT maintenance condition during at least one of the ten extinction sessions. Resurgence of problem behavior was observed at high levels for two of the three participants. The problem behavior re-emerged for the third participant, but not at high enough rates to meet the Lieving and Lattal definition of resurgence. This inconsistency could be attributed to his comparatively higher level of functioning and verbal repertoire (Volkert et al., 2009).

The second experiment of Volkert et al. (2009) expanded the findings obtained in Experiment 1 by evaluating resurgence during periods of non-reinforcement in lean schedules. Procedures in this experiment were similar to those of experiment one with the only differences being in the third and final condition. Instead of extinction, participants were immediately exposed to a VR 12 schedule of reinforcement following the maintenance condition (e.g. the reinforcer was delivered after, on average, 12 communicative responses instead of one response). Resurgence was observed for all three participants in the second experiment. This finding has significant implications for clinical applications of FCT where inconsistencies in treatment integrity can result in periods of time without the delivery of programmed reinforcers.

Another line of research, focused on response-class hierarchies, has provided further insight into the phenomenon of resurgence (Lieving, Hagopian, Long, and O'Connor, 2004). A response-class hierarchy is conceptualized as an operant class of behaviors maintained by a common function, but vary in topography. These behaviors are exhibited in a sort of hierarchy that can be influenced by a number of variables including, but not limited to, rate of reinforcement, immediacy of reinforcement, response cost, and likelihood of aversive consequences (Lalli, Mace, Wohn, and Livezey, 1995). Due to the hierarchical nature in which these behaviors occur, reinforcement of earlier behaviors in the chain may inhibit the occurrence of later behaviors in the chain (Harding et al., 2001; Lalli et al., 1995; Richman, Wacker, Asmus, Casey, and Andelman, 1999). When the more frequent behaviors encounter extinction, the less frequent (essentially previously extinguished) behaviors may re-emerge. As to whether this relapse of previously extinguished responding is an example of resurgence, or some other behavioral phenomenon, it is difficult to say due to a lack of sufficient research on the subject.

That said, Lieving et al. were able to find results suggesting such relapse is an example of resurgence. In that study, Lieving et al. successfully demonstrated resurgence effects within response-class hierarchies for two individuals with developmental disabilities. Both individuals exhibited behavior maintained by positive reinforcement. The first participant exhibited disruption and aggression. Disruption was reinforced for several sessions before being placed on extinction, at which point aggression was reinforced. After both responses were placed on extinction, disruption reemerged. The second participant exhibited disruption, dangerous acts, cursing, and aggression. The first phases were identical to those of the first participant, with the first response, disruption, reemerging after extinction. Experimenters then provided reinforcement for cursing. After placing cursing on extinction, disruption and dangerous acts reemerged.

One approach to understanding the mechanisms underlying response resurgence focused on errors in treatment integrity during interventions which used differential reinforcement of alternative behavior (DRA) paired with extinction (St Peter Pipkin, Vollmer, & Sloman, 2010). Treatment integrity for this type of procedure may suffer from any number of environmental variables including a caregiver’s extensive history of providing reinforcement contingent on problem behavior or an inability to consistently provide sufficient reinforcement for alternative responses (Volkert et al., 2009). Termed commission errors and omission errors respectively, experimenters combined the two types of error for experiment three of their study in which a 50% integrity condition was used (50% of instances of problem behavior and 50% of instances of alternative behavior were reinforced). Responding during this condition revealed a higher rate of problem behavior than alternative behavior suggesting that errors in treatment integrity can and do result in response resurgence.

With demonstration after demonstration of resurgence within clinical populations (Lieving et al. 2004; St Peter Pipkin et al., 2010; Volkert et al., 2009), there is a very necessary area of study emerging which seeks to identify means of mitigating the effects of response resurgence either by delaying the occurrence or preventing it all together. Marsteller and St. Peter (2014) examined the use of response-independent reinforcement schedules following DRA. For all of their four participants, the fixed-time schedule of reinforcement successfully mitigated resurgence following extinction, however, the reinforcement was delivered every 1 to 2 s, making the procedure too impractical and potentially costly to be implemented in natural settings. There are currently no published reports to support that response-independent reinforcement delivered on a more realistic schedule would be as effective.

Another successful evaluation of resurgence in a clinical setting examined the effects of DRA procedures implemented over long periods of time (Wacker et al., 2011). While the FCT procedure used did eventually result in the mitigation of resurgence, it was only after an average of 14 months spent in training that this effect was observed. As with the procedures used by Marsteller and St. Peter (2014), these findings represented an effective, yet inefficient means of mitigating response resurgence, necessitating the identification of less costly and more time-efficient procedures.

The Lieving et al. (2004) finding that supported to the phenomenon of resurgence within a response-class hierarchy was expanded upon by Hoffman and Falcomata (2014) who suggested that training multiple response alternatives could result in the resurgence of appropriate alternatives over problem behavior. Specifically, three children with diagnoses of autism and limited verbal repertoires participated in a series of four conditions. In the first condition a mand was trained using a least to most prompting sequence until the response was independently emitted across five trials. In the second condition, the trained mand was reinforced on an FR 1 schedule. A new mand modality was present, but was not reinforced. Problem behavior was not reinforced. After 5 min of efficient responding, defined as an appropriate response at least once within 10 s of the removal of the reinforcing stimuli, the third condition began. During this condition, no responses were reinforced. After 3 min with no responses allocated to the first mand, the new mand was trained via the same procedure used to train the first mand. The new mand was then placed on extinction, allowing for the resurgence of the first mand. Resurgence of the first mand was seen across participants and consistently occurred before resurgence of the problem behavior.

Carrasquillo (2014) extended resurgence literature by applying the same concept of multiple response alternatives as a means of mitigating resurgence to a different population. Carrasquillo conducted a human operant study with typically developing undergraduate students using a computer program to simulate the three phases outlined by Lieving and Lattal (2003). The study consisted of two concurrently presented components. The first component trained four alternative responses. The second component trained one alternative response. Reinforcement in the form of “credits” was delivered contingent on correct responding. In the first phase, a single target response was reinforced using a VI 10-s schedule for both components. In the second phase, the first response was placed on extinction and either multiple alternatives (first component) or one alternative (second component) were reinforced. In the third phase, all response across components were placed on extinction.

Lieving and Lattal (2003) established a criterion for evaluating resurgence during the final phase of each component. Specifically, evaluation of resurgence in the final phase of each component occurred if the initial target response had extinguished in phase 2 or had decreased to levels at or below baseline levels (Phase 1). Of the nine participants who met the criterion for evaluating resurgence in phase three, six showed higher rates of resurgence in the component which featured a single response alternative. Across participants, time spent in extinction was held constant and the VI 10-s schedule allowed for the rate of reinforcement to be held constant. The variation in responding across components is then most concisely attributed to the resurgence mitigating effects of multiple response alternatives.

While multiple response alternatives have proven to be an effective means of delaying response resurgence, these effects have been only temporary. Further research into prolonging and amplifying these effects is warranted. The use of lag schedules of reinforcement is one potential avenue of exploration in this area. Lag schedules of reinforcement are a form of differential reinforcement which require that a given response differs from some previous number of responses in order to access reinforcement, essentially reinforcing variability.

Variability has not, historically, been conceptualized as an operant dimension of behavior. One of the first studies to change this perspective was conducted by Page and Neuringer (1985). Researchers were able to generate highly variable responding in pigeons, even when the response requirement operated on a Lag 50 schedule of reinforcement. That is, in order to receive reinforcement, the 51st response needed to differ from the 50 previous responses. Lee, McComas, and Jawor (2002) extended the use of lag schedules of reinforcement to verbal behavior exhibited by three individuals with Autism who demonstrated the ability to spontaneously emit mands and intraverbals. Using a Lag 1 schedule of reinforcement, researchers were able to increase variability in responding to a social question for two of the three participants without the use of prompts. Heldt and Schlinger (2012) looked specifically at using a Lag 3 schedule of reinforcement to produce increased variability in tacting for two children with developmental disabilities. Variability in tacting was achieved across participants and was maintained during a 3-week follow-up session.

A recent study examined the use of lag reinforcement schedules as a means of increasing mand topographies within an FCT procedure (Gainey, 2013). Participants included three boys aged 10 to 23-years-old, all with prior diagnoses of Autism and histories of problem behavior and poor communicative skills. After conducting a functional analysis and assessing the level of prompting necessary for each targeted mand topography, the lag schedule evaluation took place. Five minutes sessions using a Lag 0 schedule of reinforcement (functionally equivalent to an FR 1 schedule) were conducted to ensure proficient responding. A Lag 1 schedule of reinforcement was then implemented which required each response to differ from the previous response in order to access reinforcement, thereby reinforcing variation in responding. While Gainey did not specifically look at resurgence within the study, researchers were able to train multiple response alternatives and reduce problem behavior, lending support to the use of lag schedules of reinforcement to train multiple response alternatives within an FCT procedure.

The purpose of the present study was to extend literature on the application of lag schedules of reinforcement in two ways. First, by adapting the common clinical methodology to a human operant methodology similar to that used by Carrasquillo (2014). And second, by programing a phase designed to test for resurgence so that the mitigating effects of lag schedules of reinforcement can be assessed. Using a computer simulation of the Lieving and Lattal (2003) three phase model, participants responded via button clicks which that reinforced using “credits.” Two alternatively presented components differed in both the number of available responses (two and five) during the second and third phases of the study and the schedule of reinforcement (VI and Lag 3 respectively) during the second phase of the study.

CHAPTER 2

METHOD

Participants

Participants included six undergraduate students over 18 years of age. Students were recruited from a Rehabilitation course and earned extra course credit for their participation in the study.

Setting and Apparatus

Sessions took place in a private study room furnished with a table and chairs. A computer program written in Microsoft® Visual Studio 2013 controlled both data collection and the presentation of stimuli throughout trials. The program was run on an Acer Aspire V5 laptop which was equipped with a Windows 8 operating system. The laptop featured a 39.6-cm touch screen and a track-pad, both of which could be used to interact with the program.

Dependent Variables

The dependent variable in the present study was response allocation, measured as the total number of mouse clicks on the available stimuli. The stimuli were 2-cm squares of different colors which were available in the center of the screen contingent on the phase and component of the study. Response allocation was recorded by the computer program.

Procedure

Prior to starting the computer program, participants were provided with written instructions regarding the study:

Participation in this study will take approximately 70 minutes. Your goal is to earn as many "credits" as possible. The number of "credits" you earn will not affect the amount of course credit you are earning for your participation in the study. "Credits" are earned by clicking buttons on the computer screen. Throughout the study you will be presented with 1 to 5 buttons at a time. Not all of the buttons will result in "credits" throughout the study.

Participants were then given brief instructions regarding interacting with the program and presented with the laptop after any questions had been answered.

Target reinforcement (Phase A). During the first phase of the study, participants were presented with the target response (pink button) in the center of the screen. Clicking on the target response was reinforced, on a variable interval (VI) 10-s schedule, with "credits" and an audible tone which signaled their delivery. That is, credits were available contingent on the first appropriate response following a period of, on average, 10-s. This phase consisted of five sessions. Each session included one multiple response alternative component and one single response alternative component, each of which lasted 2 min. The two components differed only in background color; Component 1 was light purple and Component 2 was dark teal.

Alternative response reinforcement (Phase B). During the second phase of the study, participants were first presented with the multiple response alternative component of the study. In this component, five buttons (the target response and four response alternatives – colored teal, purple, yellow, and orange) were concurrently available. Credits were delivered on a Lag 3 schedule of reinforcement, necessitating a single click on each of the alternative responses, which reset when the target response was selected. After each multiple response alternative component, participants were presented with a single response alternative component which had two buttons (the target response and one alternative response – colored blue). During each single response alternative component, reinforcement was delivered on a VI schedule yoked to the rate of reinforcement in the preceding multiple response alternative component. That is, the frequency of reinforcement in the preceding component was recorded, divided into the 120-s length of the component, and used to determine the VI schedule for the following, single-alternative component. This phase consisted of five sessions. Each session included one of each of the two components, each of which lasted for 2 min.

Resurgence test (Phase C). During the final phase of the study, the presentation of the stimuli was identical to that in Phase B. However, all of the responses were placed on extinction. As with the other phases, there were a total of five session which included one of each component. After the final session, a message box appeared which thanked the participant for completing the study and instructed them to notify the experimenter that they had finished.

CHAPTER 3

RESULTS

Figure 1 displays the response allocation across phases for the three participants who did not come under control of the programmed contingencies. For all three participants, response allocation to the target stimuli in the single response alternative component of Phase B never differentiated significantly from response allocation to the alternative stimuli. Because of this, it is impossible to interpret for these participants in Phase C with respect to resurgence.

Figure 2 depicts response allocation across phases for Participant 1. During Phase A, target responses across components were 225.1 responses per minute (RPM) in the multiple response alternative component and 258.6 RPM in the single response alternative component. Response allocation to the target responses reduced to 1.3 RPM and 3 RPM across components respectively in Phase B. Cumulative responding across the multiple alternatives averaged 170.8 RPM and responding on the single alternative averaged 193.1 RPM. The target response completely extinguished in both components. The phenomenon of resurgence can be observed in the first trial of Phase C before target responses again extinguish. Responses allocated to the target response in the multiple response alternative component (15.5 RPM) were lower than in the single response alternative component (49 RPM). This differentiation is maintained when compared as a function of proportion to baseline rates of responding, based on the model proposed by Shahan and Sweeney (2011), which is 0.07 and 0.19 respectively (Figure 3). The average cumulative rate of responding across the multiple alternatives was 156.1 RPM and the average rate of responding on the single alternative was 251.7 RPM.

Figure 4 depicts response allocation across phases for Participant 2. During Phase A, target responses across components were 58.2 RPM in the multiple response alternative component and 74 RPM in the single response alternative component. Response allocation to the target responses reduced to 4.1 RPM and 7.8 RPM across components respectively in Phase B. Cumulative responding across the multiple alternatives averaged 51.9 RPM and responding on the single alternative averaged 14.4 RPM. The target response completely extinguished in both components. The phenomenon of resurgence can be observed throughout Phase C. The average responses allocated to the target response in the multiple response alternative component (16.3 RPM) were lower than in the single response alternative component (33.3 RPM). This differentiation is maintained when compared as a function of proportion to baseline rates of responding, which is 0.28 and 0.45 respectively (Figure 5). The average cumulative rate of responding across the multiple alternatives was 59.9 RPM and the average rate of responding on the single alternative was 36.4 RPM.

Figure 6 depicts response allocation across phases for Participant 4. During Phase A, target responses across components were 141.5 RPM in the multiple response alternative component and 164.7 RPM in the single response alternative component. Response allocation to the target responses reduced to 8.1 RPM and 39.6 RPM across components respectively in Phase B. Cumulative responding across the multiple alternatives averaged 50.2 RPM and responding on the single alternative averaged 68.8 RPM. Although the target response did not extinguish in either component, it decreased substantially from baseline rates of responding in both components. The phenomenon of resurgence is highest in the first trial but can be observed throughout Phase C. The average responses allocated to the target response in the multiple response alternative component (12.1 RPM) were lower than in the single response alternative component (66 RPM). This differentiation is maintained when compared as a function of proportion to baseline rates of responding, which is .08 and .40 respectively. In the first trial, the proportion to baseline during the multiple response alternative component was 0.07 and during the single response alternative component was 0.59 (Figure 7). The average cumulative rate of responding across the multiple alternative responses was 70.7 RPM and the average rate of responding on the single alternative was 76.3 RPM.

Figure 8 shows the persistence of response allocation to the alternative responses in phase C as a proportion to response allocation to the alternative responses in phase B. For participants 1 and 2, the single alternative appears to have persisted at a higher rates than the multiple alternative. Across phase C trials for participant 1, responding to the single alternative as a proportion to phase B is 1.5, which is higher than responding to the multiple alternative which is 0.9. This trend is more pronounced for participant 2, where the single alternative as a proportion to phase B is 4.3 and the multiple alternatives as a proportion to phase B is 1.5. For participant 5, persistence of the alternative responses is not differentiated and is therefore difficult to meaningfully interpret.

CHAPTER 4

DISCUSSION

The results of the present study demonstrated that the resurgence of previously reinforced target responses was consistently lower following the reinforcement of multiple response alternatives using a Lag 3 schedule of reinforcement than when following a single response alternative reinforced on a yoked variable interval schedule. This phenomenon was observed in the responding of all of the three participants whose responding came under control of the programed contingencies. These findings supported those of Carasquillo (2014) and Hoffman and Falcomata (2014) by showing higher levels of response resurgence in the single alternative component when compared to a multiple alternative component. As a method for the mitigation of response resurgence, these findings have significant clinical implications because they are the first to show support for the use of lag schedules. These findings also supported those of several other studies that have demonstrated resurgence following extinction (Lieving et al. 2004; St Peter Pipkin et al., 2010; Volkert et al., 2009), thus extending current literature on response resurgence, more generally.

When considered with the findings of Carasquillo (2014) which used multiple schedules to teach multiple response alternatives, it is possible that simply teaching multiple responses is sufficient to mitigate resurgence of the target response independent of the actual schedule used. Future studies should explore such conceptual implications through the comparison of multiple schedules, lag schedules, and other schedules that have been shown to effectively train multiple responses to determine which of these approaches is the most effective in mitigating resurgence. The means through which the alternatives are trained may also have some impact on the persistence of the alternative responses. In the current study, the single alternative response appeared to persist at a higher level than the multiple alternative responses for two of the three participants. This finding is likely due to the frequently observed, patterned responding in the multiple alternative component which necessitated a higher inter-response time if participants allocated responses across the available options instead of toward a single response.

While there exists an increasingly sizeable body of research demonstrating the phenomenon of resurgence across populations, research on mitigating this phenomenon is in its infancy. Studies such as Marteller and St. Peter (2014) and Wacker et al. (2011) have demonstrated means, albeit impractical or inefficient, of mitigating resurgence. It is possible that when used in combination with a procedure such as the one used in the present study, a new and practical method of reducing response resurgence in clinical settings may emerge.

The clinical implications of these findings are not limited to the FCT methodology through which resurgence is commonly discussed in the applied literature. In fact, there are many possible applications which should be explored. For individuals who engaged in perseveration on specific topics, a method such as the one explored herein could be beneficial because the initial target response (talking about a specific topic) would not be completely extinguished, but would be observed at lower rates. Additionally, multiple alternative responses (e.g., topics) would persist, which would be preferable over a single alternative response. Another possible avenue for the further application of lag schedules to mitigate response resurgence could be through training job interview answers. If the participants have only a few possible responses to interview questions in their repertoire, it would be ideal to reinforce multiple/variable alternatives without extinguishing the responses already in the individual's repertoire. More conceptually, the present study demonstrates that lag schedules are an effective means of training response alternatives while simultaneously mitigating, but not extinguishing, previously reinforced responses, suggesting that such a procedure might be adaptable to any number of areas in which this outcome would be beneficial.

The present study encountered limitations which should, if possible, be addressed in future studies. First, components were presented in the same order across participants, potentially resulting in sequence effects. This presentation was necessary in order to achieve a yoked rate of reinforcement in the single response alternative component due to the unpredictable nature of responding in the multiple response alternatives component. Additionally, the order in which the components were presented biased the study against the hypothesized outcome by introducing extinction during the multiple response alternative component, thereby reducing its effect during the subsequent exposure in the single response alternative component.

Another limitation of the present study is the lack of recording of rates of reinforcement across trials. It is assumed that the rate of reinforcement was equal across components due to the fact that the computer program did not encounter any errors during the course of the experiment. However, data was not specifically recorded by the program to confirm this assumption. This limitation does not impact the examination of resurgence as it applies to this study, but it does limit the ability to draw conclusions that may have been possible based on such data.

The use of human operant participants poses unique challenges to any experiment. The current study did not explicitly test the reinforcer efficacy of the “credits” participants received, however, many studies have shown that points function as a reinforcer for typically developing adults (Galizio and Buskist, 1988). Additionally, multiple participants in the current study made comments which support that their responding was maintained by the receipt of points such as, “I got so pissed because I was 60 points away from 3,000 when it stopped giving them.” Another participant variable that may have impacted outcomes was that five of the six participants in the present study were distracted by the cell phones at least once during the course of the study. One participant, who did not come under control of the programmed contingencies, even sent multiple text messages during phase C of her session.

A final limitation of this study is that the presentation of the stimuli in the multiple response alternative component was not varied, resulting in a common pattern of responding across participants. Reinforcement in the multiple alternative component was delivered contingent on patterned responding based on the Page and Neuringer (1985) study which required responses to be sequenced. Because the target response was always to the left of the alternative responses, participants would often respond to each stimuli once, starting with the left and ending on the right, and still receive reinforcement. For the participants who failed to come under control of the contingencies during the single response alternative component of the study, a similar pattern of responding was seen where participants alternated their responses between the stimuli at such a high rate (as high as 6.2 responses per second) that it was virtually impossible to identify which stimuli had actually resulted in reinforcement. Future studies could address this limitation by varying the physical locations of the stimuli on the screen so as to encourage varied responding and potentially facilitate discrimination of the programmed contingencies.

Future research should also consider examining verbal behavior of the participants. Such a focus could allow for insight into the mechanisms through which the lag schedule of reinforcement resulted in the observed responding. Anecdotal observations of responding in the present study revealed that many of the participants developed verbal rules for the programmed contingencies, both correct and incorrect. It is conceivable that information such as this, gained in a human operant setting, could result in better understanding for the same mechanisms in clinical populations.

There are also considerations which should be taken with respect to adapting the present methodology for clinical populations. While the rate of responding during resurgence was consistently lower in the multiple response alternative component, it was not nonexistent for any of the participants. Were the target response a severe problem behavior instead of a button click, even low levels of responding could be cause for concern. Future studies should consider identifying the optimal number of response alternatives for mitigating resurgence.

Existing research regarding clinical methodologies for mitigating response resurgence have identified long periods of time spent in training and response-independent reinforcement as possible avenues. However, these procedures can be impractical. The amount of time necessary to correctly implement the procedure and the demand on caretakers to implement the procedure respectively make faster alternatives more appealing. Given that inadequate implementation of existing programs is often the catalyst for resurgence to begin with, there is an even greater need for simpler and more time sensitive approaches to mitigating the resurgence of problematic behavior.

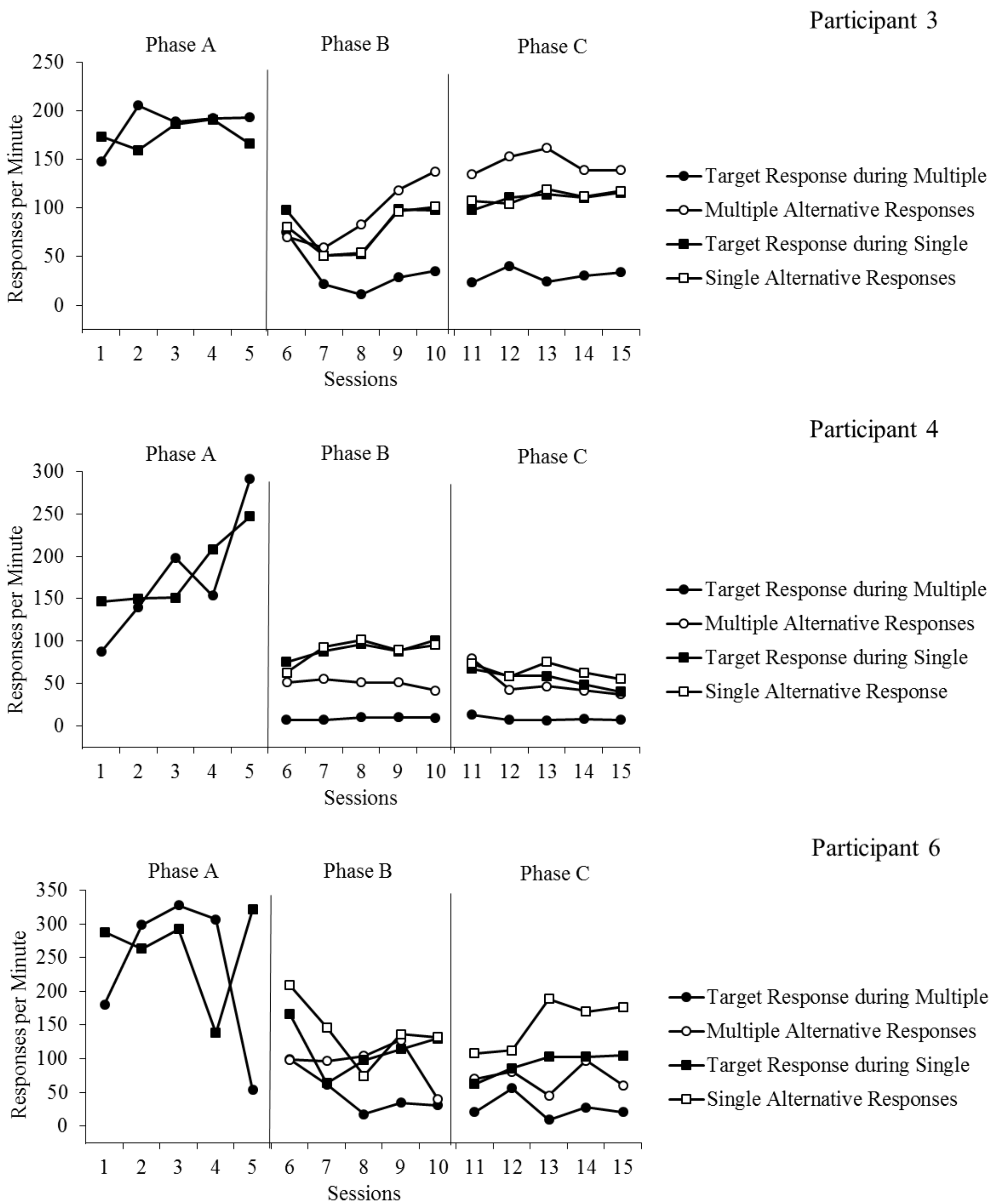

Figure 1. Response allocation across phases for the three participants whose responding did not come under control of the programed contingencies.

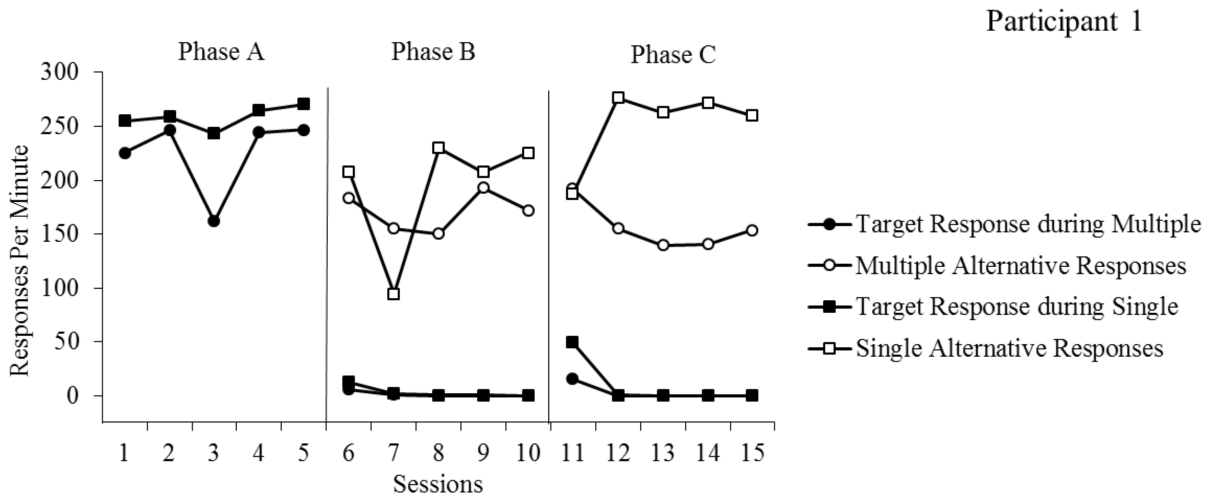

Figure 2. Response allocation across phases for Participant 1.

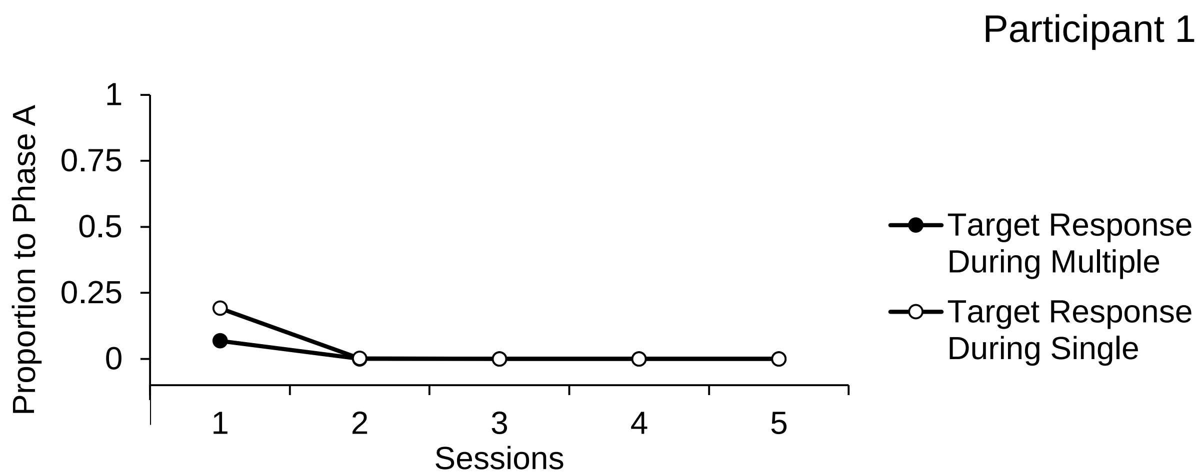

Figure 3. Response allocation to the target response in phase C as a proportion of responding in phase A for participant 1.

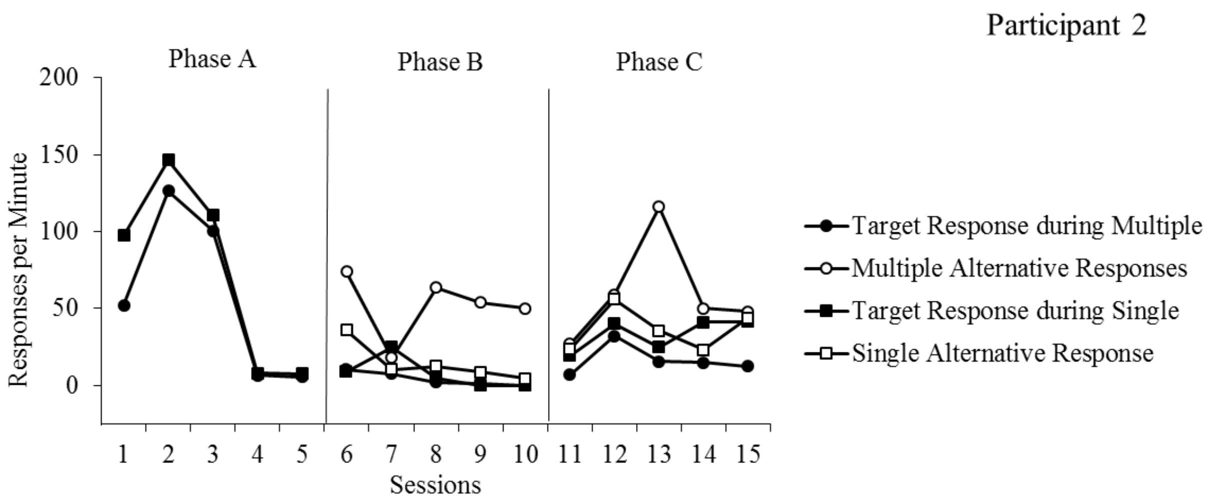

Figure 4. Response allocation across phases for Participant 2.

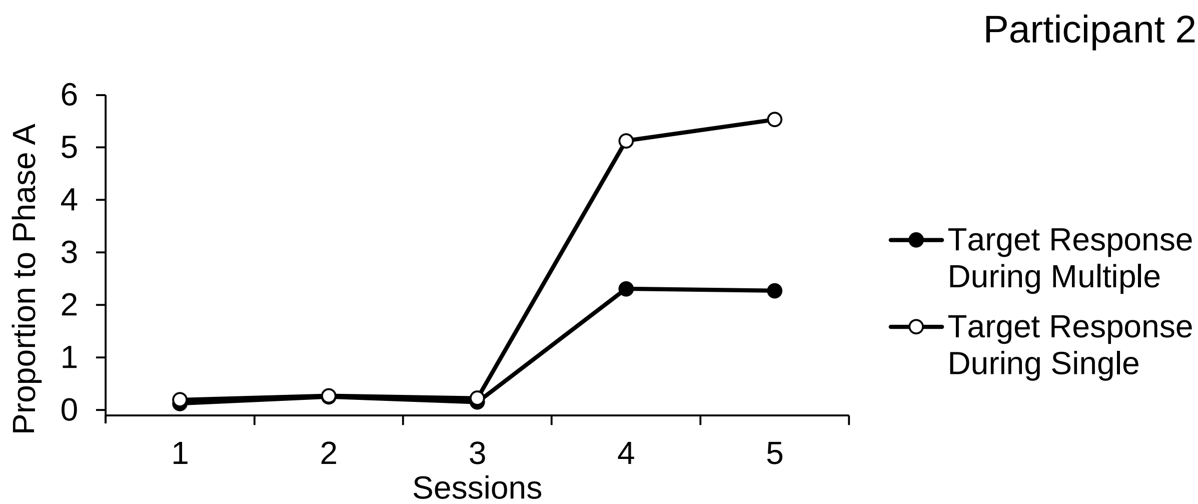

Figure 5. Response allocation to the target response in phase C as a proportion of responding in phase A for participant 2.

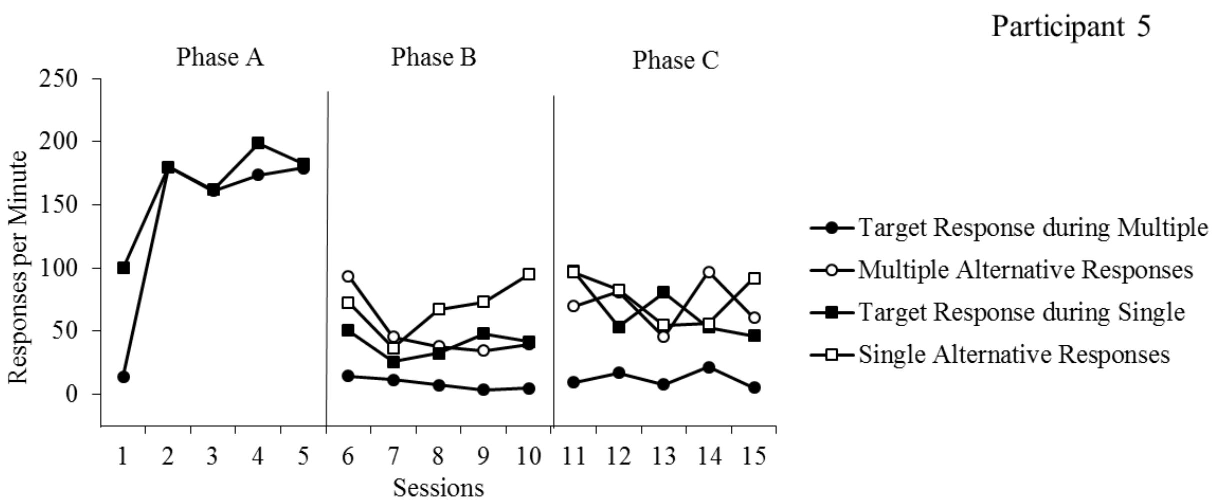

Figure 6. Response allocation across phases for Participant 5.

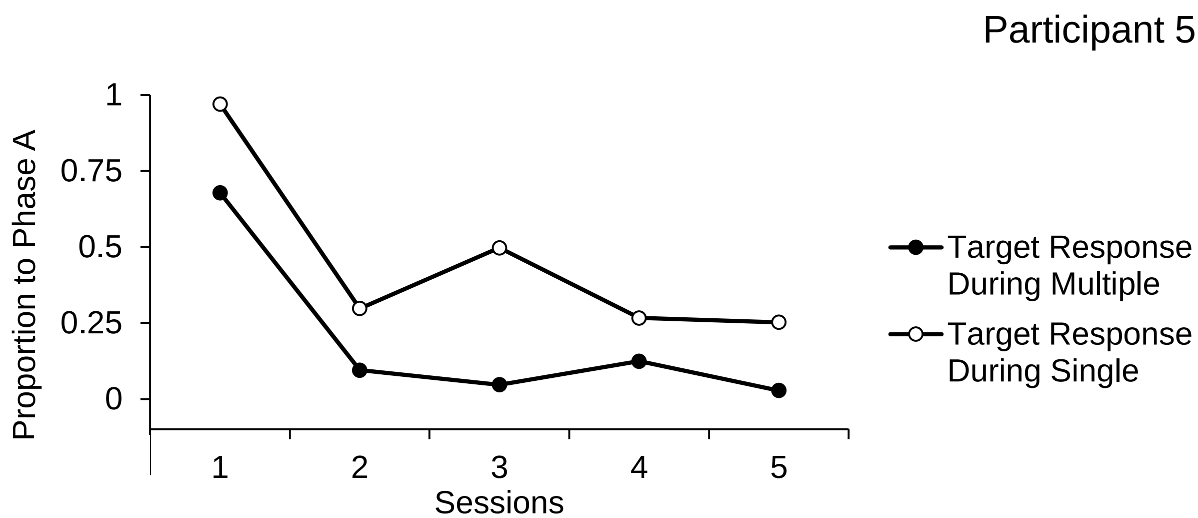

Figure 7. Response allocation to the target response in phase C as a proportion of responding in phase A for participant 5.

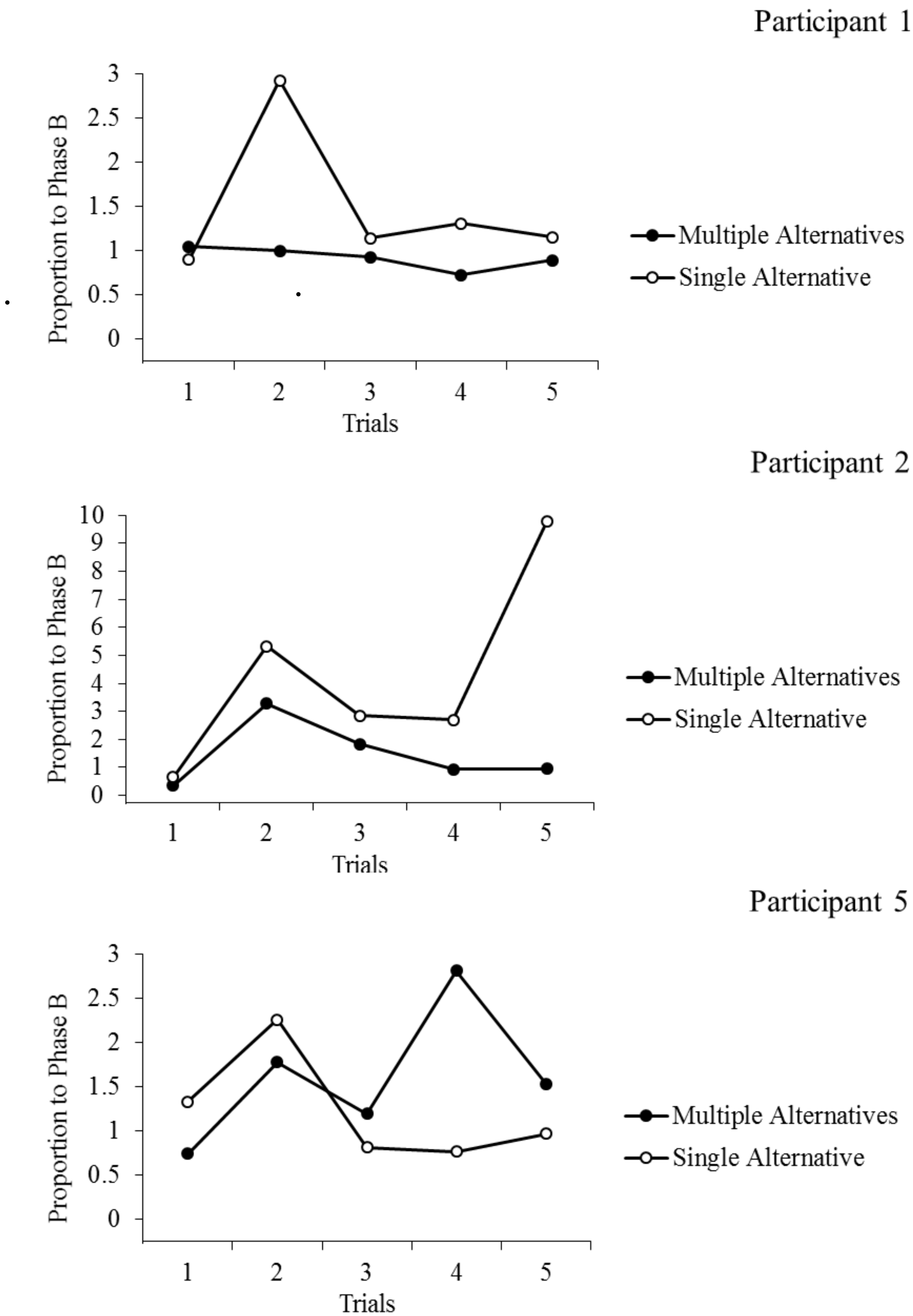

Figure 8. Response allocation to alternative responses in phase C proportionate to responding in phase B across participants.

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VITA

Graduate School
Southern Illinois University

Ashley F. Bagwell

afbagwell@siu.edu

University of Texas, Austin
Bachelor of Arts, Psychology, May 2013

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Major Professor: Dr. Joel Ringdahl