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On the Influence of Private Stimulus Magnitude When Reporting Private Events

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Abstract

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The nature of private events provides challenges to developing a scientific understanding of the conditions under which humans learn to describe private events. Replicating and extending procedures from Stocco et al. (2014), we further evaluated the conditions under which verbal responses come under the control of private stimuli. Given that some participants vocal responses came under the control of public stimuli in Stocco et al. (2014), we implemented more subtle public accompaniments with all participants to reduce the likelihood of public stimuli acquiring control of participant's verbal responses. Further, we systematically manipulated the visual clarity of the presented stimuli using blur effects to simulate varying magnitudes of private stimuli. Participants were four undergraduate students who vocally responded to these novel private stimuli within a listener contingency reversal design. Three of four participants acquired tacts of the private stimuli. Our results suggest that tacts of private stimulation can be established regardless of magnitude when public accompaniments strongly correspond with private stimulation and listener reinforcement practices are stable in acquisition. These findings further support the necessity of analog arrangements to investigate private events empirically.

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CHAPTER 1: INTRODUCTION

Skinner (1957) defined the tact relation as "a verbal operant in which a response of a given form is evoked (or at least strengthened) by a particular object or event, or property of an object or event" (p. 82) and is established by generalized reinforcement from the verbal community. The experimental analysis of verbal behavior has devoted significant attention to investigating the tact relation (Petursdottir, 2018), including the functional independence of the tact and mand (Lamarre & Holland, 1985), procedures to teach novel tacts to individuals diagnosed with Autism Spectrum Disorder (ASD; LeLonde et al., 2020; Partington et al., 1994; Sundberg et al., 2000), and the emergence of untrained tacts following listener training (Ribero et al., 2010). Skinner (1957) emphasized the role of the listener in establishing speakers' tacts of environmental events. The crucial role the listener plays in the development of a speaker's tacting repertoire is by mediating consequences in response to the speaker's verbal responses. Consider a child and parent visiting a zoo. As they approach the enclosure for zebras and the child sees a zebra, the child says, "Horse!" The parent withholds reinforcement for the vocal response and states, "No, that's not a horse, that's a zebra!" Later, as the child and parent leave the zoo, they pass the zebra enclosure, and the child sees the zebra, stating, "Zebra!" The parent reinforces the vocal response by responding, "Yes, that's right, that's a zebra!" This consequence strengthens the child's response in the presence of the nonverbal stimuli that reliably evoke the tact "zebra" in their verbal community. In the above example, the parent's consequences to the child's vocal responses establish the relationship between the nonverbal stimuli, the child's vocal response, and generalized conditioned reinforcement (e.g., praise), functionally establishing the tact of "zebra."

However, presenting or withholding reinforcement for verbal responses about private events, contingent on the private event, is impossible (Skinner, 1945). That is, given that a private event is only accessible to the speaker, there is no “Zebra” available to the listener to control the subsequent presentation or withholding of reinforcement for the speaker’s tact. Skinner (1945) described how listeners respond to the problem of privacy by, among other strategies, reinforcing tacts based on publicly accessible stimuli that cooccur with private events, termed "public accompaniments." For example, suppose a college student visits a dentist’s office claiming that their tooth aches while no visible indicators for the source of pain are evident (e.g., swelling, tooth decay). In this scenario, the dentist cannot immediately be sure of the accuracy of their tact because the physiological sensations of tooth pain are inaccessible to the dentist as a listener. Continuing our example, if a college student approaches the dentist claiming that their “tooth aches” while there is a large hole in the tooth, the dentist is more likely to reinforce their tact of the private event (i.e., “tooth ache”) as the private event (i.e., tooth pain) strongly correlates with the accessible public accompaniment (i.e., a large hole in the tooth).

The nature of private events also provides challenges to developing a scientific understanding of the conditions under which we learn to describe private events accurately. Given that private events arise within the skin of the speaker and are accessible only to the speaker, they cannot be directly studied by researchers. As a result, analog arrangements that recreate the relevant stimulus characteristics of private events are a necessary starting place for an experimental investigation of private events. Stocco et al. (2014) described an analog preparation for studying environmental variables that can influence the accuracy of reports about private events. In Experiment 2, the authors created two decks of 30 cards, with one side of each card functioning as a public accompaniment (i.e., observable to both researcher and participant)

and one side functioning as an analog to a private event (i.e., observable only to the participant). The public accompaniments for each deck were one–third of a painting (i.e., Monet's Water Lilies, van Gogh's Wheat Field Under Threatening Skies). The private events were one of three Wingdings™ symbols that varied for each deck. The experimental blocks consisted of four sessions, where two experimenters presented cards and delivered points in separate, alternating sessions. Initially, participants were taught to label private stimuli (e.g., symbol) with nonsense syllables (e.g., "WEF") in the presence of highly correlated public accompaniments (e.g., a section of Monet's Water Lilies). Experimenters reinforced participants' verbal responses based on the available public accompaniment to the private stimuli across two conditions. In the first condition (i.e., constant reinforcement schedule across experimenters), experimenters reinforced the same verbal response to the same private stimulus in the presence of the same public accompaniment. In the second condition (i.e., varied reinforcement schedule across experimenters), experimenters reinforced different verbal responses to the same private stimulus in the presence of the same public accompaniment. Larger differences in participants' responses were observed when the reinforcement contingency varied across experimenters, and smaller differences were observed when the reinforcement contingency was held constant across experimenters.

The experimental preparation of Stocco et al. (2014) provided an empirical framework for investigating verbal responses about private events. However, the experimenters noted that some participant's responses came under the control of the public accompaniments rather than the private event analogs (Experiments 1 and 2). In response to these findings, experimenters increased the complexity of the associated public accompaniments in Experiment 3. The increased stimulus complexity of the public accompaniment successfully transferred stimulus

control of the tact to the private event analog for two of three participants. However, one participant required the removal of the public accompaniment to tact the private event reliably. Given that participants in Experiment 3 had also participated in the previous experiments and thus had established stimulus control for tacting the public accompaniments rather than the private event analogs, findings suggest that the increased public accompaniment complexity was insufficient to transfer stimulus control to the private analogs for all participants.

Beyond the empirical questions investigated by Stocco et al. (2014), questions remain about how the magnitude of private stimulation might impact the acquisition of verbal responses. In addition to the problem of privacy, empirically investigating private events presents a second challenge, the problem of saliency. Previous behavioral discrimination research has demonstrated that organisms may respond differentially to various intensities of external stimulation on the basis of their physiology and environmental histories (Hanson, 1959; Neitz & Jacobs, 1989). Moreover, research has demonstrated that nonhuman organisms can be taught discriminated responses on the basis of private stimulation (Miller & DiCara, 1967). Although some authors have suggested that some private events may be less salient than others (Palmer, 2009; Silverman et al., 1994, Skinner, 1945), less is known with respect to the private stimulation experienced by neurotypical human adults.

In this study, we sought to extend the literature investigating verbal responses about private events by systematically replicating and extending the procedures reported by Stocco et al. (2014). First, we implemented more subtle public accompaniments with all participants to reduce the likelihood of the public accompaniments acquiring stimulus control of participants' verbal responses and to assess if a listener's consistent reinforcement practices for tacts of private events can bring participants' vocal tacts under the control of private stimulation. Additionally,

we presented participants with analogs of private events with varying visual clarity (i.e., blur effect) to assess the extent to which stimulus magnitude may influence the acquisition of verbal responses about private events. This magnitude manipulation was introduced to assess if consistent reinforcement practices can establish vocal tacts when the magnitude of private stimulation is variable and to assess the effect on participants acquisition of novel vocal tacts. Finally, we omitted the constant reinforcement condition across experimenters to prevent characteristics of the listener from acquiring discriminative control of participants' tacts across conditions; instead, having a single experimenter implement a listener contingency reversal across experimental conditions to assess if the change in reinforcement practices is sufficient to control participants tacts of private events.

CHAPTER 2: METHOD

Participants and Setting

Participants were four undergraduate students at the University of the Pacific. Experimenters recruited participants through digital advertisements posted in undergraduate psychology courses and paper flyers posted in the department. Upon completing their participation, participants could exchange the total points they received during the sessions for gift cards. Following the compensation procedure described by Stocco et al. (2014), the exchange rate was $5 in gift card value for every 100 points received, with a maximum compensation of $40. The total number of sessions ranged from 5 to 12 per participant (M = 9.8). Participants received compensation of $10, $10, $15, and $20 respectively for the points accumulated during the study, rounded up to the nearest $5 increment. All sessions took place in a research room equipped with a table, two chairs, and a one-way mirror. A video recording device was positioned behind the participant to record the private stimuli, which were inaccessible to the experimenter during sessions.

Materials and Stimuli

In line with the procedures reported by Stocco et al. (2014), participants were provided a sheet of paper listing all possible nonsense syllables for a given session. We used a deck of 30 cards that arranged a stronger private-public correspondence (100%) than Stocco et al. (80%) for all sessions. Each card measured 2.3 in. x 3.4 in.

Private Events

In the original study by Stocco et al. (2014), the private event analogs were Wingdings™ symbols, used to minimize the potential effects of participant history. Following the same

rationale, abstract stimuli sourced from Li & Yang (2012) were used in all sessions. Three different abstract stimuli were included in the deck of cards, and each abstract stimulus was printed on 10 cards (Stocco et al., 2014). Each of the 10 copies of the three abstract stimuli were degraded in quality with a radial blur effect, ranging from 10% to 100% in increments of 10%, to create a deck of 30 cards. These symbols were considered analogous to private stimuli because they were observed only by the participants during sessions.

Public Accompaniments

An image was printed on the reverse side of each card from the private stimuli. These images were considered analogous to public accompaniments because they were visible to both the participant and the experimenter during sessions. Stocco et al. (2014) used sections of Monet's Water Lilies and van Gogh's Wheat Field Under Threatening Skies for public accompaniments in experiments 1 and 2. Images of baseball players, based on player positions, were used as complex public accompaniments in experiment 3. Our study used an image of a painting, 'Shakyamuni Buddha' by an unknown artist ('Unbekannt'), manipulated across private stimuli. A subtle cue was digitally altered across three iterations of the painting, creating three distinct public accompaniments. In total, three private stimuli, each with ten levels of radial blur degradation, and three public stimuli were combined to create three symbol-image combinations for the deck of cards (see Table 1 for details).

Nonsense Syllables

In line with the procedures of Stocco et al. (2014), each private stimulus was assigned a designated nonsense syllable prior to the start of sessions. The nonsense syllable served as the tact for the private event. At the beginning of each session, participants were presented with a

sheet of paper listing the nonsense syllables used within that session, “KEZ,” “SUY,” and “NEY.” The preassigned syllable-private stimulus pairings are detailed in Table 1.

Procedures and Experimental Conditions

As in Stocco et al. (2014), prior to each session, the experimenter explained to the participants that they would learn to label symbols printed on cards. Participants were shown lists of nonsense syllables and informed that each syllable corresponded to a symbol on the cards (e.g., “In this deck of cards, you will see three symbols: KEZ, SUY, and NEY”). In Stocco et al., experimenters slid cards private symbol side down to participants. Our study implemented two card stands, side by side, to present public accompaniments and private event analogs to the participant simultaneously. The experimenter demonstrated placing a card in each card stand to present a private symbol (card stand 1) and public accompaniment (card stand 2) to the participant and instructed them never to show the private symbol to the experimenter. Throughout the sessions, no participants revealed any private stimuli to the experimenter. Finally, participants were informed that they could exchange points earned for gift cards at local stores.

In line with the session procedures described by Stocco et al., a session consisted of thirty trials, each including ten presentations of each private stimulus in the deck. Before presenting the first cards, the experimenter showed the participant the list of nonsense syllables they could use during that session. The experimenter then removed the top cards from the deck, placed them in the card stands, and if the participant did not respond within 10 s during the first trial, instructed them to say one of the syllables listed on the sheet in front of them. After the participant uttered a nonsense syllable, the experimenter either awarded a point or deducted one. The experimenter recorded these points on a sheet of paper in front of the participant, announcing 'Point' or 'Point

lost' accordingly. Point delivery contingencies varied across conditions as described below. After delivering the appropriate consequence, the experimenter placed the cards, private stimulus side down, to the side and proceeded to present the next cards. This process was repeated until all the cards had been presented.

Positive Audience Condition

In the positive audience condition, the experimenter delivered points for reporting "KEZ" when public accompaniment 1 was present and removed points for any other report (i.e., "SUY", "NEY"). Similarly, the experimenter delivered points for reporting "SUY" when public accompaniment 2 was present and removed points for any other report (i.e., "KEZ", "NEY"). Finally, the experimenter delivered points for reporting "NEY" when public accompaniment 3 was present and removed points for any other report (i.e., "KEZ", "SUY").

Negative Audience Condition

In the negative audience condition, the experimenter removed points for reporting "KEZ" when public accompaniment 1 was present and delivered points for alternative responses (i.e., "SUY" or "NEY"). Similarly, the experimenter removed points for reporting "SUY" when public accompaniment 2 was present and delivered points for alternative responses (i.e., "KEZ", "NEY"). Finally, the experimenter removed points for reporting "NEY" when public accompaniment 3 was present and delivered points for alternative responses (i.e., "KEZ", "SUY").

Dependent Measures and Data Analysis

Correct Responses

We measured each participant's number of correct responses, out of ten possible private stimulus presentations per session, in each experimental condition. Correct responses were

defined as the reinforced vocal responses by the experimenter during positive audience sessions. Given that the participants encountered the same private stimuli and highly correlated public accompaniments in each session, regardless of audience condition, the number of correct responses in the presence of the private stimuli per session is an indicator of participants' discriminative responding in each audience context (i.e., positive, negative).

Acquisition Criteria for Tacts and Inclusion Criterion for Private Stimuli

The acquisition criterion for tacts was established to ensure that participants demonstrated a high level of accurate responding before proceeding to subsequent experimental conditions. The acquisition phase for a tact of private stimuli refers to any session during the first positive audience condition in which a participant's response accuracy for a given tact was less than 90%. The acquisition criterion was met when a participant's response accuracy reached or exceeded 90% for a given tact in any session during this initial positive audience condition. To advance to the subsequent condition, participants were required to meet the acquisition criterion for at least two of the three tacts for the private stimuli.

The inclusion criterion for private stimuli was established to facilitate analysis of the order in which private stimuli of varying magnitudes came to control participants' vocal tacts. The inclusion criterion is met when participants correctly identify a private stimulus at a specified level of degradation in two consecutive presentations across sessions, or if participants response accuracy for a given tact reaches or exceeds 90%. In the case that a participants response accuracy for a given tact reached or exceeded 90% during the second session, the second session was included in the subsequent analysis. However, participants did not need to meet this criterion to advance to subsequent conditions.

Experimental Design

A reversal design was used to assess the experimental control of the point contingency manipulations on participants' percentage of correct responses across conditions. The point delivery contingencies based on public accompaniments varied across audience conditions (i.e., experimenter presentations). That is, the private–public relations were the same across audience conditions, but the public accompaniments signaled different point delivery contingencies for the experimenter. The procedures for Experiment 2 of Stocco et al. (2014) included point contingency manipulations that were the same (i.e., constant) or varied across two audience member conditions. However, given that a single experimenter implemented all sessions with our participants, the constant sessions were omitted. Moreover, no signaled change across conditions occurred prior to participants encountering different consequences for their verbal reports. Differing from the procedures for Experiment 2 in Stocco et al., a listener contingency reversal was implemented for verbal reports. Rather than specifying an alternative correct report in the negative audience conditions, any report other than the reinforced response in the positive audience condition resulted in point delivery. It was expected that participant verbal reports would conform to the different reinforcement contingencies operating in the presence of each audience condition.

Data Collection and Interobserver Agreement (IOA)

The experimenters used pen and paper to record the public accompaniment present and nonsense syllable spoken by the participant on each trial. Experimenters referred to video recordings after each session to record the private stimulus present for each trial. Experimenters recorded the number of trials on which each verbal response, public accompaniment, and private stimulus occurred and the percentage of trials with accurate tacting of private stimulus was

calculated. An independent observer recorded data for a minimum of 25% of sessions for all participants. An agreement occurred when the same verbal response (e.g., “KEZ”), public accompaniment (e.g., public accompaniment 1), and private stimulus (e.g., private stimulus 1) were scored by both the experimenter and independent observer on a single trial. A disagreement occurred when the verbal response, public accompaniment, or private stimulus scored by the experimenter differed from that of the independent observer on a single trial. For example, if the experimenter scored the verbal response “SUY” on one trial, but the independent observer scored “NEY” on the same trial, that would count as a disagreement. Interobserver agreement was calculated by dividing the number of agreements by the number of trials and converting them to a percentage. The mean agreement was 98.8% for all participants (range, 97–100%).

CHAPTER 3: RESULTS

Results are shown in Figures 1–4. Figure 1 displays the percentage of correct stimulus–syllable tacts for each participant: P1 in the top-left panel, P2 in the top-right panel, P3 in the bottom-left panel, and P4 in the bottom-right panel. The correct vocal response for each private stimulus in the presence of the positive audience is indicated below the stimulus information in the left panel of each graph. Black circles represent the percentage of correct responses by participants across the positive audience sessions. White circles represent the percentage of correct responses by participants across the negative audience sessions.

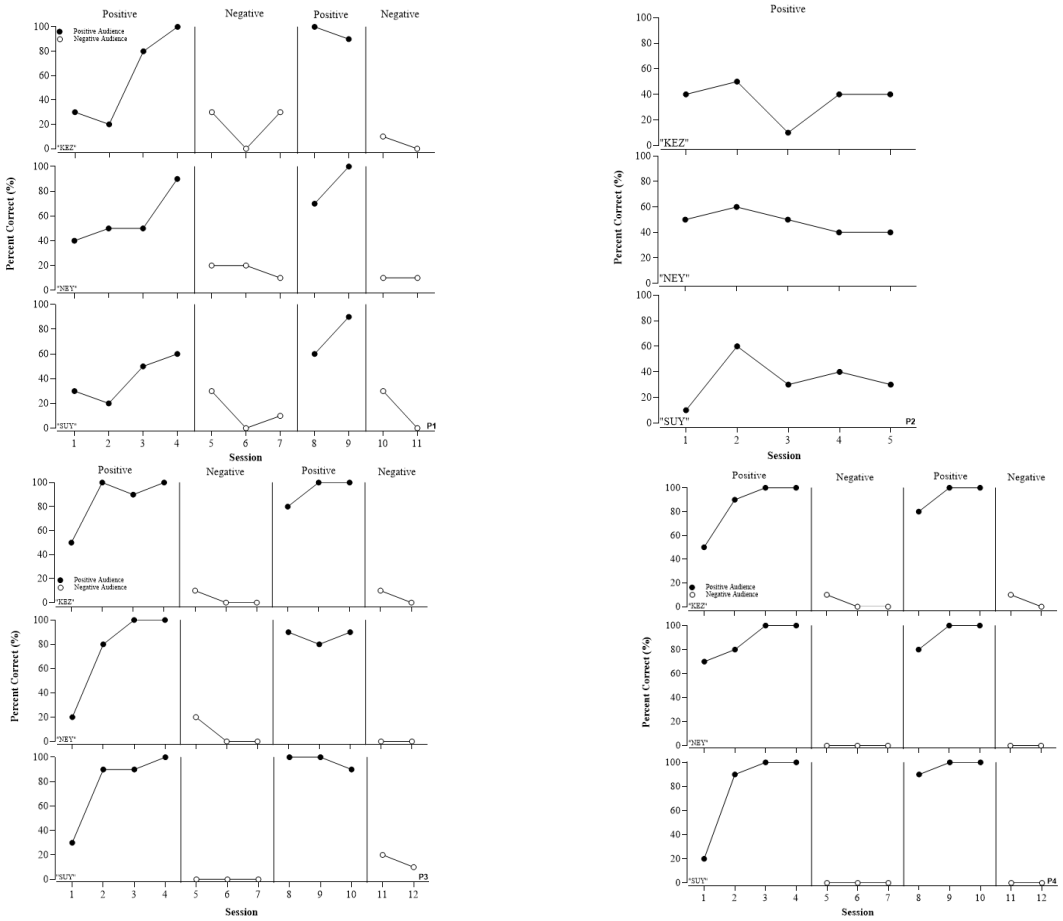
During the initial session, participants' accuracy in tacting the private stimuli was low, with P1, P2, and P3 at 33% and P4 at 47%. By the end of the initial positive audience condition, two of the four participants (P3 and P4) met the acquisition criteria for all three tacts of the private stimuli. Participant 1 met the acquisition criteria for two of three private stimuli. Participant 2 maintained a stable and low level of accurate responding, between 30% and 40% across all stimuli, did not meet the acquisition criteria for any tact of the private stimuli, and did not proceed to subsequent phases. During the initial negative audience condition, three out of four participants (P1, P3, and P4) exhibited immediate, low, and stable rates of engaging in the previously reinforced response with rates ranging from 0% to 30% for P1, 0% to 20% for P3, and 0% to 10% for P4. Upon returning to the positive audience condition, P1, P3, and P4 showed immediate, high, and primarily increasing rates of accurate responding, with rates between 60% and 100% for P1, 80% and 100% for P3, and 80% to 90% for P4. During the return to the negative audience condition, P1, P3, and P4 exhibited immediate, low, and generally decreasing

rates of engaging in the previously reinforced response, mirroring the rates observed during the first reversal.

During the initial session under the positive audience condition, Participant 2 labeled between 10% and 40% of the stimuli correctly, and by the fifth session, had maintained a stable and low level of accurate responding, between 30% and 40% across all stimuli. As previously noted, these low rates of accurate responses—falling below the acquisition criterion—resulted in Participant 2 not advancing to all experimental conditions.

Figure 1

Differences in Participants' Correct Responses Across Private Stimuli and Audience Conditions



(Figure 1 Continued)

Note. Correct responses were defined as the vocal responses that resulted in reinforcement in the positive audience condition.

Figure 2 displays the cumulative records of vocal responses for each participant in the presence of each private stimulus and across audience conditions. The records depict that within the initial positive audience condition, two of four participants (P3 and P4) vocal responses to the private stimuli conformed to the point delivery contingencies within 15 trials (second session). Participant 1's vocal responses to the private stimuli conformed to the point delivery contingencies within 30 trials (third session) for two of three private stimuli ("KEZ" and "NEY") and within 35 trials (fourth session) for the third private stimulus ("SUY"). Participant 2's vocal responses to the private stimuli did not conform to the point delivery contingencies and remained variable across five sessions.

During the initial negative audience condition, two of three participants' (P3 and P4) vocal responses to the private stimuli conformed to the point delivery contingencies within 1 trial (first session). Participant 1's vocal responses to the private stimuli conformed to the point delivery contingencies within 10 trials (first session) for one of three private stimuli ("SUY") and within 25 trials (third session) for two of three private stimuli ("KEZ" and "NEY").

During the return to the positive audience condition, all three participants' (P1, P3, P4) vocal responses to the private stimuli conformed to the point delivery contingencies within 5 trials (first session). During the subsequent return to the negative audience condition, all three participants' (P1, P3, P4) vocal responses to the private stimuli conformed to the point delivery contingencies within 11 trials (second session).

Figure 2

Differences in Participants' Cumulative Vocal Responses Across Private Stimuli and Audience Conditions

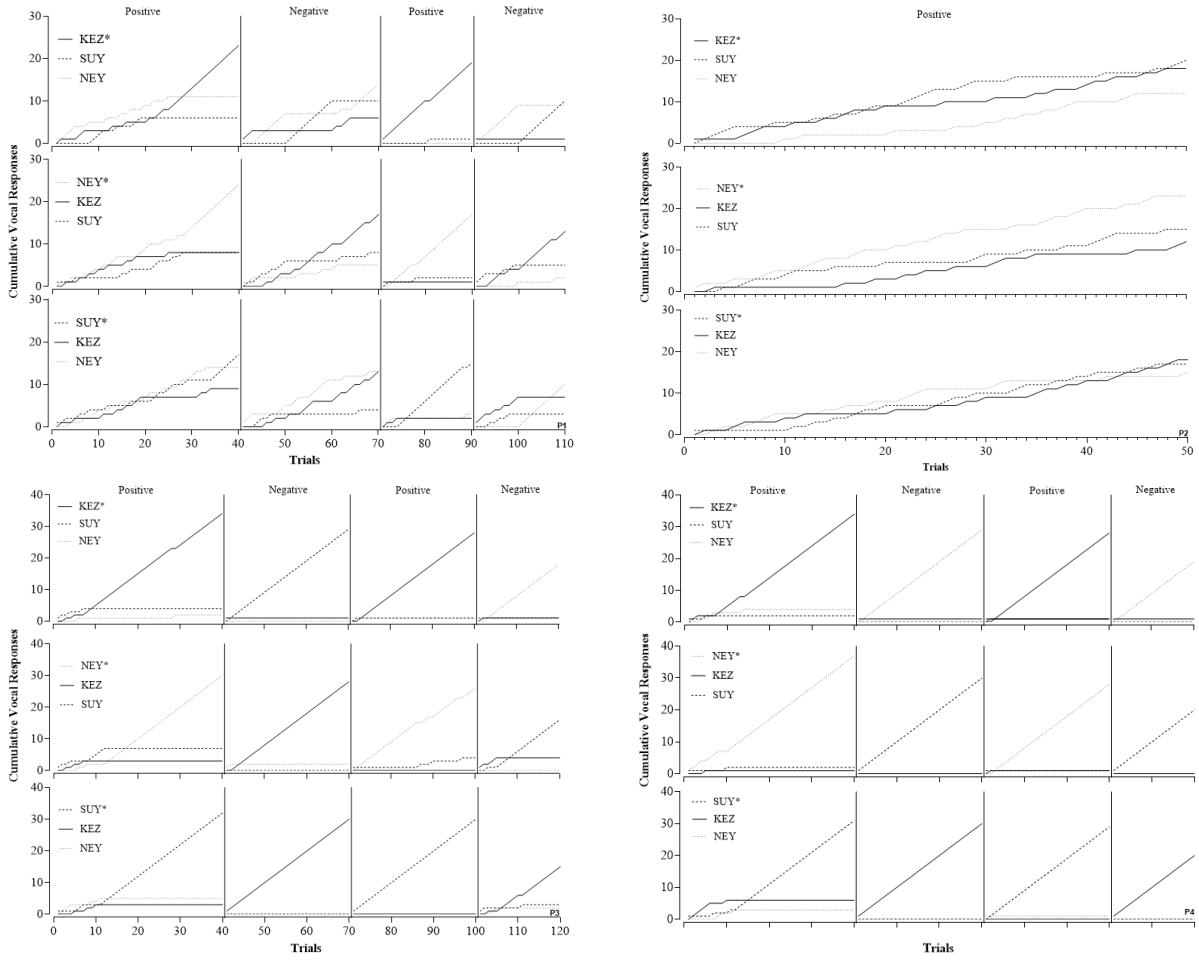
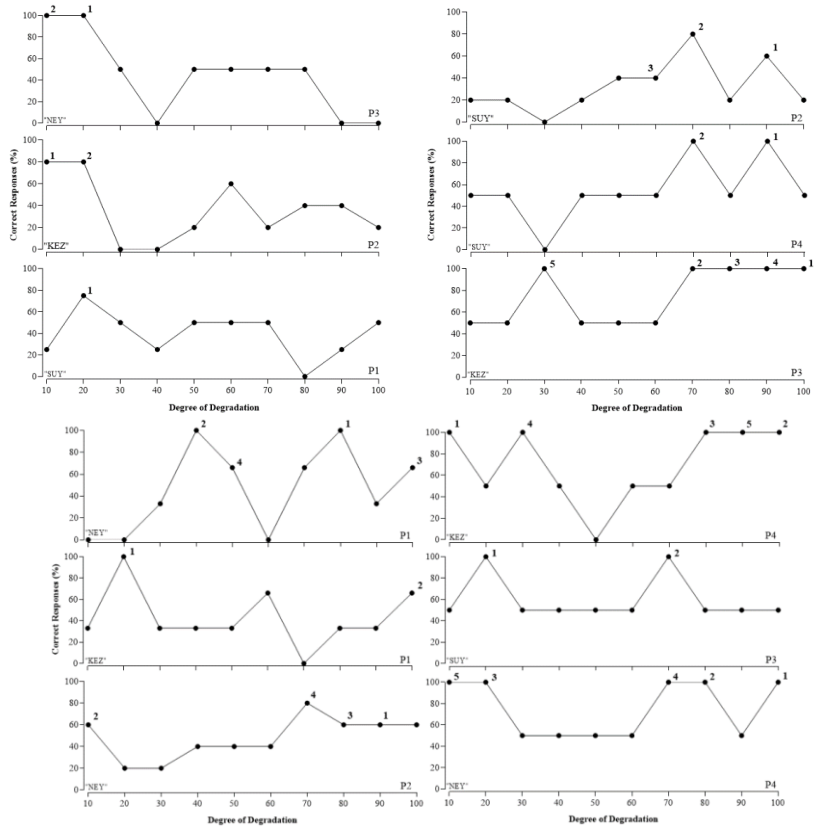


Figure 3 depicts the effects of stimulus degradation on participants' correct tacts of the private stimuli during acquisition. Numbers in Figure 3 illustrate the order in which participants met the inclusion criterion for a private stimulus at each level of degradation in acquisition. In visual analysis, three weak patterns of responding emerge. The top-left panel shows a direct relationship between the degree of stimulus degradation and correct responding emerged for participants who initially identified stimuli degraded to a minor extent (i.e., Participant 1, panel 3; Participant 2, panel 1; Participant 3, panel 2). The top-right panel shows an inverse

relationship between degree of stimulus degradation and correct responding emerged for participants who initially identified highly degraded stimuli (i.e., Participant 2, panel 3; Participant 3, panel 1; Participant 4, panel 3). The bottom panel shows a mixed relationship between degree of stimulus degradation and correct responding emerged for participants who initially identified stimuli that were highly degraded followed by stimuli degraded to a minor extent, or vice versa (i.e., Participant 1, panels 1 and 2; Participant 2, panel 2; Participant 3, panel 3; Participant 4, panels 1 and 2).

Figure 3

Differences in Participants' Correct Responses Across Stimuli by Degree of Stimulus Degradation



Note. Numbers denote the order of private stimulus acquisition by participants.

CHAPTER 4: DISCUSSION

Stocco et al. (2014) provided an empirical framework for investigating verbal responses about private events. We systematically replicated the procedures of Stocco et al. to further evaluate the conditions under which verbal responses can come under the control of private stimuli. Further, we investigated a private stimulus magnitude and listener contingency reversal on participants' accuracy when tacting private events. Three of the four participants met the acquisition criteria for tacts of private stimuli during the initial positive audience condition. In contrast, one participant did not meet the acquisition criteria for any of the tacts of private stimuli during the initial positive audience condition. Experimental control was demonstrated across the positive and negative audience conditions (i.e., listener contingency reversal). Our results suggest that tacts of private stimulation can be established regardless of magnitude when public accompaniments strongly correspond with private stimulation and listener reinforcement practices are stable in acquisition.

Our findings replicate the effects reported in Stocco et al. (2014) across all three participants who encountered both audience contingencies. Participants acquired discriminated responding to private stimuli across audience conditions, suggesting that both private stimuli and audience conditions acquired stimulus control of tacting. Moreover, participants demonstrated stable responding in accordance with the reinforcement contingencies in each audience condition, regardless of private stimulation magnitude. Our systematic replication of Stocco et al. (2014) implemented similar analog stimuli and point delivery contingencies across positive and negative audience conditions. However, the presented public stimuli in our experimental arrangement were perfectly correlated with the private stimuli to facilitate differential

reinforcement of the participants vocal responses across experimental conditions. This stands in contrast with the procedures reported in Stocco et al. (2014), where participants were presented with public stimuli that were highly (i.e., 80%) but not perfectly correlated with the private stimuli. Moreover, where the authors of Stocco et al. (2014) implemented a point removal contingency for some participants when responding in initial sessions was highly variable, we implemented a point removal contingency for inaccurate reports of private stimuli with all participants across conditions. As a result, participants in our experimental arrangement demonstrated discriminated responding in the presence of the private stimuli in fewer sessions than was reported for participants within the complex public accompaniment sessions in Stocco et al. (2014).

Our experimental arrangement did not specify the presented private stimulus's degree of degradation when the programmed verbal response first contacted reinforcement. The initially reinforced tact of any private stimulus (i.e., "KEZ") could occur at any degree of degradation (e.g., 80%) based on participants' random (i.e., not under the control of private stimuli and audience condition) initial responses. As a result, our experimental participants did not respond in accordance with our hypothesized linear generalization gradient. That is, we hypothesized that decreases in accurate responding would occur in direct relation to the degree of degradation of the private stimulus. Instead, the effect was idiosyncratic with respect to each participant's history of consequences within the experimental arrangement. Although three weak patterns of responding emerged during the acquisition phase (Figure 3), participants responding to the private stimuli was stable in accordance with the acting reinforcement contingencies across all subsequent experimental conditions.

The procedures of Experiment 2 reported in Stocco et al. (2014) required two experimenters who implemented the same point delivery contingencies (i.e., constant) and varied point delivery contingencies across sessions to assess the extent to which the presence of the experimenter acquired control of participants' tacts for private events. However, all conditions in this study were implemented by a single experimenter and only varied reinforcement contingencies were implemented. Across all three participants who encountered the negative audience condition, vocal responses quickly conformed to the programmed reinforcement contingencies (Figure 2). Our findings suggest that participants verbal responses to the novel private stimuli are sensitive to changing reinforcement practices by a member of the verbal community. Consider once more a college student visiting a dentist office claiming that their tooth aches. If a highly correlated public accompaniment (e.g., a tiny hole in the students tooth, unnoticeable to the untrained eye) is present when the student makes their claim to the dentist, the dentist will reinforce the student's tact of the private stimulation. As a result of the dentist's specialized training in identifying the public accompaniment, the dentist will inform the student that they have a cavity. In future instances, it is more likely that the student will identify the private stimulation of a toothache as a cavity, regardless of magnitude, so long as the dentists reinforcement practices are stable. With respect to the negative audience condition, consider a subsequent dental appointment where the same college student visits the dentist's office claiming that they have a cavity, and the same highly correlated public accompaniment is present. Following a brief examination with a magnifying tool, this time the dentist punishes the students tact of the private stimulation by informing them they have a tooth abscess. With respect to our experimental arrangement, the same private stimulus and highly correlated public

accompaniment may be present and only the listener's behavior with respect to the available public accompaniment may shift participants tacts of the private stimulation.

There are three primary limitations to our study. First, as a result of the increased correlation between the public and private stimuli implemented in our study compared to the stimuli presented in Stocco et al. (2014), we cannot be certain that the public stimuli did not acquire control participants vocal responses. Future methodological refinements may introduce experimental conditions following acquisition where public accompaniments are removed to directly assess public vs. private control of participants' tacts via changes in response accuracy.

Second, participants were presented with variable magnitudes of private stimulation across all experimental sessions. As a result of not controlling the magnitude of private stimulation presented when the programmed vocal response first contacts reinforcement, we did not establish an orderly relation between private stimulus magnitude and participants response accuracy. Our results suggest that the effect of private stimulus magnitude on participants response accuracy is minimized when public accompaniments are highly correlated with public stimuli and listener reinforcement practices are stable in acquisition. However, additional research is needed on the relationship between the initial acquisition of private stimulus tacts at a given magnitude and the development of private stimulus classes. Future researchers may consider the implementation of a pretraining/test arrangement common to stimulus generalization research (Guttman & Kalish, 1956), implementing pretraining with private stimuli of high magnitude (i.e., 0% degradation) to assess private stimulus generalization when tacting private stimuli across magnitudes.

Third, is that the use of the term "private stimuli" in our experimental arrangement captures only one of two components typically associated with describing private stimuli. Private

stimuli, as described by Skinner (1945), involve stimulation that arises from within the organism and is inaccessible to outside observers. As our experimental arrangement makes the private stimuli inaccessible to outside observers during sessions but does not evoke or elicit private stimulation originating from within the skin of the participant, it may be the case that private stimulation arising from within the organism have qualitative differences that we have yet to reasonably approximate in a laboratory setting. However, future researchers implementing analog arrangements to investigate private events empirically should continue refining their experimental preparations to assess additional dimensions of private stimuli that may be relevant to establishing private stimulus control, such as the physical similarity between private stimulus analogs and the duration with which the private stimuli are presented.

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Table 1

Private Stimulus–Public Accompaniment Relations and Reinforcement Practices in Each Audience Condition

	Private Stimulus 1			Private Stimulus 2			Private Stimulus 3		
Private Stimulus Reference Image (10% Degradation)									
Public Accompaniment Reference Image (Manipulation Highlighted)									
Public Accompaniment Manipulation	Left	Middle	Right	Left	Middle	Right	Left	Middle	Right
Private – Public Correspondence	100%	0%	0%	0%	100%	0%	0%	0%	100%
Response Reinforced by Positive Audience	KEZ	NEY	SUY	KEZ	NEY	SUY	KEZ	NEY	SUY
Responses Reinforced by Negative Audience	NEY / SUY	KEZ / SUY	KEZ / NEY	NEY / SUY	KEZ / SUY	KEZ / NEY	NEY / SUY	KEZ / SUY	KEZ / NEY
Participant Vocal Response	KEZ	NEY	SUY	KEZ	NEY	SUY	KEZ	NEY	SUY
Positive Audience Consequence	+1	-1	-1	-1	+1	-1	-1	-1	+1
Negative Audience Consequence	-1	+1	+1	+1	-1	+1	+1	+1	-1

Table 2

Private Stimulus Images, Vocal Tacts, and Degradation Levels

	Stimulus Degradation Levels									
	10	20	30	40	50	60	70	80	90	100
"KEZ"										
"NEY"										
"SUY"