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Experimental Analysis of Separate Functions of Two Aberrant Licking Topographies in an Adolescent with Traumatic Brain Injury

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EXPERIMENTAL ANALYSIS OF SEPARATE FUNCTIONS OF TWO ABERRANT LICKING TOPOGRAPHIES IN AN ADOLESCENT WITH TRAUMATIC BRAIN INJURY

by

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A Research Paper
Submitted in Partial Fulfillment of the Requirements for the
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Approved by:

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Experimental functional analysis has been successful in identifying environmental factors maintaining challenging behaviors and indicating effective interventions. However, an analysis for multiple topographies of behavior may yield imprecise hypotheses if those topographies are combined within the same contingency within the analysis and aggregated for analysis on a single graph. The current study explored the utility of separate graphing and independent analysis strategies during the assessment for two topographies of licking, “self” and “other.” A series of three analyses were conducted. Contingencies in the first analysis were programmed for both topographies. An analysis of each topography on separate graphs indicated separate functions; however, strong conclusions were not possible due to the presence of undifferentiated data. Next, contingencies for the second analysis were programmed only for self licking, and then contingencies for the third analysis were programmed only for other licking. Results strengthened the hypotheses that “other” licking was maintained by tangible reinforcement and “self” licking was maintained by automatic reinforcement. This study showed how independent analysis and separate graphing strategies may improve the precision of a functional analysis targeting multiple topographies, and demonstrated how very similar topographies may serve separate functions.

DEDICATION

This research is dedicated to my mother and daughter. Your inspiration reaches from past to future.

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CHAPTER 1

INTRODUCTION

Functional analysis is a powerful tool which informs intervention design by identifying the environmental conditions maintaining maladaptive behavior. Once the factors that influence behavior are known, intervention components can be selected based on their ability to disrupt maintaining contingencies or to reinforce adaptive replacement behaviors (Kennedy, 2000; Iwata, Pace, Cowdery, & Miltenberger, 1994; Mace, 1994; Repp, 1994; Sturmey, 1995). The utility of functional analysis methodologies for identifying functions of problem behavior has been well-established in the literature; the model has been flexible enough to generalize to a number of problem behaviors (Iwata, Pace, Dorsey, et al., 1994; Hanley, Iwata, & McCord, 2003; Mace, 1994; Sturmey, 1995). However, the wide variety of modifications and extensions demonstrated in the literature also implies that the methodologies present a number of limitations and challenges (Sturmey, 1995). Further research is needed to determine what conditions warrant modifications and to develop technologies which improve the sensitivity, precision and efficiency of functional analyses.

The methodologies utilized in the current study were based on the model described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) and Iwata, Pace, Dorsey, et al. (1994) because of its prevalence and its ability to provide direct and comprehensive analysis of multiple reinforcement relations. In a review of 277 published works that contained demonstrations of experimental functional analyses, Hanley et al. (2003) reported that this model accounted for 87% of the analyses. Although a number of experimental designs were utilized with this model (e.g., multielement, extended reversals, pairwise), and the literature demonstrated many procedural variations (e.g., varying dimensions of session duration, test number and type, etc.), the basic strategy for detecting functional relations was essentially the same. The model uses an ABC framework in which behavior is directly observed in the context of specific antecedent and consequent events that are either manipulated or controlled (Hanley et al., 2003; Iwata, Pace, Dorsey, et al., 1994). To test for a behavior's sensitivity to social reinforcement, the subject is repeatedly exposed to carefully controlled antecedent conditions which increase the likelihood of target responding, and the suspected environmental reinforcer is delivered contingent upon the occurrence of the target response while all other responses are ignored. To test if the behavior is sensitive to nonsocial reinforcement (automatic reinforcement; behavior that is reinforced by the sensory consequences that it directly produces) the subject is exposed to conditions that remove competing sources of stimulation and eliminate socially mediated consequences. Each of these test conditions may be compared to a control condition, in which the establishing operations for target behavior are eliminated and no contingencies for target behavior are programmed. When the target response occurs at differentially higher rates in one of the test conditions, then it is hypothesized as having a relation (or sensitivity) to that environmental variable. Said another way, the success of a functional analysis in determining environmental determinants of behavior depends on the extent to which the procedures systematically evoke the behavior of interest and demonstrate differentiation between test conditions.

Hanley et al. (2003) commended the model for its ability to carry out multiple tests concurrently and confirms its use in the literature as a comprehensive assessment tool. For instance, the report indicated that 89.2% of analyses included multiple test conditions. Significant proportions of studies included tests for social positive reinforcement in the form of attention (82.7%) or access to tangibles (34.7%), social negative reinforcement in the form of escape from demands (89.2%), or nonsocial (automatic) reinforcement (59.6%). Hanley et al. considered the model as comprehensive, not only because it could identify one function of behavior based on results generated from multiple test conditions, but also that it could concurrently provide evidence for additional functions. Conversely, by including multiple test conditions and a control condition within the analysis, the model can provide evidence that alternative hypotheses (including hypotheses for multiple functions) are less plausible.

The advantage of a conclusive and comprehensive analysis is clearer when considering how a hypothesis can effectively guide treatment. A hypothesis not only indicates mechanisms to change behavior but also contraindicates procedures that are ineffective or counterproductive. As an example, when a behavior serves to escape demands, escape extinction (continued demands contingent upon occurrence of problem behavior) may be recommended to weaken the target response-reinforcer relation. On the other hand, time-out or planned ignoring procedures may be contraindicated because they would be expected to reinforce the target behavior (Iwata, Pace, Dorsey, et al., 1994; Smith, Iwata, Vollmer, & Zarcone, 1993). Without the benefit of a clear or accurate hypothesis, a practitioner must decide whether to conduct additional analyses to clarify results or risk implementing a treatment that may exacerbate problem behavior or prove ineffective. The decision is difficult when extending the analysis would strain available resources or delay treatment for subjects whose behavior poses physical risks to themselves or others, or whose placement in a least-restrictive environment is in jeopardy.

It is just as important to assess behavior across a variety of conditions in order to detect or refute sensitivity to multiple sources of reinforcement. When a behavior is multiply controlled, a treatment designed to address a single function may improve behavior in one condition, whereas it may exacerbate behavior in different conditions (Smith et al., 1993). Using the example from above, time-out from reinforcement in the form of adult attention may effectively reduce attention-maintained behavior, but may exacerbate behavior that is also sensitive to escape from demands. Alternatively, behavior that is sensitive to multiple sources of reinforcement may not significantly be reduced until both maintaining contingencies are addressed (Lalli & Casey, 1996). For example, behavior that is sensitive to both escape from demands and automatic reinforcement may be only partially reduced by providing breaks contingent upon appropriate behavior and arranging escape extinction for the target problem behavior. Further reductions may require treatment that addresses automatic reinforcement of the behavior, such as providing preferred leisure materials during those breaks. These examples illustrate that when a functional analysis is limited to only one or few test conditions, important functions may be overlooked and treatments may be flawed or insufficient. Comprehensive analyses may safeguard against these risks by indicating treatments that can address all relevant functions.

One of the limitations of analogue functional analyses is that a number of them do not yield clear conclusions due to undifferentiated results (Kennedy, Meyer, Knowles, & Shukla, 2000; Iwata, Pace, Dorsey, et al., 1994; Smith et al., 1993). In a study of 20 children with severe aberrant behaviors, Vollmer, Marcus, Ringdahl, and Roane (1995) applied a systematic decision-making strategy to achieve differentiated results. They reported 50% of the analyses (results for 10 children) remained undifferentiated after brief and multielement methodologies were employed. Clarification of 7 of the remaining children was achieved by applying additional strategies as extensions. Specifically, five of the children (25%) continued to exhibit undifferentiated patterns that were consistent with automatic reinforcement, and results for 2 of the children (10%) achieved differentiation in social test conditions. Thus, results for 3 of the children (15%) remained inconclusive after investing additional time and resources. Furthermore, in an epidemiological study of 152 children exhibiting self-injurious behaviors, Iwata, Pace, Dorsey, et al. (1994) reported that results for 9.2% of functional analyses produced undifferentiated results. Half (4.6%) of these resulting data patterns appeared consistent with automatic reinforcement and treatment was applied without further confirmation of the hypothesis. Half (4.6%) remained inconclusive. Considering these two studies, it is difficult to say whether the prevalence of undifferentiated results generalize to other applications of the analysis model. It is possible their results are limited due to constraints in participant populations (i.e., referred populations, age, disability, disability characteristics), topographies targeted (i.e., self-injury and severe aberrant behavior), or the number of targets evaluated in each analysis. However elusive the prevalence of undifferentiated data may be, it is apparent that the standard model does not always yield clear results, and that extensions or modifications may be required to clarify results.

Hanley et al. (2003), in their comprehensive review of the functional analysis literature, confirmed that challenges due to undifferentiated results are pervasive across varied applications of functional analysis models. They reported 4.1% of analyses were undifferentiated. However, their results did not clarify the extent of the problem. The authors emphasized that this value may underestimate the proportion of analyses that were initially inconclusive because: (a) a number of analyses they scored as differentiated were initially inconclusive and subsequent analyses strategies (i.e. alternative experimental designs, control of idiosyncratic variables, alternative strategies for validating suspected relations) were employed to achieve differentiation; and (b) their sample does not capture data from failed or complex analyses which are less likely to be submitted or accepted for publication. The latter point is particularly concerning because it implies that undifferentiated results may occur at much higher rates in applied settings than has been reported in the research literature. Most importantly, it emphasizes that research is needed to address the causes and resolution of undifferentiated data in functional analyses.

Several studies have illustrated how behavior that is automatically reinforced by its direct sensory product may explain undifferentiated data patterns (Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Sidener, Carr, & Firth, 2005; Tang, Patterson, & Kennedy, 2003; Vollmer, Marcus, & LeBlanc, 1994). When the behavior directly produces reinforcing sensory consequences, then the reinforcer is available any time the subject is free to engage in that behavior (Piazza et al., 2000). This means that the functional reinforcer for automatically maintained behavior is essentially available in all functional analysis conditions. The extent to which a subject engages in the behavior to access this reinforcement may depend on the ability of other activities to compete with the sensory reinforcement. For instance, behavior that persists in the absence of social reinforcement may persist in the social positive reinforcement (i.e. attention) condition due to low amounts of stimulation available. It may persist in the social negative reinforcement (i.e. demand) condition because there are limited activities available during break periods, or tasks do not compete during demand periods. It may even persist in a test for social positive tangible reinforcement or a control condition if the leisure materials or attention provided do not effectively compete.

That a number of data patterns may be produced when automatically maintained behavior is assessed presents challenges for interpretation. When responding persists at similar levels in the absence and presence of social contingencies it is difficult to distinguish whether behavior in a social test condition is under exclusive control of social or nonsocial reinforcement, or whether behavior is maintained by multiple sources of reinforcement (Iwata, Pace, Dorsey, et al., 1994). Smith et al. (1993) illustrated this difficulty when one of their subject's SIB (self-injurious behavior) persisted across alone and attention conditions. This pattern suggested SIB was sensitive to both automatic and social positive reinforcement. However, upon implementing a nonsocial intervention (i.e., noncontingent access to a variety of stimulus materials) in the attention condition, SIB was nearly eliminated, providing evidence that SIB was automatically reinforced rather than multiply controlled.

It is important to point out that a hypothesis for automatic reinforcement in a routine analogue analysis is based on indirect evidence and it must be considered with some caution (Smith et al., 1993). Since the reinforcer for the behavior is not manipulated by any test condition (we neither block nor deliver the reinforcer) we do not demonstrate direct differential effects. We can, however, reduce the plausibility for an alternative social reinforcement explanation. Vollmer et al. (1995) pointed out that behavior that is socially maintained may carry over into a nonsocial test conditions due to the subject's failure to discriminate conditions, or due to an extinction burst occasioned when socially-maintained behavior no longer contacts reinforcement. They suggested when socially reinforced behavior is repeatedly subjected to conditions in which social reinforcement is unavailable (i.e., by extending nonsocial test conditions) it should eventually extinguish. When these researchers utilized this strategy with one subject, an extinction effect was demonstrated and subsequent condition reversals yielded differentiation in the social negative test condition (see Phase 3 and 4 results for Guy). It should be noted that this strategy may be somewhat limited when behavior is multiply controlled. In cases where the nonsocial test condition is extended and responding persists, support is provided for automatic reinforcement, but there remains the possibility that social reinforcement is responsible for target responding in social test conditions.

As the previous discussion eludes, undifferentiated data may result when behavior is multiply controlled. Studies reporting behavioral sensitivity to more than one source of reinforcement have occasionally been reported in the literature (Borrero & Vollmer, 2006; Day, Horner, & O'Neill, 1994; Kennedy et al., 2000; Lalli & Casey, 1996; Smith et al., 1993). For example, Lalli and Casey (1996) conducted an initial functional analysis that demonstrated differentiation for aggression in the attention condition, but less clear differentiation for the demand and tangible conditions. Treatment was conducted in a demand context and the subject was allowed to take breaks which included access to toys. However, significant reductions in aggression did not occur until social interaction was added to the break periods. Thereby, evidence was provided that aggression indeed served all three functions.

In another study, Kennedy et al. (2000) presented the case of one subject whose initial analysis demonstrated high and undifferentiated stereotypy in all conditions (attention, demand, and no attention) except for the control condition. These results suggested that stereotypy may be multiply controlled, but did not permit strong conclusions about how many distinct functions were operating. In a follow-up study, they utilized a multiple baseline across behavioral functions to demonstrate the effects of matched treatment effects. Each baseline represented a functional analysis condition and intervention involved reinforcing a trained alternative communication specific for the suspected function (i.e., raising a hand to access attention, signing "break" to escape demands, signing "more" to access preferred tangibles during the alone condition), respectively. Systematic reductions occurring when treatments were implemented provided evidence that the behavior was indeed serving all three functions. This case emphasized that the form of the behavior (i.e. stereotypy) did not predict function, rather a behavior that appeared to be automatically reinforcing proved to be sensitive to social reinforcement as well. The latter two studies emphasized the importance of assessing behavior across multiple contexts to detect multiple sources of reinforcement. Doing so may permit treatment to occur in all relevant contexts and address each function.

When multiple topographies of behavior serve separate functions, assessment results may become clouded (Derby et al., 1994). This is a particularly concerning issue because it is common practice for multiple response categories (or multiple topographies within a response category) to be targeted in functional analyses. Hanley et al. (2003)

report that as many as 27.8% of the analyses they reviewed targeted two or more topographies. They suggest that either cases of multiple control or separate control by different topographies may be, in part, responsible for the 4.1% of results that were inconclusive. Furthermore, they point out many of the cases reported as multiple control, may indeed be cases where multiple topographies having separate functions were analyzed together (14.6% of analyses were reported as multiple control; 36% of these involved studies of multiple topographies). Overall, these data suggest that combining separate topographies in an analysis may yield unclear or imprecise results and that the prevalence of this challenge may be greatly underestimated.

Derby et al. (1994) demonstrated a serious methodological concern for the functional analysis of multiple behaviors and offered a technology for resolving separate functions. According to Derby et al., the functional analysis of multiple topographies that serve separate functions may yield inconclusive or inaccurate results when data for all topographies are analyzed in aggregate. When these researchers assessed two aberrant response categories for each of four subjects, their initial functional analyses suggested automatic reinforcement as a maintaining function. However, due to either undifferentiated data patterns across multiple conditions, or due to elevated levels of responding for one response category relative to the other, these hypotheses were incomplete. When the topographies from each response category were analyzed on separate graphs, precise hypotheses were generated about separate functions for different response categories. Interestingly, in the initial analysis for two subjects, high levels of automatically-maintained stereotypy masked the functions of a more concerning topography, SIB. Had each topography not been analyzed separately, the riskier behaviors may not have been addressed in treatment. Not only was the Derby et al. study important in emphasizing that aggregate graphing may obscure separate functions, but also it illustrated that the functional analysis model was capable of distinguishing separate functions by making a simple modification to the data collection and analysis procedures.

Another methodological concern for aggregated analyses is exemplified in a study by Thompson, Fisher, Piazza, and Kuhn (1998). These researchers suggested that when a functional analysis includes multiple topographies, consequences delivered contingent upon one topography may alter the probability of another topography to the extent that the analysis fails to detect a relevant function. In their initial analysis, social attention was programmed for two forms of aggression, chin grinding on the therapist (defined as any chin-to-body contact) and other aggression (defined as hitting, kicking, pinching, and scratching). When high rates of chin grinding (later revealed to serve an automatic function) produced social attention, other aggression was suppressed (abolished) and its sensitivity to attention was overlooked. In other words, the value of attention as a reinforcer for other aggression was diminished when it became available for chin grinding, even though chin grinding was not functionally related to attention.

Subsequently, a second analysis utilized a reversal design to compare test phases in which attention was delivered contingent upon all aggression (chin grinding and other aggression) to phases where it was delivered only upon other aggression. The results showed that chin grinding persisted across all conditions; it was high in both test conditions and the control conditions (where noncontingent attention was provided). Other aggression rarely occurred when attention was available for all aggression, whereas it occurred almost exclusively when attention was delivered only for other aggression.

These results suggested that separate topographies may require independent analysis in cases where multiple functions are suspected in order to avoid a Type II error. Unfortunately, it was unlikely the technology of separating the topographies graphically (as suggested by Derby et al., 1994) would have detected both functions in the Thompson et al. (1998) study because providing contingencies for both topographies altered the response allocation toward aggression.

When a case arises where behavior is suspected of serving multiple functions it may be prudent to microanalyze several topographies of the same behavior to determine whether multiple topographies serve multiple functions. If separate functions for different topographies are operating, separate treatments may be indicated (or common treatments may be contraindicated). In the current study, we present a case of an adolescent girl whose aberrant licking appeared to have at least two distinct topographies: self licking (licking her own body or clothing) or other licking (licking objects and other people). Based on informal observation we suspected that licking was multiply controlled and that separate topographies may be sensitive to different and/or multiple sources of reinforcement (i.e., social and nonsocial). The primary purpose of our study was to evaluate the conditions maintaining each of the topographies. We also sought to extend the research of Thompson et al. (1998) and Derby et al. (1994) by applying strategies used in each study in a series of three functional analyses. The first assessment demonstrated a traditional functional analysis where contingencies were provided for both topographies and data was analyzed on aggregate and separate graphs. This permitted an evaluation of whether the separate graphing strategy was useful in specifying distinct functions of separate behaviors. Subsequently, independent analyses were conducted for each topography while the strategy of graphing topographies separately was continued. This permitted a more direct evaluation of the functions of each topography, attempted to detect any masked functions, and attempted to make alternative hypotheses less plausible. For instance, the second analysis provided contingencies only for self licking while other licking was ignored. The third analysis provided contingencies only for other licking while self licking was ignored.

CHAPTER 2

METHODS

General Method

Participant and Setting

One participant with a traumatic brain injury participated in this study. Trish was a 17-year old girl who was residing in a group home with at least five other adolescents with brain injuries. Trish sustained her injury at the age of eleven and she subsequently exhibited multiple physical, cognitive, and neurobehavioral impairments. For instance, she walked with an unsteady gait, she performed below her academic grade level, and she primarily communicated with single words or short phrases. Trish also required one-on-one assistance with most daily living tasks. The focus of this study was Trish's licking behaviors which date back approximately five years. Trish's licking included tongue or mouth contact to her own body or clothing, and to other objects and people in her environment. No underlying medical cause for her licking behavior had been hypothesized. Because Trish's licking was unsanitary and socially inappropriate, it was a barrier to her participation in typical community and academic environments. Although she received one-on-one assistance to participate in most activities, keeping her safe was difficult because she would sometimes place small, filthy, or sharp objects in her mouth, and would sometimes elope when assistance was provided. Thus, her licking indirectly posed risks for choking, cutting her mouth, or injury from falling (due to her unsteady gait). Based on informal observation, it appeared that some forms of the licking occurred across most of Trish's daily environments (e.g., touching an item and then licking her finger, or licking her own clothing) while others seemed to occur more episodically (e.g., licking another person on the arm or face). These observations led researchers to hypothesize that different topographies of the licking response may have contacted various sources of reinforcement and may now be maintained by multiple or separate reinforcement contingencies. A Differential Reinforcement of Other Behavior (DRO) intervention targeting one of the topographies of licking was partially successful in her academic setting, but her appropriate behavior had not generalized to any other setting or form of licking. This procedure consisted of differential reinforcement for the absence of direct mouth/tongue contact upon other people or items (other than food or her own body parts/clothing) during 2-min intervals. The procedure was conducted by her aide during 2-hr school sessions.

All functional analyses sessions were conducted in an off-site treatment center in a therapy room which measured 2.0 m x 3.7 m. The room had a single paned observation window covered with blinds, one or two stationary chairs (depending on the experimental condition), a locked standing cabinet, four locked upper cabinets, and an L-shaped countertop supported by three 2-drawer file cabinets (unlocked but empty). The room was modified to facilitate observation of her hands and mouth by placing three large mirrors on the walls. The only other materials present were specific to the experimental conditions.

Measurement System and Interobserver Agreement

Data for all functional analyses sessions were collected on two topographies of licking using a 10-s partial interval recording system. Each ten minute session was divided into 60 intervals. Session results were expressed for each response as the percent of intervals with occurrences. Self licking (SL) was defined as Trish placing her tongue or mouth on or around her own body part or clothing. Other licking (OL) was defined as Trish placing her tongue or mouth directly on or around an object, or another person's body part or clothing. For the purpose of analysis in Assessment 1, these response scores were combined to derive a third measure, aggregated licking. For instance, if an observer recorded either a SL or OL occurrence in the same interval, an aggregated licking occurrence would be derived for that interval. Observers recorded data from within the session room with a pencil and paper data recording sheet. Observers were instructed to withhold social attention from Trish and to avoid eye contact. Intervals were cued via an electronic recording device with headphones. Observers were graduate students who had obtained at least two 90% interobserver agreement (IOA) scores with another observer. A graduate student enrolled in a behavior analysis and therapy program acted as therapist for all sessions.

A second observer collected data simultaneously and independently in 47.6%, 57.6%, and 36.2% of sessions during Assessments 1, 2, and 3, respectively. Interobserver agreement (IOA) for each response was calculated on an interval-by-interval basis. An agreement was defined as both observers scoring an occurrence or a non-occurrence in the same interval. The total number of agreements was divided by the number of agreements plus disagreements, and then multiplied by 100% to determine percent IOA. Mean percent IOA for Assessment 1 was 96.8% for SL, 97.3% for OL, and 96.5% for aggregated licking. Mean percent IOA for Assessment 2 was 96.8% for SL and 97.7% for OL. Mean percent IOA for Assessment 3 was 96.1% for SL and 99.1% for OL.

Design

A series of three analogue functional analyses were conducted (corresponding to Assessments 1, 2, and 3) to determine maintaining contingencies for each topography of licking. Each of these three assessments followed a multielement design (Iwata, Dorsey, et al., 1982/1984) in which session conditions were alternated in a quasi-random fashion.

General Procedures

Paired stimulus preference assessment. Stimuli to be used in all three functional analyses were chosen prior to the first functional analysis via a paired stimulus preference assessment (Fisher, Piazza, Bowman, Hagopian, & Owens, 1992). Initially eight leisure items were identified for the assessment. Trish was familiar with all items. Prior to the assessment the therapist showed Trish each item while providing a brief description. Then all items were presented to Trish in pairs, she was allowed to choose one, and then she was given 3 min of access to that item. Each item was paired once with every other item, for a total of 28 presentations. In order to determine a preference hierarchy, percent of times chosen was calculated for each item by dividing the number of times chosen by the number of times presented, and then multiplying by 100%. Three highly preferred items were chosen for use in the tangible and play conditions: 20Q® electronic game (86%), Connect Four® electronic game (86%), and an electronic skateboard game (57%). Two moderately preferred items were chosen for use in the social attention conditions: A spinning light toy (43%) and a yo-yo ball toy (29%). The electronic skateboard game was removed from the study after session 21 in Assessment 1 because Trish had placed the entire game inside her mouth. Although the game was not a choking hazard (it was too large), putting the game entirely inside the mouth posed a risk for dental injury to Trish and a risk for bites to the therapist who retrieved items after sessions or within the tangible sessions.

General functional analyses procedures. Each functional analysis included five conditions, based on those described by Iwata, Dorsey, et al., (1982/1984): (a) social attention, (b) demand, (c) no attention, (d) tangibles, and (e) play. Contingencies within a condition were arranged differentially for one or both licking topographies as opposed to other behavior; however the data for the two topographical responses were collected independently. A description of each condition is provided below. Session order was determined in a quasi-random fashion, where no more than two of the same condition was conducted back-to-back on any given day. Prior to conducting sessions each day, a drawing (with replacement) was held to determine the order for that day. Sessions lasted 10 min and one to five sessions were conducted each day, two to five days per week. Contiguous sessions were separated by at least 5 min. Sessions continued until data paths for one or more conditions were differentiated, or when no differentiation occurred over time and data patterns were considered stable.

Social attention. In this condition, moderately preferred leisure materials were available. Prior to the session the therapist showed Trish each item and asked her to pick one. To start the session, the therapist handed the item to Trish and said, “I have some work to do.” The therapist then sat in a chair next to Trish and pretended to work on some paper work (e.g., wrote notes on a piece of paper). Contingent on the occurrence of a target response, brief attention was delivered by the therapist in the form of a gentle reprimand (e.g., “Stop, don’t do that!” or “That’s gross!”). If Trish attempted to lick the therapist on the eyes or mouth, the therapist averted her face slightly, but did not otherwise move away. No licking responses were blocked and all other behaviors were ignored by the therapist. If licking was continuous (e.g., mouthing a finger; multiple kisses in quick succession) the therapist continued to deliver a reprimand until after the target response subsided. No more than one reprimand followed the last target response when they occurred in this pattern. This condition served as the test condition for behavioral sensitivity to social positive reinforcement in the form of social attention.

Social tangible. In this condition, the therapist gave Trish access to highly preferred leisure materials for 30 s just prior to beginning the session. The therapist presented a choice of the preferred items by showing the items to Trish and allowing her to choose one. The session began when the therapist said, “My turn,” and simultaneously began removing the items. Once the items were removed, the therapist held them in her lap while sitting next to Trish. Contingent on the occurrence of a target response the therapist delivered the items for 30 s. When the 30 s expired, and with the stipulation that target behavior was absent for at least 5 s, the therapist removed the items away from Trish by saying, “My turn,” while simultaneously retrieving the items. All other responses emitted by Trish were ignored by the therapist. This condition tested if the target behavior was sensitive to social positive reinforcement in the form of access to tangible items.

Demand. In the demand condition, academic tasks were presented to Trish in a continuous fashion. Trish’s teachers identified academic tasks that she was capable of performing, but rarely completed without prompting. Text required for each task was printed on the front of a laminated index card (e.g., “She quickly shut her eyes” was typewritten on the card). Printed on the other side of the card, to facilitate task presentation and prompting, was the initial instruction (the task request) and an academic model. The initial instruction was a script that the therapist read to present the task, and it included a description of the task and the request to point to the correct answer (e.g., "Point to the adverb in this sentence"). The academic model was in the form of a grammatical rule (or hint) and/or a similar task example with a correct answer indicated (e.g., "An adverb tells when, where, why, or in what conditions something happens. Example: He slowly pulled on his shoes"). In all, sixty-five task cards were available for the assessment. The session began when the therapist said, "We have some work to do," and immediately presented the first task. The therapist delivered an initial verbal instruction (she read the request from the back of the card), and then she presented materials (the front of the index card) in Trish's line of vision. Trish was not allowed to take possession of the card. Noncompliance within 5 s resulted in subsequent prompts: the repeated request plus model (showing Trish the back of the card and reading the academic model), then the repeated request plus physical guidance. Compliance with the initial request, or the repeated request plus model, resulted in brief specific praise. For instance, the therapist labeled the behavior and provided approval (e.g., "Great job picking out the adverb"). Target responses resulted in task termination (a break) for 30 s, where materials were removed from reach and the therapist turned away from Trish and avoided eye contact. All other behaviors were ignored. After the 30-s break, task presentation was continued, with the stipulation that the target behavior was absent for at least 5 s. This condition tested for behavioral sensitivity to social negative reinforcement in the form of escape from demands.

No attention. In the no attention condition, Trish and the data collector(s) were present in the room, but no tasks or leisure materials were present. To start the session the therapist replied, "Wait in here until I come get you," and then left the room. No attention was available to Trish. No consequences were programmed for the target or other behaviors. This condition tested to see if the target response maintained in the absence of socially mediated reinforcement.

Play (control). In the play condition, Trish was provided with highly preferred materials and the therapist provided neutral comments and/or interaction at least every 30 s, with the stipulation that target behavior was absent for at least 5 s. In addition, the therapist returned any of Trish's social initiations with brief replies, comments, or attention (e.g., provided eye contact or directed facial expressions); however, any requests regarding study conditions/intent were ignored. No consequences were programmed for the target responses. All other behaviors were ignored. This condition was the control to which other condition results were compared. Non-contingent social attention was provided to control for the social attention condition, task demands were absent to control for the demand condition, and preferred leisure materials were present to control for the austere environment in the no attention condition.

Assessment 1

First Functional Analysis: Contingencies for Both Topographies

Procedure. The target behavior for this analysis included both self licking (SL) and other licking (OL). Data were collected on each response independently across all conditions. Contingencies in each social reinforcement test condition (i.e., social attention, demand, and social tangible) were programmed for both self and other licking. Otherwise, condition procedures were identical to those described in the general functional analyses methods. Providing contingencies for multiple behaviors was a practice that was commonly reported in the functional analysis literature (Hanley et al., 2003). Recording data for each topography simultaneously was a modification based on the work of Derby et al. (1994) that permitted the generation of hypotheses regarding the functions of each topography.

Assessment 2

Second Functional Analysis: Contingencies for Self Licking

Procedure. The target response for this analysis was self licking (SL). As such, contingencies in each condition were programmed for only self licking (SL) while data continued to be collected on both self licking (SL) and other licking (OL) independently. Trish's OL and all other non-targeted behaviors were ignored across conditions. Otherwise, condition procedures were identical to those described in the general functional analyses methods. These procedures enabled a more direct examination of the function of self licking, independent of other licking.

Assessment 3

Third Functional Analysis: Contingencies for Other Licking

Procedure. The target behavior for this analysis was other licking (OL). As such, contingencies in each condition were programmed for only other licking (OL) while data continued to be collected on both self licking (SL) and other licking (OL) independently. Trish's SL and all other non-targeted behaviors were ignored across conditions. Otherwise, condition procedures were identical to those described in the general functional analyses methods. These procedures enabled a more direct examination of the function of other licking, independent of self licking.

CHAPTER 3

RESULTS

Assessment 1: Results and Discussion

Figure 1 displays Trish's licking patterns during the first functional analysis. When SL and OL were displayed in aggregated form (top panel), licking levels were variable but highest in the tangible condition relative to the control and all other conditions. Trish's licking was moderate and variable, with undifferentiated data paths, in the play, demand, no attention, and social attention conditions. An analysis based on these aggregated data may lead one to conclude that Trish's licking served multiple functions. First, because Trish's licking in the tangible condition was differentiated at higher levels than in the control and other conditions, one might hypothesize all licking was sensitive to social positive reinforcement in the form of access to tangible materials. Then, because licking was sustained when social reinforcement was unavailable (i.e., the no attention condition), and similar patterns occurred across the play, demand, and social attention conditions, one might hypothesize that licking was also sensitive to automatic (sensory) reinforcement.

When SL and OL results were graphed separately, their separate contributions to the aggregated data patterns were revealed. Levels of SL (middle panel) were moderate and variable across all five conditions. The persistence of SL in moderate and undifferentiated levels across the control and all test conditions supported a tentative hypothesis that the SL topography was maintained by automatic reinforcement. That is, SL may have directly produced a sensory product that either positively or negatively reinforced the behavior. This automatic reinforcer was uncontrolled in that it was readily available during all functional analysis conditions, permitting it to occur simultaneously or successfully compete with activities in each condition.

Levels of OL (bottom panel) were shown to occur in moderate levels in the tangible condition, while remaining very low and stable in the control condition, suggesting behavioral sensitivity to positive reinforcement in the form of access to tangibles. Low and undifferentiated levels of licking were observed in the remaining test conditions. The OL pattern during the tangible condition was relatively stable, with the exception of the last data point (the session in which Trish inserted the electronic game into her mouth). These results suggested that the OL topography was maintained by access to tangible materials.

Further support for the OL hypothesis came from the review of within-session data patterns and the experimenter's anecdotal reports. During the tangible condition, OL was observed to occur almost exclusively when the therapist attempted to remove materials, rather than when materials were held by the therapist. Following nearly every attempt to remove materials, OL was the first licking topography to occur; therefore OL, rather than SL, almost exclusively produced the programmed contingencies. The OL response was so efficient, that Trish rarely lost possession of the preferred item and opportunities to emit responses during periods when the therapist held the item were diminished. For these reasons, the pattern of OL was closely related to the schedule for materials removal (after every 30 seconds of access), and the stable levels of OL may be explained by the consistency of that schedule.

Overall, Assessment 1 results were considered tentative for a number of reasons. First, Assessment 1 did not rule out multiple control of SL due to difficulties in interpreting undifferentiated data. For instance, it is possible that SL was controlled by social positive, social negative, and/or automatic reinforcement. A direct demonstration of experimental control over socially reinforced behavior was not possible, given the persistent responding in the control and no attention conditions and the threat of uncontrolled automatic responding across conditions. Thus, to what extent responding in the social test conditions (i.e., social attention, demand, or tangible) was maintained by uncontrolled automatic reinforcement versus programmed social reinforcement remained unclear. It was also possible that behavior maintained by social reinforcement contributed to responding in the no attention and control conditions due to intermittent reinforcement outside the analogue conditions, carryover (e.g., an extinction burst), or Trish's failure to discriminate changing contingencies. For instance, behavior maintained by attention may be occasioned by conditions of low stimulation in the presence of another person, which is a discriminative stimulus (S^D) signaling the availability of social attention (Hanley, Piazza, Fisher, & Adelinis, 1997). Hence, any SL which served to access attention may have continued to occur in the no attention condition in which a similar S^D was present (i.e., the observers may have served as an S^D due to a history of providing social attention contingent on SL). Yet, behavior such as this would be expected to extinguish in the no attention condition due to the absence of socially mediated reinforcement (Vollmer et al., 1994; Vollmer et al., 1995). Levels of SL persisted in the no attention condition across Assessment 1, permitting a number of interpretations: (a) SL was not sensitive to social reinforcement; (b) SL was sensitive to nonsocial and social reinforcement, but the variability in the data obscured small scale extinction effects for the portion of SL controlled by social reinforcement; or (c) SL was sensitive to social reinforcement, but, due to limited exposure to the no attention conditions (only 4 sessions were conducted in Assessment 1), observation of extinction effects were precluded. The two subsequent analyses continued to evaluate the influence of social and nonsocial reinforcement on SL.

Other reasons to cautiously interpret results stemmed from the findings of Thompson et al. (1998), which suggest that functional relations may not be detected when contingencies within an analysis are programmed for multiple topographies or behaviors. Specifically, consequences delivered contingent upon one behavior may suppress (or abolish) another behavior. In this first functional analysis, the delivery of social consequences contingent upon SL may have interfered with the detection of attention or escape functions for OL. For instance, if attention was already available following instances of SL (even if SL was not functionally related to attention), then there was no need for Trish to engage in OL to access the therapist's attention and OL may have been suppressed. Likewise, the delivery of tangible materials contingent upon OL may have interfered with the detection of a tangible function for SL. As previously mentioned, Trish reliably engaged in OL immediately after the therapist attempted to remove materials; therefore, materials were already made available contingent upon OL, and SL was no longer required. In other words, it is possible that tangible reinforcement available after OL may have suppressed (abolished) SL to levels that were undifferentiated, and a tangible function for SL may have been overlooked as a result. It is important to note that this alternative explanation is consistent with the notion of multiple control (SL is maintained by automatic and tangible reinforcement). In the two subsequent analyses (Assessments 2 and 3), the strategy of analyzing separate topographies independently was utilized in effort to empirically support or refute the plausibility of multiply controlled SL or OL.

Anecdotal reports regarding the task materials and patterns of behavior across demand and break periods seem worthy of remark in this discussion. First, Trish was observed to occasionally interact with the index cards by touching them with a finger and then licking her finger (or licking her finger and then touching the cards). It is possible that the cards may have served as discriminative stimuli, signaling that automatic reinforcement was available through interaction with the cards. This may be important because, should this be the case, SL levels may have been partially influenced by the rate at which task materials were presented, or by some other dimension of task presentation (e.g., task novelty, response effort to access the cards, duration of access periods).

Apart from the issue of whether task materials did or did not affect levels of SL, anecdotal reports regarding the demand condition may favor the hypothesis of automatic reinforcement over social negative reinforcement. Trish was generally compliant with demands, orienting toward materials and emitting tasks responses for most requests. However, when materials were removed contingent upon SL, she was observed on occasion to frown, ask, “why?” “why did you take the cards away?” or make negative comments (e.g., “oops,” or “darn”). Additionally, Trish was observed to interrupt licking her finger on more than one occasion. For instance, she touched an object, moved her finger very close to her mouth, then abruptly stopped the finger and moved it away. Although these reported behaviors were neither frequent, nor were they direct evidence of activity preferences, they may have indicated that Trish preferred the demand periods to the contingent break periods. A preference for the demand periods would reduce the plausibility of SL serving an escape function within this analysis. Finally, Trish's SL during the demand sessions was observed to occur in both demand and contingent break periods, whether task materials were or were not present. Persistence of SL in contingent break periods where Trish was functionally alone (no access to materials or the therapist's attention) suggests automatic reinforcement of the behavior (Goh et al., 1995).

Because the current procedures neither established a clear preference for demand periods over contingent break periods, nor provided data to compare proportions of SL occurring in the demand versus break periods, conclusions regarding the impact of the task materials or social negative reinforcement were somewhat unclear. In other words, these observations were consistent with an automatic hypothesis for SL, albeit they did not exclude an escape hypothesis. It was speculated that removing the escape contingency for SL in the demand condition of a future analysis (see Assessment 3) may help rule out an escape function if comparable or reduced levels of SL were demonstrated.

Overall, Assessment 1 generated tentative hypotheses that other licking was maintained by access to tangible materials, and that self licking was maintained by automatic reinforcement. Based on these results, two additional functional analyses were conducted to further evaluate the validity of these hypotheses and to reduce the threat of alternative reinforcement hypotheses.

Assessment 2: Results and Discussion

The results for Assessment 2 are displayed in Figure 2. When the contingencies were only arranged for SL, levels of SL (top panel) were moderate and variable across all five conditions. Despite demonstrating the highest mean percent of intervals in the tangible condition, levels of SL were not clearly differentiated, with at least half of the data points displaying significant overlap with data points from other conditions. The persistence of SL in moderate and undifferentiated levels across the control and all test conditions suggested that the SL topography may have been maintained by automatic reinforcement. Thus, when Assessment 2 results were analyzed independently, they generated an identical hypothesis about the function of Trish's SL as Assessment 1 results.

When Assessments 1 and 2 results were interpreted in series, the plausibility of the functional hypothesis for SL was strengthened while the plausibility of alternative hypotheses was reduced. First, the no attention condition in Assessment 2 was a direct replication, or extension, of the no attention condition from Assessment 1 (i.e., there were no procedural differences). Consistency across assessments suggested that SL in this condition was more likely maintained by automatic reinforcement and less likely to be influenced by social reinforcement because no extinction effect was observed over a combined total of 9 sessions. Second, Assessment 2 limits the plausibility of a Type II error, in which a tangible function for SL may have been overlooked in Assessment 1 due to the availability of tangible reinforcement following OL occurrences (see Assessment 1 discussion). In Assessment 1, OL produced tangible reinforcement almost exclusively, despite contingencies being programmed for both SL and OL. Had Trish's SL been sensitive to tangible reinforcement, and had it been suppressed (abolished) in Assessment 1, SL would likely have increased in Assessment 2 because tangible reinforcement was contingent upon SL exclusively. Yet, Trish's SL patterns were consistent in the tangible conditions across Assessments 1 and 2, whether SL produced access to materials or not. These data suggest that SL in the tangible condition was sensitive to automatic reinforcement rather than tangible reinforcement.

Third, Trish's SL patterns within the play, demand, and social attention conditions were consistent across assessments. This was to be expected because Assessment 2 closely resembled a replication of Assessment 1 for these conditions. In more detail, SL almost exclusively produced the programmed events in the test conditions (i.e., SL produced attention in the social attention condition, escape in the demand condition), and attention was delivered noncontingently in the play condition if no target behavior had occurred for 5s. Other licking rarely occurred in these conditions during Assessment 1. Assessment 2 was very similar to Assessment 1 in that SL exclusively produced the programmed events in the attention and demand conditions, and attention was delivered noncontingently in the play condition if no SL had occurred for 5s. No programmed contingencies were programmed for OL at all in Assessment 2. The replication in these conditions, together with the replication of the no attention condition and the consistent SL patterns across tangible conditions, represented additional support for an automatic reinforcement hypothesis.

Finally, based on Trish's increased exposure to experimental conditions, it is less likely that undifferentiated results occurred due to carryover or failure to discriminate changing conditions. In summary, SL data from Assessment 2 further supported an automatic reinforcement hypothesis, reduced the plausibility that SL was sensitive to tangible reinforcement, and reduced the plausibility that undifferentiated responding was the result of Trish's failure to discriminate between conditions.

When the contingencies were not arranged for OL, levels of OL (bottom panel) were variable and moderate, occurring almost exclusively in the tangible condition while remaining very low and stable in all other conditions. These were interesting results because no contingencies were directly programmed for OL; one might have expected that OL, in the absence of programmed contingencies, would have demonstrated an extinction effect across the 8 sessions in Assessment 2. Examination of the within-session data, together with anecdotal reports, revealed that the pattern of OL was similar to what was demonstrated in analysis one: Trish frequently engaged in OL immediately after the therapist attempted to remove materials. However, in Assessment 2, SL was the topography that produced access to preferred materials. Thus, when SL followed OL in temporal proximity, the resulting pattern resembled an intermittent reinforcement schedule for the OL. This may explain why OL did not show a pattern of extinction across sessions. Additionally, the therapist reported that the force with which Trish licked her in Assessment 2 was markedly increased or aggressive in nature, relative to Assessment 1. For instance, Trish licked the therapist on the ears, and face (as opposed to the hands or arms), sometimes the licks were harder and longer, and sometimes Trish would pull the therapist's arm or clothing to draw her close before licking the therapist. This increase in force and aggression was consistent with the behavioral body of literature describing negative side effects and emotional responding associated with removal of functional reinforcement (e.g., Lerman, Iwata, & Wallace, 1999). It was plausible that the increase in magnitude of OL and aggression represented initial stages of an extinction burst or extinction-induced aggression (Lerman et al., 1999), but that intermittent reinforcement ultimately maintained the behavior. Given this explanation, the resistance of OL to extinction and its increased magnitude contributed to, rather than refuted, a functional hypothesis of tangible reinforcement.

The hypotheses that SL was maintained solely by automatic reinforcement and OL was maintained solely by tangible reinforcement were still considered tentative for a number of reasons. Although Assessment 2 reduced the plausibility of tangible reinforcement for SL, the procedures did not rule out the possibility of sensitivity to adult attention or escape from demands. It was possible that SL levels in the social attention or demand conditions were influenced to some extent by social reinforcement. Also, Assessment 1 or 2 did not permit a direct evaluation of OL in the social attention and demand conditions, free from the contingencies provided for SL. In other words, there was still concern that multiple functions for OL went undetected due to interference of SL. Assessment 3 was conducted to further evaluate whether social reinforcement (i.e., attention or escape from demands) influenced SL or OL.

It is worthy of remark that Trish continued to interact with the index cards as she did in Assessment 1 (i.e., touching the cards, and then licking her finger, or licking her finger and then touching the cards). She also was occasionally observed to make negative comments or interrupt licking her finger when breaks were delivered in the demand condition, and SL persisted in both demand and break periods throughout sessions. These patterns appeared to be consistent with Assessment 1 results.

Overall, Assessment 2 provided support to refute a social tangible reinforcement accounting for SL, strengthened the hypothesis that SL was maintained by automatic reinforcement, and demonstrated OL patterns that were consistent with a tangible reinforcement function.

Assessment 3: Results and discussion

Figure 3 displays Trish's licking patterns for the third functional analysis. When the contingencies were only arranged for OL, OL (top panel) did not occur at all in the first tangible session, and it increased over three sessions to moderate and stable levels. Other licking almost exclusively occurred in the tangible condition, remaining very low and stable in other conditions. Thus, when Assessment 3 results were analyzed independently, they generated an identical hypothesis regarding the function of OL as Assessments 1 and 2.

In the context of Assessments 1 and 2, Assessment 3 OL levels were consistent with previous assessment data and visual inspection of the graph showed that the stability of the data more closely matched results from Assessment 1 (Assessment 2 OL levels were similar, but the variability in the data path persisted across sessions). Anecdotally, Trish no longer engaged in intensified OL, nor did she exhibit aggressive behaviors. Thus, Assessment 3 provided additional support for a single tangible function for OL, and further reduced the plausibility that OL was multiply controlled. This means that Assessment 3 limited the plausibility of a Type II error, in which a social attention or escape function for OL may have been overlooked due to the availability of reinforcement following SL occurrences in Assessment 1 (see Assessment 1 discussion). In the social attention and demand conditions of Assessment 1, SL produced the programmed social consequences almost exclusively, despite contingencies being programmed for both OL and SL. Had OL been sensitive to attention or escape as reinforcement, and had OL been suppressed (abolished) in Assessment 1, OL would likely have increased in Assessment 3 because reinforcement was contingent upon OL exclusively. Yet, OL patterns were consistently very low and stable in these conditions across Assessments 1 and 3, suggesting OL was not sensitive to social positive or negative reinforcement (i.e., attention or escape from demands, respectively).

Self licking patterns (bottom panel) remained moderate, undifferentiated, and variable across the play, no attention, attention, and tangible conditions. The SL pattern in the demand condition was slightly higher than in other conditions and displayed a slightly increasing trend over the analyses. The moderate and undifferentiated levels of SL across four conditions were consistent with an automatic reinforcement hypothesis. Thus when Assessment 3 results were analyzed independently, they generated an identical hypothesis for SL as did Assessments 1 and 2, even though procedures did not include contingencies for SL. Results for SL in the demand condition are discussed below.

When the three functional analyses were considered in series, Assessment 3 both strengthened the automatic hypothesis for SL and reduced the plausibility that SL was sensitive to social attention. Across all social attention test conditions of Assessments 1 and 2, in which SL primarily produced attention, Trish's SL levels were comparable. In Assessment 3, there were no longer programmed contingencies for SL. Instead, the contingencies were programmed for OL, and, in that OL rarely occurred, attention was rarely available. Had SL been sensitive to attention, SL would likely have decreased (i.e., demonstrated an extinction effect) in Assessment 3 due to the absence of social attention. Yet, SL persisted at comparable levels across all three assessments, whether attention was available or not. These data suggested SL was not sensitive to attention and were consistent with the hypothesis of automatic reinforcement.

The levels of SL exhibited in the demand condition were interesting for two reasons: (a) SL levels in Assessment 3 were slightly higher than levels observed in Assessments 1 or 2, and (b) SL was the primary contributor to licking in this condition, but SL was not the topography that produced contingent escape. In other words, SL responding was maintained by some source of reinforcement other than contingent escape in the form of 30-s breaks. A number of plausible explanations for this phenomenon were proposed. First, one might have hypothesized that SL was maintained by social negative reinforcement in Assessments 1 and 2, and that responding in the demand condition of Assessment 3 represented an extinction burst that was due to the absence of escape contingencies. However, this explanation is unlikely because SL not only failed to extinguish over 10 sessions, but also demonstrated a slightly increasing trend across sessions. Stated more precisely, increasing levels of SL in Assessment 3 reduced the plausibility that SL was sensitive to social negative reinforcement.

Alternatively, SL may have increased in Assessment 3 because the availability of automatic reinforcement was signaled by discriminative stimuli (the index cards) at a higher frequency than in Assessments 1 or 2. Trish was observed (across all assessments) to touch the cards and then lick her finger, or lick her finger before touching the cards. It is possible that the presence of the cards occasioned this particular topography because licking her finger after touching similar materials produced sensory reinforcement in the past. The cards may have represented a preferred stimulus with which she could obtain automatic reinforcement (relative to the ambient stimuli continuously available in the therapy room), or each card may have signaled the availability of novel sensory products. Moreover, each task presentation included a prompt to touch the card, which may have served to increase the saliency of the index cards as discriminative stimuli for licking, or to occasion touching the cards, which in turn, produced a sensation that served as a discriminative stimulus for licking her finger.

Although the cards were present in all three assessments, the frequency with which cards were available increased in Assessment 3 relative to Assessments 1 or 2. In Assessments 1 and 2, because breaks were delivered contingent upon SL, and because SL occurred at moderate levels, breaks were more frequent and the task materials were available discontinuously. In Assessment 3, because breaks were contingent upon OL, and because OL occurred at near-zero rates (OL was observed in only 4 intervals across 10 sessions), breaks were rarely available and the task materials were almost continuously available. Therefore, it is reasonable to suggest that SL may have increased in Assessment 3 as the frequency with which cards were accessible increased.

A third hypothesis was that SL was maintained by automatic reinforcement in all three analyses, but that breaks contingent upon SL in Assessments 1 and 2 had a slightly punishing effect on SL during the demand presentation periods. This hypothesis suggests that Trish preferred engaging in the task activities over experiencing the conditions during breaks, in which leisure materials and social interaction were unavailable. For instance, during Assessments 1 and 2, SL produced contingent removal of activities and social interaction. If break conditions were less preferred than demand conditions, then the probability of SL during subsequent demand periods may have decreased. Nevertheless, SL may have persisted during breaks because automatic reinforcement was available without a punishment contingency. The overall effect may have been a slight suppression of SL across the demand conditions in Assessments 1 and 2. In contrast, SL during the demand periods in Assessment 3 did not produce contingent breaks (and OL rarely produced breaks due to near-zero responding); therefore, automatic reinforcement was available throughout the sessions, relatively free from the influence of punishing consequences. Anecdotal reports from Assessments 1 and 2 may lend support to this hypothesis as Trish was occasionally observed to make negative comments when breaks were delivered, and she also appeared to interrupt SL on occasion (see discussions for Assessments 1 and 2 for examples).

Finally, it is possible that SL was maintained by automatic reinforcement, but that, due to satiation with reinforcement available for complying with demands (e.g., brief praise delivered by the therapist), task engagement in Assessment 3 no longer competed with SL as effectively as in prior assessments. As a result of decreasing the reinforcer effectiveness of task engagement, engagement in SL may have been altered through a number of mechanisms. For instance, a shift in response allocation from task responses to SL may have occurred due to the change in relative preference, even though forms of stimulation may have differed (Ahearn, Clark, DeBar, & Florentino, 2005; Vollmer et al., 1994). A variation on this explanation suggests that reductions in task engagement may result in relative activity deprivation, establishing automatic reinforcement for self licking as a more effective reinforcer (Cooper, Heron, & Heward, 2007). A different explanation suggests that, to the extent that task engagement is incompatible with self licking, the reduction in task engagement may simply present increased opportunities to engage in SL. In any case, this hypothesis suggests that the effects of satiation influenced responding indirectly by reducing the ability of task engagement to compete with SL (Cooper et al., 2007). It is also debatable whether satiation may have occurred slowly over time, across all three assessments, or whether Assessment 3 may have been particularly susceptible to satiation effects due to a denser schedule of demands presented to Trish. The former may imply SL levels in Assessment 3 were influenced by order effects, whereas the latter may imply the change in contingencies associated with Assessment 3 influenced SL.

Clearly, conclusions regarding the slight SL increase were not possible given these initial assessment data, and an extended analysis was expected to be complex and lengthy. Such an in-depth analysis was beyond the scope of the current study. However, it was encouraging that the three plausible explanations were consistent with the hypothesis that SL served an automatic function, and that no explanation necessarily excluded another. Given these consistencies with the SL hypothesis generated in Assessments 1 and 2, and because the increase in Assessment 3 was minimal, it was considered unlikely that a microanalysis of this phenomenon would significantly impact the overall functional analyses conclusions or treatment outcomes.

In summary, Assessment 3 strengthened the hypothesis that SL was maintained by automatic reinforcement, reduced the plausibility that SL was multiply controlled. It also strengthened the hypothesis that OL was maintained by tangible reinforcement, and reduced the plausibility that OL was multiply controlled.

CHAPTER 4

GENERAL DISCUSSION

In the current investigation, a series of three functional analyses were conducted to evaluate the environmental factors maintaining two topographies of licking exhibited by an adolescent with a traumatic brain injury. Results suggested that the topographies were maintained by separate sources of reinforcement. Other licking was maintained by tangible reinforcement, whereas self licking was maintained by automatic reinforcement. These results join the small body of research indicating that similar topographies of behavior may serve separate functions.

These results also extend the research regarding the functional analysis of multiple topographies of behavior in a number of ways. Assessment 1 provided support for the utility of separate graphing strategies described by Derby et al. (1994). According to Derby et al., the functional analysis of multiple topographies that serve separate functions may yield inconclusive or inaccurate results when data for all topographies are analyzed in aggregate. In their assessment, when data for multiple topographies were analyzed in aggregate first, and then analyzed on separate graphs, high levels of one topography appeared to mask the function of another topography on the aggregate graph. In Assessment 1 of the current case study, when SL and OL were aggregated on the graph, the analysis generated a hypothesis that all licking was under multiple control (i.e., all licking was sensitive to both tangible and automatic reinforcement). However, when the topographies were analyzed on separate graphs, more precise hypotheses were generated regarding separate sources of reinforcement. These results suggested OL was sensitive to tangible reinforcement, whereas SL was sensitive to automatic reinforcement. Although the analysis of the separate graphs did not indicate that behavioral functions were masked in the aggregate analysis (as demonstrated by Derby et al., 1994), they did enhance the analysis by permitting the specification of separate functional response classes for each topography of licking.

The hypotheses generated in Assessment 1, however, were considered tentative because they did not eliminate several alternative hypotheses. For instance, caution was warranted concerning the hypothesis of automatic reinforcement for SL. Although variable and persistent SL in all conditions is consistent with similar research hypothesizing an automatic-reinforcement of behavior (Piazza et al., 2000; Piazza, Fisher, et al., 1998; Vollmer et al. 1995; O'Reilly et al., 2010; Shore, DeLeon, Kahng, & Smith, 1997; Sidener et al., 2005; Tang et al., 2003), undifferentiated data patterns across conditions may have obscured the detection of one or more social reinforcement functions. That is to say, it was also plausible that SL was multiply controlled (Iwata, Pace, Dorsey, et al., 1994). The findings of Thompson et al. (1998) gave additional reasons to interpret Assessment 1 results cautiously. Thompson et al. suggested that when a functional analysis includes multiple topographies, consequences delivered contingent upon one topography may alter the probability of another topography to the extent that the analysis fails to detect a relevant function. Hence, aggregating contingencies for multiple topographies may result in the suppression of one or more topographies, and the analysis may overlook important functions.

Assessments 2 and 3 demonstrated how methodological extensions of Derby et al. (1994) and Thompson et al. (1998) addressed these concerns. In their discussion, Derby et al. suggested that separately plotting alternative responses (e.g., secondary targets or appropriate behaviors), even when the analysis does not program contingencies for them, may be helpful in evaluating whether one behavior alters another. Thompson et al. illustrated how comparing conditions in which the suspected functional reinforcer was delivered contingent upon only one topography versus all topographies facilitated detection of a function that was obscured in an initial aggregated analysis. In essence, this strategy compared a functional analysis for combined topographies to an independent functional analysis for a single topography. These suggestions, taken together, comprised the current strategy of conducting an independent functional analysis for each licking topography (contingencies programmed for one topography) while simultaneously evaluating the other topography on separate graphs. Thus, in Assessment 2, we designed conditions where only SL produced the programmed consequences and continued to plot SL and OL separately. Conversely, in Assessment 3, we designed conditions where only OL produced the programmed consequences and continued to plot each topography separately.

Although no functions beyond those indicated in Assessment 1 were discovered in this process, these methods were effective in strengthening our hypotheses generated in Assessment 1, and reducing the plausibility of multiple control. For SL, support for a single automatic function was generated when responding persisted at similar levels across all assessment conditions and across all three assessments (see below for an exception in Assessment 3), whether SL produced social consequences or not. For OL, the plausibility for multiple control was reduced by demonstrating near zero responding in the social attention and demand conditions, where OL was the only topography producing the programmed consequences. The data patterns also strengthened a tangible function for OL by replicating stable responding in a condition where only OL produced access to tangible materials.

Additionally, the blend of strategies (independent analyses for one topography at a time, while data were collected and graphed for all topographies throughout) permitted a more thorough assessment and may have indicated phenomena important for treatment design. For instance, Assessment 2 revealed that OL did not extinguish in the tangible condition when contingencies were programmed only for SL. This suggested that intermittent reinforcement, and perhaps even delayed reinforcement, was effective in maintaining stable levels of OL. One implication for treatment of other licking is that procedures to weaken the response-reinforcement relation (e.g., extinction and/or punishment) may be critical to achieve the desired outcome. Also, it may be prudent to avoid procedures that may reinforce a chain of behavior which includes OL (i.e., when OL occurs just before or after an appropriate behavior, and when reinforcement follows that chain; Contrucci Kuhn, Lerman, Vorndran, & Addison, 2006; Fisher et al., 1993). In another example, the higher levels of SL in the demand condition during Assessment 3 (relative to levels in Assessments 1 or 2) suggested that the change in contingencies may have influenced SL by altering stimulus events (e.g., establishing the value of automatic reinforcement, increasing the availability of discriminative stimuli, or eliminating punishing consequences). A thorough understanding of factors influencing SL may have predictive value for treatment generalization, or warrant further manipulation to facilitate treatment design. Unfortunately, the current study did not evaluate this phenomenon further; therefore any potential benefits were not afforded. In all, further research is needed to determine how the blend of these methods may facilitate assessment extensions or intervention design.

The ability of these methods to distinguish separate functions among multiple topographies has some practical implications for assessment and intervention. First, when multiple functions are determined, separate treatment components matched to each function may be indicated to effectively improve behavior (Day et al., 1994; Smith et al., 1993). However, because treatment components that address one function may be contraindicated for another function (Smith et al., 1993), options for treatment may necessarily be limited. For example, time-out procedures may be ill-advised in cases where problematic behavior is multiply controlled by attention and escape (Iwata, Pace, Dorsey, et al., 1994), or extinction for attention strategies may be contraindicated when problematic behavior serves to access both attention and automatic reinforcement (Iwata, Pace, Cowdery et al., 1994). In these situations, it is important to choose treatment components that are compatible. Another difficulty with treating behavior that is multiply controlled is that the change agent must decide which function the behavior serves at a given moment in order to implement the matched treatment component (Borrero & Vollmer, 2006; Smith et al., 1993). When multiple topographies are shown to serve separate functions, options for treatment may be increased, and implementation may be simplified. For instance, separate treatments for each topography may be conducted in conditions similar to the functional analysis baseline which produced the highest responding (Borrero & Vollmer, 2006). Alternatively, in less controlled conditions, the change agent may decide which component to implement based on the topography of behavior occurring at the moment. When topographies can be clearly discriminated as discrete occurrences, or when treatment can be carried out in separate conditions, treatment component compatibility may no longer be of concern.

The methods utilized in the current study may be useful in addressing a number of challenges that are commonly faced when multiple target behaviors are combined for functional analyses. The technologies employed may offer enhancements to common analysis strategies such as those proposed by Vollmer et al. (1995). Vollmer et al. suggested a decision-making model that progressed from brief functional analyses through extended analyses to achieve differentiation among test conditions. If, after brief and extended multielement analyses (Phases 1 and 2), responding persisted in the nonsocial test condition and was undifferentiated from one or more social test conditions, then extensions of the nonsocial test condition were suggested (Phase 3). The logic followed that if behavior was sensitive only to social reinforcement, then longer sessions (or repeated sessions) in the absence of social consequences would produce an extinction effect. Further analysis (extended reversals) to produce differentiation among social conditions could be conducted at this point to achieve differentiation. If, however, responding persisted at similar levels in the extended nonsocial test condition, then a hypothesis of automatic reinforcement could be adopted until treatment assessments could confirm or disconfirm the conclusion.

One limitation of this decision-making model is that when multiple topographies are assessed simultaneously, undifferentiated data may be explained by separate functions of separate topographies. Cases of multiple topographies having separate control may be an alternative explanation for persistence of responding in the nonsocial test conditions, even when those sessions are extended. That is, automatic reinforcement may be the primary maintaining factor in the nonsocial test condition, whereas social reinforcement may be a significant maintaining factor in one or more social test conditions. Application of the separate graphing strategies for separate topographies may facilitate the detection of separate functions when implemented in any of the first three phases. Of course, the improvements in precision and sensitivity permitted by the strategy would be most valuable at early phases of the model as they would likely streamline subsequent analyses.

The question of when it is best to implement independent analyses for separate topographies is more difficult to answer. Derby et al. (1994) pointed out that separate analyses may be warranted when preliminary information (e.g., a descriptive assessment) suggests separate functions for different topographies. However, a combined analysis may be a more reasonable option when multiple functions or separate functions are not suspected a priori, when assessment time is limited, or when a subject presents with more than two aberrant behaviors. Smith et al. (1993) suggest that once a combined analysis suggests the possibility of multiple control, then independent analyses of separate topographies may be useful. The current procedures follow a similar strategy, but incorporate the separate graphing strategies in the initial analysis to screen for multiple or separate functions. One benefit of this graphing approach is that separate, more precise hypotheses about each topography may be possible sooner than those generated by independent analyses. The investigator would have the option of implementing treatment or conducting more focused analyses on targets of interest at this point.

In general, one problem with conducting an initial combined analysis, whether separate graphing strategies are used or not, is that neither approach controls for a Type II error involving suppression of one topography due to availability of reinforcement for another topography (Thompson et al., 1998). Without independent analyses to rule out additional sources of reinforcement, treatment at this point may still be premature. Given that incomplete analyses can lead to substantial delays due to the necessity of re-designing assessments or treatments, conducting independent analyses initially may be worth the investment. Future research may compare these approaches along the lines of efficiency, precision, and treatment outcomes to determine best practices when multiple topographies are targeted.

Should separate analyses be performed first, perhaps the addition of separate graphing strategies for secondary topographies (those for which no contingencies are programmed) would be useful in detecting behaviors that are sensitive to automatic reinforcement. Such a strategy would be similar to the current Assessment 3, where SL persisted across conditions even though it was not producing programmed contingencies. If the secondary topography persists in the absence of social contingencies programmed for it, then support would be generated for an automatic reinforcement function and separate conclusions regarding the primary topography would less likely be threatened by Type II errors.

Additionally, investigators should explore how these methods can be improved by incorporating other technologies or by developing more efficient versions of similar methods. For instance, Goh et al. (1995) suggested a technique that may improve the ability to distinguish social negative reinforcement from automatic reinforcement. Within-session data may be analyzed in such a way as to compare the proportions of target responses occurring during task presentation periods versus break periods (when the subject is functionally alone). High proportions in the task presentation periods relative to break periods imply the behavior is maintained by social negative reinforcement. Conversely, high proportions in the break periods relative to task presentation periods imply the behavior is maintained by automatic reinforcement. In another example, perhaps within-session data analysis could also facilitate the detection of extinction effects of socially reinforced behavior that is carried over to other conditions, or satiation effects within a condition, especially when data are variable or undifferentiated. In a final example, Derby et al. (1994) proposed that combining brief assessments with separate graphing strategies may simplify combined assessments when multiple targets are presented, or when separate control is not suspected a priori. Future research should determine whether extending the use of brief analyses and separate graphing strategies during subsequent independent analyses would enhance the precision and/or efficiency of the assessment.

The suggestion that two topographically similar forms of behavior have separate functions is a noteworthy product of this investigation. Few examples have been published where separate functions are determined for separate topographies. Derby et al. (1994) presented four cases in which each subject presented with at least two aberrant response categories (e.g., self-injury and stereotypy; stereotypy and aggression; self-injury and aggression); in each case, separate functions for separate response categories were demonstrated. Thompson et al. (1998) presented one case in which two topographies of aggression, chin grinding (any chin-to-body contact) and other aggression (hitting, kicking, pinching, and scratching) served separate functions. Within these respective analyses, the topographies appeared distinct along a number of physical dimensions. In the current study, licking topographies only differed by the mode of interaction with the environment. For instance, SL required tongue or mouth contact with Trish's own body or her own clothing, whereas OL was defined as direct tongue or mouth contact with an object, another person's body, or another person's clothing. In that these very similar responses could be maintained by separate sources of reinforcement, and may require very different treatments, emphasizes the need to consider separate control for topographies which exhibit only subtle differences, or which differ only by their direct effect on the environment. A microanalysis of specific topographies may be necessary to design a functional analysis that is rigorous enough to precisely specify functional response classes. Future research should continue to explore how descriptive data (e.g., A-B-C) or data collected from standardized interviews can contribute to the process of designing effective functional analyses strategies when multiple topographies are targeted for intervention.

A number of limitations of this study should be discussed. First, the specific reinforcing stimuli for SL was not identified, nor was treatment assessment conducted to validate either function of licking due to time constraints. Generally, the treatment assessments generate support for functional hypotheses when they demonstrate reductions in target behavior that coincide with implementation of a treatment matched to the suspected function. In cases of multiple or separate control, the treatments are most often implemented for each functional response class, on baselines appropriate to respective behavioral functions (Borrero & Vollmer, 2006; Smith et al., 1993). Some studies present indirect evidence of an automatic reinforcement function by demonstrating improvement in the target after providing preferred materials either noncontingently (Smith et al., 1993) or contingently upon an appropriate communication (e.g., signing “more” for toys; Kennedy et al., 2000). These strategies do not directly manipulate the sensory product of the target behavior, rather they seek to compete with the sensory reinforcement. Some researchers extend the investigation in attempt to identify the specific sensory reinforcer in hopes that providing similar (matched) sensory stimulation will successfully shift responding to a more appropriate topography (e.g., Goh et al., 1995; Thompson et al., 1998). Alternatively, they may attempt to block the target behavior or mask the sensory product to weaken the response-reinforcer relation (e.g., Iwata, Pace, Dorsey, et al., 1994; Kurtz et al., 2003; Thompson et al., 1998; Tang, Patterson, & Kennedy, 2003). For instance, Kennedy and Souza (1995) reduced eye poking, which was reinforced by visual perceptual stimulation, by providing access to video games during treatment. Tang et al. (2003) identified visual perceptual stimulation as the maintaining factor of stereotypy for one subject by demonstrating systematic reductions coinciding with a visual screening procedure. These treatment assessments are considered more direct because the sensory reinforcer maintaining the problem behavior is manipulated or the behavior which can produce the reinforcement is interrupted.

It is important to note that treatments based on replacing the functional reinforcer for automatically-maintained behavior with similar stimulation may not always be a socially acceptable treatment. For instance, Thompson et al. (1998) assessed and validated the function of chin grinding by providing an artificial chin-grinding device. Although these procedures provided confirmation of an automatic function, the authors mentioned the device was socially unacceptable for their subject. An effective treatment extension was subsequently conducted where competing stimulation (toys) was provided instead. In Trish’s case, no item could be identified that would be sanitary or socially acceptable to place in her mouth. (Although gum would be socially acceptable item to place in her mouth, high levels of SL were observed while Trish chewed it.) Also, Trish's licking was so unpredictable, frequent, and quick that blocking the responses would not likely be accomplished with any integrity. It appears that in Trish's case, assessments involving the replacement of oral stimulation, or blocking taste or access to her mouth, may yield illustrative benefits, but would not likely facilitate design of a socially acceptable or sanitary treatment. One remaining positive strategy for reducing SL may involve providing alternative stimulation that competes with automatic reinforcement.

Another limitation is that no true alone condition was conducted with Trish. Because the observer(s) present in her no attention condition may have been discriminative for social attention, carryover from a social test condition may have been resistant to extinction, and responding in that condition may have clouded interpretation. An empirical demonstration of this phenomenon was illustrated by Hanley et al. (1997) when one subject's behavior persisted for 50 sessions when a therapist was present in the room, yet extinguished when left alone. However, this explanation is unlikely in the current study. Trish was exposed to many repetitions of this condition, yet SL levels persisted at consistent levels of SL across three lengthy assessments (no extinction effect was observed).

Results are also limited to one participant with unique topographies of aberrant behavior. It is not known to what extent these results would generalize to other behaviors, populations, or other cases of multiple or separate control. It is interesting that cases like Trish's have rarely been reported in the literature. In the Hanley et al. (2003)

review of functional analysis literature, data were presented to illustrate the prevalence of various populations and topographies studied. Persons with brain injuries did not appear to be represented as a population in these figures as they did not seemingly belong to the categories of developmental disabilities, autism, or typically developing. It appears that this is a population in need of further research. Additionally, licking topographies appear to be somewhat unique. Whether licking belonged in the categories of stereotypy, pica, or other was difficult to determine, yet the proportion of studies targeting these categories in combination was only 15.1%. It is especially interesting that this type of behavior emerged approximately one year following a traumatic brain injury. It could be that the sensory product of tongue and mouth contact with the environment was established as effective reinforcement due to biological injury to the brain. Alternatively, Trish's post-injury environment may have altered stimulus events in such a way as to occasion and reinforce licking behavior. Future functional analyses should continue to target the unique behaviors exhibited by persons with brain injuries and explore the impact of biological versus environmental factors in shaping and maintaining these behaviors.

Limitations regarding the assessment of social negative reinforcement warrant comment. First, the phenomenon associated with higher SL levels in Assessment 3 were not thoroughly investigated because complex follow-up assessments were judged to be beyond the scope of this study and unlikely to impact the current conclusions. All explanations discussed were consistent with the functional hypothesis of automatic reinforcement, and the magnitude of SL increase was minimal. Perhaps a more important issue stems from the unique design of the demand condition and how this may have limited our conclusions regarding the absence of escape functions. As mentioned in all three of the Assessment discussions, Trish appeared to tolerate, if not occasionally prefer, engaging in the tasks relative to experiencing escape periods where no materials or attention were available. It is possible that Trish's licking was sensitive to social negative reinforcement in the natural environment, but our analysis failed to establish escape as a reinforcer. Although the tasks were identified by her teachers as difficult for Trish to complete without prompting, it is possible that the context in which they were presented reduced the response effort or otherwise contained elements that Trish preferred. For instance, tasks were presented in multiple choice format and Trish was required to point to an answer rather than verbalize or write the answer. Among Trish's impairments were difficulty with expressive language and poor fine motor control; therefore, it is not difficult to imagine how a point response may have been easier than a written or verbal response.

Nevertheless, modifications to the demand condition were necessary to control for confounding variables. In a typical demand condition, the subject manipulates task materials and access to these materials is removed contingent upon target behavior. In Trish's case, these elements may have potentially introduced stimulus events (i.e., establishing operations or discriminative stimuli) that evoke behavior that would interfere with the evaluation of an escape function. For instance, it was suggested that taking task materials away from Trish may evoke behavior that is maintained by tangible reinforcement. It was also possible that providing free access to materials may increase the probability of licking that is sensitive to automatic reinforcement if the materials function as discriminative stimuli for such reinforcement. To reduce the threat of tangible or automatic reinforcement operating in the demand condition, Trish was not allowed to manipulate the task materials; rather she was required only to emit a point response. Although these procedures were somewhat unique, they balanced the presentation of difficult academic tasks (an establishing operation for escape) with protection from confounding threats. Given these difficulties in isolating stimulus events relevant to escape-maintained behavior, the current case study emphasized the importance of conducting direct observation across a number of contexts prior to analysis, in order to identify factors that may interfere with the functional analysis.

In conclusion, the current study demonstrates that the functional analyses of multiple topographies of behavior may yield incomplete or imprecise hypotheses about functions of multiple behaviors if those topographies are combined within the analysis and are aggregated for analysis on a single graph. More precise hypotheses regarding separate functions of different topographies may be possible when each topography is graphed independently for analysis, or when each topography is subjected to an independent analysis.

These strategies have important implications for the assessment and treatment of behaviors having multiple topographies. Separate treatments matching separate functions, or a single treatment that is compatible for all functions, may be indicated to effectively reduce aberrant behaviors. Of particular importance is that this study illustrates how topographies that differ in very subtle characteristics can be sensitive to different sources of reinforcement. These results imply that investigators should continue to strive for a categorization of behaviors by response classes instead of by topography. It may be the case that other behaviors which are traditionally categorized by topography may require more comprehensive analyses. For example, the response category of self-injury may include hitting one's head with closed fists or banging one's head directly on objects, but each may serve distinct functions. It may also be the case that some treatment failures are due to incomplete or imprecise analyses. For instance, when a combined analysis overlooks distinct functions for separate topographies, treatment may not address important reinforcement relations. The techniques demonstrated in the current study represent one small step toward a better understanding of the complexities involved in assessing multiple aberrant behaviors. Future research should continue to explore what cases warrant microanalysis of multiple topographies, and to develop technologies that enhance their functional analyses.

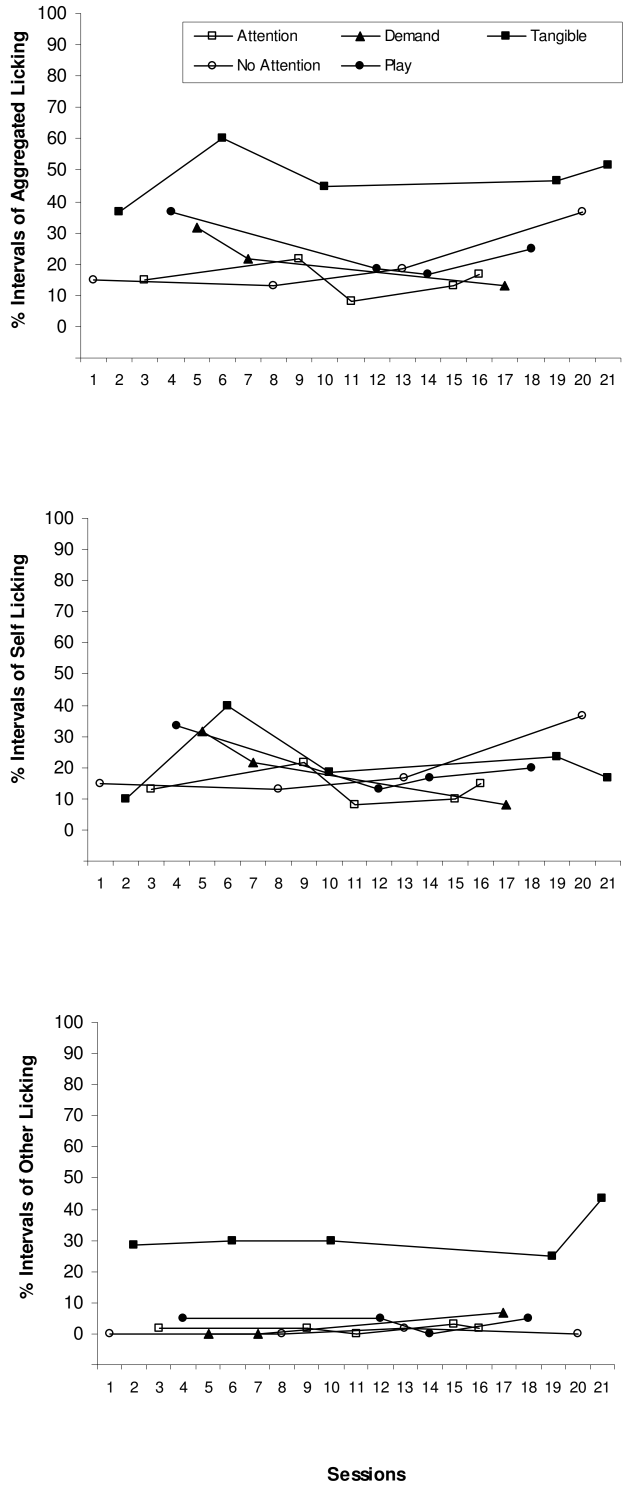

Figure 1. The percent of intervals of aggregated licking (top panel), self licking (middle panel), and other licking (bottom panel) during the five conditions of the first functional analysis (when contingencies were programmed for both self and other licking).

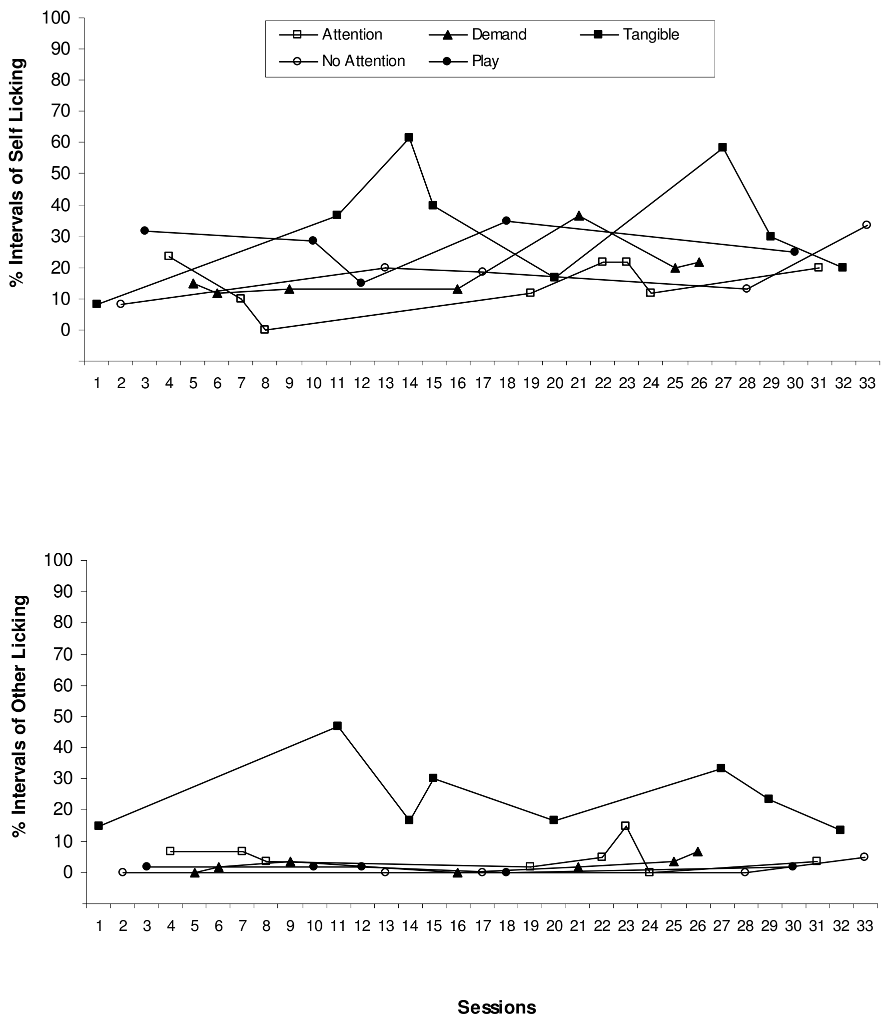

Figure 2. The percent of intervals of self licking (top panel) and other licking (bottom panel) during the five conditions of the second functional analysis (when contingencies were programmed for only self licking).

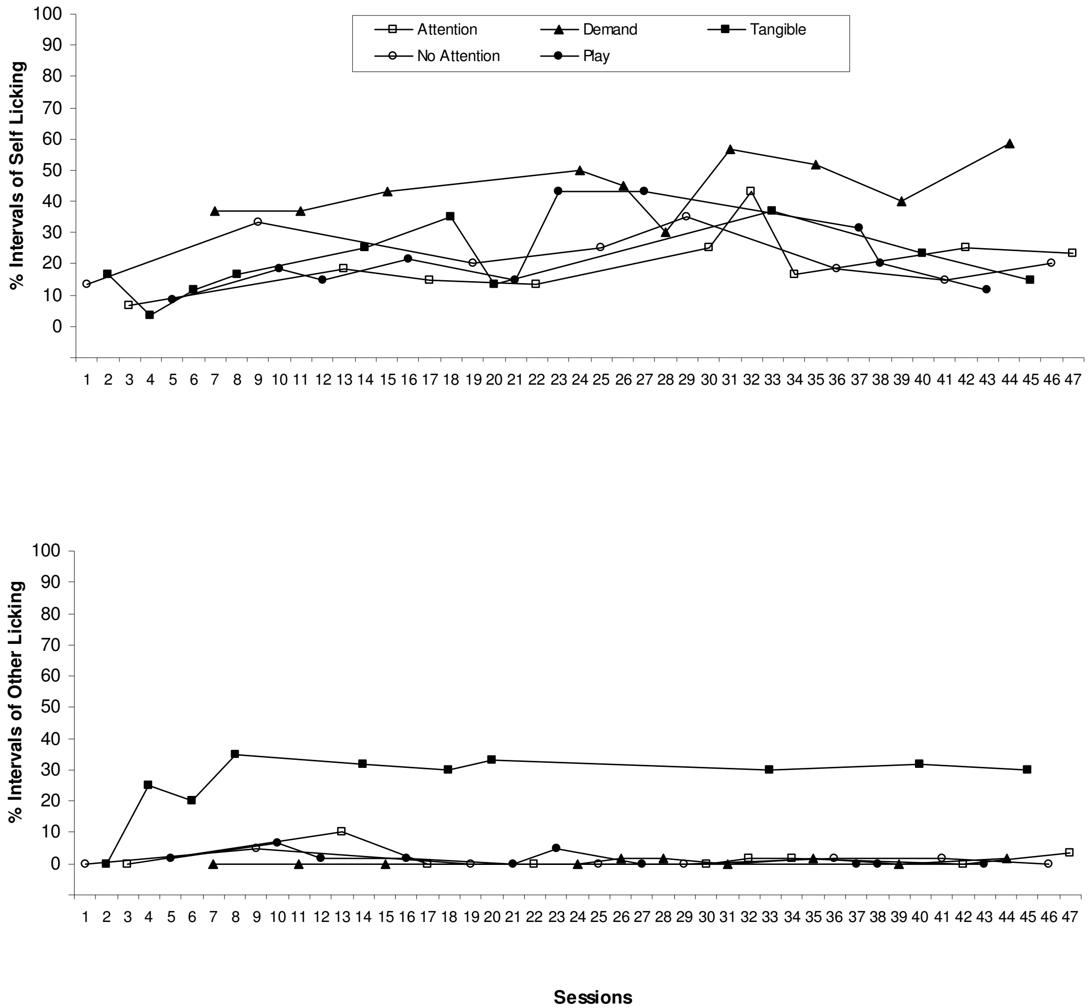

Figure 3. The percent of intervals of self licking (top panel) and other licking (bottom panel) during the five conditions of the third functional analysis (when contingencies were programmed for only other licking).

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