A COMPARISON OF RESPONSE-CONTINGENT STIMULUS PAIRING AND OPERANT DISCRIMINATION TRAINING TO ESTABLISH VOCAL STIMULI AS REINFORCERS

by

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Abstract

Conditioned reinforcers are used frequently in behavioural interventions for individuals with developmental disabilities. It is common to use several reinforcers in behavioural interventions to account for changes in preference over time and to reduce the likelihood of satiation (Moher, Gould, Hegg, & Mahoney, 2008). Conditioning procedures are effective for increasing the number of stimuli that function as reinforcers. Conditioning procedures might be particularly important for individuals with limited social reinforcers given social stimuli, such as praise, are delivered frequently as a consequence for appropriate responding. Although a number of studies have evaluated the effects of different conditioning procedures, there are no comprehensive guidelines or recommendations for establishing conditioned reinforcers. Additional research is needed to identify the most effective method(s) of establishing conditioned reinforcers. The purpose of the current study was three-fold: 1) to investigate whether there is a functional relationship between response-contingent stimulus pairing and increasing the reinforcing value of vocal stimuli, 2) to investigate whether there is a functional relationship between operant discrimination training and increasing the reinforcing value of vocal stimuli, and 3) to compare the relative effectiveness of response-contingent stimulus pairing and operant discrimination training to condition vocal stimuli as reinforcers for individuals with Autism Spectrum Disorder. Five individuals between the ages of 6- to 12-years old participated in the study. All participants were diagnosed with Autism Spectrum Disorder. An adapted alternating treatments design was used to evaluate the effects of response-contingent stimulus pairing and operant discrimination training on neutral vocal stimuli. Overall, the results showed that response frequency and session duration during reinforcer probes for response-contingent stimulus pairing and the S^D were higher following exposure to the conditioning procedures for three of five participants. These results indicate that both response-contingent stimulus pairing and operant discrimination training were effective in establishing vocal stimuli as conditioned reinforcers for some of the participants.

Lay Summary

Reinforcers are used frequently in behavioural interventions for individuals with developmental disabilities. It is common to use a variety of reinforcers in behavioural interventions. Conditioning procedures can expand the stimuli that are reinforcing for an individual. Conditioning procedures might be particularly important for individuals that do not yet find social interactions reinforcing, as social interactions are commonly provided as a consequence for appropriate behaviour. Although a number of studies have evaluated the effects of different conditioning procedures, additional research is needed to identify the most effective methods of conditioning stimuli. The purpose of the current study was to compare the relative effectiveness of two methods of making praise more valuable for individuals with Autism Spectrum Disorder. Five individuals between the ages of 6- to 12-years old participated in the study. Overall, the results showed that praise was more reinforcing following implementation of the conditioning procedures for three of five participants.

Preface

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List of Abbreviations

AATD = Adapted alternating treatments design

ABA SW = Applied Behaviour Analysis Support Worker

ASD = Autism Spectrum Disorder

BCBA® = Board Certified Behavior Analyst

CR = Conditioned response

CS = Conditioned stimulus

NS = Neutral stimulus

ODT = Operant discrimination training

RCSP = Response-contingent stimulus pairing

S^{Δ} = Stimulus delta

S^{D} = Discriminative stimulus

SPA = Stimulus preference assessment

SSP = Stimulus-stimulus pairing

UR = Unconditioned response

US = Unconditioned stimulus

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Chapter 1: Introduction

1.1 Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by repetitive behaviours and impairments in social communication skills (American Psychiatric Association, 2013). About 1 in 68 children are diagnosed with ASD (Centers for Disease Control and Prevention, 2012). Individuals with ASD may experience mild to significant impairment (Centers for Disease Control and Prevention, 2012).

Individuals with ASD may engage in various forms of repetitive motor and vocal behaviour (e.g., moving hands or body back and forth repeatedly, repeating words or phrases). Repetitive and stereotyped behaviours may interfere with learning new skills and meaningfully participating in social activities (MacDonald et al., 2007; Reese, Richman, Belmont, & Morse, 2005). Deficits in social communication skills among individuals with ASD often affect both vocal and nonvocal communication. Examples of social communication skills that may be impaired include reciprocal conversation, repetitive or stereotyped use of speech, eye contact, and initiating or responding to social interactions (American Psychiatric Association, 2013). Social communication deficits such as these can interfere with an individual's ability to develop and maintain relationships (American Psychiatric Association, 2013).

Decades of research have demonstrated applied behaviour analysis (ABA) to be an effective intervention for individuals with ASD (National Autism Center, 2015; Reichow, 2012; Wong et al., 2015). Furthermore, the efficacy of ABA in autism intervention is recognized by medical and psychological organizations (e.g., American Psychological Association, n.d.; Myers & Plauche´ Johnson, 2007; New York State Department of Health, 2017; U.S. Department of Health and Human Services, 1999; Volkmar et al., 2014). Applied behaviour analysts evaluate the environmental factors responsible for behaviour change and use the scientific principles of behaviour to improve socially significant behaviour (Baer, Wolf, & Risley, 1968). Interventions designed to reduce problem behaviour and teach adaptive skills often rely on the use of reinforcers such as activities and social interactions.

1.2 Reinforcer Identification

Reinforcement is a process in which a consequence follows behaviour and increases the probability of that behaviour in the future (Miltenberger, 2008). Identifying reinforcing stimuli is an essential component in the development of interventions for individuals with ASD. Reinforcer identification often involves a three-step process, including (a) a structured questionnaire or interview completed with people that are familiar with the individual, (b) a stimulus preference assessment (SPA), and (c) a reinforcer assessment (e.g., Fisher, Piazza, Bowman, & Amari, 1996; Karsten, Carr, & Lepper, 2011; Kelly, Roscoe, Hanley, & Schlichenmeyer, 2014). The following sections will provide a summary of procedures used in reinforcer identification.

1.2.1 Interviews

The first step in reinforcer identification is identifying stimuli to include in an SPA. Interviews with caregivers may help in developing a list of potentially preferred stimuli. Structured interviews containing both standard lists of stimuli and open-ended questions may help identify a more comprehensive list of high-preference stimuli than standard lists alone (Fisher et al., 1996). One such interview is the Reinforcer Assessment for Individuals with Severe Disabilities (RAISD; Fisher et al., 1996). The RAISD contains a series of open- and closed-ended questions designed to generate detailed information about an individual’s preferences for edible, leisure, tangible, and social stimuli. At the end of the interview, respondents are asked to select and rank the top 16 stimuli. The clinician directly assesses the individual's preference for the top-ranked stimuli using an SPA.

People who are familiar with an individual can contribute valuable information about a learner's preferences for stimuli (e.g., specific information about how to present high-preference social interactions). Furthermore, teachers and/or caregivers may prefer that some stimuli not be delivered in a classroom or therapy setting (e.g., hugs). Structured interviews such as the RAISD provide a tool for identifying both potentially preferred and caregiver-endorsed stimuli for inclusion in subsequent SPAs.

1.2.2 Stimulus preference assessments

The second step in reinforcer identification is conducting an SPA. Stimulus preference assessments are used to determine a hierarchy of potentially reinforcing stimuli. There are two main types of SPAs: (a) engagement-based SPAs and (b) selection-based SPAs (Hagopian, Long, & Rush, 2004). Engagement-based SPAs are used to evaluate the duration of engagement with stimuli (e.g., how much time is spent playing with a given toy). Examples of engagement-based SPAs include the free-operant preference assessment (Roane, Vollmer, Ringdahl, & Marcus, 1998) and the single-stimulus engagement preference assessment (DeLeon, Iwata, Conners, & Wallace, 1999). Selection-based SPAs measure whether or not an individual approaches or consumes a stimulus when presented with pairs or an array of stimuli. Examples of selection-based SPAs include the multiple-stimulus without replacement preference assessment (MSWO; Carr, Nicolson, & Higbee, 2000; DeLeon & Iwata, 1996) and the paired-choice preference assessment (Fisher et al., 1992).

Some types of SPAs may be more appropriate than other types of SPAs for a given individual. Clinicians select an SPA taking into account factors such as the learner's current behavioural repertoire as well as the type and number of stimuli being assessed. Karsten et al. (2011) developed and tested a progressive decision-making model to assist clinicians in selecting an SPA type. The model involved three steps: (a) conducting an SPA with stimuli nominated by people familiar with the individual, (b) modifying the SPA if challenges arose with the first preference assessment type, and (c) verifying SPA outcomes by conducting a reinforcer assessment. Using a decision-making model similar to that described by Karsten and colleagues may increase the likelihood of identifying high-preference stimuli that may function as reinforcers.

1.2.3 Reinforcer assessments

The third step in reinforcer identification is conducting a reinforcer assessment. In a reinforcer assessment, a stimulus is presented or removed contingent on a target response and its effect on behaviour is evaluated over time.

Reinforcer assessments can vary in at least two ways: (a) the schedule of reinforcement and (b) the number of response options. Schedules can be arranged as a fixed-ratio (FR) or progressive-ratio (PR). In an FR schedule, a reinforcer is delivered after a constant number of responses (e.g., FR1, FR5). When using a FR schedule, the reinforcing effectiveness of stimuli can be determined by assessing the response rates associated with different stimuli (Fisher & Mazur, 1997). In a progressive-ratio schedule, the response requirement increases within the session after every completed schedule (e.g., FR1, FR3, FR5). The last completed schedule is the break point for a given stimulus (Roane, Lerman, & Vorndran, 2001). In a PR schedule, the reinforcing effectiveness of stimuli can be determined by assessing the break points (Roane et al., 2001). The reinforcing effectiveness of a stimulus may vary under different schedule requirements (DeLeon, Frank, Gregory, & Allman, 2009; DeLeon, Iwata, Goh, & Worsdell, 1997; Francisco, Borrero, & Sy, 2008; Glover, Roane, Kadey, & Grow, 2008; Tustin, 1994). For example, Tustin (1994) evaluated the effects of increasing schedule requirements on response rates and found increasing work requirements may decrease the value of reinforcing stimuli.

The number of response options may also affect the reinforcing effectiveness of a stimulus. In a single-operant reinforcer assessment, the reinforcing value of each stimulus is evaluated independently from other stimuli. A single-operant reinforcer assessment assesses the absolute reinforcer value of a stimulus. In a concurrent-operant reinforcer assessment, an individual's relative preference for a given reinforcer is determined by how much responding is allocated to that stimulus compared to other concurrently available stimuli (Fisher & Mazur, 1997). Two stimuli that produce similar response rates in a single-operant reinforcer assessment may produce differential responding in a concurrent-operant reinforcer assessment because the individual must choose between the two stimuli (Francisco et al., 2008; Roscoe, Iwata, & Kahng, 1999). Furthermore, stimuli that do not function as reinforcers in a concurrent-operant reinforcer assessment may function as reinforcers in a single-operant reinforcer assessment because the absolute reinforcement efficacy of given stimulus may be masked by the availability of another, more potent, reinforcer (Francisco et al., 2008; Roscoe et al., 1999). Thus, the number of available response options affects the reinforcing efficacy of stimuli.

1.2.4 Reinforcer identification: Summary

Reinforcer identification often involves (a) interviews with people that are familiar with the individual, (b) an SPA, and (c) a reinforcer assessment (e.g., Fisher et al., 1996; Karsten et al., 2011; Kelly et al., 2014). An important goal of intervention for individuals with ASD is increasing appropriate behaviour maintained by contingencies in everyday settings. Parents and teachers frequently provide social stimuli (e.g., saying, "Good job") assuming the stimuli function as reinforcers; however, research has shown that common social stimuli, such as praise, may not function as reinforcers to increase appropriate behaviour for individuals with ASD (Dozier, Iwata, Thomason-Sassi, Worsdell, & Wilson, 2012; Greer, Singer-Dudek, Longano, & Zrinzo, 2008; Piazza et al., 1999). Given the ubiquity of social stimuli, there is a need to develop procedures to increase the reinforcing effectiveness of social stimuli that are delivered frequently by caregivers and teachers.

1.3 Conditioning Procedures

Clinicians identify reinforcers using the strategies discussed in the previous section (see Reinforcer Identification). It is common to use several reinforcers in behavioural interventions to account for changes in preference over time and to reduce the likelihood of satiation (Moher, Gould, Hegg, & Mahoney, 2008). Conditioning procedures are used to increase the reinforcing effectiveness of stimuli. Conditioning procedures might be particularly important for individuals with limited social reinforcers given social stimuli are often delivered as a consequence for appropriate behaviour.

Some early intervention manuals provide recommendations for the development of potential reinforcers through conditioning procedures (e.g., Greer & Ross, 2008; Leaf & McEachin, 1999; Lovaas, 2003). However, the procedural guidelines provided in such manuals are often vague and do not contain sufficient detail to implement the procedures (Leaf & McEachin, 1999; Lovaas, 2003). For example, some manuals describe conditioning procedures as a process in which the neutral stimulus (NS) is repeatedly paired with established reinforcers (Leaf & McEachin, 1999; Lovaas, 2003). This description of a conditioning procedure is problematic because no information is provided about how to arrange the temporal order of the

NS and unconditioned stimulus (US). Furthermore, no information is provided regarding what to do when pairing alone is ineffective (Leaf & McEachin, 1999; Lovaas, 2003).

1.3.1 Respondent conditioning

Behaviour analytic researchers have developed a variety of conditioning procedures to establish reinforcers. Conditioning procedures can be broadly classified as respondent or operant conditioning. The following sections will review respondent and operant conditioning procedures.

Respondent conditioning is also known as classical conditioning or Pavlovian conditioning. Ivan Pavlov, a physiologist, was the first to describe respondent conditioning. While studying the salivation reflex in dogs, Pavlov observed that the dogs salivated in the presence of stimuli that had been paired with food, even in the absence of food. This discovery and related findings can be explained in terms of antecedent stimuli and responses. First, a US elicits an unconditioned response (UR). Pavlov observed that food (a US) elicited salivation in his dogs (the UR). This reflex is an unlearned relation between an environmental stimulus and a physiological response (i.e., a reflex relation or US-UR relation). If a NS, such as a sound, is paired with a US (e.g., food), the sound is established as a conditioned stimulus (CS) that elicits salivation, now a conditioned response (CR). A related conditioning procedure is higher-order respondent conditioning. In higher-order respondent conditioning, an NS is paired with an already established CS. After repeated pairings, the NS is established as a CS that elicits a CR (Miltenberger, 2008).

A number of procedural variations may affect the speed of training and the likelihood that a relation will be established in respondent conditioning. One variation is the temporal ordering of the NS and the US. In simultaneous conditioning, the NS is presented in close temporal proximity to or simultaneously with the US (Catania, 2007). Trace conditioning and delay conditioning are similar to simultaneous conditioning, but there is a longer delay between the presentation of the NS and the presentation of the US (Catania, 2007). In addition, in delay conditioning, the onset of the NS occurs before and overlaps with the US; in trace conditioning, the presentation of the NS is terminated before the US is presented (Catania, 2007). Finally, in backward conditioning, the US is presented before the NS (Catania, 2007).

Another factor that may increase training time and interfere with the development of an association between the NS and US is an individual's history of exposure to the NS (Lubow, 1965). Pre-exposure to the NS in the absence of the US may interfere with the acquisition of a CS and the related CR (Lubow, 1965; Lubow & Moore, 1959). This process is known as latent inhibition (Lubow, 1965; Lubow & Moore, 1959). There are two general categories of theories that aim to explain latent inhibition. First, latent inhibition may occur because the individual habituates to the NS (e.g., Reiss & Wagner, 1972). Said differently, there is a reduction in the salience of the stimulus (Reiss & Wagner, 1972). Second, latent inhibition may occur because during pre-exposure, the NS does not reliably predict the onset of any stimulus, and this learning history interferes with the establishment of a CS-US relation (e.g., Westbrook, Jones, Bailey, & Harris, 2000). While there is not yet a widely accepted explanation for latent inhibition (Lubow & Weiner, 2010), it is clear that pre-exposure to the NS interferes with the acquisition of a CS (Lubow, 1965; Lubow & Moore, 1959; Reiss & Wagner, 1972; Westbrook et al., 2000).

A number of procedures based on respondent conditioning have been developed for use in behaviour intervention programs. The following section will describe behavioural interventions based on respondent conditioning.

1.3.1.1 Stimulus-stimulus pairing

Stimulus-stimulus pairing (SSP) has been applied to increase vocalizations in individuals with ASD and speech delays (e.g., Esch, Carr, & Grow, 2009; Miguel, Carr, & Michael, 2002; Miliotis et al., 2012; Rader et al., 2014; Stock, Schulze, & Mirenda, 2008; Yoon & Bennett, 2000). Stimulus-stimulus pairing generally involves three steps. First, the experimenter identifies a target, neutral vocal stimulus and measures its frequency of occurrence under baseline conditions. Second, the experimenter repeatedly presents the target vocal stimulus and a high-preference stimulus or reinforcer without requiring a response. Third, the experimenter measures participant vocalizations post-pairing to determine whether the target vocalization increases in frequency. The goal of SSP in this context is to expand an individual's vocal repertoire so that it can be brought under appropriate stimulus control (Esch et al., 2009). Pairings in SSP are most often response-independent, meaning that the NS and US are presented at the same time or in close temporal proximity in the absence of any response requirements (e.g., Miguel et al., 2002; Stock et al., 2008; Sundberg, Michael, Partington, & Sundberg, 1996). Conversely, response-contingent stimulus pairing refers to an arrangement in which the NS is paired with a US contingent on a response (e.g., Lepper & Petursdottir, 2017).

There is mixed research support for SSP to increase vocalizations. While SSP has increased vocalizations for some participants across studies (e.g., Miguel et al., 2002; Yoon & Bennett, 2000), a substantial number of studies have reported less favourable results (e.g., Carroll & Klatt, 2008; Dozier et al., 2012; Esch, Carr, & Michael, 2005; Normand & Knoll, 2006; Stock et al., 2008; Yoon & Feliciano, 2007). In a comprehensive review of literature on increasing vocalizations in children with language delays, Shillingsburg, Hollander, Yosick, Bowen, and Muskat (2015) found that SSP had a weak to moderate effect for 34% and 49% of the studies, respectively. Thus, 83% of the reviewed studies showed a weak or moderate effect of SSP on vocalizations.

1.3.1.1.1 Procedural variations

A number of procedural variations may improve the effectiveness of SSP. One variation is response-contingent stimulus pairing (RCSP; Axe & Laprime, 2017; Dozier et al., 2012; Helton & Ivy, 2016). Response-contingent stimulus pairing is a procedure in which the stimulus-stimulus pairing is presented immediately after the individual engages in a target response. For example, when a learner correctly matches a stimulus to a sample (i.e., the response), the instructor delivers praise (i.e., the NS) closely followed by a reinforcer. Response-contingent stimulus pairing has been referred to as response-stimulus pairing (Dozier et al., 2012), response-contingent pairing (Lepper & Petursdottir, 2017) and contingent pairing (Axe & Laprime, 2017).

Although a direct comparison between RCSP and response-independent SSP has not yet been conducted, the results of recent studies suggest that RCSP may be superior to response-independent SSP. First, RCSP may be more effective than response-independent SSP. Dozier et al. (2012) found that RCSP was effective in establishing praise as conditioned reinforcers for four of eight participants, while response-independent SSP was effective in establishing praise as a conditioned reinforcer for just one of four participants. It should be noted that Dozier et al. did not conduct a direct comparison of the two procedures. Second, RCSP may be more efficient than response-independent SSP. When reviewing the body of literature on response-contingent and response-independent stimulus pairing, there appear to be differences in the number of pairings needed to establish a conditioned reinforcer. For example, Axe and Laprime (2017) conducted three to six RCSP sessions with 3 to 26 pairings per session and found that RCSP was effective in establishing praise as a reinforcer for both participants. In contrast, Dozier et al.

conducted 1600 to 2400 response-independent pairings and found that praise was established as a reinforcer for only one of four participants. While these examples are noteworthy, it is unreasonable to make conclusions about the relative efficiency of response-dependent and independent procedures given the absence of a direct comparison. Third, response-contingent procedures are more preferred than response-independent procedures in a variety of contexts, including the delivery of reinforcers maintaining problem behaviour (e.g., Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997), the delivery of preferred stimuli (Luczynski & Hanley, 2009), and during conditioning procedures (Lepper, Petursdottir, & Esch, 2013). In summary, there is limited research comparing RCSP with response-independent SSP; however, given the promising findings from four recent studies (Axe & Laprime, 2017; Dozier et al., 2012; Helton & Ivy, 2016; Lepper & Petursdottir, 2017), additional research on RCSP is warranted.

A second procedural variation that may improve the effectiveness of SSP is the temporal ordering of the NS and US. Researchers have used different temporal orderings in applied studies. Examples include simultaneous pairing (e.g., Dozier et al., 2012; Yoon & Bennett, 2000), trace pairing (e.g., Esch et al., 2005; Helton & Ivy, 2016), and delay pairing (e.g., Axe & Laprime, 2017; Miliotis et al., 2012). In general, studies using delay pairing (i.e., the onset of the NS occurs before and overlaps with the US) have stronger treatment effects than studies using other pairing types (Shillingsburg et al., 2015). Differences in the effectiveness of conditioning procedures are likely related to the relative probabilities with which the NS predicts the onset of the US (Catania, 2007).

A third procedural variation in SSP involves the number and category of reinforcers used in pairing. Using multiple reinforcers may increase the effectiveness of a pairing procedure because satiation on a specific reinforcer may be less likely (Moher et al., 2008). At least one group of researchers has reported that a participant shook his head, “No,” when provided with the stimulus, potentially compromising the effectiveness of the conditioning procedure (Esch et al., 2005). Furthermore, edible reinforcers produce stronger effects than other categories of reinforcers in response-independent SSP (Shillingsburg et al., 2015). This is perhaps unsurprising given that food is a primary, or unconditioned, reinforcer. An SPA conducted immediately prior to a conditioning session may help to increase the effectiveness of SSP by increasing the likelihood that the stimulus functions as a reinforcer (Shillingsburg et al., 2015).

Finally, there is preliminary evidence that the number of presentations of the NS per pairing alters the effectiveness of SSP. Miliotis et al. (2012) evaluated the number of NS presentations per pairing and found that one NS presentation per pairing produced a substantially higher rate of vocalizations than three NS presentations per pairing. In other studies on SSP, experimenters have presented the NS three (Esch et al., 2009; Lepper et al., 2013), five (Miguel et al., 2002; Stock et al., 2008), or seven times per trial (Normand & Knoll, 2006). Miliotis et al. are currently the only researchers to have directly evaluated the number of NS presentations per trial. A single presentation of the NS is likely more effective than multiple presentations of NS because the stimulus consistently predicts the delivery of the reinforcer. When the NS is presented three times before delivery of the reinforcer, two instances of respondent extinction occur before the conditioning trial. Therefore, the stimulus is unpaired more often than it is paired.

1.3.1.2 Stimulus-stimulus pairing: Summary

There is mixed support for SSP to condition vocal stimuli as reinforcers (Shillingsburg, 2015). It is possible that differences in reported effectiveness are a result of procedural variations. One variation with promising research support is RCSP (Axe & Laprime, 2017;

Dozier et al., 2012; Helton & Ivy, 2016). Given the clinical importance of developing effective conditioning procedures and the limited research base, there is a need to compare RCSP with response-independent SSP and other conditioning procedures.

1.3.2 Operant conditioning

Operant behaviour is behaviour controlled by its consequences (Catania, 2007; Miltenberger, 2008). However, antecedents also play a critical role in the development of operant behaviour. For example, a discriminative stimulus (S^D) signals the differential availability of reinforcement: when the S^D is present, reinforcement is more likely to be available for the operant response than in its absence (Miltenberger, 2008). An S-delta (S^Δ) is an antecedent stimulus that signals extinction (Miltenberger, 2008). A warning stimulus is an antecedent stimulus that signals the onset of an aversive stimulus (Sidman, 1955). Discriminative stimuli have been shown to function as reinforcers (Holth, Vandbakk, Finstad, Gronnerud, & Akelsen Sorensen, 2009; Isaksen & Holth, 2009; Lepper et al., 2013; Taylor-Santa, Sidener, Carr, & Reeve, 2014). Discriminative stimuli likely function as reinforcers because they predict the onset of a reinforcer.

1.3.2.1 Operant discrimination training

Interventions based on operant conditioning are ubiquitous in instructional programming for individuals with ASD and other developmental disabilities. Antecedents and consequences are arranged to increase appropriate behaviours and decrease inappropriate behaviours. One intervention based on operant conditioning is operant discrimination training (ODT). Operant discrimination training (also known as discrimination training) is a procedure in which a reinforcer is delivered contingent on a response that occurs in the presence of an S^D, but is unavailable in its absence. Recently, ODT has been used to condition stimuli such as praise as reinforcers (Holth et al., 2009; Isaksen & Holth, 2009; Lepper et al., 2013; Lugo, Mathews, King, Lamphere, & Damme, 2017; Taylor-Santa et al., 2014).

Operant discrimination training, when used to condition NS as reinforcers, typically involves three steps. First, the reinforcing effects of a hypothesized NS are tested in baseline by delivering the stimulus contingent on a response and evaluating response rates. Next, a response is reinforced in the presence of the NS to establish the stimulus as an S^D. Last, the S^D is tested as a reinforcer by delivering it contingent on a response and comparing response rates post-ODT to response rates in baseline. Holth et al. (2009) used ODT to condition arbitrary auditory and tangible stimuli as reinforcers. In their study, Holth and colleagues compared ODT to SSP with delay conditioning. For five of the seven participants, responding was markedly higher during post-conditioning reinforcer assessments when the stimulus from the ODT condition was presented contingently, as compared to the stimulus from the SSP condition.

Operant discrimination training may be enhanced by including an S^Δ, in the presence of which extinction is in effect. Incorporating an S^Δ may increase the salience of the S^D (Esch et al., 2009). Taylor-Santa et al. (2014) evaluated the effects of ODT on conditioning reinforcers for children with ASD, interspersing S^D and S^Δ trials, and found that stimuli established as S^Ds in the ODT procedure functioned as reinforcers for all participants.

There are at least two limitations in the body of research on ODT. First, the reinforcing effectiveness of the NS was not tested before implementing ODT in some studies (e.g., Isaksen & Holth, 2009; Lepper et al., 2013). Second, the operant levels of target responses in the pre-experimental procedures were not always formally assessed (e.g., Lepper et al., 2013). It is important to assess both the target stimulus and target responses before implementing a conditioning procedure to increase the likelihood that treatment effects (if any) can be attributed to the intervention alone.

1.3.3 Summary: Conditioning procedures.

Although a number of studies have evaluated the effects of different conditioning procedures, there are no comprehensive guidelines or recommendations for establishing conditioned reinforcers, and gaps in the knowledge base persist. Response-contingent procedures appear to be more effective and more preferred than response-independent arrangements (i.e., RCSP and ODT; Dozier et al., 2012; Holth et al., 2009; Lepper et al., 2013). However, the different response-contingent conditioning procedures have not yet been compared. Clinicians providing services to individuals with ASD teach appropriate behaviour using reinforcers. Additional research is warranted given the clinical importance of developing effective conditioning procedures for individuals with limited reinforcers and the gaps in the current body of literature.

1.4 Research Questions

The purpose of the present study was to compare the relative effectiveness of RCSP and ODT to condition vocal stimuli as reinforcers for individuals with ASD. The study addressed the following research questions:

- Is there a functional relationship between RCSP and increasing the reinforcing value of vocal stimuli?
- Is there a functional relationship between ODT and increasing the reinforcing value of vocal stimuli?
- Are there differences in the effectiveness of RCSP and ODT to increase the reinforcing value of vocal stimuli?

Chapter 2: Method

2.1 Participants and Setting

The study was approved by the Behavioural Research Ethics Board at the University of British Columbia before the experimenter recruited participants for the study. The experimenter distributed recruitment flyers through behaviour consultants and agencies providing individualized treatment services to children and adults diagnosed with ASD in Greater Vancouver, British Columbia. The experimenter asked service providers and agencies to distribute the flyer to families with whom they provide services.

Five individuals diagnosed with ASD between the ages of 6- to 12-years old participated in the study. There were three inclusion criteria. First, participants were able to select from an array of concurrently available preferred stimuli. The purpose of the first criterion was to increase the likelihood of participants completing the pre-experimental SPAs. The first criterion was assessed through a caregiver interview and confirmed through the pre-experimental SPA for edible stimuli (see Stimulus Preference Assessment below). Second, participants were able to engage in an activity independently for 5 min. The purpose of the second criterion was to ensure participants could complete the expected work requirements during reinforcement assessments. The second criterion was assessed through a caregiver interview. Third, participants had a variety of edibles that functioned as reinforcers. The purpose of the third criterion was to ensure that participants had a sufficient number of edible reinforcers for inclusion in the study. The third criterion was assessed through a caregiver interview and confirmed in the pre-experimental preference and reinforcer assessment for edible stimuli (see Structured Interview and Reinforcer Assessment for Edible Stimuli below).

Ichiro, a 12-year-old boy, received a diagnosis of ASD from a licensed psychologist. Ichiro communicated vocally using short sentences. He received 15 hours per week of home-based ABA services. Ichiro attended a general education classroom located in a public school. He received full-time support at school by an ABA-trained support worker (ABA SW). Ichiro's support team included a Board Certified Behavior Analyst (BCBA®) who supervised Ichiro's home- and school-based services and a speech language pathologist (SLP). Ichiro's parents indicated that edible and activity-based reinforcers were used at home and school during instruction sessions. Through a semi-structured interview, Ichiro's parents indicated that although he preferred some social interactions, praise alone did not function as a reinforcer. Research sessions for Ichiro took place in a closed room in his home. The room contained two tables, four chairs, a couch, a closed filing cabinet, and a shelf containing books and boxes. The experimenter placed the table and chairs used in the study away from all other furniture.

Sam, a 12-year-old boy, received a diagnosis of ASD from a licensed psychologist. Sam communicated vocally using single words. Sam attended school in a self-contained classroom located in a public school. The classroom was supervised by a BCBA® and a teacher pursuing certification in behaviour analysis. Sam received full-time support at school by an ABA SW. Sam's parents reported that edible and activity-based reinforcers were used at home and school during instruction sessions. Through a semi-structured interview, Sam's parents indicated that although he preferred some social interactions, praise alone did not function as a reinforcer.

Research sessions for Sam took place in two locations. Sessions 1 to 72 took place in an unused classroom at a summer camp for individuals with ASD. The classroom contained a large table and chairs for use in the study, stacked desks and chairs, two empty bookshelves, and a stack of closed boxes. Sessions 73 to 76 took place in the living room of Sam's home. The room contained a table and chairs for use in the study, a coffee table, two couches, a bookshelf, a TV, and a variety of small family belongings. During the study, the experimenter placed the table and chairs used in the study in the middle of the room away from furniture and other family belongings.

Isabella, a 6-year-old girl, received a diagnosis of ASD from a licensed psychologist. Isabella communicated vocally using short sentences. She received 10 hours per week of home-based ABA services. Isabella attended a general education classroom located in a public school. She received full-time support at school by an ABA SW. Isabella's support team included a BCBA® who supervised her home- and school-based services, an SLP, and an occupational therapist. Isabella's parents reported that edible and activity-based reinforcers were used at home and school during instruction sessions. Through a semi-structured interview, Isabella's parents reported that although she preferred some social interactions, praise alone did not function as a reinforcer. Research sessions for Isabella took place in a closed room in her home. The room contained a table and chairs and a shelf that contained empty boxes.

Lucas, a 10-year-old boy, received a diagnosis of ASD from a licensed psychologist. Lucas communicated using Touch Chat, a tablet-based, speech-generating communication application. He received 4 to 6 hours per week of home-based ABA services. Lucas attended a general education classroom located in a public school. He received full-time support at school by an ABA SW. Lucas' support team included a BCBA® who supervised his home- and school-based services and an SLP. Lucas's parents reported that edible and activity-based reinforcers were used at home and school during instruction sessions. Through a semi-structured interview, Lucas' parents indicated that although he preferred some social interactions, praise alone did not function as a reinforcer.

Research sessions for Lucas took place in three locations. Sessions 1 to 89 took place at the participant's daycare. The room contained a table and chairs. After session 89, the participant returned to school and the experimenter was unable to continue sessions at his daycare. Sessions 90 to 102 and 117 to 132 took place in a room at a public library. The room contained two tables and a stack of chairs. Sessions 103 to 116 and 133 to 156 took place in the dining room at Lucas' home. The room contained a table and chairs and a closed china cabinet.

Matteo, a 10-year-old boy, received a diagnosis of ASD from a licensed psychologist. Matteo communicated vocally using short phrases. He received 15 hours per week of home-based ABA services. Matteo attended a general education classroom located in a public school. He received full-time support at school by an ABA SW. A BCBA® supervised Matteo's home- and school-based services. Matteo's parents reported that edible and activity-based reinforcers were used at home and school during instruction sessions. Through a semi-structured interview, Matteo's parents indicated that although he preferred some social interactions, praise alone did not function as a reinforcer.

Research sessions for Matteo took place in a closed room in his home. The room contained a desk, a table and chairs, a shelf that contained bins of instructional materials, a large cabinet with doors, a keyboard, and a small drum set. The experimenter placed the table and chairs used in the study away from all other furniture.

2.2 Experimental Design

An adapted alternating treatments design (AATD) was used to evaluate the effects of RCSP and ODT on neutral vocal stimuli (Sindelar, Rosenberg, & Wilson, 1985). An AATD is only appropriate for irreversible responses (Sindelar et al., 1985). In the current study, the effects of a conditioning procedure on the target responses could not be readily undone. The experimenter visually analyzed the graphed data to evaluate treatment effects, if any, in both conditioning sessions and reinforcer probes. Systematic visual analysis of responding with and across conditions is commonly used in single-subject designs (Parsonson & Baer, 1978).

In an AATD, two or more equivalent sets of stimuli are developed and each set is assigned to a different condition (Sindelar et al., 1985). Equating stimuli increased the likelihood that differences between the conditions could be attributed to the intervention rather than differences in the training sets. In the current study, the experimenter attempted to equate four vocal stimuli and assigned the stimuli to the following conditions: (a) baseline, (b) RCSP, (c) ODT S^D, and (d) ODT S^Δ. The experimenter generated lists of potential stimuli in consultation with her research supervisor. The experimenter selected nonsense words to reduce the likelihood that participants had previous exposure to the stimuli. There was no overlap between beginning and ending sounds in the selected words, and rhyming words were excluded.

The experimenter used a yoking procedure to control for session length across conditions. The yoking procedure was used to reduce the possibility that differences in session length would affect the results of the treatment comparison. The experimenter yoked the duration of baseline and RCSP sessions to the previous ODT session by dividing the length of the ODT session by five (i.e., the number of trials in a baseline or RCSP session). The experimenter presented response materials in a baseline or RCSP session on a fixed-time schedule equal to one-fifth of the duration of the previous ODT session. For example, if the duration of an ODT session was two minutes, the experimenter presented response materials in subsequent baseline or RCSP sessions immediately after starting the timer for the session, and every 25 s thereafter. The schedule for presentation of response materials in baseline and RCSP was recalculated after every ODT session.

2.3 Dependent Variables and Data Collection

In this section, dependent variables and data collection for the following conditions will be described: (a) baseline, (b) RCSP, (c) ODT, and (d) reinforcer probes. Stimuli required for data collection included an iPod or iPad with the *Countee* application for scoring experimental data, and a video camera and tripod for filming sessions.

2.3.1 Dependent variables during baseline

During baseline, the experimenter recorded a target response when the participant completed the target behaviour within 5 s of the presentation of response materials. The experimenter recorded a non-response if the participant did not complete the target behaviour within 5 s of the presentation of response materials.

2.3.2 Dependent variables during response-contingent stimulus pairing

During RCSP sessions, the experimenter recorded a target response when the participant independently completed the target behaviour within 5 s of the presentation of response materials. The experimenter recorded a prompted response when the experimenter manually prompted the participant to complete the target behaviour. The mastery criterion for RCSP sessions was met when the participant engaged in the target response during all trials, across two consecutive sessions. When mastery criterion was met for RCSP, the experimenter calculated the number of sessions to mastery by summing the number of completed conditioning sessions.

2.3.3 Dependent variables during operant discrimination training

During ODT sessions, the experimenter recorded a target response when the participant independently completed the target behaviour within 5 s of the presentation of the S^D. The experimenter recorded a prompted response when the experimenter manually prompted the participant to complete the target response. The experimenter recorded an incorrect response when the participant engaged in the target response anytime during the 5-s interval following the presentation of the S^{Δ}. The experimenter recorded a non-response when the participant did not respond during the 5-s interval following the presentation of the S^{Δ}. Mastery criterion for ODT sessions was met when the participant independently completed the target behaviour during S^{D} trials, and did not respond during S^{Δ} trials, for two consecutive sessions. When mastery criterion was met for ODT, the experimenter calculated the number of sessions to mastery by summing the number of completed conditioning sessions.

2.3.4 Dependent variables during reinforcer probes for vocal stimuli

The primary dependent variable for the proposed study was rate of responses during reinforcer probes for vocal stimuli. The experimenter recorded a target response when the participant completed the target behaviour, as defined in each participant's protocol (e.g., the participant attached a binder clip to the edge of a container). The experimenter calculated the rate of responses for each session by dividing the frequency of responses by the number of minutes in the session.

2.4 Interobserver Agreement

2.4.1 Interobserver agreement training

The experimenter trained research assistants to collect interobserver agreement data using behavioural skills training. First, the experimenter gave the secondary observer written and vocal descriptions of the procedures and operational definitions for the target behaviour in each condition (i.e., baseline, RCSP, ODT, and reinforcer probes). Next, the secondary observer scored videotapes of sample sessions. The experimenter provided feedback to the secondary observer about all correct responses and errors after each session was scored. The secondary observer scored sample sessions until his or her agreement score was 100% across two sessions for each condition, when compared to the same sessions scored by the experimenter.

2.4.2 Interobserver agreement data collection and scoring

Two observers independently scored sessions during reinforcer probes and conditioning sessions. The secondary observer collected data in person or from video recordings of sessions. All data were collected using the *Countee* application. Table 1 shows the mean IOA scores separated by session type. For Ichiro, two observers independently scored 37.5% of the conditioning sessions and 42.9% of the reinforcer probes. Interobserver agreement scores for Ichiro were 98.9% across all session types (range, 90% – 100%). For Sam, two observers independently scored 37.5% of the conditioning sessions and 42.9% of the reinforcer probes. Interobserver agreement scores for Sam were 99.2% across all session types (range, 89.6% – 100%). For Isabella, two observers independently scored 34.4% of the conditioning sessions and 36.3% of the reinforcer probes. Interobserver agreement scores for Isabella were 97.8% across all session types (range, 80% – 100%). For Lucas, two observers independently scored 36.1% of the conditioning sessions and 33.3% of the reinforcer probes. Interobserver agreement scores for Lucas were 99.2% across all session types (range, 80% – 100%). For Matteo, two observers independently scored 33.3% of the conditioning sessions and 44.4% of the reinforcer probes. Interobserver agreement scores for Matteo were 99.1% across all session types (range, 75% – 100%).

2.4.2.1 Experimental conditions

Research assistants scored interobserver agreement during baseline sessions, RCSP sessions, and ODT sessions on a trial-by-trial basis. Research assistants scored an agreement when the secondary observer recorded the same response type as the primary observer (e.g., an independent or prompted response). Research assistants scored a disagreement when the secondary observer recorded a different response type than the primary observer. Interobserver agreement for each session was calculated by dividing the number of agreements by five (i.e., the number of trials in baseline and RCSP sessions), or 10 (i.e., the number of trials in ODT sessions) and multiplying by 100.

2.4.2.2 Reinforcer probes for vocal stimuli

Research assistants calculated interobserver agreement for reinforcer probes for vocal stimuli using the exact agreement method (Repp, Deitz, Boles, Deitz, & Repp, 1976). Research assistants analyzed data for each session in 30-s intervals. Research assistants scored an agreement when both observers scored the same number of responses during an interval. Research assistants scored a disagreement when the observers scored different numbers of responses during an interval. Research assistants calculated interobserver agreement for each session by dividing the number of agreements by the number of agreements plus disagreements per 30-s interval and multiplying by 100. Overall agreement was calculated by dividing the sum of the agreement scores for each interval and dividing by the total number of 30-s intervals.

	Baseline	RCSP	ODT	Reinforcer probes
Ichiro	100%	100%	98.3%	97.2%
Sam	100%	100%	100%	96.6%
Isabella	98.2%	98.2%	98.2%	96.6%
Lucas	100%	100%	96.9%	100%
Matteo	100%	100%	100%	96.2%

Table 1. Mean interobserver agreement scores for all participants.
Note: RCSP = response-contingent stimulus pairing, ODT = operant discrimination training, IOA = interobserver agreement.

2.5 Pre-Experimental Assessments

The experimenter conducted pre-experimental assessments to collect information about preferred forms of social interactions and identify low-rate responses, neutral vocal stimuli, reinforcing edible stimuli, and moderately preferred colours. The pre-experimental assessments are described below.

2.5.1 Social Interactions Rating Form

The experimenter completed a structured interview called the Social Interactions Rating Form (SIRF) with the caregivers of each participant. The SIRF contains close-ended questions about different forms of social interaction, organized into three broad categories (i.e., physical with contact, physical without contact, and verbal interactions). The SIRF contains open-ended questions about an individual's preferences in case the standard set of social interactions included in the SIRF do not capture an individual's preferences. During the interview, the experimenter asked the participant's caregiver(s) to rate their child's preference for different social interactions using a 5-point scale. A rating of 'one' indicated that the interaction was aversive to the individual; a rating of 'five' indicated that the interaction was highly preferred. The purpose of this interview was to ensure parents did not endorse praise as a general category of preferred stimuli for their child.

2.5.2 Response assessment

The purpose of the response assessment was to identify five low-rate responses. The experimenter assigned one target response to each of the experimental conditions: (a) baseline, (b) RCSP, (c) ODT, and (d) reinforcer probe. The experimenter assigned a fifth response to the pre-experimental reinforcer assessment for edible stimuli. Responses were discrete and easily prompted.

The maximum duration of response assessment sessions was 5 min. The experimenter terminated a session after 30 s of no responding, or if the participant moved 30 cm or more away from the chair. At the start of each session, the experimenter prompted the participant to engage in the response using a manual prompt. After prompting two responses, the experimenter presented the instructions, "Do whatever you like, but stay in your chair." The experimenter started a digital timer. No programmed consequences were delivered for responses. The experimenter selected responses for inclusion in the study if the participant left the chair (i.e., moved 30 cm or more away from the chair), or if the participant did not engage in a response for 30 s. The response assessment continued until the experimenter identified three responses that could be equated for the amount of time and effort needed to complete the response. A fourth response was assigned to the reinforcer probe condition. A fifth response was used in the pre-experimental reinforcer assessment for edible stimuli. Table 2 lists the responses selected for each participant.

Participant	Baseline	RCSP	ODT	Reinforcer probes for vocal stimuli	Reinforcer assessment for edible stimuli
Ichiro	Stack two blocks	Insert coin into piggy bank	Open manila folder	Attach binder clip to edge of container	Insert peg into board
Sam	Stack two blocks	Open manila folder	Place eraser in bucket	Attach binder clip to edge of clipboard	Touch paper
Isabella	Open manila folder	Insert coin into piggy bank	Stack two blocks	String beads	Touch paper
Lucas	Open manila folder	Stack two blocks	Place ring on peg	String beads	Touch paper
Matteo	Stack two blocks	Place ring on peg	Place eraser in bucket	Insert card into envelope	Touch paper

Table 2. Target responses for all participants.
Note: RCSP = response-contingent stimulus pairing, ODT = operant discrimination training.

2.5.3 Baseline reinforcer probes for vocal stimuli

The purpose of the baseline reinforcer probes for vocal stimuli was to identify neutral vocal stimuli to use in conditioning sessions and to provide a comparison for response rates during experimental reinforcer probes. During the baseline reinforcer probes, the experimenter assessed the participant's rate of responding to potentially neutral vocal stimuli.

The experimenter developed lists of potential vocal stimuli in consultation with her research supervisor (see Experimental Design, above). The experimenter conducted one reinforcer probe for each vocal stimulus. The maximum duration of reinforcer probes was 5 min. The experimenter terminated the session if the participant did not engage in a response for 30 s.

Procedures for the reinforcer probes for vocal stimuli were similar to those described by Taylor-Santa et al. (2014). First, the experimenter prompted the participant to engage in the target response by delivering a manual prompt. The experimenter delivered the vocal stimulus assigned to each session after the prompted response. The experimenter conducted only one prompted trial to reduce exposure to the NS prior to conditioning. Repeated exposure to the NS in the absence of the US inhibits acquisition and increases training time (Lubow, 1965; Lubow & Moore, 1959). After prompting one response, the experimenter provided the instructions, “Do whatever you like, but stay in your chair.” The experimenter delivered the vocal stimulus assigned to each session contingently for each target response, using an enthusiastic tone of voice. The experimenter conducted the baseline reinforcer assessment for vocal stimuli before the reinforcer assessment for edible stimuli to avoid potential carryover effects.

Four neutral vocal stimuli were selected for each participant. Vocal stimuli were selected as neutral when the response rate was consistently low across sessions. A random number generator was used to assign one vocal stimulus to baseline, one vocal stimulus to RCSP, and two vocal stimuli to ODT (i.e., one S^D and one S^Δ). Table 3 depicts the vocal stimuli assigned to each condition for all participants.

	Baseline	RCSP	ODT S^D	ODT S^Δ
Ichiro	Fribble	Claptrap	Ballyhoo	Schmeggy
Sam	Schmeggy	Ballyhoo	Claptrap	Fribble
Isabella	Ballyhoo	Schmeggy	Fribble	Claptrap
Lucas	Ballyhoo	Fribble	Claptrap	Schmeggy
Matteo	Claptrap	Schmeggy	Ballyhoo	Fribble

Table 3. Vocal stimuli assigned to experimental conditions for all participants.
Note: RCSP = response-contingent stimulus pairing, ODT = operant discrimination training.

2.5.4 Reinforcer identification

A three-step reinforcer identification procedure was used to identify four neutral vocal stimuli and three reinforcing edible stimuli for each participant. The reinforcer identification procedure included a structured interview, an SPA, and a reinforcer assessment.

2.5.4.1 Structured interview

The experimenter interviewed each participant's parents using a structured interview about food preferences. The interview contained closed- and open-ended questions about a variety of foods. The experimenter asked parents to rate the participant's preference for each food on a scale of one to five. A rating of 'one' indicated that the food was aversive to the individual; a rating of 'five' indicated that the food was highly preferred. The top 8 to 16 edible stimuli (as rated by respondents) were included in a subsequent SPA.

2.5.4.2 Stimulus preference assessment

The experimenter conducted a paired-stimulus preference assessment with each participant to identify highly preferred edible stimuli (Fisher et al., 1992). The experimenter included 8 to 16 edible stimuli identified via the structured interview in the SPA array.

In the paired-stimulus preference assessment, the experimenter presented small pieces of each edible in pairs, and delivered the instruction, "Choose one." When the participant made a selection, the experimenter provided access to the selected stimulus. The experimenter presented the next trial after the participant consumed the edible. The experimenter manually blocked participant attempts to select more than one stimulus, and re-presented the instruction. The paired-stimulus preference assessment continued until all stimulus pairs were presented.

The experimenter calculated the percentage of selection responses for each stimulus by dividing the number of times a stimulus was selected by the number of trials the stimulus was presented. Stimuli were ranked from most-to-least selected, producing a hierarchy of preference for the stimuli included in the SPA. The experimenter ranked stimuli by selection percentages; the top four to six stimuli were included in the reinforcer assessment.

2.5.4.3 Reinforcer assessment for edible stimuli

The purpose of the reinforcer assessment for edible stimuli was to identify the reinforcing edible stimuli to be used in conditioning sessions. One reinforcer assessment session was conducted for each edible stimulus identified as high-preference in the SPA. The maximum duration of reinforcer assessment sessions was 5 min. Sessions were terminated after 30 s of no responding. Procedures were similar to those described by Taylor-Santa et al. (2014). First, the experimenter manually prompted the participant to complete the target response. The experimenter delivered the edible stimulus for that session after each prompted response (i.e., a fixed-ratio 1 schedule of reinforcement). After prompting two responses, the experimenter provided the instructions, “Do whatever you like, but stay in your chair.” The experimenter delivered the edible stimulus after each response for the remainder of the session.

The three edible stimuli with the highest response rates were selected for the conditioning sessions. Table 4 depicts the edible stimuli selected for each participant. Three edible stimuli were used to reduce the likelihood of satiation. The experimenter quasi-randomly assigned the edibles to conditioning sessions such that no edible was assigned to more than two consecutive sessions. No edible was associated with a particular condition, as there may have been slight variations in the reinforcing value of each stimulus.

Participant	Selected edible stimuli
Ichiro	Chocolate chip cookies, mochi crunchy rice nuggets, Sun Chips®
Sam	Bear Paw® cookies, Cheezies®, fruit snacks
Isabella	Chocolate chips, marshmallows, Starburst®
Lucas	Cheezies®, dried mango, Skittles®
Matteo	Dill pickle chips, Goldfish® crackers, Nutella® on bread

Table 4. Reinforcing edible stimuli selected for each participant.

2.5.4.4 Stimulus preference assessment for colours

The experimenter conducted a brief MSWO with eight colours (Carr et al., 2000). The purpose of the MSWO was to identify three colours for use in the three experimental conditions. At the beginning of an MSWO session, the experimenter placed eight colour cards in a line on the table in front of the participant. Each card was evenly spaced from the next. The experimenter instructed the participant to, “Choose one.” If the participant did not respond within 5 s, the experimenter re-presented the instruction one time. The experimenter manually blocked participant attempts to select more than one card, and re-presented the instruction. When the participant selected a card, the experimenter removed the selected card from the array and repositioned the remaining cards. A session continued until all cards were selected or 30 s elapsed with no selection. The experimenter conducted the assessment two additional times (i.e., three stimulus-presentation sessions). The experimenter calculated selection percentages by dividing the number of times a stimulus was selected by the number of trials in which the stimulus was available and multiplying by 100. The experimenter ranked the stimuli by selection percentages. The highest- and lowest-preferred cards were eliminated from the array, and three moderately preferred cards were randomly selected from among the remaining cards. Colour cards were used in subsequent procedures; one colour was assigned to each experimental condition (i.e., baseline, RCSP, and ODT).

2.6 General Procedures

Table 5 depicts the procedures for the study. The experimental conditions were: (a) baseline, (b), RCSP, and (c) ODT. The experimenter rapidly alternated between the experimental conditions in an AATD. The experimenter conducted reinforcer probes after every four sessions within the AATD to assess any changes to the reinforcing value of the vocal stimuli over time. The experimenter conducted sessions for each condition until 16 sessions were completed (i.e., four sessions of each condition type). An experimenter that was unfamiliar to the participant conducted one reinforcer probe for each of the four vocal stimuli immediately after mastery criterion was met to assess generalization of reinforcer effects across experimenters. The primary experimenter conducted one reinforcer probe for each of the four vocal stimuli one week after conducting the final conditioning session to assess reinforcer effects (if any) over time. The experimenter conducted 7 to 16 sessions per day, three to five days per week. The experimenter provided a 2- to 3-min break between sessions.

Phase	Procedure	Description	Objective	Duration
	Social Interactions Rating Form	Structured interview	Identify preferred forms of social interactions	10-15 min
Pre-experimental assessments	Response assessment	Free-operant	Identify four low frequency responses	30-45 min
	Identification of vocal stimuli	Reinforcer assessment	Identify four neutral vocal stimuli and provide a baseline for responses in reinforcer probes	
	Reinforcer identification	Structured interview	Identify 8 to16 preferred edible stimuli	30-45 min
		Paired-stimulus preference assessment	Identify three to five potential reinforcers	30-45 min
		Reinforcer assessment for edible stimuli	Identify three reinforcing edible stimuli	30-40 min
	Stimulus preference assessment for colours	Brief multiple-stimulus without replacement	Identify three moderately preferred colours for experimental conditions	10 min
Experimental procedures	Conditioning procedures	Baseline	Provide no-intervention condition against which to measure effects of conditioning procedures	48-144 min
		Response-contingent stimulus pairing	Establish neutral vocal stimulus as a conditioned reinforcer	48-144 min
		Operant discrimination training	Establish neutral vocal stimulus as a conditioned reinforcer	48-144 min
	Reinforcer probes for vocal stimuli		Test if stimulus is established as a reinforcer	48-140 min
	Generalization and maintenance reinforcer probes	Free-operant	Test whether reinforcer effects persist across people and over time	8-40 min

Table 5. Summary of procedures.
This table provides the description, objective, and estimated duration for each procedure.

2.6.1 Conditioning procedures

Table 6 provides a summary of the procedures in the experimental conditions. Baseline, RCSP, and ODT sessions were conducted in quasi-random order, with no more than two consecutive sessions of any condition. Before each session, the experimenter placed a poster board on the table in the colour assigned to the condition, and put on a shirt of the same colour. The purpose of assigning a colour to each condition was to increase the saliency of differences between conditions. Before RCSP and ODT sessions, the experimenter prepared and stored small pieces of edible reinforcers in a small, open container within easy reach. The container was kept out of the participant's view (e.g., on a chair beside the experimenter) to ensure that the sight of the edible stimuli did not mask the presentation of the vocal stimulus. For all conditions, the experimenter and the participant sat on opposite sides of a table, facing each other. Before the start of each session, the experimenter prompted the participant to engage in the target response to put the participant's behaviour in contact with the contingency in effect for that session. For Ichiro, the experimenter discontinued prompted exposures after session six due to uniformly high scores in all conditions (explained below in the Results section).

Due to undifferentiated responding, an error correction procedure was added after session 68 for Isabella, Lucas, and Matteo. The purpose of implementing error correction was to decrease responding during baseline and S^{Δ} trials. When an incorrect response occurred during a baseline or S^{Δ} trial, the experimenter removed response materials and turned away from the participant for 5 s. The experimenter re-presented the trial with error correction until the participant responded correctly (i.e., did not engage with response materials). The experimenter presented the response materials for the next trial at the next pre-determined time. Table 6 illustrates the procedures for baseline and all other experimental conditions.

2.6.1.1 Baseline

The experimenter conducted five trials in each baseline session. At the beginning of each baseline trial, the experimenter placed the response materials on the table in front of the learner. If the participant engaged in the target response within 5 s of the presentation of response materials, the experimenter delivered the vocal stimulus for that condition and removed response materials. If the participant did not respond within 5 s, the experimenter removed the response materials. No other programmed consequences were delivered. The experimenter presented the response materials again at the next pre-determined time.

2.6.1.2 Response-contingent stimulus pairing

The experimenter conducted five trials in each RCSP session. At the beginning of each RCSP trial, the experimenter placed the response materials on the table in front of the learner. If the participant engaged in the target response within 5 s of the presentation of response materials, the experimenter began to deliver the vocal stimulus assigned to that condition 1 s before delivering the reinforcer. The experimenter presented the vocal stimulus so that the vocal stimulus overlapped with the presentation of the reinforcer (Axe & Laprime, 2017). The reinforcer was not visible during the onset of the vocal stimulus to ensure that the sight of the reinforcer did not mask the presentation of the vocal stimulus. The experimenter delivered the vocal stimulus one time (Miliotis et al., 2012). The experimenter removed response materials after delivering the vocal and edible stimuli. If the participant did not respond within 5 s, the experimenter manually prompted a response. Following the prompted response, the experimenter delivered the vocal stimulus and reinforcer as described above. No other programmed consequences were delivered. The experimenter presented the response materials again at the next pre-determined time.

2.6.1.3 Operant discrimination training

Procedures for operant discrimination training sessions were similar to those described by Lepper et al. (2013). Each session consisted of five S^D trials and five S^Δ trials, presented in quasi-random order, with no more than two consecutive trials of either stimulus. One vocal stimulus served as an S^D, and a second vocal stimulus served as an S^Δ. During S^D trials, the experimenter delivered the S^D once (i.e., the target vocal stimulus), immediately followed by the presentation of response materials. Response materials were not visible to the participant during the presentation of the S^D to ensure the sight of the response materials did not mask the presentation of the S^D. If the participant engaged in the target response within 5 s of the presentation of the S^D, the experimenter delivered the pre-selected reinforcer, and removed response materials. After the participant consumed the edible, the experimenter presented the next trial. If the participant did not engage in the target response within 5 s of the presentation of the S^D, the experimenter manually prompted the response, delivered the pre-selected reinforcer, and removed response materials. During S^Δ trials, the experimenter presented the S^Δ one time, immediately followed by the presentation of response materials. Response materials were not visible to the participant during the presentation of the S^Δ to ensure the sight of the response materials did not mask the presentation of the S^Δ. The experimenter waited 5 s before removing response materials and presenting the next trial (either an S^D trial or an S^Δ trial). If the participant engaged in the target response in the presence of the S^Δ, the experimenter physically blocked the response for 5 s before removing the response materials. No reinforcer was delivered. The experimenter presented the next trial. An error correction procedure was added after session 68 for Isabella, Lucas, and Matteo, as described above (see Baseline).

BL	Response materials presented	↗ Response within 5 s	→ Response materials removed		
		↘ No response within 5 s	→ Response materials removed		
RCSP	Response materials presented	↗ Response within 5 s	→ VS 1 s before and overlapping with edible	→ Response materials removed	
		↘ No response within 5 s	→ Prompted response	→ VS 1 s before and overlapping with edible	→ Response materials removed
ODT	S^D and response materials presented	↗ Response within 5 s	→ Edible	→ Response materials removed	
		↘ No response within 5 s	→ Prompted response	→ Edible	→ Response materials removed
	S^Δ and response materials presented	↗ Response within 5 s	→ 5 s response block	→ Response materials removed	
		↘ No response within 5 s	→ Response materials removed		

Table 6. Procedures for experimental conditions.

Note: BL = baseline, RCSP = response-contingent stimulus pairing, ODT = operant discrimination training, VS = vocal stimulus.

2.6.1.4 Reinforcer probes for vocal stimuli

The experimenter conducted reinforcer probes for vocal stimuli immediately after every four sessions for baseline, RCSP, and ODT conditions (i.e., 20 conditioning trials). Criterion responding in conditioning procedures may be reached in approximately 40 conditioning trials (Holth et al., 2009). One reinforcer probe was conducted for each of the four vocal stimuli. The procedures for reinforcer probes were identical to the pre-experimental reinforcer assessment for vocal stimuli. Reinforcer probes continued for 5 min or until 30 s elapsed with no responses.

An unknown experimenter conducted one generalization probe for each of the four vocal stimuli immediately after the final conditioning session. The purpose of these probes was to assess generalization of reinforcer effects across experimenters. Procedures for the generalization probes were identical to the reinforcer probes described in the paragraph above, but an experimenter unfamiliar to the participant conducted the probes. The primary experimenter was present during generalization probes for all participants except Matteo.

The primary experimenter conducted one follow-up reinforcer probe for each of the four vocal stimuli one week after the last conditioning session. The purpose of the follow-up reinforcer probes was to assess reinforcer effects (if any) over time. Procedures for the follow-up reinforcer probes were identical to the reinforcer probes described above.

2.7 Procedural Integrity

During baseline sessions, procedural integrity data were collected on the following: (a) placing the correct poster board on the table, (b) putting on the correct shirt, (c) presenting one exposure trial at the start of each session, (d) delivering the vocal stimulus within 2 s of each target response or implementing error correction (after session 68), and (e) removing response materials after 5 s of no responding.

During RCSP sessions, procedural integrity data were collected on the following: (a) placing the correct poster board on the table, (b) putting on the correct shirt, (c) presenting one exposure trial at the start of each session, and (d) delivering the correct consequence within 2 s of an independent or prompted response (i.e., delivering the correct vocal stimulus first, followed 1s later by delivering the edible reinforcer).

During ODT sessions, an observer collected procedural integrity data on the following: (a) placing the correct poster board on the table, (b) putting on the correct shirt, (c) presenting one exposure trial each for the S^D and the S^Δ at the start of each session, (d) delivering the reinforcer within 2 s of an independent or prompted response in the presence of the S^D, and (e) physically blocking responses and implementing extinction or implementing error correction (after session 68) for responses that occurred in the presence of the S^Δ.

Two independent observers scored procedural integrity for a minimum of 33.3% of sessions. Data were summarized as a percentage of correct implementation per session by dividing the number of correct experimenter behaviours by the total number of experimenter behaviours, and multiplying by 100. Procedural integrity scores across all session types were 99.3% for Ichiro (range, 83.3% – 100%), 100% for Sam, 99.2% for Isabella (range, 85.7% – 100%), 100% for Lucas, and 100% for Matteo. A complete list of procedural integrity scores is provided in Table 7.

Interobserver agreement was calculated for procedural integrity by comparing procedural integrity scores for each experimenter behaviour within a session, component by component. Agreement scores for procedural integrity were calculated by dividing the number of agreements by the total number of experimenter behaviours, and multiplying by 100. Interobserver agreement scores for procedural integrity scores across all session types were 96.2% for Ichiro (range, 85.7% – 100%), 99.7% for Sam (range, 92.9% – 100%), 99.5% for Isabella (range, 87.5% – 100%), 99.8% for Lucas (range, 93.8% – 100%), and 100% for Matteo. A complete list of procedural integrity scores is provided in Table 7.

	Baseline		RCSP		ODT		Reinforcer probes	
	Integrity	IOA	Integrity	IOA	Integrity	IOA	Integrity	IOA
Ichiro	100%	97.6%	100%	95.2%	97.2%	98.6%	100%	98.4%
Sam	100%	100%	100%	98.6%	100%	100%	100%	99.8%
Isabella	98.7%	99.4%	98.2%	98.3%	100%	100%	100%	100%
Lucas	100%	100%	100%	93.8%	100%	99.4%	100%	100%
Matteo	100%	100%	100%	100%	100%	100%	100%	100%

Table 7. Mean procedural integrity scores.

Note: RCSP = response-contingent stimulus pairing, ODT = operant discrimination training, IOA = interobserver agreement.

Chapter 3: Results

Figures 1 to 6 depict the results of the treatment comparison across participants. The upper panel in each figure depicts the percentage of trials with a target response during conditioning sessions. The lower panel depicts the rate of responses during reinforcer probes. The following sub-sections will describe the results of the treatment comparison and the reinforcer probes for each participant.

3.1 Treatment Comparison for Ichiro

Figure 1 depicts the results of the treatment comparison for Ichiro. The top panel of Figure 1 depicts the percentage of trials with a target response across the experimental conditions during the conditioning sessions. Responding during RCSP was consistently high, and the mastery criterion for RCSP was met in two sessions. The mastery criterion for ODT was not met; however, the percentage of S^D trials with a target response was high and the percentage of S^Δ trials with a target response decreased after the fourth ODT session. The percentage of trials with a target response was consistently high during baseline sessions. Overall, responding was high and largely undifferentiated during baseline, RCSP, and S^D trials.

3.2 Reinforcer Probes for Ichiro

The lower panel of Figure 1 depicts the results of the reinforcer probes for vocal stimuli for Ichiro with respect to the conditioning sessions. The first four data points depict the results of baseline reinforcer probes for vocal stimuli. The purpose of the baseline probes was to identify neutral vocal stimuli for use in conditioning sessions and to provide a comparison for response rates in experimental reinforcer probes. No responses occurred during the pre-experimental reinforcer assessment, demonstrating that the vocal stimuli selected for inclusion in the current study did not function as reinforcers. Response rates during the experimental reinforcer probes were high and undifferentiated across conditions. Response rates for the four vocal stimuli remained high and undifferentiated during generalization and maintenance probes. Given the undifferentiated rates of responding, statements about the relative efficacy of RCSP and ODT cannot be made.

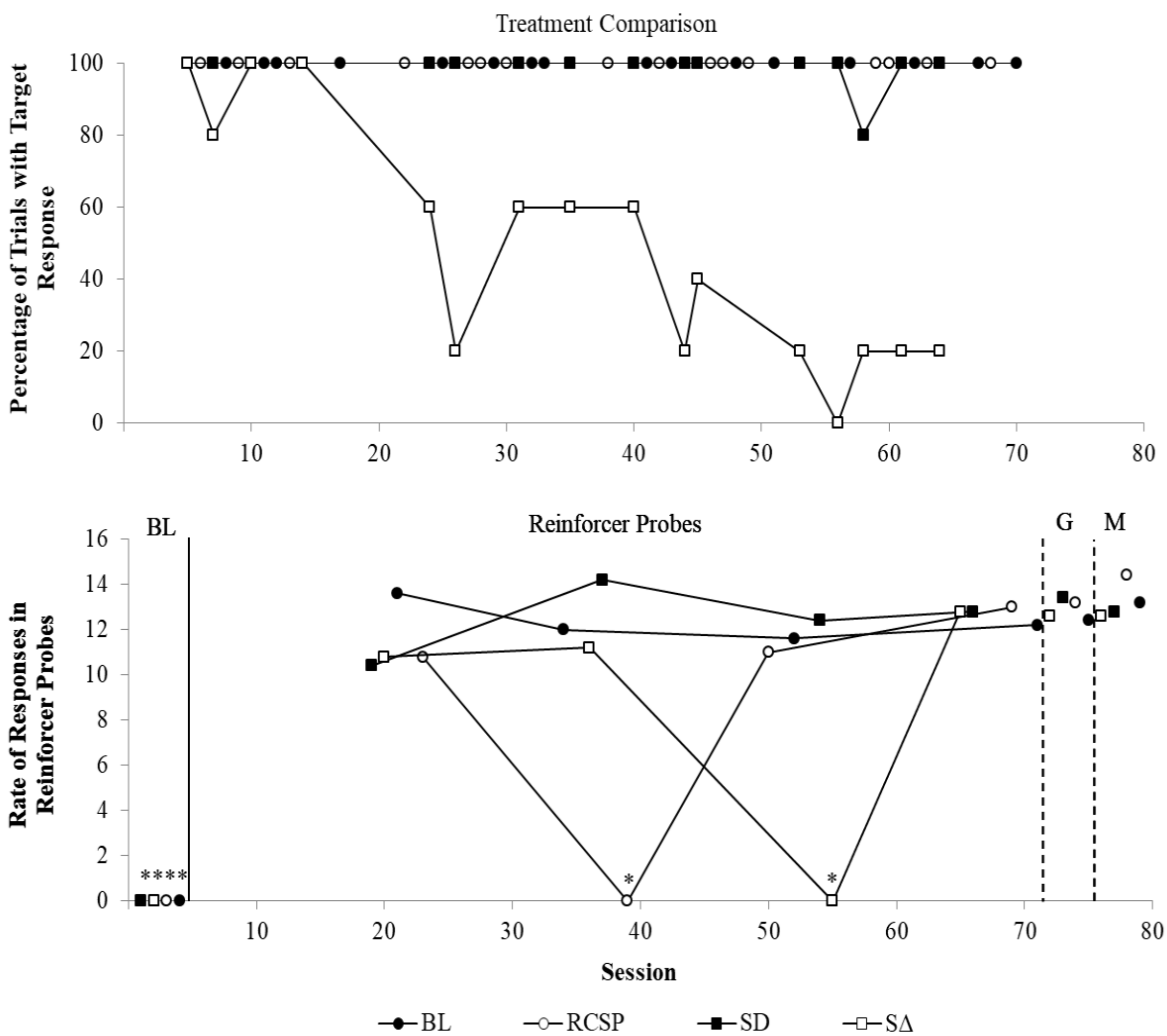

Figure 1. Treatment comparison and reinforcer probes for Ichiro.
The top panel depicts data from the training sessions. The bottom panel depicts data from the reinforcer probes. Both the top and bottom panels depict the behaviour paths concurrently over time. Note: BL = baseline, RCSP = response-contingent stimulus pairing, ODT = operant discrimination training, S^D = discriminative stimulus, S^Δ = stimulus delta, G = generalization reinforcer probes, M = maintenance reinforcer probes. Note: the asterisks indicate that the session duration was less than 5 min.

Although Ichiro's rate of responding across reinforcer probe conditions was undifferentiated, mean session duration and response frequency varied across conditions. Reinforcer probes were discontinued after 30 s of no responding; thus, the duration of sessions varied (see Method). Table 8 depicts the mean session duration and response frequency in reinforcer probe sessions for all participants. For Ichiro, the mean session duration during reinforcer probes was longest in the baseline and S^D conditions (261.43 s for both condition types). The mean response frequency was also higher in reinforcer probes for the baseline and S^D conditions than in the other conditions (53.57 responses and 54.29 responses, respectively). Overall, Ichiro's results do not provide sufficient evidence to suggest conditioning procedures were effective for increasing the reinforcing value of the vocal stimuli assigned to RCSP and S^D conditions.

	BL		RCSP		S^D		S^Δ	
	Duration	Freq	Duration	Freq	Duration	Freq	Duration	Freq
Ichiro	261.43 (30-300)	53.57 (0-68)	222.86 (30-300)	44.57 (0-72)	261.43 (30-300)	54.29 (0-71)	222.86 (30-300)	42.86 (0-64)
Sam	185.29 (30-300)	27 (0-50)	198.71 (30-300)	30.86 (0-49)	227.14 (30-300)	32.43 (0-53)	118.5 (30-300)	14.83 (0-45)
Isabella	99.64 (30-300)	7.7 (0-29)	164 (30-300)	10.8 (0-31)	152 (30-300)	9.4 (0-24)	107.55 (30-300)	6.6 (0-19)
Lucas	54.33 (30-101)	1.67 (0-4)	77.92 (30-300)	3 (0-16)	66.67 (30-161)	2.5 (0-8)	43 (30-77)	1 (0-4)
Matteo	77.11 (30-185)	2.78 (0-9)	41.66 (30-87)	1 (0-5)	86 (30-195)	4 (0-12)	109.67 (30-297)	5.33 (0-21)

Table 8. Mean session duration and response frequency during reinforcer probes.
The top number displays the mean duration (in seconds) or frequency for each condition type. The bottom numbers display the range for duration or frequency for each condition type. Note: BL = baseline, RCSP = response-contingent stimulus pairing, S^D = discriminative stimulus, S^Δ = stimulus delta, Freq = frequency.

3.3 Treatment Comparison for Sam

Figure 2 depicts the results of the treatment comparison for Sam. The top panel of Figure 2 depicts the percentage of trials with a target response across the experimental conditions during the conditioning sessions. Responding during RCSP was consistently high, and the mastery criterion for RCSP was met in three sessions. The mastery criterion for ODT was not met; however, the percentage of trials with a target response during the S^D was high. Responding during S^Δ trials was variable and generally lower than responding during S^D and RCSP trials. The percentage of trials with a target response during baseline sessions was variable, and responding during baseline was generally lower than responding during RCSP or S^D trials.

3.4 Reinforcer Probes for Sam

The lower panel of Figure 2 depicts the results of the reinforcer probes for vocal stimuli for Sam. The first four data points depict the results of baseline reinforcer probes for vocal stimuli. No responses occurred during the pre-experimental reinforcer assessment for the vocal stimuli assigned to the baseline and S^Δ conditions. One response occurred during the pre-experimental reinforcer assessment for the vocal stimulus assigned to RCSP. Three responses occurred during the pre-experimental reinforcer assessment for the vocal stimulus assigned as the S^D. The results of the pre-experimental reinforcer assessments demonstrate that the vocal stimuli selected for inclusion in the current study did not function as reinforcers. Response rates during the experimental reinforcer probes were high and undifferentiated across baseline, RCSP, and S^D conditions. Response rates were lower in the S^Δ condition. Responses rates for baseline, RCSP, and the S^D were high and undifferentiated in the generalization probe. Due to unforeseen changes in participant availability, the experimenter was unable to run the generalization probe for the S^Δ

condition. In the maintenance probe, Sam's rate of responses was highest in the RCSP condition. Sam's rate of responses in the maintenance probe was lowest in the S^{Δ} condition.

Although Sam's rate of responding across reinforcer probe conditions was generally undifferentiated, mean session duration and response frequency varied across conditions (see Table 8). For Sam, the mean session duration was substantially higher during the reinforcer probes for the S^{D} condition than during all other conditions (227.14 s). The mean session duration and mean response frequency were higher in the reinforcer probes for the RCSP and S^{D} conditions than in baseline or S^{Δ} conditions. These results suggest that the conditioning procedures were effective in increasing the reinforcing value of the vocal stimuli assigned to RCSP and S^{D} conditions.

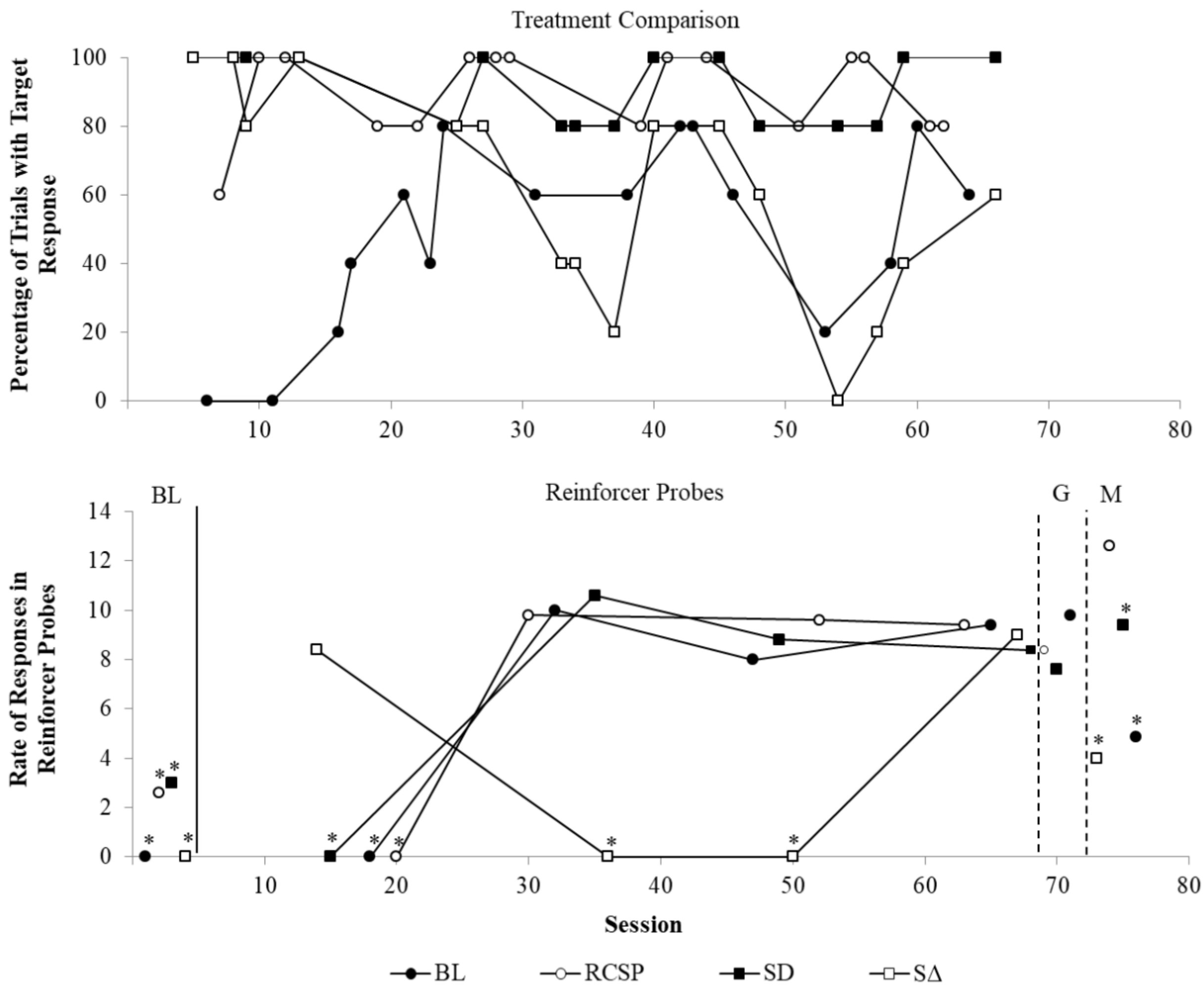

Figure 2. Treatment comparison and reinforcer probes for Sam.
The top panel depicts data from the training sessions. The bottom panel depicts data from the reinforcer probes. Both the top and bottom panels depict the behaviour paths concurrently over time. Note: BL = baseline, RCSP = response-contingent stimulus pairing, ODT = operant discrimination training, S^D = discriminative stimulus, S^Δ = stimulus delta, G = generalization reinforcer probes, M = maintenance reinforcer probes. Note: the asterisks indicate that the session duration was less than 5 min.

3.5 Treatment Comparison for Isabella

Figure 3 depicts the results of the treatment comparison for Isabella. The top panel of Figure 3 depicts the percentage of trials with a target response across the experimental conditions during the conditioning sessions. Responding during RCSP was initially variable. The mastery criterion for RCSP was met in 12 sessions. The percentage of trials with a target response during the S^D was high from the onset of the conditioning sessions. Responding during S^Δ trials was variable and generally lower than responding during S^D and RCSP trials. Due to difficulty in establishing consistently differentiated responding, error correction was implemented during baseline and S^Δ trials starting in session 69. Responding during baseline and S^Δ trials decreased after error correction was implemented. Isabella was the only participant to meet mastery criterion for ODT. Isabella met the criterion for ODT in 32 sessions.

3.6 Reinforcer Probes for Isabella

The lower panel of Figure 3 depicts the results of the reinforcer probes for vocal stimuli for Isabella. The first four data points depict the results of baseline reinforcer probes for vocal stimuli. No responses occurred during the pre-experimental reinforcer assessments for the vocal stimuli assigned to baseline, S^D, and S^Δ conditions. One response occurred during the pre-experimental reinforcer assessment for the vocal stimulus assigned to the RCSP condition. The results of the pre-experimental reinforcer assessments demonstrate that the vocal stimuli selected for inclusion in the current study did not function as reinforcers. Response rates during the experimental reinforcer probes were high and undifferentiated across all conditions. During the generalization probe, Isabella's rate of responding was highest in the baseline condition. Response rates were moderate in the generalization probes for the S^D and S^Δ conditions. No responses occurred in the generalization probe for the RCSP condition. Response rates were moderate in the maintenance probes for the baseline and S^D conditions. No responses occurred in the maintenance probes for the RCSP and S^Δ conditions.

Although the graphed rate data for Isabella were generally undifferentiated, session duration and response frequency varied across conditions (see Table 8). For Isabella, the mean session duration and mean response frequency during reinforcer probes were highest in the RCSP condition (164 s and 10.8, respectively). The mean session duration and response frequency were substantially higher during the reinforcer probes for the RCSP and S^D conditions than during the baseline or S^Δ conditions. These results suggest that the conditioning procedures were effective in increasing the reinforcing value of the vocal stimuli assigned to RCSP and S^D conditions.

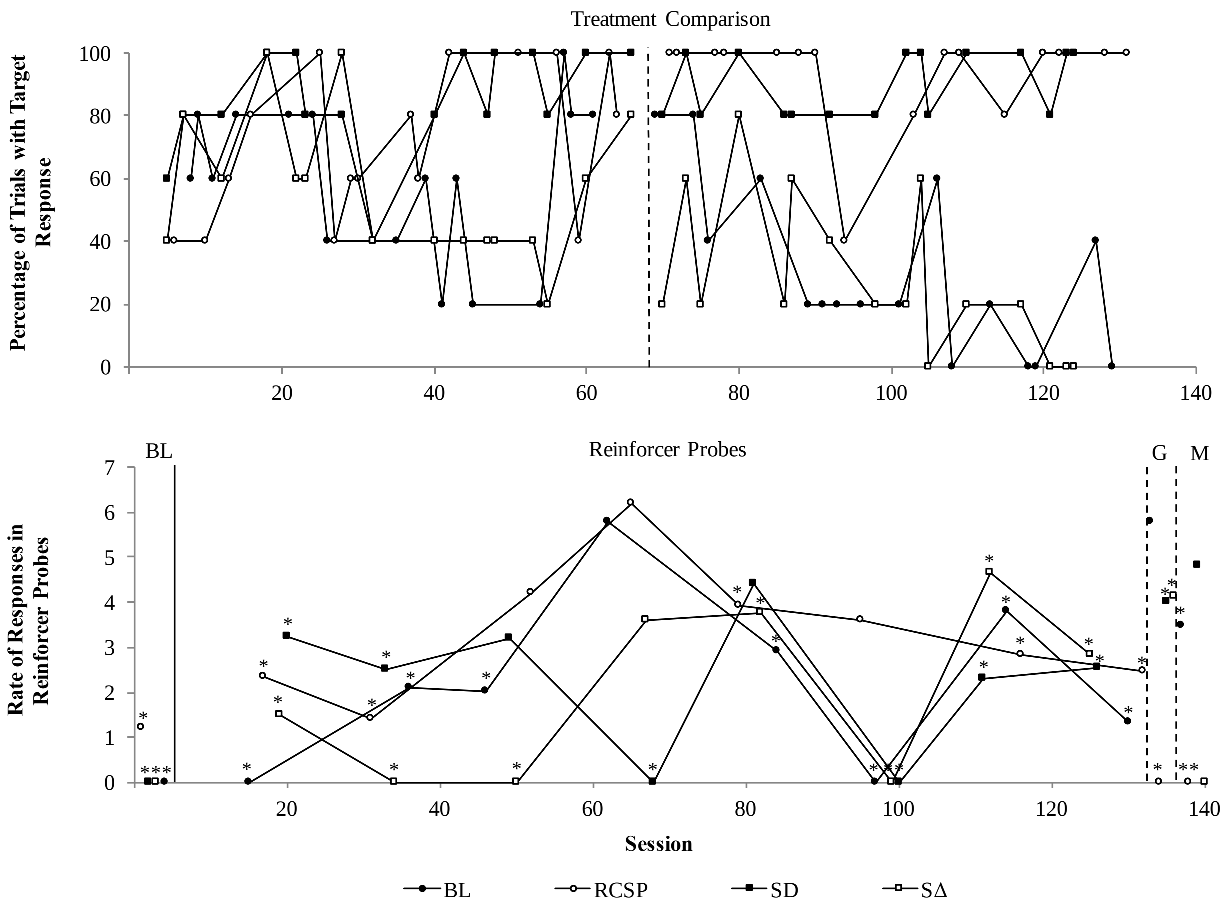

Figure 3. Treatment comparison and reinforcer probes for Isabella.
The top panel depicts data from the training sessions. The bottom panel depicts data from the reinforcer probes. Both the top and bottom panels depict the behaviour paths concurrently over time. Note: BL = baseline, RCSP = response-contingent stimulus pairing, ODT = operant discrimination training, S^D = discriminative stimulus, S^Δ = stimulus delta, G = generalization reinforcer probes, M = maintenance reinforcer probes. The phase line in the upper panel indicates the introduction of error correction. The asterisks indicate that the session duration was less than 5 min.

3.7 Treatment Comparison for Lucas

Figure 4 depicts the results of the treatment comparison for Lucas. Lucas' participation in the current study was discontinued after session 156 due to changes in his availability. The top panel of Figure 4 depicts the percentage of trials with a target response across the experimental conditions during the conditioning sessions. Responding during RCSP was consistently high, and the mastery criterion for RCSP was met in three sessions. Due to difficulty in establishing differentiated responding, error correction was implemented during baseline and S^{Δ} trials starting in session 69. The mastery criterion for ODT was not met even after error correction was implemented; however, the percentage of trials with a target response during S^{Δ} was generally lower than responding during RCSP and S^{D} trials. The percentage of trials with a target response during baseline sessions was low and variable. Fewer responses occurred during baseline than during any other condition.

3.8 Reinforcer Probes for Lucas

The lower panel of Figure 4 depicts the results of the reinforcer probes for vocal stimuli for Lucas. The first four data points depict the results of baseline reinforcer probes for vocal stimuli. No responses occurred during the pre-experimental reinforcer assessment for the vocal stimuli assigned to baseline, RCSP, and S^{Δ} conditions. One response occurred during the pre-experimental reinforcer assessment for the vocal stimulus assigned as the S^{D}. The results of the pre-experimental reinforcer assessments demonstrate that the vocal stimuli selected for inclusion in the current study did not function as reinforcers. Response rates during the experimental reinforcer probes were undifferentiated across all conditions. Lucas's response rate during the generalization probes was highest in the baseline condition. No responses occurred in the generalization probes for the S^{D} or S^{Δ}. Response rates during the maintenance probes were highest in the S^{Δ} and RCSP conditions. No responses occurred in the maintenance probes for the BL and S^{D} conditions.

Although the graphed rate data for Lucas were generally undifferentiated, session duration and response frequency varied across conditions (see Table 8). For Lucas, the mean session duration and mean response frequency were highest in the reinforcer probes for the RCSP condition (77.92 s and 3, respectively). The mean session duration and response frequency were substantially higher during the reinforcer probes for the RCSP and S^{D} conditions than during the baseline or S^{Δ} conditions. These results suggest that the conditioning procedures were effective in increasing the reinforcing value of the vocal stimuli assigned to RCSP and S^{D} conditions.

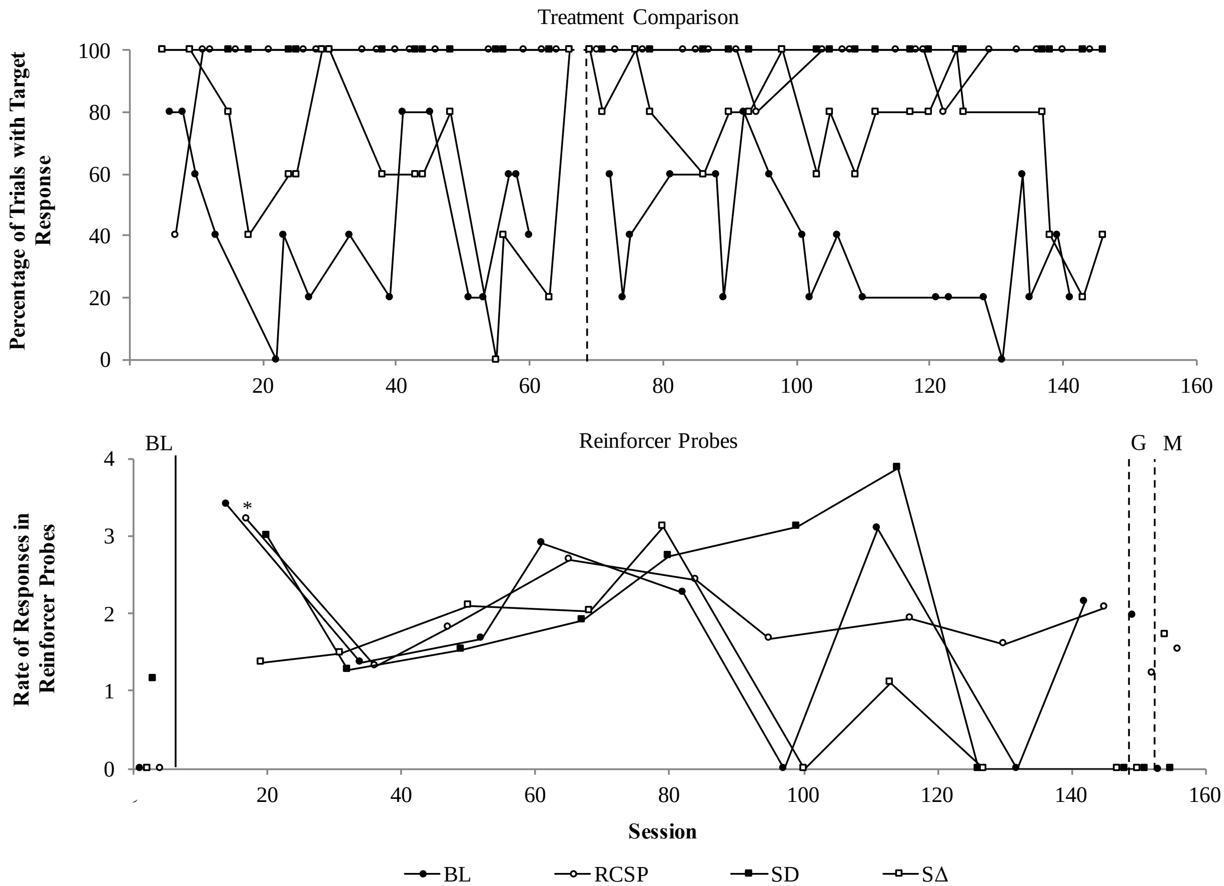

Figure 4. Treatment comparison and reinforcer probes for Lucas.
The top panel depicts data from the training sessions. The bottom panel depicts data from the reinforcer probes. Both the top and bottom panels depict the behaviour paths concurrently over time. Note: BL = baseline, RCSP = response-contingent stimulus pairing, ODT = operant discrimination training, S^D = discriminative stimulus, S^Δ = stimulus delta, G = generalization reinforcer probes, M = maintenance reinforcer probes. The phase line in the upper panel indicates the introduction of error correction. The asterisk indicates that the session duration was 5 min. The duration of all other sessions was less than 5 min.

3.9 Treatment Comparison for Matteo

Figure 5 depicts the results of the treatment comparison for Matteo. The top panel of Figure 5 depicts the percentage of trials with a target response across the experimental conditions during the conditioning sessions. Responding during RCSP was initially variable. The mastery criterion for RCSP was met in 10 sessions. Due to difficulty in establishing differentiated responding, error correction was implemented during baseline and S^Δ trials starting in session 69.

The mastery criterion for ODT was not met; however, the percentage of trials with a target response during the S^{Δ} decreased following the implementation of error correction. The percentage of trials with a target response during baseline sessions was variable. Fewer responses occurred during baseline than during any other condition.

3.10 Reinforcer Probes for Matteo

The lower panel of Figure 5 depicts the results of the reinforcer probes for vocal stimuli for Matteo. The first four data points depict the results of baseline reinforcer probes for vocal stimuli. No responses occurred during the pre-experimental reinforcer assessment for the vocal stimuli assigned to baseline, RCSP, and S^{D} conditions. One response occurred during the pre-experimental reinforcer assessment for the vocal stimulus assigned as the S^{Δ}. The results of the pre-experimental reinforcer assessments demonstrate that the vocal stimuli selected for inclusion in the current study did not function as reinforcers. Response rates during the experimental reinforcer probes were undifferentiated across all conditions. Matteo's response rate during the generalization probes was highest in the baseline condition. No responses occurred during the generalization probes for the RCSP or S^{D} conditions. Matteo's response rate during the maintenance probes was highest in the S^{D} condition. No responses occurred during the maintenance probes for the RCSP condition.

Although the graphed rate data for Matteo were undifferentiated, session duration and response frequency varied across conditions (see Table 8). For Matteo, the mean session duration and mean response frequency were substantially higher in the S^{Δ} condition than in all other conditions (109.67 s and 5.33, respectively). The mean session duration and mean response frequency were lowest in the RCSP condition (41.66 s and 1.0, respectively). Overall, Matteo's results suggest that the conditioning procedures were not effective in increasing the reinforcing value of the vocal stimuli assigned to RCSP and S^D conditions.

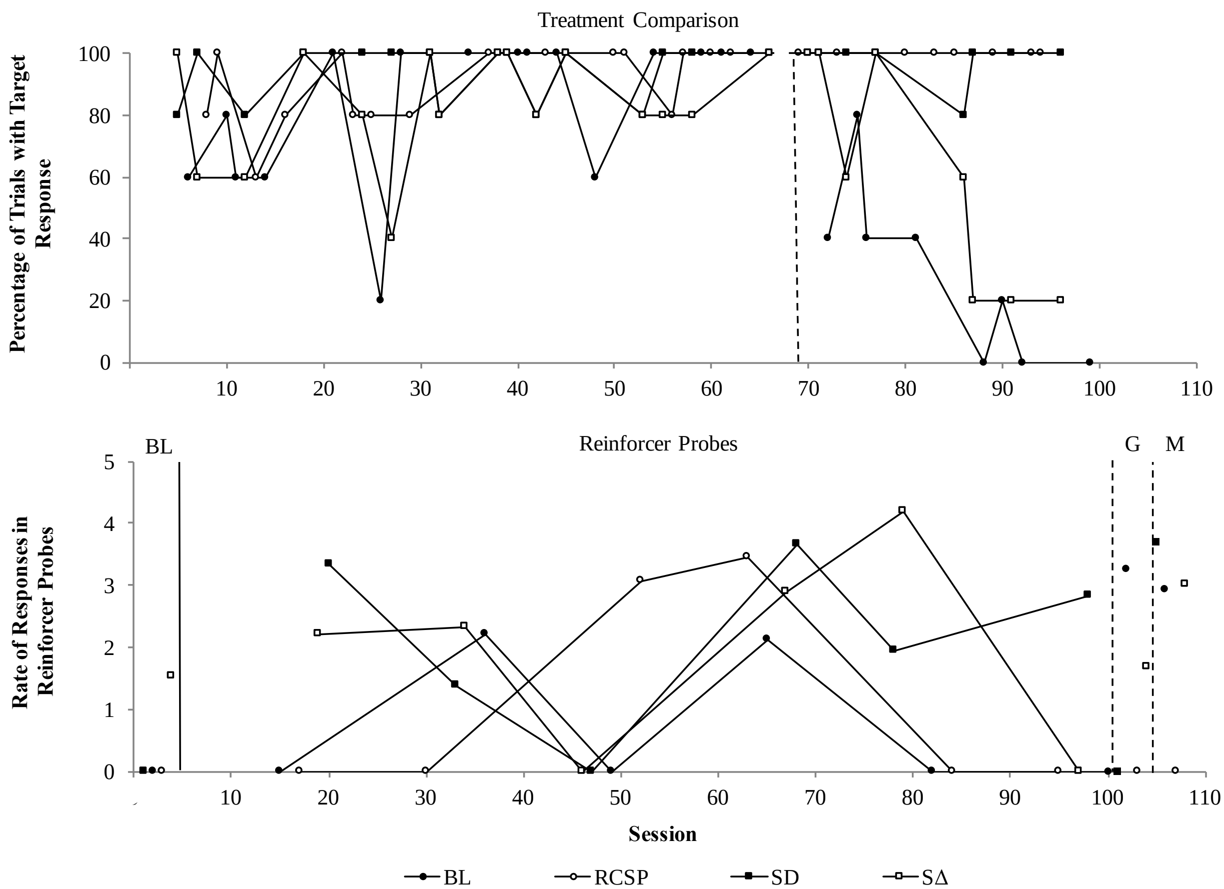

Figure 5. Treatment comparison and reinforcer probes for Matteo.
The top panel depicts data from the training sessions. The bottom panel depicts data from the reinforcer probes. Both the top and bottom panels depict the behaviour paths concurrently over time. Note: BL = baseline, RCSP = response-contingent stimulus pairing, ODT = operant discrimination training, S^D = discriminative stimulus, S^Δ = stimulus delta, G = generalization reinforcer probes, M = maintenance reinforcer probes. The phase line in the upper panel indicates the introduction of error correction. The duration of all sessions was less than 5 min.

Figure 6 depicts the results for the number of sessions to meet the mastery criterion across participants. All participants met mastery criterion in RCSP. One of five participants met mastery criterion in ODT (i.e., Isabella). Response-contingent stimulus pairing required fewer sessions to mastery than ODT for Isabella.

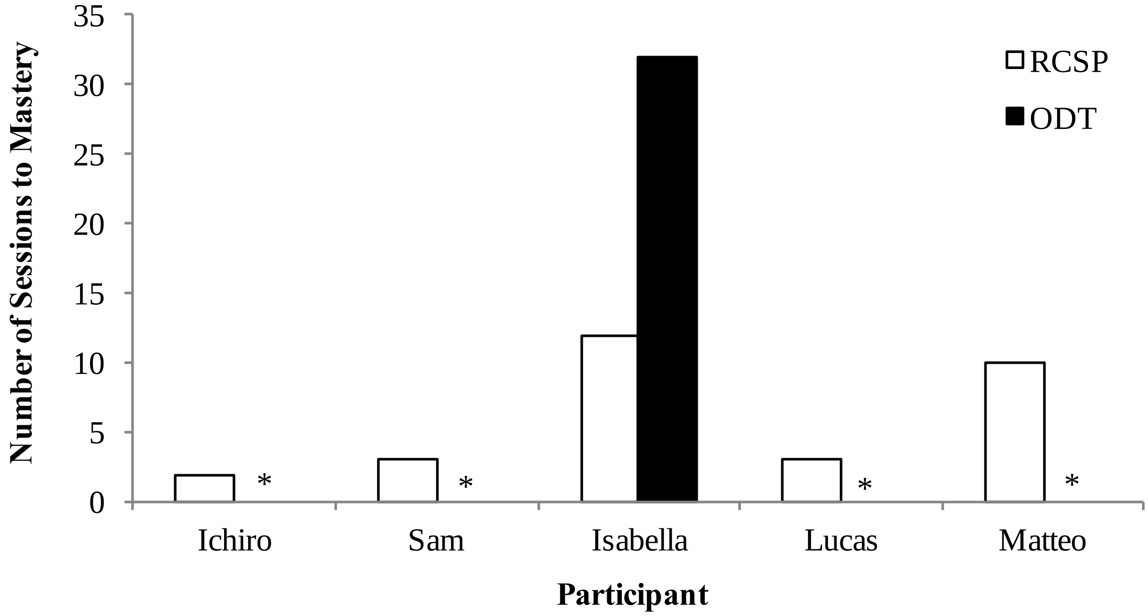

Figure 6. Number of sessions to mastery for all participants.
Note: the asterisks indicate when a participant did not meet the mastery criterion.

In summary, response frequency and session duration during reinforcer probes for RCSP or the S^D were higher following exposure to the conditioning procedures for three of five participants (i.e., Sam, Isabella, and Lucas). These results indicate that both RCSP and ODT were effective in establishing vocal stimuli as conditioned reinforcers for some of the participants.

Chapter 4: Discussion

The purpose of the current study was three-fold: 1) to investigate whether there is a functional relationship between RCSP and increasing the reinforcing value of vocal stimuli, 2) to investigate whether there is a functional relationship between ODT and increasing the reinforcing value of vocal stimuli, and 3) to compare the relative effectiveness of RCSP and ODT to condition vocal stimuli as reinforcers for individuals with ASD. Overall, the results indicated that both RCSP and ODT were effective in establishing vocal stimuli as conditioned reinforcers for some participants.

Response-contingent stimulus pairing and operant discrimination training are response-contingent procedures. Response-contingent procedures are often more preferred than response-independent procedures (Hanley et al., 1997; Luczynski & Hanley, 2009; Lepper et al., 2013). Furthermore, response-contingent procedures appear to be more effective than response-independent procedures, in part because the participant is more likely to attend to the NS in response-contingent arrangements (Dozier et al., 2012; Holth et al., 2009; Lepper et al., 2013). Clinicians providing services to individuals with ASD teach appropriate behaviour using reinforcers. Given the clinical importance of developing effective conditioning procedures for individuals with limited reinforcers, a comparison of the two most promising conditioning procedures was warranted (i.e., RCSP and ODT).

One of the research questions investigated in the current study was whether there were differences in the effectiveness of RCSP and ODT to condition vocal stimuli as reinforcers. For two participants (Isabella and Lucas), mean session duration and response frequency were highest during reinforcer probes for the stimulus assigned to the RCSP condition. Stated differently, the stimulus assigned to the RCSP condition may have functioned as a reinforcer following exposure to the conditioning procedure. For one participant (Sam), mean session duration and response frequency were highest during reinforcer probes for the S^D. For the remaining two participants, mean session duration and response frequency were highest during reinforcer probes for the baseline stimulus and the S^D (Ichiro), or during reinforcer probes for the S^Δ (Matteo).

The current study contributes to and extends the literature on conditioning reinforcers in at least four ways. First, the current study was the first to compare two response-contingent conditioning procedures, RCSP and ODT. Response-contingent procedures appear to be more preferred and more effective than response-independent procedures (e.g., Dozier et al., 2012; Hanley et al., 1997; Holth et al., 2009; Luczynski & Hanley, 2009; Lepper et al., 2013). Given the importance of determining the most effective protocol for conditioning stimuli as reinforcers, a comparison of RCSP and ODT was both highly relevant and necessary.

Second, the results of the current study support the use of RCSP to condition vocal stimuli as reinforcers. The stimuli assigned to RCSP were relatively more reinforcing than the stimuli assigned to baseline or S^Δ for three of five participants, and were relatively more reinforcing than the stimuli assigned to baseline, S^Δ, or S^D for two of five participants. These results replicate the results of previous studies in that RCSP may have been effective in conditioning social stimuli as reinforcers (Axe & Laprime, 2017; Dozier et al., 2012, Helton & Ivy, 2016). Furthermore, these results provide preliminary evidence that RCSP may be more effective than ODT for some learners.

Third, while only one of five participants (Isabella) met mastery criterion for discrimination training during ODT (i.e., two consecutive trials with 100% accuracy), some degree of differentiated responding during ODT was observed for all participants. Discriminated responding is achieved when a participant is more likely to respond in the presence of the S^D than in its absence (Reynolds, 1961). At the time study participation was terminated, all participants were more likely to respond in the presence of the S^D than in the presence of the S^Δ. Responding was highest during S^D reinforcer probes relative to the other conditions for only one participant (Sam). However, three of five participants engaged in substantially more responding during S^D reinforcer probes than during reinforcer probes for either the S^Δ or baseline (Sam, Isabella, and Lucas), suggesting that ODT may have been effective in establishing the S^D as a reinforcer for these participants. These results replicate previous findings and support the use of ODT to condition social stimuli as reinforcers (Holth et al., 2009; Isaksen & Holth, 2009; Lepper et al., 2013; Lugo et al., 2017; Taylor-Santa et al., 2014).

Fourth, we addressed two limitations in previous studies. Similar to Dozier et al. (2012), we demonstrated that the vocal stimuli selected for use in conditioning procedures were neutral prior to conditioning (Dozier et al., 2012). A pre-experimental reinforcer assessment for vocal stimuli has been absent in some previous studies (e.g., Helton & Ivy, 2016; Isaksen & Holth, 2009). We also demonstrated that the responses selected for inclusion in experimental procedures occurred at low rates during free-operant assessments, an evaluation that has been reported in just two previous studies (Holth et al., 2009; Taylor-Santa et al., 2014). It is important to assess both target stimuli and target responses before implementing a conditioning procedure, because in the absence of such assessments limited conclusions can be drawn about the effects of the conditioning procedure.

4.1 Unexpected Findings

There are a number of unexpected findings and noteworthy observations that warrant discussion. First, Ichiro engaged in high and undifferentiated responding during reinforcer probes. Second, Matteo engaged in more responding during reinforcer probes for the S^{Δ} than for any other stimulus. Third, all participants engaged in largely undifferentiated responding during the treatment comparison. These results will be discussed below.

Ichiro engaged in high levels of responding across all conditions during reinforcer probes. There are at least three explanations for these results. First, it is possible that praise functioned as a generalized conditioned reinforcer for Ichiro prior to his inclusion in the current study; if so, its topographical similarities to the vocal stimuli used in the current study may have contributed to Ichiro's results (i.e., brief vocal statements delivered using an enthusiastic tone of voice). This explanation, though plausible, is unlikely, as the results of the pre-experimental reinforcer probes indicated that the vocal stimuli selected for inclusion in the study did not function as reinforcers.

Second, it is possible that the task selected as the target response for reinforcer probes was automatically reinforcing (i.e., attaching binder clips to containers). Although Ichiro did not respond during the pre-experimental response assessment for this task, only one response assessment session was conducted. Ichiro may have engaged in additional responses if subsequent assessment trials had been conducted. That said, it is more likely that the prompted exposure trials conducted prior to the start of each session account for his increased responding.

Third, perhaps the most plausible explanation for Ichiro's undifferentiated responding is his instructional history. Prior to his participation in the current study, Ichiro had worked with the primary experimenter for over nine years. During that time, specific programming had been implemented to thin schedules of reinforcement to teach Ichiro to continue to respond during periods of extinction. Furthermore, Ichiro had an extensive learning history with prompting procedures. In the current study, the experimenter prompted a response at the start of each session. Given this prompt and Ichiro's instructional history, it is plausible that compliance alone functioned as a reinforcer.

A second unexpected finding was that Matteo engaged in substantially more responses during reinforcer probes for the S^{Δ} than for any other vocal stimulus. It is possible that the vocal stimuli selected for inclusion in the study may not have been equally neutral despite experimenter efforts to identify neutral stimuli via pre-experimental reinforcer assessments. No responses occurred during the pre-experimental reinforcer assessments for the stimuli randomly assigned to baseline, RCSP, and S^{D} conditions; however, one response occurred in the pre-experimental reinforcer assessment for the vocal stimulus assigned as the S^{Δ}. Given the limited information provided by the one-trial pre-experimental reinforcer assessment, it is unclear if the stimulus assigned as the S^{Δ} may have functioned as a reinforcer prior to inclusion in the current study.

A third unexpected finding was that most participants engaged in high and undifferentiated responding during the treatment comparison even after meeting mastery criterion for RCSP in relatively few sessions. To address undifferentiated responding, an error correction procedure was implemented after session 68 for Isabella, Lucas, and Matteo. Isabella met mastery criterion for ODT in session 124. Neither Lucas nor Matteo met mastery criterion for ODT; however, following the implementation of error correction, responding during baseline and S^{Δ} sessions decreased to 40% or fewer trials per session for Lucas and 20% or fewer trials for Matteo. There are at least two reasons that error correction may have been effective in increasing differentiated responding. First, error correction may have increased the saliency of the differences between experimental conditions. A limitation of alternating treatment designs and AATDs is multiple treatment interference (Barlow & Hayes, 1979; Sindelar et al., 1985).

Despite efforts to establish differences between experimental conditions, it is possible that the stimuli used were insufficiently salient (i.e., coloured poster boards and shirts). The introduction of error correction may have sufficiently increased the saliency of differences between conditions and thus enhanced stimulus control on subsequent trials (Rodgers & Iwata, 1991; Worsdell et al., 2005). Second, responding may have decreased during baseline and S^{Δ} trials because a non-response allowed participants to avoid the error correction procedure (Rodgers & Iwata, 1991). In the current study, when a participant responded during a baseline or S^{Δ} trial, the experimenter implemented the error correction procedure. The experimenter continued to present the error correction procedure until the participant stopped responding. When the participant did not respond during a baseline or S^{Δ} trial, they avoided the error correction procedure. Decreased responding during baseline and S^{Δ} trials may be attributed to error correction functioning as a punisher; non-responses could have been strengthened via negative reinforcement (Worsdell et al., 2005). However, the specific mechanism responsible for behaviour change in the current study cannot be determined in the absence of an analysis.

4.2 Methodological and Procedural Rigor

A number of procedures were included to increase the methodological and procedural rigor of the study relative to earlier research, including considerations relating to the pre-experimental assessments and conditioning procedures.

We incorporated a number of procedural variations from previous studies to increase the effectiveness of RCSP and ODT. First, we used delay pairing in RCSP procedures, similar to the procedure described by Axe and Laprime (2017). In general, studies using delay pairing have stronger treatment effects than studies using other pairing types (Shillingsburg et al., 2015).

Second, exposure to the NS was limited to one trial during the pre-experimental reinforcer assessment. As noted previously, repeated exposure to a NS in the absence of the US inhibits acquisition and increases training time (i.e., latent inhibition; Lubow, 1965; Lubow & Moore, 1959). Third, the experimenter presented the NS only one time during each pairing in RCSP. Presenting the NS one time may be more effective than presenting the NS multiple times (Miliotis et al., 2012). As noted in the Introduction, a single presentation of the NS is likely more effective than multiple presentations of NS because the stimulus consistently predicts the delivery of the reinforcer. When the NS is presented multiple times before delivery of the reinforcer, multiple instances of respondent extinction occur before the conditioning trial (i.e., the stimulus is unpaired more often than it is paired).

Fourth, the edible reinforcer (i.e., the US) was hidden from view until after the onset of the vocal stimulus (i.e., the NS) during RCSP trials. Previous studies have not provided information about the location of the US (e.g., Axe & Laprime, 2017; Dozier et al., 2012; Lepper et al., 2013; Taylor-Santa et al., 2014). The sight of a US such as food prior to the presentation of the NS may block the conditioning of social stimuli as reinforcers (Kamin, 1969).

Fifth, to account for the possibility that satiation may interfere with acquisition during conditioning, we used three edible reinforcers and quasi-randomly assigned the reinforcers to conditioning sessions. Satiation may reduce the efficacy of both the primary reinforcer and the newly conditioned reinforcer (Moher et al., 2008). Furthermore, using a variety of reinforcers when initially establishing a conditioned reinforcer may make the conditioned stimulus less sensitive to satiation effects (Moher et al., 2008). In the current study, the use of multiple reinforcers during conditioning procedures may have decreased the likelihood that satiation would affect the results of one procedure.

Sixth, we conducted study sessions in close succession, with a minimum of three sessions per week. Response-contingent stimulus pairing and ODT may be less effective when sessions are run infrequently (Axe & Laprime, 2017; Taylor-Santa et al., 2014). Although a formal evaluation has not been conducted, previous studies have reported that delays between conditioning sessions may slow acquisition (Taylor-Santa et al., 2014) or result in deterioration of previously acquired responding (Axe & Laprime, 2017).

4.3 Limitations

There are a number of limitations in the current study that warrant discussion. First, we did not achieve consistently differentiated responding between BL, RCSP, and S^D conditions for Ichiro and Sam. A limitation of the AATD is the possibility of multiple treatment interference, which may account for Ichiro and Sam's results (Sindelar et al., 1985). Multiple treatment interference may have contributed to the undifferentiated responding observed for Isabella, Lucas, and Matteo before error correction was implemented. When responding in a baseline or control condition is high and undifferentiated from responding in treatment conditions, experimental control is weakened (Sindelar et al., 1985). For Ichiro, although responding was high during baseline sessions, responding decreased during S^Δ trials. For Sam, although there was some overlap in data paths, responding was consistently lower during baseline and S^Δ trials. Thus, although we did not achieve consistent response differentiation for Ichiro and Sam, the results suggest some differentiation in treatment effects.

A second limitation is that the experimenter was familiar to three of the five participants prior to their participation in the study (Ichiro, Isabella, and Lucas). It is unclear whether study results may have differed if an unfamiliar experimenter had implemented study procedures. The results of previous studies suggest that familiarity with the experimenter may improve performance (Fuchs & Fuchs, 1986). In this study, the experimenter may have served as an S^D signaling the availability of reinforcers. That said, the experimenter selected vocal stimuli and tasks for inclusion in the study only when they were shown to be associated with low or no responses in pre-experimental assessments. The same experimenter conducted all pre-experimental assessments and the treatment comparison. These considerations reduce the likelihood that participants' familiarity with the experimenter affected study results.

A third limitation is that the primary experimenter was present during generalization probes for all participants except Matteo. Generalization probes were conducted to evaluate participant responding in the presence of an experimenter that was unfamiliar to the participant. The primary experimenter was seated within the participant's line of sight to facilitate the collection of interobserver agreement data. Although she did not interact with the participant during generalization probes, it is possible that her presence had an effect on responding given that she ran all previous conditioning sessions and reinforcer probes (i.e., the presence of the experimenter may have been established as an S^D). In future studies, researchers should ensure that individuals present during generalization probes are unfamiliar to the participant, or at the very least have not been involved in the implementation of conditioning procedures.

A fourth limitation is that it is possible there were differences in the difficulty of the responses during the conditioning procedures. In the current study, the experimenter attempted to equate the responses for difficulty in gross and fine motor movements as well as the time needed to complete the response; however, responses were evaluated subjectively and may have differed in terms of the complexity of the motor movement. For example, Ichiro's target responses included stacking two blocks, opening a manila folder, and inserting a coin into a piggy bank. In this example, inserting a coin into a piggy bank may have differed from the other responses in terms of fine motor difficulty. Equating responses is important in an AATD because it increases the likelihood that differences between the conditions can be attributed to the intervention in effect. In the future, researchers should consider consulting an Occupational Therapist to assist with equating motor responses.

4.4 Implications for Practice

In the current study, we compared two procedures previously demonstrated to be effective for establishing conditioned reinforcers (e.g., Axe & Laprime, 2017; Dozier et al., 2012; Lepper et al., 2013). The results of the current study showed that both RCSP and ODT were effective for establishing praise as a conditioned reinforcer for some participants. In addition, the results of the current study provide tentative support for the use of RCSP over ODT to condition reinforcers. The RCSP procedure produced 100% response accuracy in 2 to 12 sessions for all participants. Furthermore, although design of the current study required the duration of RCSP sessions to be yoked to the duration of ODT sessions, in practice, RCSP may require fewer trials and less time to implement than ODT. Response-contingent stimulus pairing, as implemented in the current study, produced higher response frequency during reinforcer probes relative to baseline or S^{Δ} for three of five participants and higher response frequency during reinforcer probes relative to S^{D} for two of five participants. In contrast, 100% response accuracy during ODT was achieved for only one of five participants and required 32 ODT sessions. The number of sessions required to achieve discriminated responding in ODT in the current study may not be feasible in clinical practice (Lugo et al., 2017).

Response-contingent stimulus pairing is easy to implement and would require little therapist training (Lepper & Petursdottir, 2017). Furthermore, trials could be embedded easily in instructional sessions or throughout a learner’s day. With training, RCSP trials could be implemented by therapists and teachers within already occurring opportunities to maximize the likelihood of a conditioning effect. Additional comparisons of RCSP and ODT are necessary given the limited information provided by the current study. In addition, researchers should consider evaluating the efficiency and social acceptability of both procedures when implemented in an applied setting.

4.5 Future Directions

There are a number of directions for future research based on the results of the current study, including differing participant characteristics, the topography of the neutral stimuli, and maintenance and generalization procedures.

Procedures for conditioning social stimuli may have different effects for older populations due to prolonged exposure to social stimuli in a variety of contexts. Latent inhibition interferes with acquisition and increases training time (Lubow, 1965). The majority of applied research on conditioning procedures has been conducted with children (e.g., Axe & Laprime, 2017; Holth et al., 2009; Isaksen & Holth, 2009; Lepper et al., 2013; Taylor-Santa et al., 2014). Furthermore, it has been suggested that SSP may be more effective with younger in contrast to older populations (Shillingsburg et al., 2015). It is possible that an older learner's history of exposure to social stimuli in the absence of a reinforcing stimulus may block the effectiveness of conditioning procedures. Given this, researchers might consider comparing the effectiveness of RCSP and ODT to condition social stimuli for participants of different ages.

Factors such as the words used, tone of voice, and facial expressions may affect the reinforcing value of praise and other social stimuli (Gardner, Wacker, & Belter, 2009; Kodak, Northup, & Kelley, 2007; Piazza et al., 1999). Additional research is needed to evaluate how topographical variations such as these may affect acquisition of a conditioned stimulus.

Furthermore, given similarities in tone of voice and facial expression, future studies could examine the extent to which one conditioned praise statement could affect the conditioning of other praise statements.

In the current study, maintenance probes were conducted one week after the final conditioning session to assess whether responding persisted after the target vocal stimuli were no longer paired with edible stimuli. Session duration and response frequency during maintenance probes were comparable to experimental reinforcer probes. The results of previous studies have shown a deterioration in responses when the conditioned reinforcer was no longer paired with the US (e.g., Axe & Laprime, 2017; Esch et al., 2009; Lugo et al., 2017). Extended maintenance probes following the final conditioning session may be helpful in evaluating the long-term effects of RCSP and ODT.

4.6 Conclusion

The current study was the first to compare two response-contingent conditioning procedures, RCSP and ODT. Response-contingent procedures appear to be more preferred and more effective than response-independent procedures (e.g., Dozier et al., 2012; Hanley et al., 1997; Holth et al., 2009; Luczynski & Hanley, 2009; Lepper et al., 2013). Given the importance of determining the most effective protocol for conditioning stimuli as reinforcers, a comparison of RCSP and ODT was both highly relevant and necessary.

The results of the current study replicate the findings of previous studies in demonstrating the effectiveness of RCSP and ODT to condition social stimuli as reinforcers (Axe & Laprime, 2017; Dozier et al., 2012, Helton & Ivy, 2016; Holth et al., 2009; Isaksen & Holth, 2009; Lepper et al., 2013; Lugo et al., 2017; Taylor-Santa et al., 2014). Furthermore, the current study provides preliminary evidence that RCSP may be more effective than ODT for some learners.

An important goal of intervention for individuals with ASD is increasing appropriate behaviour maintained by the contingencies in everyday settings. Social stimuli, such as praise, are delivered frequently as consequences for appropriate responding. Effective conditioning procedures might be particularly important for individuals with limited social reinforcers given the ubiquity of praise and other social stimuli. The results of the current study provide further support for the use of RCSP and ODT to condition vocal stimuli as reinforcers.

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