

A Literature Review of Stimulus Control and
Fading Discriminative Stimuli

A Thesis

Presented to

The Faculty of the Graduate School
at the University of Missouri-Columbia

In Partial Fulfillment

of the Requirements for the Degree

Master of Applied Behavior Analysis

by

ETHAN DULTZ

Dr. Wesley Dotson, Thesis Supervisor

JULY 2023

Running head: A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

The undersigned, appointed by the dean of the Graduate School, have examined the thesis entitled

A LITERATURE REVIEW OF STIMULUS CONTROL AND FADING DISCRIMINATIVE
STIMULI

presented by Ethan Dultz

a candidate for the degree of Master of Applied Behavior Analysis

and hereby certify that, in their opinion, it is worthy of acceptance.

Professor Wesley Dotson

Professor Jena Randolph

Professor Matthew Burns

ACKNOWLEDGEMENTS

I would like to thank my thesis committee, Dr. Wesley Dotson, Dr. Matthew Burns, and Professor Jena Randolph for all their advice throughout this process. I would also like to thank my first advisor during graduate school Dr. Jennifer Weyman for her help early on in this thesis process.

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....II

LIST OF TABLES.....IV

ABSTRACT.....V

INTRODUCTION.....1

 Functional Communication Training.....1

 Multiple Schedules.....3

 Extinction in multiple schedules.....4

 The importance of stimulus and contingency control.....5

METHOD.....7

 Search Procedure.....7

 Inclusion and Exclusion Criteria.....7

 Reliability.....8

 Variables of Interest.....8

RESULTS.....9

DISCUSSION.....15

REFERENCES.....21

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

LIST OF TABLES

Table 1. Table depicting the summary of Multiple Schedule Variables.....20

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

ABSTRACT

A multiple schedule is a compound schedule in which two or more component schedules of reinforcement, extinction (EXT), or punishment are alternated based on the passage of time; each component is correlated with a unique stimulus. This review summarizes the stimuli used within a multiple schedule. Thirteen studies were identified through a systematic search process and several different characteristics were evaluated. The variables evaluated were the types of stimuli used, the extension of findings to other settings or people, and if the stimuli were faded. The discussion consists of the findings, implications, and recommendations for future researcher

Introduction

Individuals with Autism Spectrum Disorder (ASD) have difficulty communicating and interacting with others, restricted areas of interest and repetitive behavior, and other characteristics that affect their ability to function in school, work, and other areas of life (American Psychiatric Association, 2013). Many people on the spectrum struggle with problem behavior, which can take many forms depending on the individual. Studies quoted a prevalence rate of overall problem behavior among individuals on the spectrum of around 60%, with more challenging behaviors such as outwardly directed aggression being reported in 10-15% of individuals (Deb et al., 2022). A separate study evaluated 222 children under the age of 7, who met the criteria for infantile autism. This study's results indicated that 50% of children experience problem behavior in the form of self-injurious behavior (SIB) which is classified as aggressive behaviors directed towards oneself (Baghdadli et al., 2003). Both studies show that individuals with ASD engage in problem behaviors and that there need to be procedures in place to decrease these unsafe behaviors.

Functional Communication Training

One of the most established procedures to reduce challenging behavior in ASD is Functional Communication Training (FCT). FCT is a differential reinforcement procedure in which an alternative, communicative response is taught to replace a less appropriate or more dangerous challenging behavior. FCT typically progresses through three stages; a functional analysis is conducted, then a socially acceptable communicative response is reinforced, and then the FCT treatment is extended across settings and people (Tiger et al 2008). For example, sometimes functional analysis has been conducted and the individual has an escape function. This means they engage in behaviors, like throwing a tantrum, to get out of demands. In that case FCT

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

can teach them to ask for a break, which is a safer and more appropriate behavior, when they do not want to do work, rather than throwing a tantrum. This could then be extended into other settings such as their school or home so they can ask for a break there instead of engaging in challenging behavior.

Extending the FCT treatment into the natural environment involves bringing the behavior under more natural control, often requiring that the reinforcement used during teaching is faded out to allow reinforcers in the generalization environment to take over. An example of this is when a communication response (such as teaching an individual to say iPad instead of engaging in a problem behavior such as aggression) is taught in a clinic by therapists and then that same response is transferred to the home environment and facilitated by the parents. A study by Mancil et al., (2006), evaluated how FCT treatments could be used within the home, a more natural environment. The study taught an individual how to communicate with caregivers via handing over a picture icon for a horse, a helicopter, a blanket, or a movie. He was taught how to communicate when he wanted the horse, helicopter, blanket, or the movie, the study taught this by prompting him to exchange the card and then providing independent opportunities to exchange the card. For example, a learning trial would consist of the therapist or the caregiver withholding the item that the participant wanted. They then would state, "If you want (item), ask" and then if the card was handed to the therapist or the caregiver the item was given to him. By the end of the study the individual was able to choose between 4 different cards with no verbal prompt given. This would involve the child having to look at the cards and determine the correct one to receive what they wanted. For three of the responses taught distracter cards were also used that either looked different or similar to the card to ensure that the card was controlling his response and not certain characteristics controlling the response. The treatment was also generalized from the therapist

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

conducting the research giving prompts to a caregiver. This study resulted in lower levels of challenging behaviors and an increase in spontaneous communication within the home.

Multiple Schedules

One way to implement reinforcer schedule thinning following functional communication training is a multiple schedule of reinforcement, which can produce desirable rates of and patterns of communication responses as alternative responses (Miller et al., 2021). A multiple schedule is a compound schedule in which two or more component schedules of reinforcement, extinction (EXT), or punishment are alternated based on the passage of time; each component is correlated with a unique stimulus (Saini et al., 2016). Those stimuli are the presence of discriminative stimuli (SD), such as a green card in the reinforcement period and a red card in the extinction phase. In a multiple schedule with a red and a green card, it might proceed as follows: the card is on green for 60s, during that time responses would be reinforced. Following that there may be 60s of the card on red where the responses would not be reinforced. Research of multiple schedules started in basic laboratories. An experiment by Nevin, (1974), evaluated the use of multiple schedules with pigeons that were trained to request food with the presence of two different colored keys. When a green key was lit, the contingency was that responses were reinforced after an average length of 1 minute had elapsed. When a red key was lit, the contingency was that responses were reinforced after an average length of 3 minutes had elapsed. More recently research have been extended to a variety of socially significant and applied settings such as clinic therapy rooms, treatment facilities, and more naturally occurring settings such as the client's home (Saini et al., 2016).

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

Extinction in multiple schedules

Another aspect of multiple schedules that needs to be considered is the use of extinction components that are embedded within them. While many studies use multiple schedules with different reinforcement-based contingencies, the use of extinction as one of the contingencies is rarer. Extinction is defined as a removing reinforcement for a previously reinforced behavior, thus resulting in occurrences of that behavior to decrease in the future. In a multiple schedule involving extinction, it could proceed as follows: the green light is illuminated for 60 seconds. During that time reinforcement is in effect. Then, red light is illuminated for 60 seconds. During that time extinction is in effect.

Lerman and Iwata, (1995), showed that exposure to extinction can sometimes lead to a temporary increase in the target response. For example, the first time a child is denied access to attention when they engage in SIB you could potentially see more SIB to gain attention from anyone in the surrounding environment. Another potential side effect of extinction is extinction-induced aggression, or a temporary increase in aggression due to the previously reinforced behavior no longer being reinforced (Lerman et al., 1999). There is little to no research on the potential side effects of including extinction components in multiple schedule interventions (Saini et al., 2016).

One study that did include the evaluation of an extinction condition in a multiple schedule intervention was an article by Tiger et al., (2004). In the article, the effects of colored stimuli to control approaches to teachers were evaluated in a classroom using a multiple schedule. The colored stimuli used in this study were colored leis that specified the associated contingency. Children were exposed to different conditions in which teachers wore different colored leis and

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

responded differently to the child's approaches and requests for attention. A red lei was worn to signal when attention was available for one participant, a blue lei was worn to signal when attention was available for the other participant, and a white lei was worn when attention was not available for either participant. The results of this article were that multiple schedule increased requests when they were reinforced but requests continued when they were not reinforced for two participants.

The importance of stimulus and contingency control

Saini et al., (2016), discussed that one of the main reasons that multiple schedules are used is that they are a highly effective arrangement for establishing stimulus control. Changes in a multiple schedule result in a clear change that happens immediately. In a multiple schedule arrangement, the different contingencies are specified by unique stimuli. For example, the reinforcement schedule may be correlated with a green stimulus card and the extinction contingency is correlated with a red stimulus card. When the card changes from red to green, responding will increase, a change from green to red results in a decrease in responding. In this scenario, stimulus control is demonstrated when the behavior changes due to a specific card being present. When stimulus control is well-established the presence or absence of stimuli influences the occurrence of a response.

Within multiple schedules the use of contingency control is used, this refers to a change in target responding only when the response contacts the scheduled contingency put in place during each component (Saini et al., 2016). A change from a reinforcement to an extinction component without correlated stimuli would not result in an immediate shift in responding. In an article by Fischer et al., 1998, the use of discriminative stimuli was evaluated to see the effects of teaching

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

two individuals how to engage in two separate communication responses. The participants were first taught how to request two things, first the reinforcer for problem behavior and secondly an alternative reinforcer. Next the participants were taught to request each reinforcer in the presence of an SD. The results of the article showed that during all applications problem behavior was rapidly reduced to low levels when signaling that a reinforcer was present.

The use of stimuli that are distinctly different is a key aspect of a multiple schedules. Some stimuli such as a colored lanyard are more arbitrary, while others such as a laptop being displayed are more naturalistic, as they resemble the stimuli that occur outside of instructional settings that should control the same response. Boyle et al., (2020), explored incorporating naturalistic SDs into schedule thinning following FCT. In FCT reinforcement occurred on a FR 1 schedule meaning all FCRs were reinforced. During thinning, the schedule was adjusted first adjusted to 1 minute for each component of the schedule and then the extinction component was thinned until it lasted 8 minutes. For some schedules, the stimuli used were naturalistic (a laptop that displayed a calendar, a notebook, a pencil, and a cellphone). In other, the stimuli were arbitrary (a colored lanyard with a green or red notecard attached). There were three total participants with two participants demonstrating differentiated communication in fewer sessions when arbitrary stimuli were used. A limitation of this study is that for the third participant there was no discrimination for either condition. Meaning that the use of arbitrary stimuli was more effective in this study but does not always lead to discriminated responding.

In summary, problem behavior in ASD is prevalent and there is a need to understand common interventions to address it. FCT is a well-established procedure that relies on establishing both contingency and stimulus control of behaviors to replace problem behaviors with more

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

desirable and appropriate alternatives. The purpose of this literature review is to examine in more detail the use of FCT with individuals with ASD, specifically in regard to how studies establish and manipulate stimulus control to ultimately reduce problem behavior in naturalistic environments.

Method

Search Procedure

An investigation into the literature was conducted using the databases Google Scholar, Wiley Online Library, PubMed, and EBSCOHost. Keywords used in the search included: “multiple schedule,” “Autism,” “ASD,” “Functional Communication Training,” and “FCT”. Articles had to be published from 2006 onward, to make sure the review included recent literature that was pertinent to the variables of interest. The references of identified articles for other relevant papers were examined to identify additional studies that were not identified in the initial search. Once a pool of articles is identified, they were reviewed for inclusion or exclusion from the review.

Inclusion and Exclusion Criteria

The inclusion criteria for these articles were: (a) the study had to involve human participants, (b) a multiple schedule had to be used, (c) functional communication training (FCT) needed to be included in the article, (d) the participants had a diagnosis of Autism Spectrum Disorder (ASD). Articles were excluded if (a) they were conducted using individuals with any diagnosis other than ASD; meaning that an individual could have multiple diagnoses but had to be diagnosed with ASD, (c) the study was non-experimental, (d) the study was a literature review of other studies. A stop criteria was added to the Google Scholar search due to the number of articles

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

that were accumulated, the first 50 articles were evaluated to determine inclusion or exclusion criteria.

Reliability

Inter Observer Agreement (IOA) was conducted by one independent person to best ensure articles involved met the inclusion and exclusion criteria. The independent person evaluated 30% of the empirical articles using the inclusion and exclusion criteria. The percent agreement with the initial rating by me were recorded by taking the number of articles agreed divided by the total number of articles and multiplied by 100. Of the reviewed articles interobserver agreement was 100%.

Variables of interest

Once the final articles to be included were identified, they were placed in a summary table (table 1) and described along the following dimensions: the types of discriminative stimuli evaluated within each study, how the discriminative stimuli were faded, and how the studies extended their findings into natural environments. The types of discriminative stimuli were a variable of interest because of the comparison between naturalistic and arbitrary stimuli. The interest in how the studies generalized their findings to more naturalistic environments is why the fading of discriminative stimuli was a variable of interest. Furthermore, how they extended their findings into natural environments was a variable of interest for similar reasons, generalizing the skill to settings such as the home or school, where the skill would be the most socially significant.

Each variable of interest was scored and described in a summary table (table 1). The types of stimuli were scored as either arbitrary, naturalistic, or both, this was a description of the type of stimuli that the researchers evaluated within the study. Arbitrary stimuli are stimuli that the

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

research choses such as a colored schedule-correlated stimuli, an example being a red card during the nonreinforcement condition of a multiple schedule. The other stimuli are naturalistic stimuli which are overt behavior by the therapist or caregiver to signal that they are busy, such as talking on the phone.

Secondly, how the discriminative stimuli was faded was scored with a yes or a no. If the stimuli were attempted to be faded out of the treatment, then it would be scored as a yes but if no attempts were made then it was scored as a no. A way that the stimuli could be faded could be by changing the transparency of the stimuli. An example of this would be using an arbitrary stimuli and then fading the color of the stimuli out. This would then fade out the discriminative stimuli and could allow for the stimulus control to be transferred to a verbal statement.

The last variable that was described in the table was the extension of the study's findings. If the study extended their findings, they were described in their own words within the table and if they were not extended the studies were described as not applicable. Some studies extended their studies by teaching the skill in a novel environment, while others taught the skill with new people. Some of the studies used new people that were the participant's caregivers which is ideal due to the fact that they could then take the skill home with them.

Results

13 articles met the inclusion criteria for the literature review. Every article contained a Functional Communication Component (FCT) to their study, where they either taught FCT themselves or the participants involved has already been taught functional communication responses through FCT prior to the study and evaluated multiple schedules in some aspect. For example, Quigley et al., 2021, evaluated the effects of FCT and schedule thinning through a

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

multiple schedule with one participant in their home. The second part of the study was whether the intervention results maintained in the participants optimal context. It was determined that FCT with schedule thinning was effective to reduce chained responding across settings and that multiple schedule effectively signaled times when items were available or unavailable.

Miller et al., (2021), evaluated an initial assessment for informing the initial duration of extinction for alternative responding. They also evaluated the effectiveness of competing stimuli during extinction and assessed a method for fading the availability of the competing stimuli. The variables of interest in this study were the rates of destructive behavior and the FCR. The results of this study were that with the procedures used all four participants experienced terminal schedules of reinforcement with rapid reductions in problem behavior soon after baseline.

A study by Torres-Viso et al., (2018), produced a systematic replication of a functional analysis (FA) of the relation between mands and problem behavior. This study consisted of one participant, with the mands consisting of requests for others to change where they were positioned or proximity, or to put tangibles back in their original position. The FA confirmed the relation between problem behavior and mand compliance. Functional communication training plus extinction was used to decrease problem behavior. When a multiple schedule was introduced to increase the nonreinforcement period problem behavior remained low for the participant.

In a study conducted by Campos et al., (2017), the effects of a multiple schedule used to treat behaviors maintained by negative reinforcement was evaluated. The study included two individuals who emitted escape-maintained problem behavior. The study evaluated a multiple schedule with alternating Fixed ratio (FR-1) and extinction components to evaluate the effects on problem behavior and functional communication responses (FCRs). Problem behavior remained

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

low during FCT sessions and multiple schedule phases but alone did not result in discriminated manding. The experimenters added two extra phases, multiple schedule plus reinforcement for compliance during the Sdelta phase and multiple schedule plus response blocking. Once these modifications had been made discriminated responding occurred in both participants.

Destructive behavior maintained by both social positive (tangible) and social negative (escape) reinforcement was addressed in a study by Briggs et al., (2018). First FCT was used to treat problem behavior and then the schedule of reinforcement was thinned using a multiple schedule which was later modified into a chained schedule. Both multiple schedules and chained schedules proved effective at maintaining FCRs while also decreasing destructive behaviors to near zero levels. The study then evaluated the preference for each schedule arrangement (multiple vs. chained), which resulted in client preference shifting from chained to multiple as the response requirement increased.

Haq et al., (2018), evaluated the effects of a fixed-lean multiple schedule to evaluate the effects of abrupt shifts to terminal schedules of reinforcement in relation to challenging behavior. Other purposes of the study were to evaluate the potential effects of alternative stimuli during a fixed-lean multiple schedule and to assess the social validity of this treatment with participants and caregivers. This study's results resulted in low levels of challenging behavior and discriminated mands during the fixed-lean multiple schedule. However, this study did not provide any evidence to support the inclusion of alternative stimuli.

In a study conducted by Campos et al., (2023), the effects of static and dynamic signals within the context of multiple schedules were evaluated with four participants. Signals were considered static if they lacked movement and dynamic if they included movement or were

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

animated. The purpose was to evaluate which type of signal resulted in faster stimulus control over behavior. The results of this study suggest that the use of static or dynamic does not produce any differentiated responding. Discriminated responding occurred with both static and dynamic signals for three out of the four participants. Only dynamic signals results in discriminated responding for one of the participants.

Boyle et al., (2021), conducted a study that evaluated the comparison of naturalistic and arbitrary discriminative stimuli during schedule thinning with three participants. Naturalistic stimuli were things such as talking on the phone or watching something on a laptop. The arbitrary stimuli was a lanyard that was green for the reinforcement time and red for nonreinforcement time. The results of the study were that discriminated responding occurred in fewer session when arbitrary stimuli were used for two of the participants. Previous research had demonstrated success when rapidly schedule thinning with arbitrary stimuli, but researchers wanted to extend the study to evaluate to what extent communication would maintain with each stimuli. Two of the participants maintained discriminated responding in both naturalistic and arbitrary conditions, with neither condition maintained responding in the third participant.

A study conducted by Shamlan et al., (2016), evaluated the use of naturally occurring stimuli and therapist-arranged discriminative stimuli following functional communication training with three participants. The purposes of the study were to compare the effects of arranged and natural occurring stimuli on discriminated FCRs and the generalization of discriminated FCRs when in novel contexts in which the naturally occurring stimuli were either relatively easy or difficult to discriminate. The arranged stimuli in this study were colored cards, and the natural stimuli was overt behavior by the therapist to show that they were busy. The results of the study

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

were that two of the three participants acquired discriminated responding of the FCR quicker when the stimuli were arranged compared to the naturally occurring stimuli. During generalization two of the three participants showed greater discriminated responding to novel contexts with arranged stimuli rather than naturally occurring stimuli.

In a study by Weyman et al., (2022), a trial-based functional analysis was used to assess problem behavior related to ritual interruption and to treat the behavior using functional communication training plus a multiple schedule. The effects were evaluated on four individuals that all engaged in ritualistic behaviors. The multiple schedule was used to thin the schedule of reinforcement of the FCRs by using a red or green card to signal reinforcement or nonreinforcement time. The results of this study were that trial-based functional analysis can determine the function of ritualistic behavior, that the treatment was effective in all the participants, and that in three of the four participants treatment generalized to addition rituals.

A study by Pizarro et al., (2021), evaluated how participants skills related to color discrimination may be related to the emergence of discriminated responding in a multiple schedule with color that as the schedule-correlated stimuli. Other purposes of the study were to evaluate varied multiple schedule arrangements, if topographically dissimilar stimuli facilitated discriminated responding, and if employing different color stimuli across multiple schedule arrangements reduced the likelihood of discriminated responding. Results showed that participants' ability to select and tact colors was strongly correlated with the efficiency of standard multiple schedule arrangements. Also, that multiple schedule arrangements employing topographically dissimilar stimuli were observed to be equally as effective as standard

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

arrangements and the inclusion of different colored stimuli across arrangements did not reduce the likelihood that discriminated responding emerged.

Greer et al., (2019), extended previous research that showed that bringing FRCs under the control of schedule-correlated stimuli facilitates rapid thinning of the reinforcement schedule as well as transfer of FCT to different people and settings. This study evaluated the transfer to caregivers and the degree to which FCT treatment effects could be transferred to caregivers with and without schedule-correlated stimuli. The study resulted in rapid transfer of treatment effects only when caregivers used the schedule-correlated stimuli.

Finally, A study conducted by Kranak and Falligant, (2022), analyzed terminal schedule probes and schedule thinning effects following functional communication training. Schedule thinning was conducted using a multiple schedule that signaled the reinforcement and nonreinforcement period. The purpose of the study was to conduct terminal probes before schedule thinning and problem behavior was analyzed to determine if it was plausible. The results showed that rates of problem behavior in the terminal probes exceeded that of baseline in two out of the three treatments prior to schedule thinning. This means that it is more effective to systematically fade the reinforcement period out when schedule thinning versus using terminal probes to fade out reinforcement time.

The results of this literature review in regard to the discriminative stimuli used, if they were faded, and if the findings were extended to evaluate if treatment could be generalized across people or settings, are summarized in table 1. When evaluating the discriminative stimuli that were used, they were put into two categories: arbitrary and naturalistic stimuli. Arbitrary stimuli are stimuli that the research chooses such as a colored schedule-correlated stimuli, an example being a red card

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

during the nonreinforcement condition of a multiple schedule. The other stimuli are naturalistic stimuli which are overt behavior by the therapist or caregiver to signal that they are busy, such as talking on the phone or watching a video on a laptop. Of the 13 studies evaluated three of the studies evaluated the use of naturalistic stimuli. These studies observed that arbitrary stimuli have been found to be more effective in teaching discriminated responding,

The second aspect that was evaluated was if the discriminative stimuli was faded out within the schedule. This could include pairing the stimuli with a vocal response and then slowly fading out the colored stimuli so that the vocal response was the stimuli that controlled the behavior. Of the 13 studies that were evaluated none contained any fading procedures for the stimuli that was used in the multiple schedule. The last thing that was evaluated during this review was the extension of the findings to more natural settings. 7 of the 13 contained generalization procedures that varied from generalizing the treatment of new behaviors to teaching caregivers. While some of the studies extended their findings by teaching the procedures to caregivers so it could be used at home or in novel contexts it was observed that only 3 of the 7 studies included the caregivers. The other 4 studies evaluated the treatment effects across other therapists or novel contexts.

Discussion

The purpose of this literature review was to evaluate the research on the fading of multiple schedules to more naturalistic settings within FCT interventions. The studies included revealed that multiple schedules are effective for many individuals, but the stimuli used are typically arbitrary and not faded out when mastery criteria have been met. Multiple schedules are a widely used schedule thinning procedure after functional communication training. This is due to the ability of multiple schedules to control behavior and produce discriminated responding (Saini et

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

al., 2016). This literature review revealed a gap in the literature as none resulted in any attempts to fade out stimuli. This is a topic for future research so that multiple schedules could become more effective in natural settings such as homes or schools where it is not always feasible to always have a red and green board around.

The use of stimuli was an area of interest in this study because of the comparison of naturalistic to arbitrary stimuli. Boyle et al., (2020), explored incorporating naturalistic SDs, such as the presence of a laptop, into schedule thinning following FCT. Naturalistic stimuli are an important aspect to consider for clinicians' treatment goals as it a more discrete way for the individual to know if reinforcement is available or not. The use of a brightly colored card has been shown to be effective but is not discreet and could be potentially stigmatizing if used in a public place. While multiple schedules are effective, they are also not discreet, individuals could be bullied within school settings for the use of a large colored board. The use of arbitrary stimuli could lead to bullying as the stimuli is plain for all to see. The use of naturalistic stimuli such as an overt behavior, talking to another person or on the phone could be less stigmatizing. This could be less stigmatizing as it is not plain for all to see and is clear sign that they are busy. The use of this naturalistic behavior being what controls the behavior of an individual could also lead to more generalization across setting. In this review it was found that only 3 of the studies evaluated different kinds of naturally occurring stimuli. This shows that not enough research has been conducted on naturally occurring stimuli. Future experimenters should continue to evaluate the rate at which discriminated responding is controlled by discriminative stimuli and use what we know regarding applied FCT to take advantage of what research has already been conducted surrounding stimulus control.

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

Another aspect that was evaluated during this study was if the stimuli used within the study was attempted to be faded out. This is an interesting variable as there is not much literature regarding the fading of stimuli within a multiple schedule. While there is a hole in the research here it is an area of interest due to the idea that fading out the stimuli could lead to better generalization of stimulus control into the natural environment. The review showed that no studies had tried to fade their stimuli. Meaning that more research should be conducted in this area to determine if fading the stimuli to a more naturalistic or discrete stimuli could lead to higher rates of generalization in novel contexts. An article by Schlichenmeyer et al., (2015), using response cost as an intervention rather than FCT, faded a stimulus signaling RC by adding more steps to the initial process. They used a four-step process that started with the participant receiving reinforcement after the completion of a task. Following that the stimulus was faded by increasing the response cost. The amount of work required before reinforcement was increased by having the participant seek out the trash can as it was moved farther away. This led to the stimulus being faded from simply completing the activity to having to walk outside of the classroom to throw away supplies before receiving reinforcement. The study found that rates of behavior remained low during the fading process where response cost was systematically increased. The results of this literature review show that none of the studies had a criteria to fade out stimuli or even fade the stimuli from arbitrary to naturalistic. While it may not be feasible to completely fade out the stimuli used within a study it is worth evaluating the validity of fading to a more discrete or natural stimuli. The use of stimuli such as a red and green card has been shown to be highly effective, however these procedures are not the easiest for caregivers to implement, transferring the stimulus control from a card to a behavior that can be overtly done by a caregiver would allow for a more naturalistic transition into the real world.

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

Generalization is an aspect of treatment that 7 of the 13 evaluated, with only 3 of those 7 evaluating generalization of the treatment to caregivers, the other 4 studies evaluated the treatment effects across other therapists or novel contexts. While both these are important to evaluate, an important aspect to note is that after treatment is over the caregivers are the ones who would continue treatment. Due to this it is important to train caregivers and then potentially evaluate the generalization aspects of treatment over time. It is important to remember that an experiment is typically conducted in a very controlled environment to effectively evaluate the experimental variables. While this is important it does not always reflect how things happen in the natural environment. The use of multiple schedules has been shown to be effective both in and out of clinics but not all treatments that are evaluated in the clinics are generalized to the participants caregivers or home environment. This is important since once the study is over the parents or caregivers are the ones that need to be continuing treatment. As clinicians use literature to create and modify treatment plans this is an area of interest to ensure that their treatments generalize to the home environment where it would be the most socially significant to the participant and caregiver.

In summary, the purpose of this literature review was to determine what stimuli were being used within multiple schedules and if those stimuli were being faded. It found that arbitrary stimuli are more likely to be used, with naturalistic stimuli being evaluated in only 3 of the 13 studies. The review also found that only 7 out of 13 researchers extended their findings to novel environments and people, such as the home and with caregivers. Lastly, the review also found that none of the included studies faded their stimuli out of the multiple schedule. This is important because more research needs to be evaluated with caregivers and in the home since they will be the ones conducting the treatments after the study is over. Another reason this is important is because if

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

stimuli were faded it could potentially lead to a less stigmatizing environment for the participants involved and more generalization in novel environments with novel people.

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

Figures

Table 1

Summary of Multiple Schedule Variables

Summary Table

Studies in Alphabetical Order	Number of Participants	Arbitrary or Naturalistic Discriminative Stimuli	Fading of Discriminative Stimuli	Extension of findings to other settings or people
Boyle et al. (2021)	3	Both	No	Caregiver Probes
Briggs et al. (2018)	1	Arbitrary	No	N/a
Campos et al. (2017)	2	Arbitrary	No	N/a
Campos et al. (2023)	4	Arbitrary	No	N/a
Greer et al. (2019)	2	Both	No	Caregiver Transfer
Haq et al. (2018)	2	Arbitrary	No	N/a
Kranak and Falligant. (2021)	2	Arbitrary	No	N/a
Miller et al. (2022)	4	Arbitrary	No	Generalized to novel therapist and environments
Pizzaro et al. (2021)	9	Arbitrary	No	N/a
Quigley et al. (2021)	1	Arbitrary	No	Embedded into natural environment
Shamlian et al. (2021)	3	Both	No	Generalization to novel activities
Torres-Viso et al. (2018)	1	Arbitrary	No	Extended to new therapists and novel contexts
Weyman et al. (2022)	4	Arbitrary	No	Generalized to novel rituals

References

References marked with an asterisk indicate studies included in the literature review.

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders* (5th ed., text rev.). <https://doi.org/10.1176/appi.books.9780890425787>

Baghdadli, A., Pascal, C., Grisi, S. and Aussilloux, C. (2003), Risk factors for self-injurious behaviours among 222 young children with autistic disorders. *Journal of Intellectual Disability Research*, 47: 622-627. <https://doi.org/10.1046/j.1365-2788.2003.00507.x>

*Boyle, M. A., Bacon, M. K. T., Carton, S. M., Augustine, J. J., Janota, T. A., Curtis, K. S., Forck, K. L., & Gaskill, L. A. (2020). Comparison of Naturalistic and Arbitrary Discriminative Stimuli during Schedule Thinning Following Functional Communication Training. *Behavioral Interventions*, 36(1), 3–20. <https://doi.org/10.1002/bin.1759>

*Briggs, A. M., Akers, J. S., Greer, B. D., Fisher, W. W., & Retzlaff, B. J.. (2018). Systematic Changes in Preference for Schedule-Thinning Arrangements as a Function of Relative Reinforcement Density. *Behavior Modification*, 42(4), 472-497–497. <https://doi.org/10.1177/0145445517742883>

*Campos, C., Bloom, S. E., Kollin, L., & Weyman, J. R.. (2023). Comparing the effects of static and dynamic signals during multiple schedules. *Behavioral Interventions*, 38(2), 302-316–316. <https://doi.org/10.1002/bin.1920>

*Campos, C., Sleiman, A., Urcuyo, B., & Leon, Y. (2017). Further Evaluation of the Use of Multiple Schedules for Behavior Maintained by Negative Reinforcement. *Behavior Modification*, 41(2), 269-285–285. <https://doi.org/10.1177/0145445516670838>

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

- Deb, S.S., Unwin, G., Cooper, S.A., Rojahn, J. (2022). Problem Behaviour. In: Bertelli, M.O., Deb, S., Munir, K., Hassiotis, A., Salvador-Carulla, L. (eds) Textbook of Psychiatry for Intellectual Disability and Autism Spectrum Disorder. Springer, Cham.
https://doi.org/10.1007/978-3-319-95720-3_7
- Fisher, W. W., Kuhn, D. E., Thompson, R. H., Establishing Discriminative Control of Responding using Functional and Alternative Reinforcers during Functional Communication Training. *Journal of Applied Behavior Analysis*. 1998 Winter;31(4):543-60. 10.1901/jaba.1998.31-543.
- *Greer, B. D., Fisher, W. W., Briggs, A. M., Lichtblau, K. R., Phillips, L. A., & Mitteer, D. R. (2019). Using schedule-correlated stimuli during functional communication training to promote the rapid transfer of treatment effects. *Behavioral Development*, 24(2), 100–119.
<https://doi.org/10.1037/bdb0000085>
- Halle, J. W., & Holt B., Assessing Stimulus Control in Natural Settings: an Analysis of Stimuli that Acquire Control during Training. *Journal of Applied Behavior Analysis*. 1991 Fall;24(3):579-89. 10.1901/jaba.1991.24-579.
- Hanley, G. P., Iwata, B. A., & Thompson, R. H. (2001). Reinforcement Schedule Thinning Following Treatment with Functional Communication Training. *Journal of Applied Behavior Analysis*, 34, 17–38. 10.1901/jaba.2001.34-17
- *Haq, S. S., Machalicek, W., Garbacz, S. A., & Drew, C.. (2018). Employing a Fixed-Lean Multiple Schedule in the Treatment of Challenging Behavior for Children With Autism

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

Spectrum Disorder. *Behavior Modification*, 42(4), 610-633–633.

<https://doi.org/10.1177/0145445517743206>

*Kranak, M. P., & Falligant, J. M. (2022). Analysis of terminal schedule probes and schedule thinning effects following functional communication training. *Behavioral Interventions*, 37(2), 323–333. <https://doi.org/10.1002/bin.1842>

Lerman, D. C., & Iwata, B. A., Prevalence of the Extinction Burst and its Attenuation During Treatment. *Journal of Applied Behavior Analysis*. 1995 Spring;28(1):93-4.
10.1901/jaba.1995.28-93.

Lerman, D.C., Iwata, B.A. and Wallace, M.D. (1999), SIDE EFFECTS OF EXTINCTION: PREVALENCE OF BURSTING AND AGGRESSION DURING THE TREATMENT OF SELF-INJURIOUS BEHAVIOR. *Journal of Applied Behavior Analysis*, 32: 1-8. <https://doi.org/10.1901/jaba.1999.32-1>

Mancil, G. R., Conroy, M. A., Nakao, T., & Alter, P. J. (2006). Functional Communication Training in the Natural Environment: A Pilot Investigation with a Young Child with Autism Spectrum Disorder. *Education and Treatment of Children*, 29(4), 615–633.

*Miller, S. A., Fisher, W. W., Greer, B. D., Saini, V., & Keevy, M. D. (2021). Procedures for determining and then modifying the extinction component of multiple schedules for destructive behavior. *Journal of Applied Behavior Analysis*, 55(2), 463–480.
<https://doi.org/10.1002/jaba.896>

Nelson, Amelia, "Increasing Variable Play in Children with Autism Using a Lag Schedule and Stimulus Fading" (2019). *Thesis Projects*. 12.
https://scholarship.rollins.edu/mabacs_thesis/12

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

Nevin, J.A. (1974), RESPONSE STRENGTH IN MULTIPLE SCHEDULES. *Journal of the Experimental Analysis of Behavior*, 21: 389-408.

<https://doi.org.proxy.mul.missouri.edu/10.1901/jeab.1974.21-389>

*Pizarro, E. M., Vollmer, T. R., & Morris, S. L.. (2021). Evaluating skills correlated with discriminated responding in multiple schedule arrangements. *Journal of Applied Behavior Analysis*, 54(1), 334-345-345. <https://doi.org/10.1002/jaba.759>

*Quigley, J., Dowdy, A., Trucksess, K., & Finlay, A. (2021). An Investigation of Functional Communication Training and Schedule Thinning Using a Multiple Schedule on Elopement to Access Stereotypy. *Journal of Autism & Developmental Disorders*, 51(9), 3224-3234. <https://doi.org/10.1007/s10803-020-04788-7>

Saini, V., Miller, S. A., & Fisher, W. W. (2016). Multiple schedules in practical application: Research trends and implications for future investigation. *Journal of Applied Behavior Analysis*, 49(2), 421-444. <https://doi.org/10.1002/jaba.300>

Schlichenmeyer, K. J., Dube, W. V., & Vargas-Irwin, M. (2015). Stimulus fading and response elaboration in differential reinforcement for alternative behavior. *Behavioral Interventions*, 30(1), 51-64.

*Shamlian, K. D., Fisher, W. W., Cavanaugh, B. M., Querim, A. C., Steege, M. W., & Samour, K.. (2016). Evaluation of multiple schedules with naturally occurring and therapist-arranged discriminative stimuli following functional communication training. *Journal of Applied Behavior Analysis*, 49(2), 228-250-250. <https://doi.org/10.1002/jaba.293>

A LITERATURE REVIEW OF FADING MULTIPLE SCHEDULES

Tiger, J. H., & Hanley, G. P. (2004). Developing stimulus control of preschooler mands: An analysis of schedule-correlated and contingency-specifying stimuli. *Journal of Applied Behavior Analysis, 37*(4), 517–521. <https://doi.org/10.1901/jaba.2004.37-517>

Tiger J. H., Hanley, G. P., & Bruzek, J. Functional Communication Training: a Review and Practical Guide. *Behavior Analysis in Practice. 2008 Spring; 1*(1):16-23.

10.1007/BF03391716. PMID: 22477675; PMCID: PMC2846575.

*Torres-Viso, M., Strohmeier, C. W., & Zarcone, J. R. (2018). Functional analysis and treatment of problem behavior related to mands for rearrangement. *Journal of Applied Behavior Analysis, 51*(1), 158-165–165. <https://doi.org/10.1002/jaba.437>

*Weyman, J. R., Bloom, S. E., Garcia, A. R., & Campos, C. (2022). An application of the trial-based functional analysis to assess problem behavior evoked by ritual interruption. *Behavioral Interventions, 37*(4), 926-940–940.
<https://doi.org/10.1002/bin.1882>