# THE EFFECTS OF A LAG SCHEDULE ON MAND VARIABILITY ON CHILDREN WITH AUTISM WHO USE A SELECTION BASED COMMUNICATION SYSTEM

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Applied Behavior Analysis – Master of Arts

2024

## ABSTRACT

The purpose of this study is to examine if Lag schedules can increase variability in children who use a selection-based communication system. For this study, two preschool aged children who use a selection-based communication were provided a binder with different mand frames. A multiple baseline design was used where all mand were reinforced in baseline sessions, followed by Lag 2 schedule condition to test if variation would emerge to meet the response requirements. Results of this study did not support the use of a Lag schedule to increase mand variability. Both participants failed to vary their responding and mand extinction was observed. Assent withdrawal and negative behaviors were also observed in both participants when the Lag schedule was put into effect. Limitations and possible future directions with practitioner-based research are discussed.

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# INTRODUCTION

People with Autism Spectrum Disorder (ASD) are at risk of social stigmatization due to the restrictive patterns of behavior including repetitive speech characteristics of ASD (ASD; Centers for Disease Control and Prevention, 2022). Social deficits such as repetitive speech patterns can lead to difficulties in holding others interest in conversation and the formation of social relationships (Rodriguez & Thompson, 2015). Furthermore, repetitive speech patterns can create difficulties in maintaining social relationships because of restricted conversational topics (Rodriguez & Thompson, 2015). Repetitive speech patterns, a characteristic of ASD have demonstrated to increase difficulties in forming and maintaining social relationships.

Fortunately, behavioral interventions have demonstrated that the use of a Lag schedule can help increase variability in responses (Susa & Schlinger, 2012). For example, Esch and colleagues (2009) conducted a study to examine the effects of a Lag schedule on vocal variability. In this study, two male children diagnosed with ASD who exhibited a limited vocal repertoire were presented with different speech sounds which were reinforced on a Lag 1 schedule of variability (Esch et al., 2009). Results from this study displayed that a Lag 1 schedule increased vocal sound variability.

Multiple studies have extended the findings of Esch et al. (2009) and examined the effects of Lag schedules on vocal response variability in children with ASD. Susa and Schlinger (2012) examined the effects of using a Lag schedule to increase response variability to answer the question "How are you?" in one 7-year-old male with ASD. The child was asked "How are you?" multiple times using verbal scripts to teach additional responses. A Lag schedule of reinforcement was then used to praise responses that differed from either the one, two, or three previous answers. Results of Susa & Schlinger (2012) demonstrates that a Lag schedule can

increase variation in answers to social questions, a skill that may be important in developing social relationships with a child's peer group.

Michael (1985) discusses the differences in selection-based and topography-based responding in the context of verbal behavior. Topographical based responding involves changes in the response form, and in verbal behavior this is demonstrated by changing the sound of spoken word. Selection based verbal behavior is a non-vocal form of communication that involves exhibiting the same response such as pointing to items the person desires, but those points or gestures are directed toward different stimuli (here, the topography of the behavior, selection, is generally the same across response opportunities).

This paper will be expanding previous research on Lag schedules to observe if similar results can be demonstrated in a population that relies heavily on selection based verbal behavior using picture icons. In exact terms this paper aims to answer, what are the effects of a Lag schedule on mand variability in children with autism who use picture icons to communicate? This extension will analyze if teaching variability to children with ASD can be conducted in the same manner regardless of vocal language status. If found to be effective, these findings should help facilitate social relationships for children with ASD regardless of their mode of verbal communication.

## METHOD

### *Participants*

Two participants were recruited, one girl and one boy. Anna was a girl who was four years old at the time of the study and Mark, a boy, was six during the study. Each child had a medical diagnosis of autism spectrum disorder (ASD) from an outside agency and were recruited at an early intensive behavioral intervention center associated with a large Midwest university where they received 30 hours of ABA services per week. Both Anna and Mark had a VB-MAPP mand score of 6 at the time of this study.

### *Setting*

Sessions took place in at a university associated intensive behavioral intervention center (Plavnick, et.al, 2020) for 10 minutes at time and were video recorded. Sessions were conducted separated from their peers in the hallway. The area contained two chairs on opposite sides of a small table with a paper and pen data-collection clipboard. Next to the experimenter was a gray storage bag containing a bin with edible items, communication binders, Velcro sentence strips for the communication binders, and picture icons.

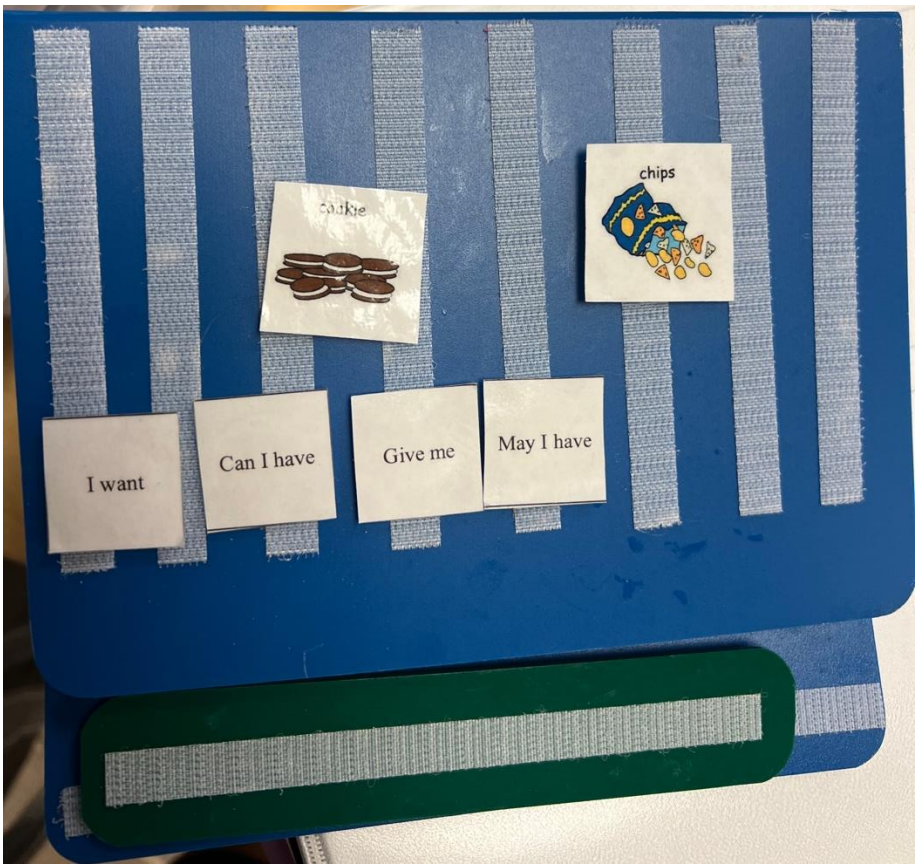
### *Materials*

Communication binders were assigned to each participant Mark had a blue binder and Anna had a red binder. Binders had blue and green sentence strips attached at the bottom of the book (see photo in Figure 1). The color of the sentence strip varied depending on what condition was in place. During baseline sessions blue, green, and the participants regular sentence strips were rotated, during the Lag schedule condition the green sentence strip was used exclusively. Picture icons were 1-inch laminated paper squares with colored pictures of edible snack items and the name of the items in black font. Picture icons of mand frames consisted of white

laminated 1-inch paper squares that had size 12 black Times New Roman font. The researcher had five snack items during research sessions based on preference assessment results as described in detail below. A camera on a tripod was used to record session data.

**Figure 1**

*Communication binder with a green sentence strip*




*Response measurement*

Each research session was recorded and reviewed by the researcher later. A second research assistant also reviewed videos for the purposes of interobserver agreement and procedural fidelity (see below).

A mand was defined as any instance in which a mand frame picture icon and an item picture icon, in that order, were placed on a sentence strip and handed to the researcher. An

example of a mand is a sentence strip with an “I want” icon (mand frame picture icon) on the left side and a “chip” icon (item picture icon) on the right side. Instances of picture icons in a different order (e.g., item, mand frame), icons not on the sentence strip, or an icon missing from the sentence strip when handed to the researcher were not scored as mands.

Varied mands were defined as a mand that differed from any previous mands that occurred in that research session. An example of this measure would be that Participant A used “I want___” five times and “I need___” twice. In the case of this example, the number of varied mands for that session would be two.

Total number of mands was defined as the number of mands the participant engaged in within the session.

Rate of manding was taken as a secondary measure because some participants opted to terminate their sessions before 10 min elapsed. Rate of manding was calculated by taking the number of total mands that occurred in the session and dividing it by the minutes in the session.

Percentage of mands reinforced was defined as the number of mand frames that resulted in reinforcement in a session divided by the number of mand frames of that session and multiplied by 100 to yield a percentage. This variable depends on adherence to a Lag schedule, in which “reinforcement is contingent on a response being different in some specified way (e.g., different topography) from the previous response (e.g., Lag 1) or a specified number of previous response (e.g., Lag 2 or more)” (Cooper et al., 2020).

*Interobserver agreement*

Interobserver agreement data were collected for 30% of sessions for each subject. An independent observer watched recorded data of sessions. Agreements are defined as follows. For agreement on mand frames, that the observers and researcher both noted the same mand frame.

For agreement on varied mands, agreement was scored if both the researcher and second observer noted the same number of varied mands. For agreement on total number of mands, agreement was scored if both researcher and second observer noted the same number. For mands reinforced, and agreement was scored if both the researcher and second observer obtained the same percentage of mands reinforced for that session. Disagreements were defined as observers having discrepancies in any of the above criteria not corresponding between researchers. Data was collected for 60% of Anna's sessions and 30% of Mark's sessions. Mean agreement was 98% for Anna's sessions (range 93%, 100%). Mean agreement was 95% for Mark's sessions (range 85%, 100%).

*Procedural fidelity*

Procedural fidelity was measured by having the researcher follow a task analysis created for the research session and having a second observer code for if the task analysis (Table 1) was followed for at least 30% of sessions. Both Anna's and Mark's sessions demonstrated 100% fidelity. An occurrence of behavior being followed is defined as any instance where the researcher's behavior corresponded with what was described in the task analysis.

**Table 1**

*Procedural Fidelity*

| | Yes | No | N/A |
|---|---|---|---|
| **Prior to Session** | | | |
| 1. Materials are accessible to researcher and/or participant (i.e., PECS binder with correct color strip, edible items, stopwatch, pencil, data sheets) | | | |

**Table 1 (cont'd)**

| | | | |
|---|---|---|---|
| 2. Camera is turned on and, in a position, to see participants binder and the table | | | |
| 3. Researcher states; date, time, condition, researcher, and participant number, study name, and session number | | | |
| **During Session** | | | |
| 4. Researcher asks the participant to sit in their chair and gets items for MSWO out | | | |
| 5. Researcher conducts modified MSWO. Has 5 edible items on table in an array. Tells participant to "pick one" or some variation. Participant eats the edible. Researcher shifts array of remaining 4 edible items. Researcher says "pick one" or some variation. Participant takes the edible and consumes it. Researcher says, "thank you" or some variation. | | | |
| 6. Researcher says "let's have snack" or "I have ___ and ___" or some variation and starts 10 min timer | | | |

**Table 1 (cont'd)**

| | | | |
|---|---|---|---|
| 7. If Tx: Have participant point to sentence strip, can be prompted | | | |
| 8. Participant asks for items during this time, when participant hands sentence strip to the researcher, the researcher says the mand out loud. | | | |
| 9. While the participant is eating the edible, the researcher records the mand on the data sheet. | | | |
| 10. The researcher resets the icons in the correct position on the participants binder. | | | |
| 11. If participant asks for an item not available or with the wrong icons, wrong mand frame, or in the wrong order, error correction procedures are run. | | | |
| 12. If participant does not follow the Lag schedule the researcher says the mand out loud and resets the participants binder. No reinforcement of feedback is given. | | | |

**Table 1 (cont'd)**

| | | | |
|---|---|---|---|
| 13. Steps 7-10 occur for 10 min. When the timer goes off the researcher says "snack is over" or some variation. And dismisses participant. | | | |
| **After Session** | | | |
| 14. The researcher turns the camera off | | | |

*Preference assessment*

Before the beginning of the study, the researcher conducted a paired stimulus preference assessment (Fisher et al., 1992) with eight edible items. Items used for the preference assessment were informed by professionals familiar with the participant. To account for changes in participant preference, before the start of each research session, the top five items from the paired stimulus preference assessment were presented to the participant by the researcher in a modified Multiple Stimulus Without Replacement preference assessment (MSWO) (DeLeon & Iwata, 1996). The modified MSWO consisted of the researcher placing the top five preferred items on the table and instructing the client to "pick one"; and once a selection was made the client consumed the item while the remaining four items were shifted in the array. The client was then told again to "pick one" and allowed to consume the edible. Following the second selection, the remaining items were put into a closed bin out of sight of the child. The researcher put the first two items selected on table to signal to the participant that they were available.

*Design*

A non-concurrent multiple baseline across participant design was used to evaluate the effects of the independent variable (Lag schedule) on mand frame variability (Slocum et al., 2022).

*Procedure*

*Baseline*

Participants were brought into the hallway and sat at a table across from the researcher. As noted above, at the start of each session the researcher conducted a modified MSWO. After the top two edibles were selected the researcher stated "it's time for a snack" or some variation of the phrase and a new communication binder and sentence strip were presented to the participant with picture icons for items identified as preferred via the preference assessment. At this point, the researcher presented the discriminative stimulus, "ask me for something you want" and participant had 10 minutes to request snack items. All mand frames were reinforced during baseline regardless of the mand frame used. The session was concluded after 10 minutes when the experimenter said, "snack is all done". All mand frames were returned to the same position on the binder following each trial (Figure 1)

To test that the color of the sentence strip did not correlate to changes in mand frame use and number of mands, at least three baseline sessions were conducted each utilizing all three-sentence strip colors in a random order. The random order was identified by the researcher utilizing a random number generator (random.org, 2024). Blue was 1, green was 2, and their own sentence strip was 3.

Because where or how mand frame icons are presented on the binder may unintentionally inflate the primary dependent variable, the mand frame icons were placed in the same location on

the binder throughout the entirety of the study. Each time a participant gave the researcher a sentence strip, the researcher would return the mand frame icons to the same positions. Because variability in item selection was not being evaluated, the edible icons were placed on the binder at random.

Mark's baseline sessions were modified on the third session after the previous two sessions had to be terminated due to problem behavior. Specifically, modeling was used for the first two mands in the session to show Mark that the binder was used the same way as his treatment binder. Additionally, after the second independent mand other preferred edible items from the modified MSWO were brought out to attempt to contrive motivation.

**Lag Schedule**

*General procedures*

Sessions were conducted in the same manner as the baseline sessions with the following modifications. When the participant sat down, they were asked and physically prompted to point to their sentence strip. Pointing to the sentence strip was used to increase the likelihood the participant attended to the visual cue associated with the Lag schedule. During the session, if a participant requested an item that was not available, the researcher said, "we don't have that ask for something else" and the mand was not counted or recorded. When the Lag schedule was in effect, mands were reinforced if the mand frame met a Lag 2 schedule of reinforcement. A Lag 2 schedule requires the mand frame used to be different from the previous two to receive reinforcement. The first two responses in each session were reinforced as long as they differed to allow early contact to reinforcement. If the mand did not follow the Lag schedule the researcher read the mand (ex: "I want frosting") and placed the icons back on the binder. No reinforcement or neutral feedback was given. Sessions were terminated if the participant demonstrated signs of

assent withdrawal. After ten minutes had passed the researcher said, “snack is all done” and the participant was taken back to the treatment room.

*Teaching Sessions (Anna Only)*

Following Anna’s third treatment session one teaching session was conducted. This session followed the same procedures as those listed for the Lag schedule sessions with the following modifications. There was a second prompter sitting behind Anna that physically prompted putting all mand frames on the sentence strip following a randomized order that met the Lag schedule. Prompting occurred for 10 minutes.

## RESULTS

The top panel in Figures 2 and 3 depict Anna's rate of manding and variation across baseline and Lag schedule conditions. It is observed that during baseline sessions, Anna increased her rate of manding, and her variation decreased from using two mand frames to using only one mand frame. In the first three Lag schedule sessions, Anna's rate of manding decreased rapidly and she only used one mand frame 'May I have'.

After three Lag schedule sessions of consistent decreases in rate of manding and no variability, Anna was exposed to a teaching session (described above). Following this teaching session, Anna still engaged in the sole mand frame, 'May I have'. The experiment was concluded when the third Lag schedule session after teaching demonstrated consistent levels of low rate of manding and variability. The teaching session is indicated by the dotted line in the top graph of Figure 2.

The bottom panel in in Figures 2 and 3 illustrates Marks rate of manding and mand frame variability across baseline and Lag schedule sessions. Similar trends of low rates of variability are observed for Mark. However, the first three baselines for Mark have notable differences. The first two baseline sessions, Mark did not mand once during the 10-minute session. To show Mark that the communication binder is used in the same manner as his regular communication binder, the first two mands of the third baseline sessions were prompted with variation. When Mark showed an interest in the binder other preferred edible items were added in the session to attempt to contrive motivation and increase mands. Mark used two different mand frames ('I want' and 'Can I have') during this session. Two more sessions were conducted after this prompted baseline session and Mark only used the mand frame 'I want'.

Following baseline, the Lag schedule was introduced. An immediate decrease in manding

occurred and variability did not increase. Additionally, each session had to be terminated due to assent withdrawal within the first six minutes of each session. The decision was made to conclude the study for Mark following three Lag schedule sessions without a teaching session due to the consistent low level data trends and ethical concern of assent withdrawal.

**Figure 2**

*Graphs depicting rate of manding across sessions for Anna (top) and Mark (bottom)*

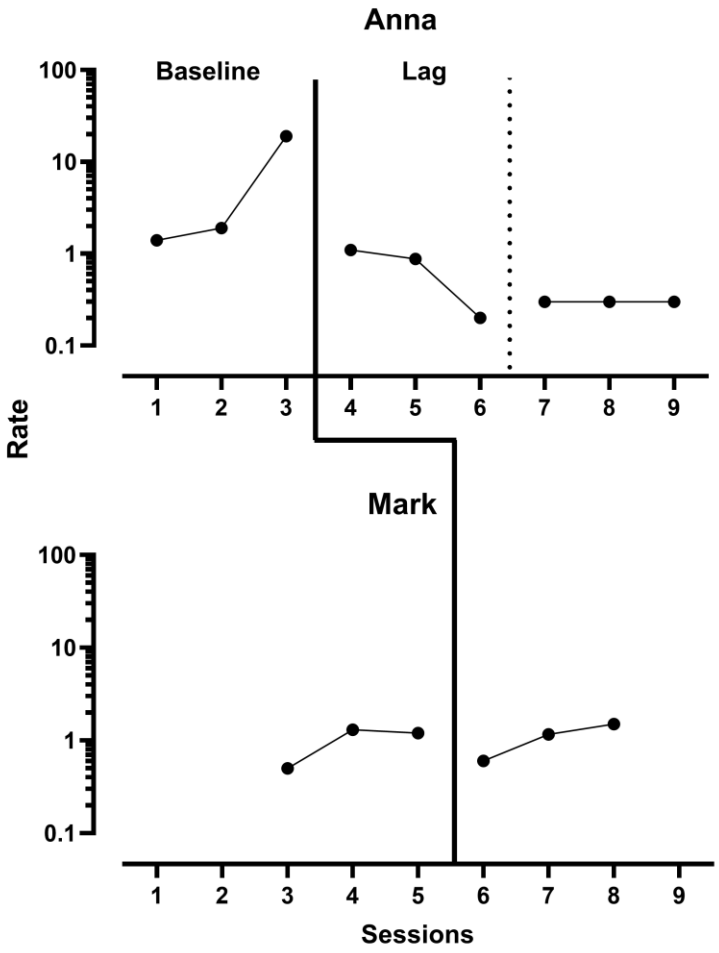
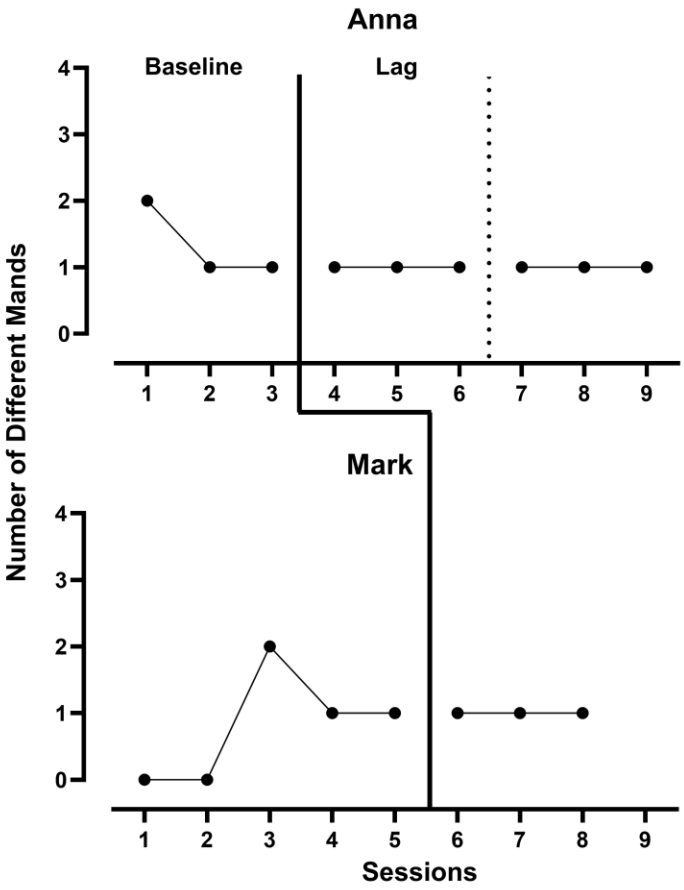


**Figure 3**

*Graphs depicting mand variability across sessions for Anna (top) and Mark (bottom)*



## DISCUSSION

Results of this study demonstrate that the use of a Lag schedule did not increase variability of manding in children who use picture icons to communicate. Below we discuss the results of this finding and possible future directions for research. As well as possible clinical applications of these results.

One explanation for our results is that the requirements of the Lag 2 schedule may have had too high of a response effort to meet. The use of a Lag 2 schedule was chosen because we hypothesized the selection-based communication system of picture icons would reduce response effort, therefore making varied responding more likely to occur than if the responses were more effortful, such as in vocal responding. Because participants had to vary their response from the previous two mands, effort in accessing reinforcement may have resulted in ratio strain, "A behavioral effect associated with abrupt increases in ratio requirements when moving from a denser to thinner reinforcement schedules; common effects include avoidance, aggression, and unpredictable pauses or cessation in responding." (Cooper et al., 2020). This ratio strain could help explain the assent withdrawal and negative behaviors that we observed in conjunction with low rates of variability.

A second explanation for lack of varied responding is that participant behavior may have been sensitive to extinction, resulting in a decrease in responding within each session. Extinction is a key element to the Lag schedule, whereas when a response does not produce a reinforcer, extinction then serves as a discriminative stimulus to engage in a response of a different form. However, to the best of our knowledge, extinction did not develop discriminative properties and therefore resulted instead in response suppression. The role of extinction in response suppression is also supported by our observed instances of negative participant behavior that correlated with

lack of access to reinforcer such as 'flopping, crying, and eloping'; these negative behaviors often resulted with the participant withdrawing assent to participate in that session.

For both participants, negative behaviors were observed when the Lag schedule was put into effect. These negative behaviors resulted in assent withdrawal from each participant during different Lag schedule sessions. Although extinction does not appear to have been a discriminative stimulus for variation, it is possible that it served as a discriminative stimulus for negative behavior. This is particularly likely given that both participants had past histories of negative behaviors and limited vocal verbal repertoires. With limited vocal language, negative behavior may have a long history of reinforcement for these participants, possibly causing the varied responses to the Lag schedule to be to engage in negative behaviors that have resulted in reinforcement in the past.

As noted in Lerman and Iwata 1995, extinction has been observed to correlate with increased aggression and extinction bursts. This was observed in both of our participants across different measures. For example, Anna went from having an average of 1.7 mands per minute in baseline to 1.1 mands/minute, .8 mands/minute, and .2 mands/minute during the first three treatment sessions. As her rates of manding decreased, an increase in negative behavior was also observed. Mark did not exhibit a decrease in rate of manding, but the average total mands across sessions went from 10 mands in a session to an average of 1.3 mands per session. Additionally, Mark had negative behaviors at the start of the study where the binder had to be modeled and paired with reinforcement before he manded using the provided binder. Once the Lag schedule was implemented, his total mands decreased and negative behaviors were observed that resulted in each Lag schedule session to be terminated early due to assent withdrawal.

It is possible that the negative behaviors observed could be a result of a lack of variation in choice options. However, modified MSWO preference assessments were conducted prior to the start of each session to account for changes in participant preference. Furthermore, when Mark exhibited negative behaviors during the third baseline session other items from the MSWO not selected were added and this did not correlate to an increase in variability of manding. Mark only asked for each new item once using the same mand frame.

## LIMITATIONS

Possible limitations of this study include participant exposure to a Lag schedule and the number of participants in the study. Prior to this experiment, neither participant had encountered a Lag schedule. To help Anna understand what the Lag schedule required, a teaching session was conducted after the third treatment session with prompting of each response to ensure access to reinforcement. Following this teaching session, Anna's behavior did not change in a noticeable way and variability did not occur in subsequent treatment sessions. Future research should evaluate additional strategies (e.g., more teaching sessions or compare different ways of teaching) to teach children with autism to respond to a lag schedule of reinforcement.

Furthermore, although we did not measure social validity as a primary dependent variable, the behaviors we observed correlated with extinction and the instances of assent withdrawal, raise questions about the use of a Lag schedule in this context. The proposed hypothesis was that exposure to the Lag schedule would result in participants changing their behavior to match the variability requirement. Neither participant varied their behavior and instead a decrease in manding behavior was observed. It could be argued that variability in manding is not a socially valid behavior. Especially if variation comes at the cost of manding. Manding is the first verbal operant to develop, it allows children to gain access to preferred and necessary items and is correlated to reduction in negative behaviors (Miguel, 2017). One could argue that having the foundation skill of being able to mand is more important than teaching variation in mand frames. Manding being put on extinction as an accidental effect of a Lag schedule could create deficits in a necessary daily living skill that is already difficult for children with ASD.

This study only consisted of two participants, which is insufficient to make generalizations about a broader population. But the consistent difficulties observed with each participant suggest that future studies should at least consider some forms of non-contingent reinforcement to mitigate reductions in reinforcement when participants are learning to respond to a Lag schedule.

Another future direction of study could include practitioner-based research on how to teach the use of various mand frames to children who use picture icons as a form of communication. Perhaps if children are taught to use different mand frames than the use of a Lag schedule would be easier to implement because each frame was already established with a reinforcement history.

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