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A behavioral economic analysis of choice

Jamie Leigh Lebowitz
Northeastern University

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A Behavioral Economic Analysis of Choice

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By

Jamie Leigh Lebowitz

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Author: Jamie Leigh Lebowitz

Department: Counseling and Applied Educational Psychology

Approved for Thesis Requirements of Master of Science Degree

_____   _____

Jason C. Bourret

_____   _____

Eileen Roscoe

_____   _____

Chata Dickson

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By

Jamie Leigh Lebowitz

B.S, George Washington University

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Abstract

Previous basic and applied research has found conflicting results when measuring

reinforcer efficacy with traditional methods. This study was conducted to test a

behavioral economic approach to measuring the reinforcing efficacy of choice.   In study

1, a concurrent-chains schedule was used to measure preference between concurrent

(choice) and simple Fixed ratio 1 (no choice) terminal links. Participants were presented

with a two plates: a plate with five edible items and a plate with one edible item. Results

determined that all four participants preferred the concurrent link to the simple FR1 link.

In Study 2, concurrent and simple FR1 conditions were arranged for one participant in a

multiple schedule and schedule requirements for both were systematically manipulated.

Data from Study 2 were analyzed as work and demand functions. The locations of

demand and work curves for concurrent and simple FR1 terminal links under increasing

FR schedule requirements demonstrate preference for the concurrent terminal link.

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A Behavioral Economic Analysis of Choice

The significance of choice has been widely examined in both the basic and applied settings. Choice responding has been typically examined using concurrent schedules in which two or more responses are simultaneously available and each is associated with an independent schedule of reinforcement (Fisher & Mazur, 1997). Research has demonstrated that choice can improve on-task behavior (Dunlap, 1994; Dyer, Dunlap & Winterling, 1990; Parsons, Reid, Reynolds, & Bumgamer, 1990), and disruptive behavior (Powell and Nelson, 1997; Hanley, 1997).

In a study by Catania (1980), two pigeons' preference for free choice over forced choice was investigated. In a six-key chamber, variable-interval links of concurrent chain schedules operated on two lower white keys and terminal links operated on four upper keys. Free choice terminal links arranged three green keys and one red key and forced choice terminal links arranged one green key and three red keys. Green upper keys were correlated with fixed interval reinforcement and red upper keys were correlated with extinction. Catania (1980) examined preference for the initial link and showed that free choice was consistently preferred to forced choice even when the reinforcer was the same regardless of which initial key had been pecked.

Tiger, Hanley, & Hernandez (2006) evaluated preschool-aged children's preference for choice. Four studies were conducted to, (a) evaluate the preference for choice, (b) enhance the value of choice, (c) establish the value of choice, and (d) quantify a preference for choice. Preference for choice was evaluated using a concurrent chain schedule. Participants included six preschool children ages 2.5-5.5 years-old. Five of the six participants were typically developing and one of the participants was diagnosed with

an autism spectrum disorder. The participant selected from a choice of three different colored worksheets. The choice, no-choice and control conditions were correlated with an orange, blue, and yellow worksheet, respectively. In Study 1, the experimenter prompted the participant to "choose one" and delivered an academic prompt appropriate to the selected worksheet (i.e., "Touch J"). After a response on the orange worksheet (choice), the therapist delivered praise and a plate of five identical edible items from which the participant could select one. If the participant responded on the blue worksheet (no-choice) the therapist delivered praise and a plate with a single edible item that the participant could select. If the participant responded on the yellow worksheet (control) praise alone was delivered. Two participants maintained a preference for the choice component, two participants had no preference for any component, and for three participants preference was transient.

The next component of the experiment (Study 2) was to enhance the value of choice for participants who demonstrated a preference for choice. To accomplish this, the same initial link stimuli were used from Study 1 and the terminal links were each correlated with a different color worksheet.   The independent variable was the quantity of edible items from which to choose. The items on the plate increased from 4 to 8, 12, and 16 items. Study 2 showed that for all three participants, as the number of items from which to choose was increased, responding on the choice terminal link increased. Study 3 established a preference for choice by systematically increasing the number from which to choose in the choice link only. The three participants who did not demonstrate a clear preference for any of the terminal links participated in this study. Results showed an increase in responding on the choice link but only within the context of an increased

number of edible items from which to choose. Results from the first three studies identified choice as valuable and showed that manipulating the number of items from which to choose can influence the efficacy of choice as a reinforcer.

In Study 4, the authors manipulated response requirements by increasing the number of tasks in the choice initial link from 2, 3, 4, 8, 12, 16, and 32, while one academic task remained in the no-choice and control initial links. This manipulation was a successful attempt to quantify the preference for choice. Results showed a preference for the choice component as compared to the no-choice component under conditions in which response effort favored the no-choice component.

Modifying schedules or prices and applying a behavioral economic model to results has been shown to be an effective method for describing the reinforcing efficacy of different reinforcers (Johnson & Bickel, 2006), substitutability of reinforcers (Petry & Bickel, 1998), and changes in preference as a function of schedule requirement (Tustin, 1994; Roane, Lerman, Vorndran, 2001).

Tustin (1994) examined preference within a behavioral economic framework using a progressive ratio (PR) schedule. In a PR schedule, the response requirement increases within a single session. Tustin found that initial preference for stimuli reversed as schedule requirement increased. His findings suggest that current assessments of preference may make unreliable predictions about reinforcer efficacy in tasks that require higher response effort. Roane et al. (2001) evaluated preference between two reinforcers under increasing schedule requirements by assessing two highly ranked stimuli under increasing schedule requirements in PR schedules. Results showed that one stimulus was associated with higher response rates under increasing schedule requirements. These

results suggest that although two reinforcers may be effective in low schedule requirements (FR1), they may be differentially effective when assessed under higher schedule requirements.

Currently, there are no studies examining the effects of choice as part of an arranged consequence. Additionally, there is no research examining the systematic manipulation of the price of choice and the availability of choice across an array of FR values. The purpose of the current research is three fold. The first purpose is to replicate the procedures of Tiger et al. (2006) and determine if preference will be observed for concurrent terminal links (choice) over simple FR1 (no choice) terminal links. The second purpose is to evaluate the response rates maintained by concurrent and simple FR1 terminal links across a range of initial link schedule values. The third purpose is to extend the findings of Tustin (1994) by examining the utility of behavioral economics to describe relations between responding maintained by both simple and concurrent terminal links in chain schedules. The current research will refer to terminology specifically in terms of schedules; simple FR1 will indicate forced choice or no-choice and concurrent will indicate free choice or choice.

Method

Participants, Setting, and Materials

The participants in Study 1 were four boys who attended a school for individuals diagnosed with developmental disabilities. Brad was an 8-year-old boy diagnosed with an autism spectrum disorder and bi-polar disorder. Brad communicated with a picture exchange communication system and limited vocals. Brad could follow multi-step directions, label items, accept, reject, imitate, and request. Louis (who also participated in

Study 2) was a 7-year-old boy diagnosed with pervasive developmental disorder (not otherwise specified). Louis communicated vocally for the purposes of requesting, accepting, rejecting, labeling, and answering familiar questions. Travis was an 8-year-old boy diagnosed with an autism spectrum disorder. Travis communicated with a picture exchange communication system with limited vocals and could follow multi-step directions. Scott was a 7-year-old boy diagnosed with an autism spectrum disorder. Scott communication vocally and could follow multi-step directions. All participants received thirty hours a week of intensive therapy in a 1:1 (teacher:student) teaching ratio in a small classroom with limited distractions.

Sessions were conducted in a small, quiet cubby in the participant's classroom. The space contained two chairs, a table, video recording equipment, and materials necessary for the study. Sessions were conducted 4 or 5 times a day, 5 times per week. Materials included a Tupperware container, pennies, mini morsel chocolate candies, green Skittles®, blue M&Ms®, mini marshmallows, a small plate, and a timer.

Response Measurement and Interobserver Agreement

During preference assessments, the dependent variable was a selection response, which was defined as the participant picking up one of the items and consuming it. The participant had 30 s to select an item. If no item was selected within the 30-s interval, the trial was ended. A trained observer recorded whether the participant selected each item presented on a trial-by-trial basis. A second observer collected reliability data during 33% of the preference assessment. The average agreement for approach and consumption was 100% across all participants.

During the concurrent schedule the dependent variable was a selection response, which was defined as the participant taking one edible off a plate. Data were collected by a trained observer on a trial-by-trial basis. Percent selection of each link was calculated by dividing the number of selections by the total number of trials.

Interobserver agreement data were collected during 50% of the sessions. Agreement was calculated on a trial-by-trial basis by dividing the total number of agreements by the total number of agreements plus disagreements and multiplying by 100. Across all participants, agreement was 100%.

During the concurrent (CS) and simple (SS) terminal link chain sessions, the response measured was putting pennies in a container, defined as the participant picking up one penny and putting the penny past the entry point on the slot on top of the penny container. Data were collected using data collection software on a palm top or laptop computer. Initial link was recorded on a frequency key. The total duration of the availability to respond was recorded on a duration key. Responses per minute were calculated by dividing the number of responses by the duration of session time with consumption time taken out. Sessions were 5 min in duration. Interobserver agreement data were collected by having one independent observer record data for 33% of sessions. Agreement was calculated by dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100. Mean agreement was 90% (range, 80% to100%).

Procedure

Preference Assessment. Prior to the study, a collection of potential reinforcers was generated based on staff interviews and informal observation of the participants. A total

of eight edible stimuli were assessed for each participant using a paired-stimulus preference assessment (Fisher et al., 1992). On each trial, the stimulus chosen by the participant was scored as approached, and the individual was allowed to consume the item. For Brad, the most highly preferred stimulus was mini morsel chocolate candy; for Louis, green Skittles®; for Travis, mini marshmallows; for Scott, blue M&Ms®.

Study 1 (Concurrent Schedule). During the concurrent schedule, the participant was presented with two plates with identical edible items on each plate. One plate contained five of the same edible item, and the other plate contained one edible item. The two plates were presented at the same time and the participant was instructed to choose one plate. The participant then selected one of the edible items off the selected plate, the plates were removed, and the trial was ended. If no selection was made within 5 s of plate presentation, the trial was ended and a "no response" was scored. Attempts to take more than one edible off the plate were blocked. Sessions were composed of 15 trials.

Study 2 (Concurrent and Simple Terminal Links in Chain Schedules). Concurrent (CS) and simple (SS) terminal links were arranged in a multiple schedule. During a CS session, the initial link was responding on the penny container and the terminal link was a plate of 5 edibles from which the participant could choose one. During a SS session, the initial link responding was the same, however, the terminal link was a plate of 1 edible. A reversal design was used to evaluate the effects of initial link schedule recommendations. Initial link FR values were manipulated, including, FR 1, FR 2, FR 4, and FR 8. Double logarithmic scales were used to evaluate Pmax and Omax values for both CS and SS work and demand curves. The Pmax represents the point at which the

curve changes from being inelastic to elastic. Elasticity refers to the proportional decrease in exchanges per minute to the increase in price, or FR value.

<div align="center">Results</div>

Data from Study 1 are shown in Figure 1. Travis selected the concurrent link more frequently (M=79.5) than the simple link (M=19.7). Louis also selected the concurrent link more frequently (M=63.4) than the simple link (M=35.7). Scott also selected the concurrent link more frequently (M=83) than the simple link (M=16.25). Brad's selections were equivalent between the concurrent and simple terminal links. Therefore, in order to establish a value for the concurrent link we increased the number from which to select to 10. Following this manipulation, steady frequent selection on the concurrent link became evident (M=61). When we decreased the number of items back to five there was no clear differentiation between the concurrent and simple links. When the number of items was increased again to 10, the same effect was observed.

Data from Study 2 are shown in Figure 2. Louis's response rates within the FR 1, FR 2, and FR 4 phases increased steadily in both CS and SS terminal link conditions. During the FR 8 phase differentiation is clear for the first time with high response rates in the CS terminal link sessions. Replicating the FR 8, differentiation emerges again with higher response rates than the previous FR 8 phase.

The demand function for both SS and CS terminal link sessions with their corresponding Pmax values are shown in Figure 3. Exchanges per minute are plotted on a double logarithmic axis across increasing FR exchange values. The data points represent the phase mean values in each condition. The line was obtained by fitting the Hursh (1988) equation. The equation accounted for 98% of variance in the CS data, and 88% of

variance in the SS data. The higher Pmax value for the CS sessions indicates the

relatively higher consumption or exchanges per minute during the CS sessions across

increasing FR values.

The work function for the same data is shown in Figure 3. Responses per minute

are plotted across increasing FR values. The equation accounted for 99% of variance in

the data for CS sessions and 97% of variance in the data for SS sessions. Corresponding

Omax values, representing the peak response rate for CS and SS sessions are plotted as

well. The higher Omax value in the CS sessions indicate that the CS maintained higher

response rates, at peak rate of 27 responses per minute, where SS had a peak rate of 11

responses per minute.

Discussion

During the concurrent schedule analysis all four participants demonstrated a

preference for the concurrent (choice) link, replicating the Tiger et al., (2006) findings.

One participant's preference emerged for the concurrent link only when the number of

edible items from which to choose increased to 10 items. This finding replicates past

literature that participants prefer to choose their reinforcer over having the same

reinforcer delivered by someone else (Geckeler, et al., 2000; Graff & Libby, 1999; Graff

et al., 1998).

When both schedules were implemented in a multiple schedule design and

response requirements were manipulated, response rates were identical in all lower FR

schedule values. However, when the response requirement was increased to FR 8, access

to the concurrent schedule (choice) maintained higher rates of responding. These findings

of differences in absolute reinforcing efficacy at higher FR values replicate and extend

the findings of Deleon et al., (1997) and Tustin (1994). These findings also allow for the examination of the utility of behavioral economics of the reinforcing efficacy of different consequences. If only lower FR values were used, no differences would have been observed. Interpreting the data within the framework of behavioral economics suggests that reinforcers arranged concurrently or part of a choice paradigm may be less elastic then those arranged by a simple schedule of reinforcement.

Fisher, Thompson, Piazza, Crosland, and Gotjen (1997) showed preference for choice using a concurrent-operants arrangement and a yoking procedure. During the choice condition, the participants selected between two reinforcers and during the no choice condition, the therapist delivered the reinforcer yoked to the chosen item from the choice condition. Responding was allocated toward the choice option for all participants. The behavioral mechanisms underlying the effects of providing individuals with choice are unclear and previous research has come to inconclusive results. What is known is that in a concurrent arrangement, relative response rates shift toward the option with the more valuable consequence (Fisher & Mazur, 1997). This study has practical implications for applied settings. Providing individuals with the opportunity to choose may maintain higher response rates. This finding may be helpful when trying to fade schedules of reinforcement to natural contingencies in an individual's environment.

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Figure Captions

Figure 1. Brad, Louis, Travis and Scott's percent selection of choice terminal link

Figure 2. Louis's responses per minute across increasing FR values

Figure 3. Work and demand functions for both concurrent and simple terminal links
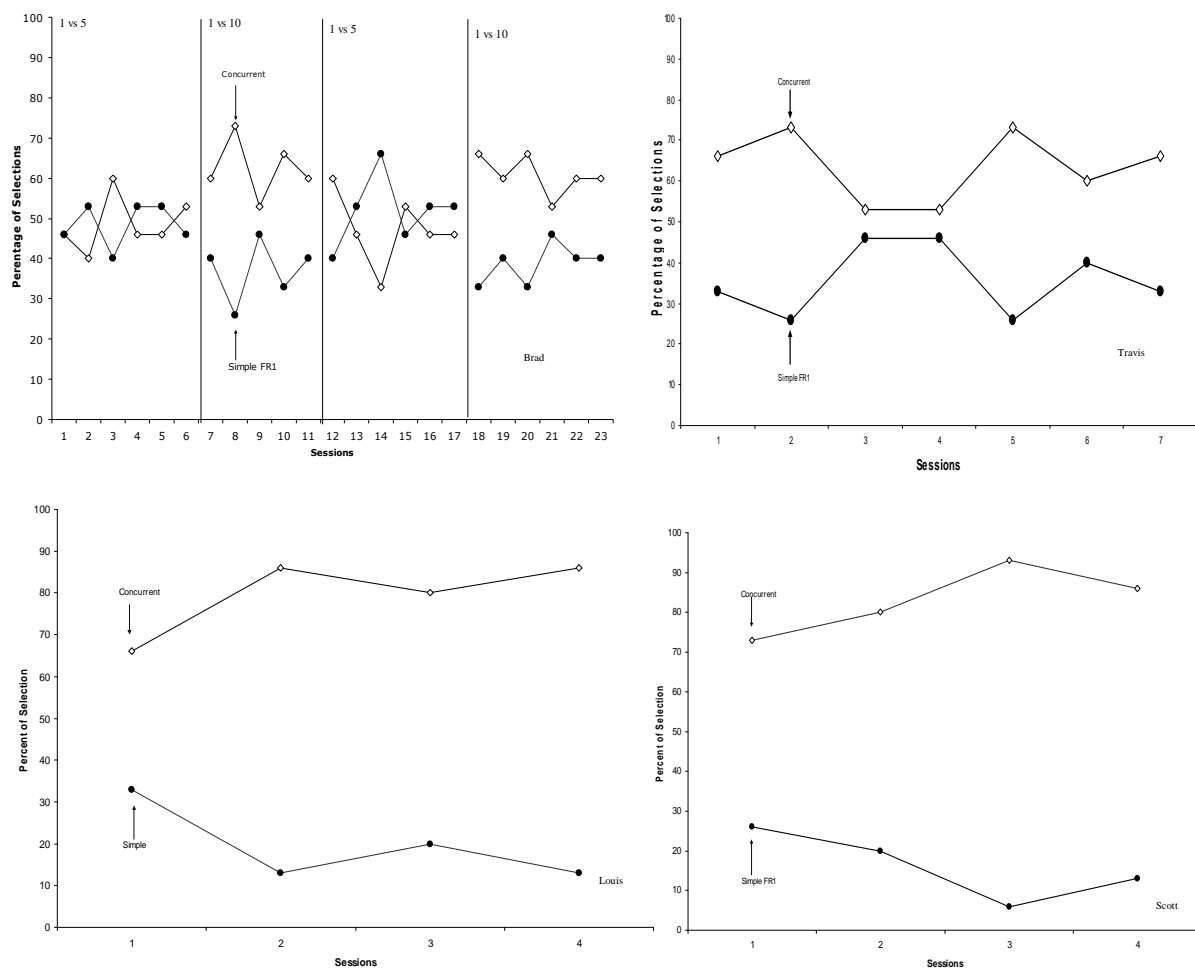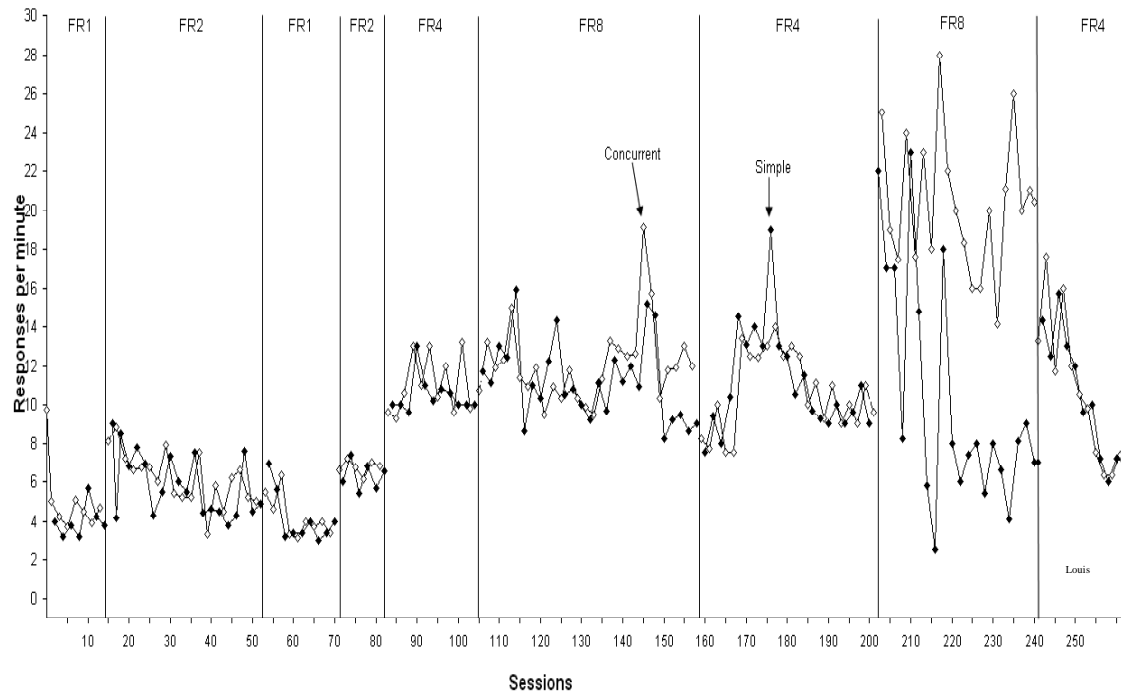
Figure 1

Figure 2

Figure 3