EFFECT OF RESOURCE AVAILABILITY ON DYADIC FITNESS

Ana Barbara Vieira Sinay Neves, B. A.

Thesis Prepared for the Degree of

MASTER OF SCIENCE

UNIVERSITY OF NORTH TEXAS

August 2010

APPROVED:

Sigrid S. Glenn, Major Professor
Jesus Rosales-Ruiz, Committee Member
Manish Vaidya, Committee Member
Richard G. Smith, Chair of the Department of Behavior Analysis
Thomas L. Evenson, Dean of the College of Public Affairs and Community Service
James D. Meernik, Acting Dean of the Robert B. Toulouse School of Graduate Studies

Neves, Ana Barbara Vieira Sinay. Effect of Resource Availability on Dyadic Fitness. Master of Science (Behavior Analysis), August 2010, 34 pp., 7 illustrations, references, 18 titles.

College students participating in dyads played a game designed as an analog of early hunters whose survival, as a dyad and ultimately individually, depend on rabbits they hunt. Dyadic fitness was defined as both participants being able to hunt and it was measured by the proportion of trials in a condition that both participants hunted.

The effects of scarcity (alternating rich and poor conditions) on dyadic fitness were examined in two experiments. First experiment results did not show a difference in dyadic fitness as a function of the independent variable.

The second experiment increased the number of hunting seasons and also the discrepancy between scarcity in rich and poor seasons. Second experiment results show that dyads start fit in rich seasons and become increasingly fit in poor seasons. External variables could not be ruled out; therefore, additional experiments still need to be carried out to clarify results.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

Since ancient times humans have been raising questions about who are we and where we came from. The difference between movement and life leads to speculations about what life is. What is the difference between a machine and a human being? Animations and machines move, but they are not behaving in the same sense as living creatures behave. This distinction often leads to affirmations like “Something inside the organism, defining life, controls the behavior.”

B. F. Skinner (1904-1990), the scientist who laid the foundations of behavior analysis, suggested that to understand human behavior fully, we must understand the species history, particular learning histories of individuals, and the histories of particular groups of people that we call cultures. Skinner’s focus was on explaining individual peoples’ behaviors, which are a result of those three complementary histories. Depending on the answers a scientist is pursuing, the scientist can investigate the processes giving rise to a species history, an individual history, or a cultural history.

Analysis of Behavior of Individuals

The important discovery that parts of the body can react to external stimuli changed discussions about how to explain human behavior. The idea of completely spontaneous behaviors was modified by the acceptance of partial control by the environment. Reflexes, conditioned and unconditioned, are relations between a stimulus (an environmental event) and a response (behavior controlled by the stimulus). These respondent relations are highly consistent and precise relations between stimuli and responses. Part of the answer about who we are refers to investigations regarding eliciting stimuli and respondent behaviors, mostly in the field of physiology (Skinner, 1953).

When dealing with reflexes it is possible to identify a specific controlling stimulus and a specific response of a part of the organism. However, when dealing with the behavior of the whole organism the environmental events controlling the behavior are less evident. Several antecedent events and conditions can affect the behavior. The result is a probabilistic relation that makes it harder to detect the current controlling antecedent stimulus. This lack of observed antecedent causes of behavior is the occasion for creating hypothetical constructs inside the organism to serve as explanations.

The habit of looking for explanations inside the organism competes with the disposition to look for variables that can be scientifically analyzed. Those variables can be found in the immediate environment of the organism and in the history of its behavior/environment relations. If we know enough about those variables, we can predict behavior; and if we can change enough of those variables, we can change behavior (Skinner, 1953).

When reconstructing the history of human behavior, Skinner (1981) places the origin of life on Earth at the time a molecule with the power to reproduce itself came into existence. Reproduction was the first consequence, leading to natural selection of increasingly complex organisms under diverse conditions. The interchange between organism and environment is the condition for the evolution of organismic structures and the functions that we call behavior.

Identifying behavior as a field of inquiry, however, is not the same as identifying a unit of analysis that leads to a scientific understanding of behavior. We all learn to talk about our own and others' behaviors. But talk in terms of appropriate behavioral uniformities or an orderly behavioral relation is another matter (Skinner, 1953).

Skinner initiated the scientific analysis of the behavior of whole organisms when he demarcated units of operant behavior. The relationship between the antecedent environment and the response is different from respondent behavior. The concept of probability of response allows examining the effect of variables that are not all or none. Operant responses vary in probability in relation to their current environment because of a history of contingent consequences that occurred under varying environmental circumstances (Skinner, 1938).

In operant behavior antecedent stimuli do not elicit responses. The stimulus just changes the probability of responses in the previously reinforced class. The relationship between the elements of the unit of analysis in operant behavior is a contingency – a probabilistic relation. It is necessary to define a behavior (e.g., pressing a lever) and observe its frequency before implementing a contingency between that behavior and consequences. The definition does not need to be in terms of topography, but needs to allow delivering the consequences differentially. Thus, the term operant is used to describe responses the probability of which can be predicted and controlled by their consequences.

Jack Michael (1982) re-introduced the term motivating operations (originally discussed by Keller & Schoenfeld, 1950) to identify antecedent conditions, events or operations that alter the reinforcing or punishing effectiveness of other environmental events and alter the frequency of behaviors that are relevant to those environmental events. Behavioral theoretical terms are employed when events of the class specified reliably affect the behavior of individual organisms. For example, water is classified as reinforcer only if it reliably follows lever pressing and that contingency increases the frequency of pressing the lever. Similarly, water deprivation is classified as a motivating operation if its presence or absence alters the effectiveness of water as a reinforcer and the frequency of pressing when water follows pressing (Laraway et al., 2003).

Analysis of "Cultural Things"

Cultural materialism is an anthropological discipline founded by Marvin Harris (1927-2001) in the 1960s. Harris's goal in his first book *The Nature of Cultural Things* (1964) was "to show how a taxonomy of cultural things can be grounded in the observation of nonverbal behavior of individuals" (Harris, 1964, p. v).

Harris based his enterprise on empirical observations. He made an effort to delimit (1) a cultural field of inquiry, (2) a measuring device and (3) logico-empirical measuring and classifying operations designed to examine cultural things. Each of these three components of his approach are examined below.

When defining a cultural field of inquiry Harris (1964) argued that a sufficiently large group of practicing scientists regarding a field worthy of their professional interest is the only way to distinguish successful delimitations of a field of inquiry. Harris stepped forward and asserted human behavior, action or activity as constituting the cultural field of inquiry. "By human behavior, I mean the gross changes of state which the body parts of human beings exhibit" (Harris, 1964, p. 20).

The measuring device Harris suggested was the human senses especially eyes and ears, Other equipment like stopwatches, cameras and balance scales can also be employed, but only after direct observation of the field of inquiry has been conducted.

Saying that human behavior is the cultural field of inquiry is not the same as saying that human behaviors are cultural things. Human behavior is taken as a stream of uninterrupted events. The continuity and contiguity of events must still be analyzed into lawful and logically useful recurrences. Cross-cultural definitions of the same behavior are not evident. In different cultures, the movements done to get married or impose taxation on a product may differ. "One must know beforehand what kinds of evidence will provide grounds for a positive or negative identification" (Harris, 1964, p. 25).

Logico-empirical measuring and classifying operations must be constructed based on observations of the behavior in the field of inquiry. Those definitions must come from replicable processes of observation, not by consulting a dictionary. Similar to Skinner, Harris delimits his field of inquiry in terms of the relations between body motion and the environment. Moreover, when classifying cultural entities both authors take a similar perspective: they use the environmental effect of the body movement to break the behavior stream and classify useful units. In Harris's words:

> The fact that every motion of a body part is necessarily associated with some spatio-temporally contiguous and continuous alteration of things in the body's immediate environment opens up broader operational horizons. Such nonbehavioral events do not comprise part of our formally defined field of inquiry, but they must nonetheless be considered at an early stage in the development of classificatory procedures aimed at typing the body motions themselves. (Harris, 1964, p. 28)

Harris justifies using the environmental effect to delineate movements, stating that this strategy is suggested by the precedents of natural language and firmly established as part of the research strategy in experimental psychology. The exact movement done by the body is not as important as its environmental effect when classifying.

> When we speak of an actor as carrying an object, we understand only that the designated bit of behavior involves the transposition of an object supported by some portion of the actor's body. We do not know, unless additional explication is made, whether the object was carried in the actor's hands, or on his head, back, chest, or neck. Similarly, the basic response in the Skinnerian version of behaviorism is the bit of behavior known as bar-pressing. The latter is an appropriate term if the bar is pressed by the rat's nose, head, total body, left paw, right paw, hind legs, etc. (Harris, 1964, p. 29)

Harris labeled the smallest cultural thing as an *actone*, which consists of a bit of body motion and its environmental effect. Then, he moved to classify actones based on regularities of the body motions that people exhibit in specific places, times or in the presence of certain objects. Those supra-actone regularities in term of time and space coordinates Harris called episodes. A particular episode and its absolute stage coordinates constitute an idio-episode. Continuous sequences of idio-episodes are called idio-episode chains. An example is a person returning from work every day, going to the kitchen and preparing dinner. An idio-episode chain labeled preparing dinner can include slicing bread, opening the refrigerator, getting cheese and ham, closing the refrigerator, and making a sandwich.

Many such chains occur for each individual in the course of a day. Therefore the observer needs to condense the observations in some way. Some chains depend on certain antecedent stimuli to initiate their occurrence. Harris used logico-physical dependency upon an antecedent stimulus to condense the chains. An episode chain that includes each step in getting ready for work begins with the sound of the alarm and includes activities such as rising, removing night clothes, showering, brushing teeth, etc... Harris labeled those points where an important logico-physical antecedent stimulus is present as nodes and proceeded to talk about nodal-chains.

Those idio-episode chains and nodal-chains are of interest in a science of culture as long as they are repeated by several individuals in the same culture. Harris made the point that peoples" behaviors in the presence of certain stimuli, such as classroom, or dinner table, are usually ceremonialized. Those patterns are what Harris, as ethnographer, was interested in. The repetition does not need to be precisely the same to establish a useful class, but the content and structure must be unambiguously specified. Moreover, one should not try to record every instance of behavior to find out if it is repeated. Just record the chains that happen more often and are replicated with fidelity of content and structure by a large part of the population.

Harris did not invoke the subjective purpose or understanding of the behaving person as of interest to the ethnographer. The idea of breaking the behavior stream into nodal chains solves the problem of finding a method that allows reliable observation across individuals and the unambiguous identification of those nodal chains that characterize specific cultures.

To move from nodal analysis of individual behavior streams to the analysis of multi-actor situations it is necessary to choose between specifying a place and recording everything that happens in that place or specifying an actor and following him while recording his nodal chains wherever they might go. In either case, specification of the place is a prerequisite for supra-actonic constructions. The specification of a place combined with behavioral criteria results in a unit that Harris called a *scene*. Further abstraction involves the linking together of frequently observed sequences of scenes into units labeled *serials*. This linkage can be achieved in three ways: (1) Scenes can regularly follow one another in a given place, (2) scenes are linked based on a particular actone object (e.g. manufacturing process, fishing and selling a fish) and (3) scenes are linked by personnel (e.g. a worker in an organization, the fisherman). Linking together recurrent sequences of scenes provides the operational basis for the construction of a type of unit that is very useful in the social sciences: a group of actors who recurrently engage in interactive and interlinked behavior.

Harris (1964) paused in his construction of cultural level entities to discuss the term *group*. He stated that a group can be defined behaviorally, biologically or both. Social sciences are usually more interested in behaviorally defined groups. Behaviorally defined groups can be categorized as *paragroups* and *endogroups*. A paragroup is a group whose members never meet or participate in a common multi-actor scene (e.g. fishers, students, clients). The group can increase in number every time a new actor performs a particular idio-episode (e.g., someone engages in the behaviors that define fisherman). Endogroups are defined by joint participation of a definite number of specific individuals in a particular multi-actor scene (fishers Peter, John and Andrew fishing together).

A specific kind of endogroup, labeled *idioclone,* occurs when one particular multi-actor idioscene is specified (e. g. all the people at Linda's birthday party in 2007). If the idioclone is ever replicated while remaining logically-empirically identifiable, Harris labels the unit a *nomoclone* (e. g. the same people at Linda's birthday party in 2008). The same people need to participate in the scene to classify the group as a nomoclone. If, over time, the people participating in the scenes change (e. g. some people stop going and some new people attend Linda's birthday party in 2009), Harris labels the series of idioclones or nomoclones identified in terms of the replicated scenes a *permaclone*. Note that Harris does not define a group based on the actor's subjective understanding, but on the density of scenic interactions in particular spatial and temporal loci (Harris, 1964; 1979).

A pragmatic use of a data language based on environmental effects is adequate for describing order in the relationship between the organism and its environment. However, when looking for the fundamental nature of this order, Harris states that specific environmental effects are essential for the survival of organisms, such as ingesting food or creating new individuals. The way this effect is achieved is diverse in the human species and might be worthy of description because of its physical value. Therefore Harris states:

> Our basic behavioral units must, in short, avoid too deep commitment in either direction; they need to consist of terms which convey some minimal information about the behavior stream in the narrow sense, as well as the important physical events which accompany the flow of the behavior stream. (Harris, 1964, p. 30)

For a scientific approach, it is logical to examine first those variables most directly constrained by the natural environment. Therefore, the principle of infrastructural determinism maintains that changes in the structural and superstructural patterns are driven by changes in the infrastructure. A cultural materialist observer will start by observing and describing infrastructural variables because the strategy of cultural determinism states that is the place a scientist is more likely to find order. “We know that powerful restraints exist on the infrastructural level; hence it is a good bet that these restraints are passed on to the structural and superstructural components" (Harris, 1979:57).

Behavioral and Cultural Contingencies

In the article "Metacontingencies in Walden Two," Sigrid Glenn told the story of the first time she read Skinner's book *Walden Two* and how she was ready to pack up and look for a world like the one Skinner describes in his book. Instead of the apathy of waiting for the appearance of such a world, she concluded that a more fruitful approach was to work to create a better world by developing ways to change our current environment. The work was more than applying principles of behavior analysis, it involved creating a technology.

When describing elements operating in the Center for Behavioral Studies, Glenn distinguished between contingencies of reinforcement (contingent relations between a class of responses with a common consequence) and what she labeled metacontingencies (contingent relations between a class of operant classes and a common cultural consequence). She suggested that the difference between our world and Walden Two was a difference in the metacontingencies.

The metacontingencies were portrayed as a unit of analysis describing the functional relations between a class of operants in a particular setting and a long term consequence common to all operants. Internal socially arranged contingencies of reinforcement, described as supporting the metacontingency, are designed and implemented because of the relation between the mediating contingencies and a common long term outcome. Verbal behavior provides a link between contingencies and metacontingencies by enabling a single act to occur in response to events widely dispersed in time and providing social consequences maintaining behaviors under control of the rule until it is possible to discern the long term consequence. Glenn suggested that a major difference between our world and Walden Two is the verbal behavior linking the contingencies and metacontingencies.

In “Contingencies and Metacontingencies: Toward a Synthesis of Behavior Analysis and Cultural Materialism,” Glenn (1988) identified behavior analysis as a discipline that provides a bridge between biological and cultural subject matters. In this sense, behavior analysis studies the order in emergent processes that creates complexity. She also identified similarities between behavior analysis and cultural materialism. Both disciplines use the environment to explain changes in their subject matter; both fit into a scheme similar to the one used in physical and biological sciences. They differ in the phenomena playing roles in their units of analysis. In behavior analysis, that is the relationship between activities of individuals and the environment; in cultural materialism, it is the relation between recurring cultural practices and the environment.

In the 1988 paper, Glenn focused on describing key concepts of cultural materialism as delineated by Harris (1964 and 1979). Actones, scenes, nomoclones and permaclones were viewed as entities based on behavioral dimensions. Finally Glenn defined infrastructure, structure and superstructure. Next, Glenn distinguished between behavioral contingencies and metacontingencies. Behavioral contingencies were defined as contingent relations between activities of individual organisms and environmental events constituting a unique history. Here Glenn defined a metacontingency as “the unit of analysis encompassing a cultural practice, in all its variations, and the aggregate outcome of all the current variations” (Glenn, 1988, p. 168). Metacontingencies were said to describe functional relations at the cultural level and the interlocking behavioral contingencies comprising the cultural practice is what is selected. Therefore, metacontingencies account for the survival of the cultural practices.

In a paper titled "Verbal Behavior and Cultural Practices," Glenn (1989) reviewed three kinds of selection (natural, operant and cultural selection). In this paper, Glenn discussed cultures in terms of the verbal behavior of speakers and listeners, involving interlocking contingencies among individuals. She labeled the interlocking contingencies as *cultural practices* and having outcomes beyond the consequences of individual behaviors. The unit of analysis was posed in the functional relation between the cultural practices and their outcomes. The role of verbal behavior as part of the practices that coordinate the behavior of the member of groups and speeding up the transmission of practices to new members was explored. The metacontingencies (described as the relation between cultural practices and their outcomes) explained both the nonverbal behavior and the verbal behavior that supports infrastructural practices allowing survival of the group.

In a chapter in Lamal (1991), Glenn further discussed the parallels among biological, behavioral, and cultural selection and reiterated the concept of cultural practices with an aggregate consequence beyond the consequences of individual behavior.

In Lattal and Chase (2003), Glenn continued to develop the concept of metacontingencies. She started by describing a process of transmitting learned behavior across individuals and between generations and labeled this process as pre-culture. The minimal requirements for this phenomenon are "(1) an operant lineage (class) of behavioral instances must be originated in the repertoire of as least one organism; (2) instances of that operant must have a stimulus function with respect to the behavior of conspecifics; and (3) contingencies of reinforcement must be repeated in successive repertoires in order to establish a lineage of learned behavior that replicates *across organismic boundaries*" (Glenn, 2003, p. 240).

Later in the paper, the author introduced the concept of interlocking behavioral contingencies to describe what happens when the coordinated behavior of two hunters - one going from the right side and the other form the left-- results in trapping their prey. The cooperative behavior is repeated when the coordination produces more reinforcement than independent behavior. In the case of maximization due to the consequences of interlocking contingencies, the selection process works at two levels: (1) the contingencies of reinforcement select the cooperative behavior of each participant and (2) the outcome of the interlocking contingencies functioning as a cohesive whole select the interlocking contingencies themselves. In the transition from behavioral to cultural level selection, the same event can function as reinforcers and cultural-level selectors to the interlocking contingencies. Glenn labels the relation between the interlocking contingencies and their consequences as metacontingencies. The role of operant behavior in cultural selection is that of a cultural-level replicator, but cultural level units involve the selection of the interlocking behavioral contingencies.

Glenn (2004) continued to refine concepts. She emphasized that the locus of cultural analysis is supraorganismic – there is transmission of behavioral content from the repertoire of one organism to the repertoire of another organism-, whereas the locus of change in behavior analysis is the behavioral stream of one individual.

In this paper, Glenn distinguished between macrocontingencies and metacontingencies. The 2004 definition of macrocontingencies accompanies a more restricted definition of *metacontingencies*. The most recent definition of metacontingencies describes just the relationship between interlocking behavioral contingencies, functioning as a unit, and producing an outcome that affects the probability of recurrences of the IBCs. The change occurs in a lineage of interlocking behavioral contingencies rather than in the recurring acts of individuals. This new kind of selection accounts for the evolution of complex cultural entities.

Glenn and Mallot (2004) applied the concept of metacontingencies to organizations, describing complex organizations as systems interacting with their external environments. In the context of organizations, the definition of metacontingencies includes relations between the IBCs, an aggregate product and a *receiving system*. The receiving system receives the aggregate product, functioning as a selecting environment for the IBCs.

Malott and Glenn (2006) identify a cultural problem as when an aggregate product of the behavior of many people causes problems for those people or others. They distinguish between three types of aggregate products: (1) the sum of the products of recurring behavior of many people behaving individually; (2) a unique product that is an end in itself resulting from the interrelated behavior of many people and (3) an aggregate product resulting from the organized and recurring interrelated behavior of many people. The locus of change can be individual organisms' operant lineages (targeting operant contingencies) or cultural lineages (targeting recurring interlocking operant contingencies). And interventions can occur at behavioral or cultural levels.

Toward Experimental Analysis of Behavior and Culture

The scientific study of operant behavior became possible when Skinner constructed an apparatus that allowed observing and recording frequencies of behavior as a function of environmental events manipulated by the experimenter. Is it possible to construct such an apparatus to observe cultural processes in which behavior is embedded?

Glenn described lineages of interlocking behavioral contingencies as a parallel to Harris' concepts of nomoclone (if the same participants were involved) and permaclone (if participants changed over time). In this study, I designed the procedures to observe a dyad operating as a small nomoclone. The dyad was observed during two different levels of scarcity of resources, manipulated by the experimenter.

EXPERIMENT I

Method

Participants and Setting

Five females and one male, ages between 18 and 26, participated in three dyads. Three participants were undergraduate students, taking an introductory course in behavior principles, and three were graduate students in the Department of Behavior Analysis at the University of North Texas.

One dyad included two female undergraduates, ages 20 and 21; another dyad included two female graduate students, ages 23 and 26; and the remaining dyad included one 18-year-old, male undergradate and one 26-year-old female graduate student.

The experiment took place in a small research room equipped with a table, three chairs and a computer.

Apparatus

The experimental procedure was implemented by a computer program written in Visual Basic.NET and using Microsoft Office Excel. The computer keyboard was altered by labeling the active keys. The altered keyboard is depicted in Figure 1.

Experimental Design

The dyads participated in one experimental session consisting of 360 trials, divided into 6 "hunting seasons" of 60 trials each. An experimental condition (rich or poor) was assigned to each season. Thus, the level of environmental scarcity was the antecedent condition manipulated (comparable to a motivating operation in operant analyses).

Poor and rich conditions were represented by proportion of hunts that each player came home with no rabbits (p = .36 in rich conditions and p = .23 in poor conditions).

A reversal A-B-A-B-A-B design was used for two dyads. Starting with a poor condition, then shifting to a rich condition; then to a poor condition and back to Rich Condition 2 additional times (poor-rich-poor-rich-poor-rich). For the remaining dyad, conditions were in different order (A-A-B-B-A-A).

The dependent variable was dyadic fitness, compared in rich and poor conditions. Dyadic fitness was defined as both participants being able to hunt and it was measured by the proportion of trials in a condition that both participants hunted. The program was designed so that maintaining dyadic fitness through each season required both participants to give at least three rabbits (at various times) to the other participant.

Procedure

A trial began when either of the two participants pressed the key labeled “Hunt.” In each trial, pictures of rabbits and a pair of numbers then appeared at the top of the screen representing how many rabbits each hunter brought home (Figure 2). Each player then was required to distribute his or her resources in one or more of the following ways: place rabbit(s) in his/her store to be used within the current or next trial; trade rabbit(s) for tablets/coins to be exchanged for money at the end of the experiment; give 1 or more rabbits to the other participant; eat a rabbit to remain able to hunt again. A participant was required to eat a rabbit in order to be able to hunt on the next trial.

The money accumulated in each season was displayed at the top of the screen in boxes labeled S1 to S6. If a participant did not eat a rabbit on any trial, a panel labeled “OUT” covered that participant‟s side of the screen. When a participant went out, that participant lost all resources he or she had accumulated during that hunting season and that participant could not hunt again while the remaining player could still hunt. When the second player went out, also losing all resources accumulated for that season, both hunters could return to hunt until the season ended. The program was designed to insure that no hunter could survive indefinitely without the other.

If a season ended while one participant was out and the other participant was hunting alone, then the participant who was still hunting got to keep the points he or she had accumulated during that season. Both participants could hunt again in the following season.

The experimental program was established to include two pre-set sequences of 60 pairs of numbers (rabbits obtained from the 60 hunts). One pre-set number sequence was designed to represent poor hunting conditions and the other sequence to represent rich conditions. The number of rabbits each participant received when the key labeled "hunt" was pressed was 0, 1, 2, or 3. The number obtained was independent of the participants‟ performance during the experiment.

In each season, there were 10 trials in which each participant received only 1 rabbit. The number of rabbits received in the remaining 50 trials was different for seasons in the poor and rich conditions. During seasons of poor conditions there were 22 trials in which one or the other participant participants received 0 rabbits at different times, 14 trials in which they received 2 rabbits and 14 in which they received 3 rabbits. In rich conditions participants received 0 rabbits in 14 trials, 2 rabbits in 18 trials, and 3 in the remaining 18 trials.

A simulation in Excel was constructed to program the sequences of numbers used in the experimental conditions. The sequence was designed to assure that in all conditions, each participant must give a rabbit to the other at least 3 times in order for both to continue hunting throughout the entire 60-trial season. I labeled a situation where one participant had to give a rabbit in order for the other to continue hunting an "opportunity to save."

Trial Structure

In the upper middle of the screen was a box reading “Hunt.” This was the only box that either participant could respond to by pressing the “Hunt” key in the middle of the altered keyboard. After a participant pressed this key, the box displayed two numbers. The number on the left side of the card, under the label “P1,” was the number of rabbits obtained by participant 1 and the number on the right side of the card, under “P2,” was the number of rabbits obtained by participant 2.

Below the Hunt box, the computer screen was divided in two, with displays that were the mirror image of one another, one side for each participant. At the top of each side there were six boxes, labeled 1-6, each box displaying “$0, 00.” This amount increased depending on the amount of money that each participant earned during the current hunting season.

The first action of every trial was pressing the “Hunt” key, which displayed the card containing the number of rabbits each participant got that trial. In the upper left and right corners of the screen there were two unlabeled boxes, the one on the right for participant 1 and the left for participant 2. When a card was displayed, the number of rabbits specified on the card was displayed in the corresponding participant boxes. Participants were required to move all the rabbits from that box before proceeding to the subsequent trial.

Participants moved the rabbits from their individual boxes using the marked keys on the keyboard. Pressing the key labeled “Eat It.” moved one rabbit to the participant“s “Eat it” box, which could not be removed. A rabbit in the “Eat It” box was required for a participant to continue to the next trial, and it reset to zero at the end of each trial. If a participant failed to put a rabbit in this box for one trial she lost all that he earned to that point during that season and a box labeled “Out” covered her side of the screen. When this happened, the participant’s keys became inoperative and she could not participate until the same happened to the other participant. When both participants failed to fulfill the “Eat it” box, both lost everything earned in that condition and boxes labeled “Out” covered both sides of the screen. After that, the “Out” boxes disappeared, the keys became active again and they could proceed to the next trial in the current season.

By pressing her key labeled “Trade,” a participant moved a rabbit to her “Trade” box. For every five rabbits placed there, the counter for that season increased by 50 cents, and the rabbits in the box disappeared. Once a rabbit was moved to the Trade box, it could not be used for any other purpose.

Participants could also store rabbits received in a trial in the box labeled “Store” by pressing the keys with the corresponding label. In the next trial that stored rabbit’s color changed from colorful to grey. If the participant did not move the grey rabbit during that trial it disappeared when the next trial was initiated. Thus, the store contained perishable resources.

A participant could give a rabbit to the other participant by pressing the “Give” key. When this happened a rabbit disappeared from the giver’s participant box and a new box containing the rabbit appeared at the top part of the screen of the receiver participant. The recipient could then move this rabbit to one of her boxes by pressing the same keys described above, with the exception of the key labeled “Give.” The next trial could not begin until all rabbits were removed from this box and then the box disappeared.

Pressing the key labeled “Switch” on the keyboard, allowed participants to toggle from box to box. . The active box was shown as white and the inactive boxes as red.

After moving all the rabbits, each participant was required to press the key labeled “Done” in order to complete participation in that trial. Once a participant did that, her keys became inactive and she could not do anything else during that trial. If a participant received a rabbit after pressing “Done,” her keys became active again and she was required to move the received rabbit and then press “Done” again to finish action. After both participants pressed “Done” the trial ended.

To initiate another trial one of the participants was required to press “Hunt.” The season ended after 60 trials and the entire experiment ended after 6 seasons, each season assigned to either rich or poor condition.

Data Collection

The program was designed to collect data on a number of variables so that it could be used by several experimenters. The variables of interest in the current experiment were: 1) how far into the season the dyad remained fit and 2) give responses by each participant.

All data were collected using the Visual Basic.NET and graphed using Microsoft Office Excel.

Results

Figure 3 compares dyadic fitness in rich and poor conditions for Dyads 1, 2, and 3 when all rich conditions for each dyad are combined and compared to poor conditions for that dyad. There is no difference in aggregate fitness as a function of environmental scarcity, with the possible exception of Dyad 2. Dyad 1 was fit 204 of the 240 days (85%) in poor seasons and 109 of the 120 (90.8%) hunting days in rich seasons. Dyads 2 and 3 hunted 180 days when environmental resources were scarce (poor) and 180 days when environmental resources were more abundant (rich.) Dyad 2 was fit for 153 of 180 days (85%) in poor seasons and 180 of 180 days (100%) on rich seasons; Dyad 3 was fit for 168 of 180 days (93.3%) days in both poor and rich seasons.

Figure 4 displays the fitness data for successive conditions, rich and poor, for Dyads 1, 2 and 3. Dyad 1 was fit for 46 days of Season I (poor), 49 days of Season II (poor), 58 days of Season III (rich), 51 days of Season IV (rich). In the last two poor conditions, Dyad 1 was fit 54 and 55 days respectively. Dyad 2 was fit for 33 days of Season I (poor) and all 60 days in all subsequent seasons. Dyad 3 was fit for 54 days of Season I (poor), 60 days in Season II (rich), 54 days in Season III (poor), 60 days in Season IV (rich), 60 days in Season V (poor), and 48 days in Season VI (rich).

Figure 5 displays the behaviors of "giving" and "giving back" a rabbit to the other participant in Dyad 3. The cumulative record shows the number of times participants in Dyad 3 gave rabbits to each other and the black marks indicate the times that participants gave back the rabbit. Giving back is defined as giving a rabbit to the other participant, after having received a rabbit from that participant in the same trial. The graph includes the "giving" and "giving back" of both participants, representing instances of interlocking behavioral contingencies. Participants in Dyad 3 gave 4 times in Season I (poor) and never gave back. In Season II (rich), 12 giving responses were made and seven times a participant gave back. In the subsequent Season III (poor), participants gave 5 rabbits and gave back 3 rabbits. In Season IV (rich), participants gave one rabbit and it was given back. A rabbit was given 3 times in Season V (poor) and returned once. One rabbit was given, and returned, in Season VI (rich).

EXPERIMENT II

Method

In the first experiment, the probability of getting 0 rabbits in the poor conditions was 0.36 and the probability of getting 0 in the rich condition was 0.23. Therefore, there was not much difference in scarcity in the rich and poor conditions. In the second experiment I increased the difference in the values of rich and poor conditions. In Experiment II, the probability of getting 0 in the poor conditions was 0.46 and the probability of getting a 0 in the rich condition was 0.16.

Participants and Setting

Three females and one male, ages between 18 and 45, participated in two dyads. All were undergraduate students, taking the introductory course on Behavior Principles in the Department of Behavior Analysis, at the University of North Texas.

One dyad included two female students, ages 20 and 23; and the other dyad included one 22–year-old female student and one 45- year- old male student. The experiment took place in a research room equipped with a table, three chairs and a computer.

Apparatus

Apparatus was the same as used in Experiment I.

Experimental Design

The level of environmental scarcity was the antecedent condition manipulated. Poor and rich conditions are represented by proportion of hunts that each player obtained 0 rabbits (p = .46 in rich conditions and p = .16 in poor conditions). Each dyad worked under two different conditions of environmental scarcity, shown in Table 1. A reversal A-B-A-B-A-B design was used, beginning with a poor condition. Dyadic fitness, measured as in Experiment I, was compared in rich and poor conditions.

Procedure

A simulation with Python was constructed to program a pre-set sequences of 100 pairs of numbers (rabbits obtained from the 100 hunts) used in Experiment II.

In each season, there were 14 trials in which each participant received only 1 rabbit. The number of rabbits received on the remaining 86 trials differed for seasons in the poor and rich conditions. During poor seasons there were 36 trials in which participants received 0 rabbits, 25 trials in which they received 2 rabbits and 25 in which they received 3 rabbits. While in rich seasons participants received 0 rabbits in 16, 2 rabbits in 35 trials, and 3 in the remaining 35 trials.

The dyads participated in 1 experimental session consisting of 600 trials, divided into 6 “hunting seasons” of 100 trials each. Other elements of the procedure were the same as in Experiment I.

Results

Figure 6 shows overall dyadic fitness for Dyads 5 and 6, comparing performance for all rich conditions to performance for all poor conditions.

Dyads 4 and 5 hunted 300 days, when the environment was characterized by scarcity (poor), and 300 days when the environment was characterized by more abundance (rich). Dyad 4 was fit for 199 of 300 (66.3%) days in poor seasons and 262 of the 180 (87.33%) hunting days in rich seasons. Dyad 5 was fit for 146 of 300 (48.7%) days in poor seasons and 252 of 300 (84%) of rich seasons.

Figure 7 shows season by season dyadic fitness as the independent variable was manipulated across six conditions (seasons). Dyad 4 was fit for 40 days in Season I (poor), 100 days in Season II (rich), 65 days in Season III (poor), 71 days in Season IV (rich), 94 days in Season V (poor) and 91 days in Season VI (rich). Dyad 5 was fit for 20 days in Season I (poor), 89 days in Season II (rich), 49 days in Season III (poor), 100 days in Season IV (rich), 89 days in Season V (poor), and 77 days in Season VI (rich).

In poor conditions, dyadic fitness starts low in the first condition and increases in each of the subsequent poor conditions (III and V) for Dyads 4 and 5.

Dyadic fitness is fairly consistent across rich conditions. It drops slightly on the fourth condition for Dyad 4, increasing again in the next rich condition (VI). For Dyad 5, dyadic fitness increases slightly from the first to the second rich condition (II and IV) and drops slightly in the last rich condition (VI). The data points on dotted lines in Conditions IV and V depict situations where both participants had rabbits to eat, but pressed the "done" key.

DISCUSSION

This research offers a procedure designed to study the interrelated behavior of two people as a function of the external environment in which the interrelated behavior occurs. This preparation allowed observations of the effects of rich and poor environments on the aggregate product dyadic fitness. By definition, dyadic fitness at the end of a hunting day allowed both participants to hunt on the next day. The preparation used in this research does not include a clear cut cultural consequence external to the cultural system, but such a variable can be added to the preparation in future research.

In both experiments I manipulated environmental scarcity from poor to rich conditions and observed the frequency of the aggregate product dyadic fitness. In the first experiment, Dyads 1, 2 and 3 showed no difference in aggregate fitness as a function of rich and poor conditions. However, the magnitude of the difference in environmental scarcity for poor and rich conditions was small.

I considered the possibility that increasing the difference in the values of environmental scarcity for rich and poor conditions would produce a more noticeable effect on dyadic fitness. Therefore, for Dyads 4 and 5 in Experiment II, I increased the difference between rich and poor conditions. In Experiment II the dyads become increasingly fit across the poor conditions and they ended about as fit as they were in the rich conditions, which remained fairly constant throughout the sessions for both dyads.

Experiment II shows that dyadic fitness may be affected by environmental scarcity. However comparisons between Experiments I and II are limited for two reasons:

(1) It was not possible to maintain in Experiment II the standard number of 3 opportunities to save per season used in the 60-dayr season of Experiment I while increasing the

difference between rich and poor seasons. The solution was to increase the number of days per season from 60 to 100 on Experiment II.

(2) The number of times that participants came back empty handed (received a 0 after pressing the key marked "hunt") differed in Experiment I and Experiment II. In Experiment I, participants came back empty handed 22 out of 60 (36,66%) days in poor seasons and 14 out of 60 days in rich seasons (23,33%); in Experiment II, participants came back empty handed 46 out of 100 (46%) days in poor seasons and 16 out of 100 (16%) days in rich seasons.

Another limitation of this research is that all dyads began in poor seasons, so there may be some historical effects that were not examined. Future research could counterbalance the initial conditions and they include gradual and sudden changes in environmental scarcity.

A parameter that was not used in this research, but that can be manipulated, is the number of rabbits that each participant receives when coming home with 2 rabbits or more. This parameter was investigated in an experiment performed by Ward, Eastman and Ninness (2009), wherein participants received resources on the same proportion of trials in each condition, but the range of possible resources obtained during these trials increased by one in successive conditions. Giving was observed in 5 out of 7 dyads investigated; 4 of those 5 dyads had similar rates of giving and one had strikingly high rates that increased through the experiment.

The transmission of patterns of interactions from one generation to another can also be investigated. To work with a lineage of IBCs would also be interesting. For example, after a dyad has been through the entire experimental session, pair each participant with a naïve participant to form two new dyads and track divergence in practices.

Finally, it might be possible to investigate patterns of interaction developed in the IBCs using the present preparation. Dyad 3 developed an unexpected pattern of interaction depicted in the ‘giving back’ of Figure 5 Participants were giving back rabbits to each other, when the rabbits given were not essential for them to eat on that day. This was not expected for two reasons: (1) there is not a clear advantage for giving back a given rabbit and (2) participants cannot take a rabbit from the given box to give the rabbit back, they have to press “Store” to put the rabbit in the store and then press “Give” to give the rabbit back. There might be a relation between giving back and the decrease in the number of rabbits given to each other as depicted in Figure 5 but there are not enough data to make any definitive statement. The effect of this practice on a lineage of IBCs and the transmission of this practice could be investigated if participants of that dyad were joined with naïve participants to perform the experiment again.

The path to construct an apparatus that allows measurement at the cultural level is expected to be long and changes in the apparatus are highly probable, but this should not be taken as an excuse to avoid this kind of study.

Figure 1. Altered keyboard.

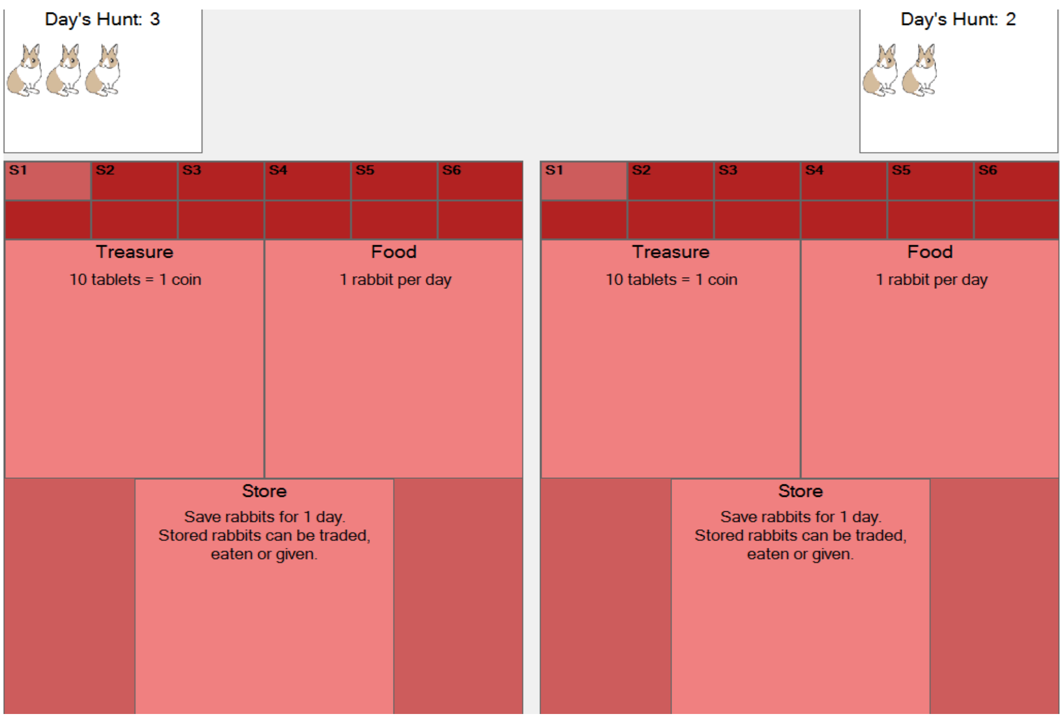

Figure 2. Initial setup of the experiment.

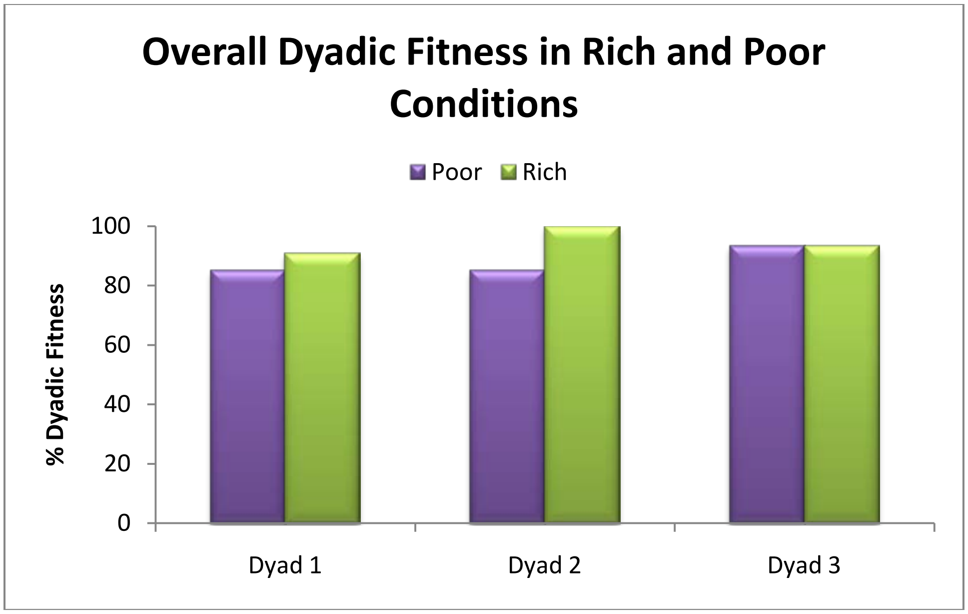

Figure 3. Proportion of dyadic fitness as a function of poor and rich environments for Dyads 1, 2 and 3.

Dyadic fitness as a function of conditions

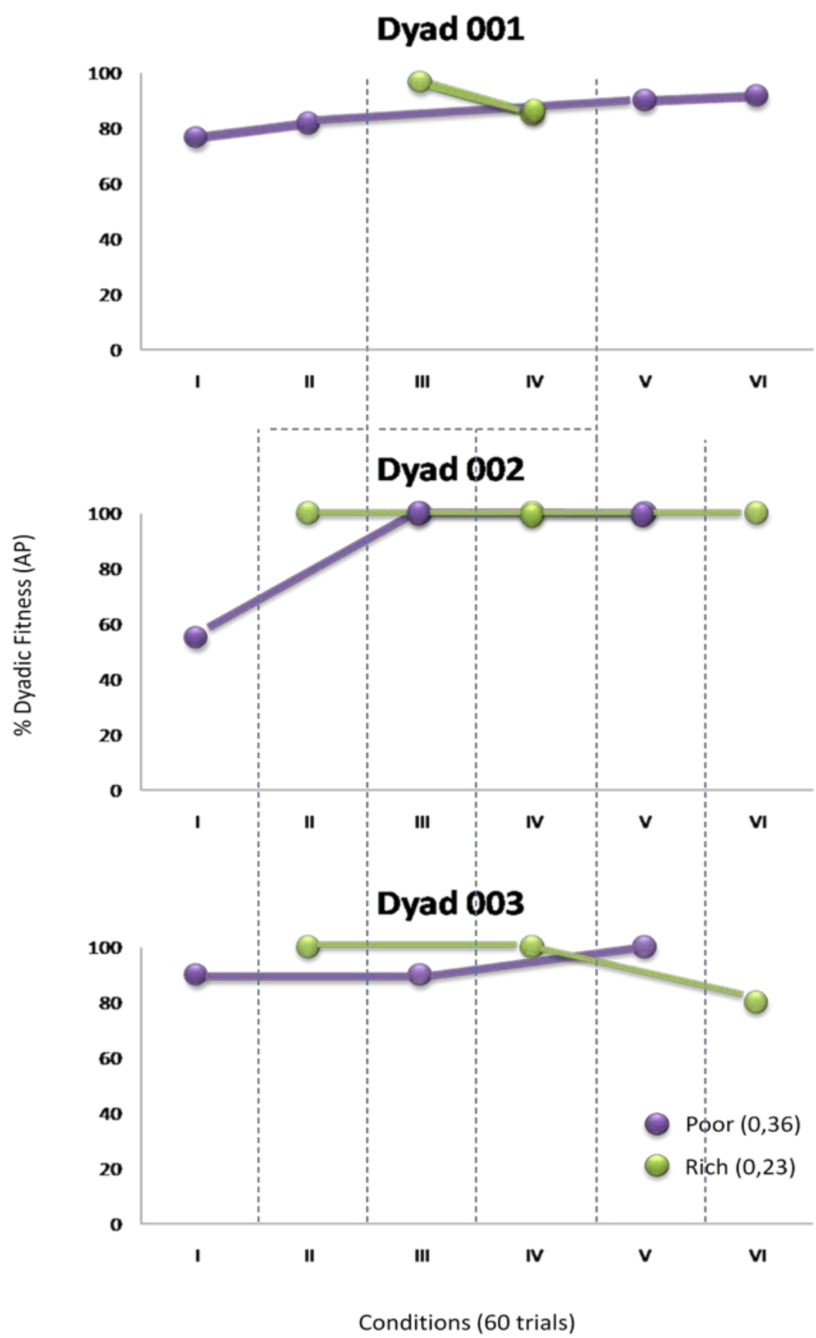

Figure 4. Dyadic fitness as a function of conditions for Dyads 1, 2 and 3.

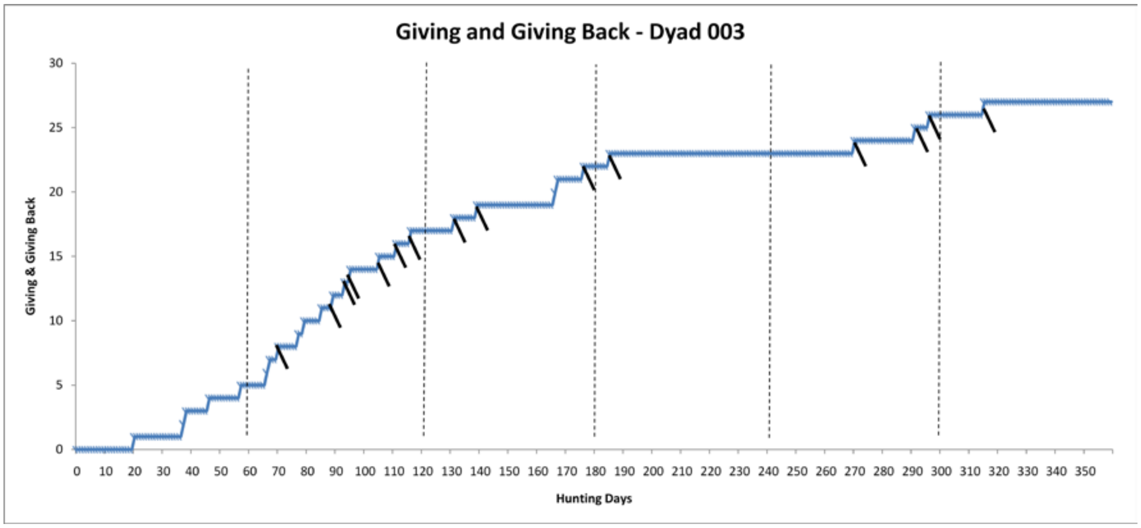

Figure 5. Giving (cumulative) and giving back (hash marks) as a function of Conditions I, II, III, IV, V and VI.

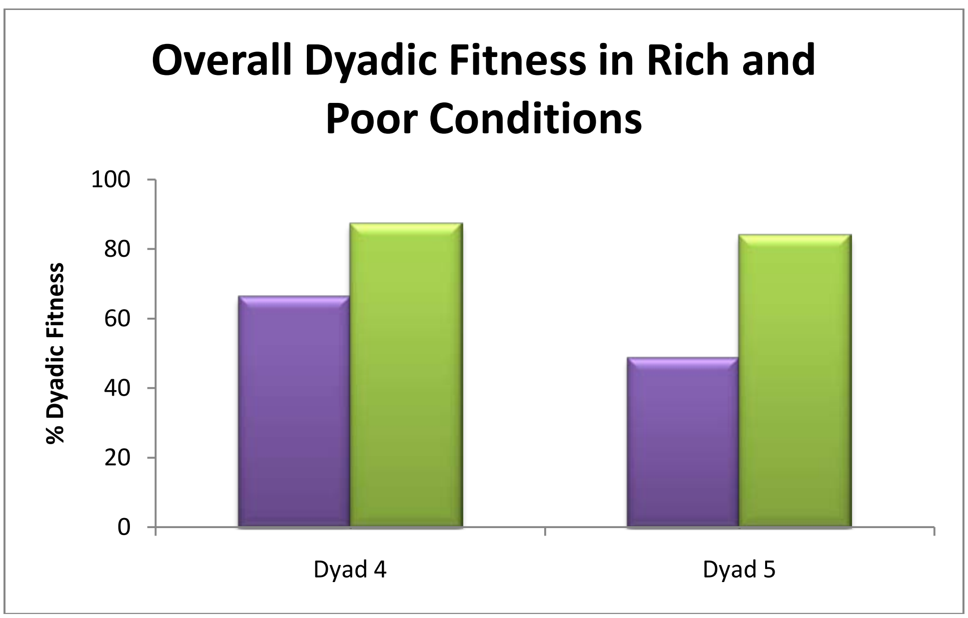

Figure 6. Proportion of dyadic fitness as a function poor and rich environmental scarcity for Dyads 5 and 6.

Dyadic fitness as a function of conditions

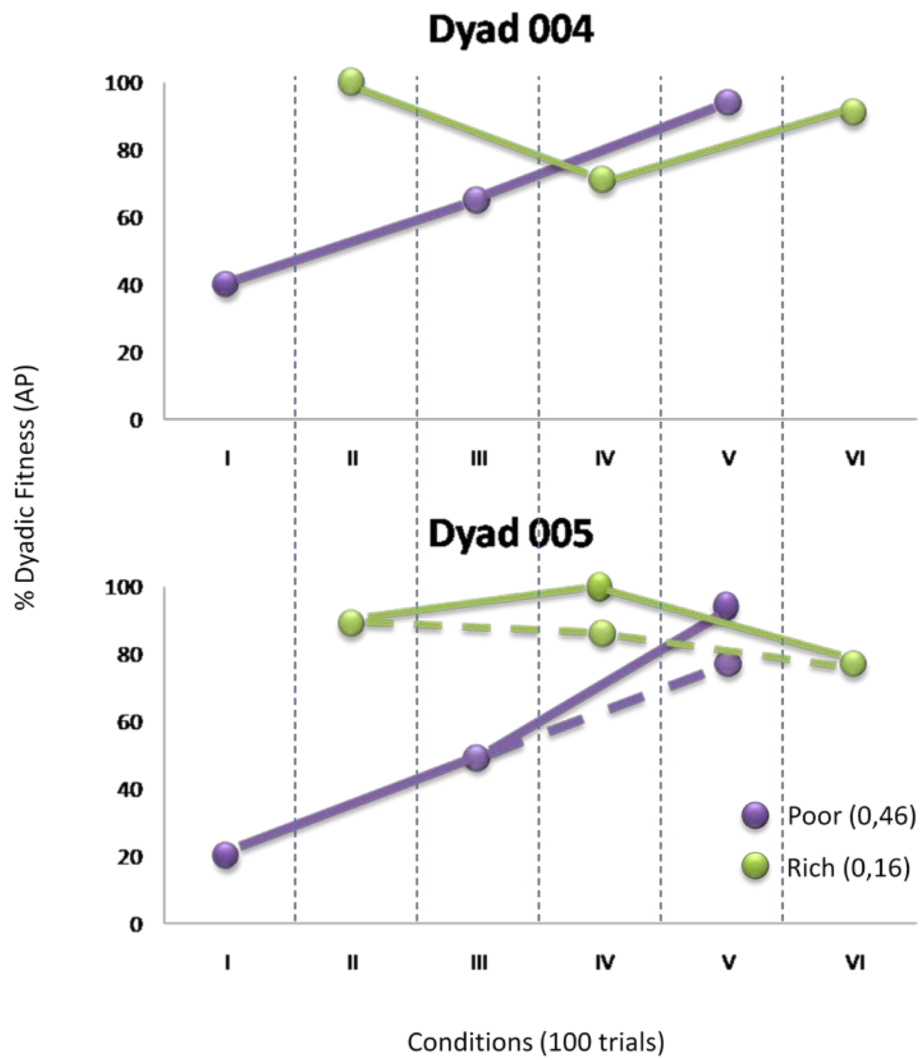

Figure 7. Dyadic fitness as a function of conditions for Dyads 4 & 5.

REFERENCES

Keller, F.S. & W. N. Schoenfeld. (1950). *Principles of psychology*. New York: Appleton-Century-Crofts.

Glenn, S. S. (1986). Metacontingencies in Walden Two. *Behavior Analysis and Social Action, 5*, 2-8.

Glenn, S. S. (1988). Contingencies and metacontingencies: Toward a synthesis of behavior analysis and cultural materialism. *Behavior Analyst, 11*, 161-179

Glenn, S. S. (1989). Verbal behavior and cultural practices. *Behavior Analysis and Social Action, 7*, 10-14.

Glenn, S. S. (1991). Contingencies and metacontingencies: Relations among behavioral, cultural, and biological evolution. In P. A. Lamal (Ed.), *Behavioral analysis of societies and cultural practices* (pp. 39-73). Washington, DC: Hemisphere.

Glenn, S. S. (2003). Operant contingencies and the origins of cultures. In K. A. Lattal & P. N. Chase (Eds.), *Behavior theory and philosophy* (pp. 223-242). New York: Klewer Academic/Plenum.

Glenn, S. S. (2004a). Individual behavior, culture, and social change. *Behavior Analyst, 27*, 133-151.

Glenn, S. S. & M. E. Malott. (2004b). Complexity and selection: Implications for organizational change. *Behavior and Social Issues, 13*, 89-106.

Glenn, S. S. & M. E. Malott. (2006). Targets of intervention in cultural and behavioral change. *Behavior and Social Issues, 15*, 31-56

Harris, M. (1964). *The nature of cultural things*. New York: Random House.

Harris, M. (1968). *The rise of anthropological theory: A history of theories of culture*. New York: Crowell.

Harris, Marvin. (1979). *Cultural materialism: The struggle for a science of culture*. New York, Random House.

Laraway, S., S. Snycerski, J. Michael, and A. Poling. (2003). Motivating operations and terns to describe them: Some further refinements. *Journal of Applied Behavior Analysis, 37*, 407-414.

Michael, J. (1982). Distinguishing between discriminative and motivational functions of stimuli. *Journal of the Experimental Analysis of Behavior, 37*, 149-155.

Skinner, B.F. (1938). *The behavior of organisms*. New York: Appleton-Century-Crofts.

Skinner, B. F. (1953). *Science and human behavior*. NewYork: Macmillan.

Skinner, B. F. (1981). Selection by consequences. *Science, 213*, 501-504.

Ward, T. A., R. L. Eastman, and R. L. Niness. (2009). An experimental analysis of cultural materialism: The effects of various modes of production on resource sharing. *Behavior and Social Issues, 18*, 58-80.