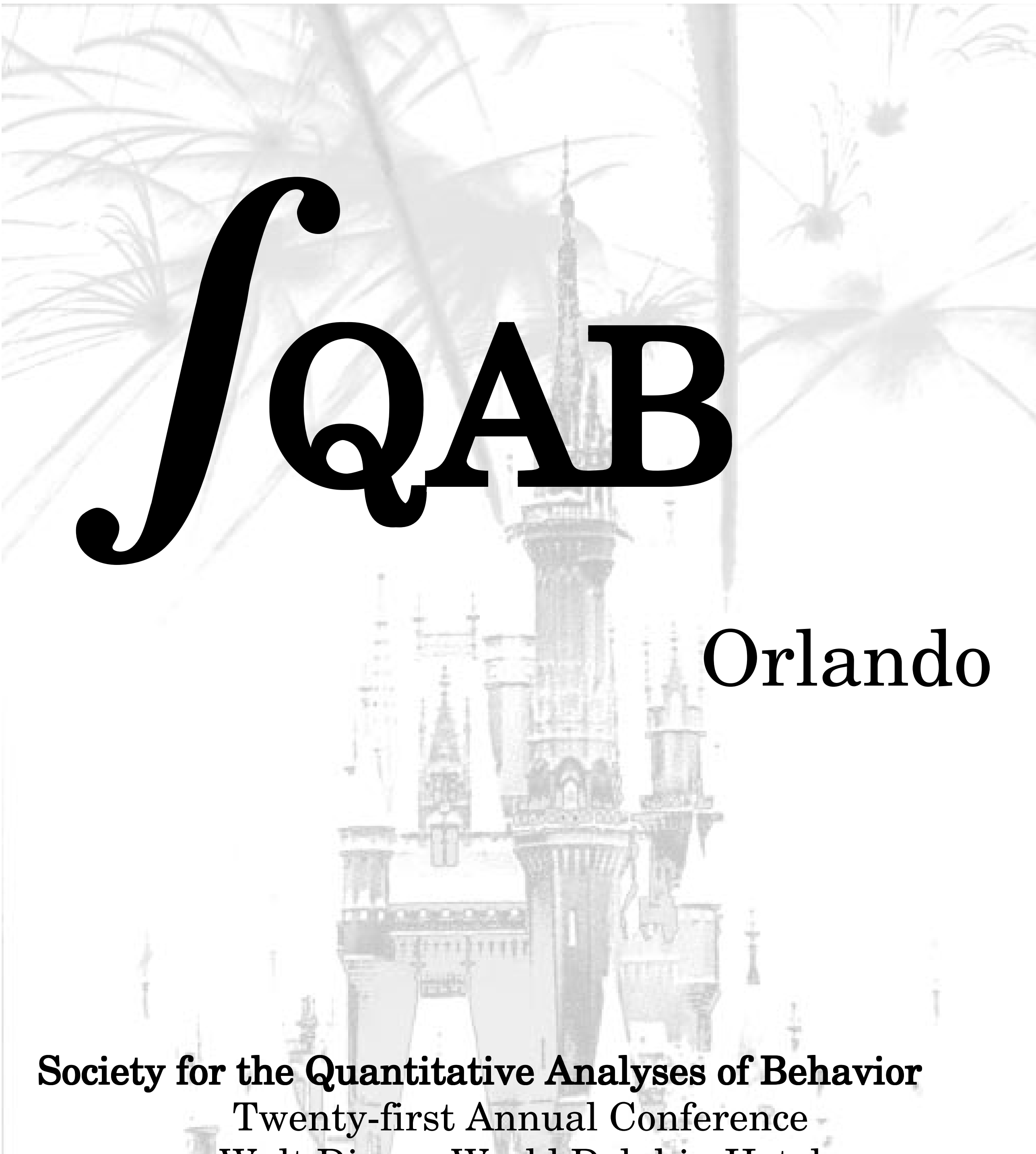

∫QAB

Orlando

Society for the Quantitative Analyses of Behavior

Twenty-first Annual Conference

Walt Disney World Dolphin Hotel

May 22-23, 1998

∫QAB

The Society for the Quantitative Analyses of Behavior (∫QAB) was founded in 1978 to present symposia and publish material which bring a quantitative analysis to bear on the understanding of behavior. This can be roughly defined as the use of mathematical formulations to characterize one or more dimensions of an obtained data set, derive predictions to be compared with one or more dimensions of an obtained data set, or to generate novel data analyses.

If you have a web browser, you can retrieve information pertaining to ∫QAB, as well as abstracts of papers from our site (http://www.jsu.edu/psychology/sqab.html).

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5:00 - 10:00+ *Registration and Cash Bar*

7:00 - 8:30 *Registration, Coffee and Pastries*

7:30 - 8:30 **Earlybird Breakfast Tutorial**

Randolph Grace
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This informal, interactive get-together-over-coffee is primarily intended for people with no quantitative background. The target audience includes both students and established researchers. You are encouraged to attend if you feel that an exposure to a few basics would make your attendance at SQAB more productive, or if you feel that you could lend your insights to help others get up and running. The session will be audience driven. It is not a prearranged lecture. Depending on your interests, it could be a question and answer dialogue or we could cover: a brief introduction to the quantitative tools which will be invoked by the subsequent speakers, an extended treatment of some particular quantitative procedure, or a discussion of analytical conundrums. This session is in keeping with the Society's strong commitment to provide support to those students and researchers interested in pursuing quantitative analyses. This tutorial is explicitly structured so that you can use it to accomplish what you need.

8:35 **President's Introduction**
Models and Mechanisms: The Legacy of William J. McGill

John A. Nevin
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Dr. William J. McGill (1922-1997) was a distinguished mathematical psychologist who served as President of Columbia University from 1970 to 1980. His work on sensory and timing processes gives us outstanding examples of mathematical modeling of biological mechanisms. I will present some analyses inspired by his teaching.

8:45 Does Behavioral Adjustment Depend on Frequency of Environmental Change?

Michael Davison & William M. Baum
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Six pigeons were trained on a procedure in which seven different concurrent-schedule reinforcer ratios were arranged in each session. The components were separated by blackouts, they occurred in an irregular order, they arranged the same overall reinforcer rate, and the different reinforcer ratios were not signaled. Conditions lasted 50 sessions, and data were collected from the last 35 sessions. The conditions differed only in the duration of the components, which varied over the range from 2 to 12 reinforcers per component. Within components, log response-allocation ratios adjusted rapidly as more reinforcers were delivered in the component, and sensitivity to reinforcement leveled off at moderately high levels after only about eight reinforcers. The duration of the components appeared to have no effect on the speed at which behavior changed after a component started; all the curves relating response ratio to reinforcers obtained were superimposable. In a second part of the experiment, the arranged overall reinforcer rate was increased substantially, and similar manipulations and analyses were carried out in an effort to separate the effects of time from reinforcers obtained. Our analysis focuses on trying to characterize the quantitative nature of the within-component behavior changes.

9:26 A Local Analysis of Concurrent Choice

James S. MacDonall
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Two-alternative concurrent choice consists of two pairs of schedules (Houston and McNamara, 1981). One member of each pair reinforces staying in the current alternative and the other reinforces switching to the other alternative. In conventional arrangements, the stay schedule in one pair equals the switch schedule in the other. Run length is the total responses to an alternative divided by the switches from that alternative (*R/C*). Recent research finds run lengths are a power function of the ratio of the scheduled probability of reinforcement for staying on that alternative (P_{st}) divided by the scheduled probability of reinforcement for switching from that alternative (P_{sw}), $B_1/C_2 = j_1(P_{st1}/P_{sw2})^k$. From this power function a local model of concurrent performance emerges, $(B_1/C_2)/(B_2/C_1) = j_1/j_2(P_{st1}/P_{sw2})^{2k}$. Ratios of run lengths are a power function of the ratio of the scheduled probability of reinforcement for staying divided by the scheduled probability of reinforcement for switching. An analogous model is developed for visit duration, the mean duration of visits to each alternative. The results of several experiments that vary the arrangement of the stay and switch schedules are consistent with this local model, but inconsistent with the generalized matching law.

10:07 A Selectionist Approach to Choice Behavior

Armando Machado
Indiana University
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In this talk I will present a selectionist model of choice behavior that is based on four key assumptions.˚ First, responses replicate at the end of epochs whose length is inversely related to the overall reinforcement rate. Second, each response replicates in proportion to its (local) reinforcement rate. The two preceding assumptions imply that whereas overall reinforcement rate sets the tempo of learning, a Weber-like fraction in the domain of reinforcement rate sets its direction. Third, different reinforcement schedules modulate the Weber-like fraction differently. Fourth, the rules that apply to single responses also apply to extended patterns of responses.˚ From this viewpoint, choice is conceived as the differential replication of a population of responses, each replicating in proportion to its fitness value. I will show how the model predicts a variety of results concerning steady--state choice behavior; how it predicts the speed of acquisition of a choice preference; how it may be extended to deal with single--response situations; and, most important, how by predicting the strength of local response patterns it may, if not solve, at least dissolve, the long-lasting molar/molecular controversy in choice studies.

10:48 *Br11hments*

11:03 On the Search for Parallels between Animal Learning and Human Cognition

William K. Estes
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The search for significant parallels between animal and human learning has been most productive when directed, not at details of performance or underlying neurology, but at high-level principles, usually expressible in quantitative form. Several candidates for a focal set of common principles are proposed and illustrated in application to research on memory and decision.

11:44 Discussion

John A. Nevin
University of New Hampshire (Emeritus)
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After Dr. Estes' talk, we will discuss the relations between his topics and other areas of current interest in the quantitative analyses of behavior.

12:25 *Lunch Break*

1:45 Behavior Distributions in Time: Orderly Functions

Robert W. Allan
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For several groups of birds key pecking was autoshaped using a 30-s clock-stimulus arrangement. Activity in the chamber was also monitored by a set of floorboard panels. Some of the birds were exposed to the trials in a continuous-trials arrangement (with no ITI), while other birds were exposed to the same trial stimulus in a discrete-trials arrangement with a 5-min ITI. Distributions of key pecking and movement were examined by using several proposed models of conditioning effects, as well as a polynomial model whose parameters may be adjusted to predict performance in these time-based schedules.

2:26 A Comparison of Top-Down and Bottom-Up Theories of Timing

Russell M. Church
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Theories of timing generally begin with assumptions about psychological processes, such as the characteristics of temporal perception, memory, and decision. Examples of such theories are a scalar timing theory, a behavioral theory of timing, a multiple-oscillator theory of timing, and a real-time conditioning theory. An alternative approach is to begin with the characteristics of the data, and infer the characteristics of the generating process. Methods for making such inferences will be described. These two approaches will be applied to data from rats obtained on random-interval schedules of reinforcement. Comparisons will be made between the top-down and bottom-up approach to explanation of timing behavior.

3:07 Time and Memory: Towards a Pacemaker-free Theory of Interval Timing

J. E. R. Staddon
Duke University
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There is a developing consensus that interval timing in animals is driven by a discrete pacemaker-accumulator (PA) mechanism that yields a linear scale for subjective time.° But PA mechanisms are fundamentally at odds with the Weber-law property of interval timing; evidence for a pacemaker system is far from conclusive; and experiments supporting linear subjective time can be interpreted in other ways. I propose an alternative approach, based on known principles of memory dynamics, that assumes time is encoded in a nonlinear, logarithmic-like way.° This alternative lacks the mathematical elegance of pacemaker-type theories, but is pacemaker-free, simpler in concept and addresses a wider range of data.

3:48 *Break - Refreshments*

4:03 The Use of Temporal Information in Pavlovian Behavior

Ralph R. Miller & Hernan I. Savastano
SUNY - Binghamton
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Although instrumental behavior has long suggested the coding of temporal information, learning about temporal relationships has been thought to depend on differential reinforcement, and hence to be irrelevant to Pavlovian situations. We will describe the temporal coding hypothesis, a framework in which: 1) Temporal proximity of two events is sufficient for learning to occur, 2) Temporal relationships between paired events are automatically encoded, i.e., temporal proximity is not merely a catalyst for learning, 3) The nature and timing of acquired responding is dependent on this temporal information, and 4) Temporal information from independent paired events can be integrated to provide temporally sensitive control of behavior by a stimulus that itself has not been paired with the reinforcer. Data will be presented supporting these assumptions, with an emphasis on the integration tenet (4) because of its novelty.

4:44 Modeling Adjunctive Behavior Sequences for Timing Tasks

John H. Wearden
The University of Manchester, U.K.
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The Behavioral Theory of Timing (BeT) of Killeen and Fetterman accounts for animal performance on timing tasks by assuming that observed behaviors such as lever-pressing and key-pecking are mediated by sequences of adjunctive behaviors occurring during the interval to be timed.° The properties of these adjunctive sequences are almost always inferred from measured behaviors: adjunctive behaviors themselves are almost never directly observed (although an article by Haight & Killeen is an exception).° An experiment on adjunctive behaviors produced during temporal differentiation of a platform-residence response by gerbils (conducted in collaboration with Helga Lejeune of the University of Liege in Belgium) directly observed adjunctive activities while the time requirement for reinforcement was varied. These data will be described briefly, but the main focus of interest is how the adjunctive sequences observed could be modeled, using developments of ideas from BeT, such as the basic notion that transition from one adjunctive behavior to another is governed by pulses from a variable-rate Poisson pacemaker.° For example, adjunctive behaviors probably have minimum and maximum "natural" durations.° What happens when these limits are exceeded?° Another issue to be explored is the relation between pacemaker pulses and adjunctive behaviors, and the effects of both "missed pulses" (where a pacemaker pulse does not advance the adjunctive sequence) and "spontaneous changes" (where the adjunctive behavior changes without a pacemaker pulse) will be explored.° Such modeling may help clarify the issue of whether adjunctive behaviors actually observed are or are not in conformity to predictions of BeT.

°

5:25 *Break*

5:30 *Business Meeting*

6:00 - 10:00+ ***Poster Session / Cash Bar***

Dis-Harmony in Quantitative Models: Speculation on the Value of Variable Schedules

Matthew Andrzejewski
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In optimal foraging paradigms, a progressive schedule is often pitted against a fixed schedule. The progressive schedule is taken as simulating a "depleting patch" and characteristics of that depletion have been the main focus of experimentation. The fixed schedule is taken as emulating a "between patch" component. However, this assumes that patches are equidistant. In quantitative models, the between patch component is characterized by a single value. Ostensibly the statistical or quantitative "expected value" of this single number represents a "stochastic" but unspecified distribution of patches. If we were to make the between patch distribution explicit, the implementation of a variable or random "between patch" schedule is straightforward, but how would we characterize its value in terms of a single number? By incorporating a variety of averaging techniques, alterations to Linear Optimality and Sums of Reciprocals equations are shown, as well as formulae for generating random schedules with set dimensions and various means. Features of schedules generated using these formulae will also be displayed. Implications for future research and a reconsideration of the value of variable schedules is offered.

The Barrier Choice Paradigm: Summarizing Five Years of Research

Carlos F. Aparicio
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This poster summarizes the results obtained in a series of experiments where a standard choice situation for rats was modified to include travel between alternatives. Barriers of different heights blocked the free passage from one lever to the other. Rats climbed the barriers traveling between alternatives. The barriers could be lifted, in identical steps of 15.2 cm, to reach a height of 76 cm. Concurrent schedules with Random-Interval components of different values were used to vary the rate of reinforcement in the alternatives. In the first experiments, the generality of the matching law was tested in a choice situation where two levers were separated by one barrier that took on different heights. Then, with the tallest barrier (76 cm) in place, an extra cost to the response of switching between levers was imposed by injecting rats (ip) with a drug (Haloperidol) that impaired the locomotion. In the last experiments the choice situation was adapted to include eight levers. Barriers of different heights blocked the free passage to the levers that concurrently provided food according to different Random-Interval schedules. Results showed that presses, obtained reinforcers, and durations of visits to the levers increased with increasing barrier size. With free access to the levers choice behavior obeyed the matching law. However, when barriers blocked the access to the levers, behavior showed enhanced sensitivity to changes in reinforcement rates. The slope of the matching relation increased with increasing barrier size. The drug reduced the behavior's sensitivity to changes in reinforcement rates. When eight levers were concurrently available and free access was permitted, the distribution of responses in the levers matched the distribution of reinforcements. Blocking the access to the levers with barriers enhanced sensitivity of relative rates of responses to changes in relative reinforcement rates. The slope of the matching relation was greater than one. Generally, results showed that in choice situations where a cost to the response of traveling among alternatives is imposed, overmatching is the rule to follow.

Evolution of Proficiency in a Computer Game

Fernando A. Gonzalez
Morris Brown College
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Nine undergraduates received hourly wages to play a computerized strategy game in which the player commands a spaceship whose mission is to find and destroy a flotilla of space bandits. To win, the player must find and destroy all the bandits. Six different commands are available. Commands are initiated by pointing and clicking on command buttons with the mouse. This produces the execution window for the selected system (e.g., weapon system). By clicking on the options (e.g., weapon type, target ID), the player executes the command. Different commands consume different amounts of energy. Energy is also lost when the ship receives a hit. The player looses when the spaceship runs out of energy. Participants played at least 100 games. Minimal initial instructions described only the mechanical aspects of playing the game. Recorded data consisted of the times of initiation and execution of each command and the state and position of each object in the game at those times. A detailed analysis of command choices indicated that players gravitated towards the same play patterns, which incorporated important non-trivial elements of the theoretically optimal strategy.

A Guessing Correction for the ROC Curve of Signal Detection Theory

Eric G. Heinemann
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Since the work of Tanner, Swets, and Birdsall in the 1960s most psychologists have agreed that Signal Detection Theory (SDT) gives a better account of results obtained in many psychophysical experiments than does High-Threshold Theory (HTT). One way in which the two theories differ is in the assumptions made concerning the occurrence of guessing. HTT assumes that subjects guess under some circumstances. SDT assumes that they never guess. Whereas the assumption made by SDT is probably correct for well motivated human subjects, experiments done with animals (e.g., in the laboratory of D. Blough, and in the laboratories of Heinemann and Chase) indicate that the subjects act as expected from the decision rules specified by SDT on most trials, but guess on the remaining trials. I shall describe the effect that guessing has upon the psychometric functions and the ROC curves obtained in such experiments.

Variations on the Spectral Timing Model

John Warren Hopson
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The Spectral Timing Model is a neural network model of animal timing used primarily to describe timing in classical conditioning. In these simulations, the model was modified to allow it to account for two new timing paradigms, the Gap and Bisection procedures. The model was able to accurately simulate a parametric study of gap timing and produced results similar to those found by the bisection procedure.

Double and Triple VI Burst Behavioral Dynamics and Tests of Linear Analysis

Robert Kessel, Robert Lucke,
William L. Palya & Donald E. Walter
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To be useful, any analysis of behavioral dynamics should allow the observations made with one dynamic environment to predict the observations expected for a novel environment. We measured the behavior of five pigeons exposed to trials containing two and three bursts of variable-interval (VI) reinforcement, followed by a relatively long period of extinction. Transitions between the VI and extinction were unsignaled as in a mixed schedule. Data from the two-burst phase was then used to predict each bird's steady-state behavior during both three-burst phases via a linear analysis. The predictions have reasonable fidelity to the observed three-burst data and the linear transfer function is low-pass in character and has an anticipatory rising edge and lagging falling edge. More broadly, the supported behavior has both considerable regularity and shows clear dependence upon changes in the reinforcement schedule parameters. We introduce a terminology for the different types of dynamic behavior.

The Ideal Free Distribution of Behavior: Group Choice

John R. Kraft
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The Ideal Free Distribution (IFD) is an optimal foraging theory that describes the way a group of foragers distributes between resource sites (Fretwell & Lucas, 1970), but it also describes the more general phenomenon of group choice (i.e., group members engaging in one of two behaviors). The non-foraging behavior of a group of humans (i.e., raising blue or red cards) distributed in accord with IFD predictions. Analyzed in a similar manner as the Generalized Matching Law of individual choice data, human IFD data produced matching with a slope of .90 with accounted for variance equalling 99%. The present research indicates that group choice, like individual choice, is sensitive to relative rates of reinforcement at the group level.

Does the Ideal Free Distribution Describe Human Behavior in a Panhandling Situation?

Le'Ann Milinder
University of New Hampshire
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The Ideal Free Distribution (IFD) is a model that describes the distribution of members of a group of foraging animals choosing between two resource sites. The model predicts that the ratio of the number of animals at each resource site will equal the ratio of resources obtained at those sites. First developed by Fretwell and Lucas (1970), the model has been a good predictor of the distribution of various species of animals in experimental situations, although some evidence for systematic deviations from the IFD have been observed. One experiment using human participants (Sokolowski, Tonneau, & Baque, in press) found that performance in a competitive game approximated the IFD. The current study examined 1) whether the IFD described human performance when participants were not explicitly required to 'win' in order to receive money; and 2) whether using a more ecologically valid procedure, a panhandling situation, would yield an ideal free distribution of human foragers. Participants could ask for money on either of two simulated 'streets' during panhandling sessions. Participants in one group received nickels (which they could keep) and participants in another group received tokens exchangeable for money (winner-take-all). Both groups were exposed to 6 different resource ratios on the two streets. Results will be presented.

The Emergence of Undermatching in a Computer Simulated Organism

Matt J. Morris
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A computer simulated organism that could learn from reinforcement and punishment was developed. The organism existed in a two-dimensional environment containing four walls and two levers. Punishment was delivered contingent upon bumping into the walls and reinforcement was delivered contingent upon pressing the levers. The organism was able to move up and down, left and right, move his left arm, and move his right arm. Reinforcement increased values associated with just-performed behaviors, while punishment decreased values associated with just-performed behaviors. The organism exhibited several operant phenomena, such as acquisition, extinction, maintenance of behavior by partial reinforcement, conditioned reinforcement, and avoidance behavior. The organism displayed some stimulus control, but did not display the typical patterns associated with the different schedules of reinforcement. Most recently, the organism ran on a concurrent VI series, and an analysis of response rate ratios vs. reinforcement rate ratios revealed undermatching with an exponent of .83 and an r^2 of 87.5%.

Sequential Order of Spaced Two-Response Sequences

Susan Schneider
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Five previous studies on rats' demarcated two-response free-operant bar-press sequences showed that when delays between sequence elements are short, matching occurs at the sequence level instead of the response level, and the sequences are emitted in consistent patterns across subjects. Four rats were exposed to four conditions of varying delays and sequence reinforcement probabilities, with overall reinforcement rate held roughly constant. In the 1-s and 2-s conditions, a timeout contingency facilitated spaced responding. In all conditions, results were much closer to sequence matching than response matching. Lag 1 sequence patterns were more uniform and were consistently statistically significant at the 0- and 1-s spacings; the increased percentage of timeout responses in the 2-s conditions is a confound. A clear correlation between the percentage timeout responses and conditional probability z-scores existed throughout. The results have significance for the molar-molecular issue, behavioural units, matching theory, sequence discriminability and behavioural detection theory, delay of reinforcement, and sequential analysis.

A Test of the Hyperbolic Rate Versus Reinforcement Rate Function

Paul Soto & Jack J. McDowell
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Two experiments investigated behavior maintained by schedules arranged using experimenter chosen feedback functions. In Experiment 1, reinforcement rate was a quadratic function of response rate. Response rates under such schedules were consistent with reinforcement maximization and inconsistent with a hyperbolically shaped response rate versus reinforcement rate function. In Experiment 2, reinforcement rate was a piecewise defined function of response rate. From zero to a specified response rate, reinforcement rate was a positive linear function of response rate. From that specified response rate to a second critical response rate, reinforcement rate was a quadratic function of response rate. Beyond the second critical response rate, reinforcement rate was a constant positive function of response rate. Response rates were again consistent with reinforcement maximization and inconsistent with a hyperbolically shaped response rate versus reinforcement rate function. The general applicability of any hyperbolically shaped response rate versus reinforcement rate function was questioned.

The Effects of Overall Food Density, Food Profitability, and Prey Conspicuousness on Frequency-Dependent Predation in Pigeons

Yoshihisa Uchida & Masato Ito
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Three experiments, using pigeons as subjects, investigated frequency-dependent predation in a choice situation using a concurrent-chains schedule. In all experiments, pigeons chose between two alternatives differing in reinforcement frequencies under two conditions of overall prey density. Prey profitability defined by the length of the outcome phases was varied across experiments. In Experiment 1, prey profitability did not differ between two alternatives, while in Experiments 2 and 3, it differed between two alternatives. Prey conspicuousness was defined by the difference in the stimuli presented during the choice phases. Two white circles were used in all Experiments, but a small green circle was mounted on one of the two white circles in Experiment 3. When log response ratios were plotted against log reinforcement frequency ratios, the slope of the fitted lines revealed that pigeons undermatched their response ratios to the reinforcement frequency ratios (i.e., negative frequency-dependent predation) when prey profitability and prey conspicuousness did not differ between two alternatives. Although results were not clear in the high density condition, most pigeons showed overmatching of their response ratios to the reinforcement frequency ratios (i.e., positive frequency-dependent predation) when prey profitability and prey conspicuousness differed under the low density condition. Therefore, the present results suggest that prey conspicuousness as well as prey profitability may play a role in the occurrence of overmatching.

The Reinforcement Context for Delayed Matching to Sample

K. Geoffrey White & Glenn Brown
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Performance on a single trial of a delayed matching-to-sample procedure in which the sample and the choice opportunity are temporally separated can be construed as a behavioral unit. Accordingly, response strength is appropriately measured by discriminability, and should be a function of the reinforcement context. Our data indicate that delayed matching performance is directly related to the probability of reinforcers obtained by correct matching responses, and is inversely related to reinforcers obtained by other behaviors during the delay interval.° The influence of the reinforcement context for delayed matching was evaluated in terms of Herrnstein's (1970) rectangular hyperbola.

°

7:00 - 7:55 *Registration, Coffee and Pastries*

7:00 - 7:55 **Earlybird Breakfast Tutorial**

Randolph Grace
University of Canterbury, New Zealand
R.Grace@psyc.canterbury.ac.nz

This informal, interactive get-together-over-coffee is primarily intended for people with no quantitative background. The target audience includes both students and established researchers. You are encouraged to attend if you feel that an exposure to a few basics would make your attendance at SQAB more productive, or if you feel that you could lend your insights to help others get up and running. The session will be audience driven. It is not a prearranged lecture. Depending on your interests, it could be a question and answer dialogue or we could cover: a brief introduction to the quantitative tools which will be invoked by the subsequent speakers, an extended treatment of some particular quantitative procedure, or a discussion of analytical conundrums. This session is in keeping with the Society's strong commitment to provide support to those students and researchers interested in pursuing quantitative analyses. This tutorial is explicitly structured so that you can use it to accomplish what you need.

8:00 **The Mechanics of Reinforcement**

Peter Killeen & Lewis Bizo
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A key construct in Killeen's (1994) mechanics is the short-term memory trace. It is asserted that reinforcement strengthens whatever is in STM. On short schedules, this includes the memory of the consummatory behavior elicited by the prior reinforcer, which undermines high rates on those schedules. This memorial interpretation is tested by evaluating the rates of decay of short-term memory for colored key-lights in a dozen pigeons; those rates are correlated with the (inferred) rates of decay of memory for pecking in the same animals on ratio schedules.

8:41 **The Time Scales of Conditioning**

Valentin Dragoi
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Operant conditioning is modulation of the type and level of emitted behavior by its reinforcing or punishing consequences. Most theories of operant behavior contend that conditioning is driven by events in the recent past (local or short-term memory); a few others advocate dependence on the more remote past (global or long-term memory).° But increasing evidence suggests that neither local nor global models are adequate.° I describe here a comprehensive theory of operant conditioning, that assumes that learning is driven by both local and global processes, and then devise an experiment that tests this hypothesis. I assume that the organism compares short and long-term expectancies of reinforcement: if reinforcing conditions improve (short-term expectancy is greater than long-term expectancy) rate of operant responding increases, whereas if reinforcing conditions worsen (long-term expectancy is greater than short-term expectancy) rate of responding decreases.° A third process, which has a time scale sufficiently large to capture the entire reinforcement history, affects the learning rate and differentiates between "experienced" and "naive" organisms. These principles are implemented as a small set of nonlinear differential equations that explain numerous experimental results on acquisition, extinction, resistance to extinction, behavioral contrast, spontaneous recovery, and choice.

9:22 *Break - Refreshments*

9:37 Computational Reinforcement Learning

Richard S. Sutton
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In the past decade there has arisen a new approach to artificial intelligence inspired by and with close parallels to psychological theories. Reinforcement learning, as this approach is called, is based on computational ideas analogous to reinforcement, expectation, secondary reinforcers, stimulus traces, and mental simulation. These ideas have led to algorithms that have proven better than all others in engineering applications from computer game-playing to channel allocation in cellular radio networks. In this talk we present the key ideas that have led to the successes of reinforcement learning, highlighting their psychological roots. We also consider how reinforcement learning's debt to psychology might be repaid. Reinforcement learning provides a new computational perspective on psychological theories. Which learning strategies require the least memory, computation, and communication? What are the quantitative tradeoffs? In particular, modern reinforcement learning research suggests a central role in all learning and cognition for a "value function," a moment-to-moment expectation of future reward, with learning being driven by its moment-to-moment variations.

10:18 Complete Behavioral Models are Necessary for the Advancement of Behavioral Science

William R. Hutchison
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Economists use computerized econometric models that boldly specify how equations describing functional relations in their domain interact as a system under a wide range of conditions. Such system models not only are valuable for consumers of the science, but their formulations and predictions aid researchers in recognizing and testing theoretical questions to advance the science. This paper will describe how a computer model of an operant organism was constructed from quantitative formulations in the experimental analysis of behavior. The model can be connected to robotic sensors and actuators, but usually behaves in a computer environment designed to administer a wide range of contingencies, including explicit training programs. Data to be presented show that the model exhibits a wide range of operant phenomena up to fairly complex verbal behavior, proving that building complete systems of behavior is feasible. The software system provides an open framework that other researchers can modify to implement alternative formulations and observe the behavioral implications. Behavior analytic models will differ from related models built from biological and computational perspectives, but the points of commonality open rich sources of ideas for advancing all of the sciences involved (e.g., Sutton's paper above).

Association for Behavior Analysis Begins 11:00 AM

I hope this year's SQAB meeting served your purposes. I would like to solicit your ideas concerning potential single themes or topics; papers which would be ideal instances of the quantitative analysis of behavior; and innovative ways to best use our time at the conference. I would also like to express the Society's appreciation to each of the presenters.

Bill Palya, Program Chair
Jacksonville State University

∫QAB-Invited Preeminent Tutorials (during ABA)

The Society is committed to simplifying the transition to quantitative analyses for both advanced researchers and students. To this end, we are sponsoring tutorials given by the preeminent researcher/teachers in the field. Inexpensive video tapes for classroom use are expected to be available (see page 17).

1:00 From Basics to Contemporary Paradigms: Choice

William M. Baum, *University of New Hampshire* (wm.baum@unh.edu)
Chair: Philip N. Hineline, *Temple University* (hineline@astro.ocis.temple.edu)
Saturday 1:00-1:50 pm Southern Hemisphere I

Presentations of behavior analysis flounder most often on the issue of determinism vs free choice. Although it is in a sense deterministic, it bears no resemblance to the bogeyman of the tender-minded. Theories of choice as operant behavior do not and cannot predict behavior at moments of time. They are inherently molar, because they pertain to categories and extended units of behavior. Both the matching law and optimality theories of choice illustrate the strengths and limitations of this approach.

2:00 From Basics to Contemporary Paradigms: Signal Detection

John T. Wixted, *University of California, San Diego* (jwixted@ucsd.edu)
Chair: Marc Branch, *University of Florida* (branch@psych.ufl.edu)
Saturday 2:00-2:50 pm Southern Hemisphere I

Signal-Detection Theory (SDT) is one of the few conceptual frameworks that can shed light on behavior as diverse as pigeons remembering which keylight appeared several seconds ago to humans deciding whether or not an x-ray exhibits evidence of an anomaly. While slightly too theoretical for some, SDT is well-conceived, and it has managed to avoid the insidious evolution toward infinite complexity that plagues so many other theories. The purpose of this tutorial is to explain the basic assumptions of SDT and show that, whether or not one fully agrees with those assumptions, the theory provides a sensible and sometimes enlightening interpretation of a wide range of behavioral phenomena.

3:00 From Basics to Contemporary Paradigms: Behavioral Momentum

John A. Nevin, *University of New Hampshire (Emeritus)* (tnevin@worldnet.att.net)
Chair: Richard L. Shull, *University of North Carolina - Greensboro* (shullr@goodall.uncg.edu)
Saturday 3:00-3:50 pm Southern Hemisphere I

In the metaphor of behavioral momentum, steady-state response rate is analogous to the velocity of a physical body moving under constant conditions. When responding is disrupted, the short-term change in response rate depends directly on the magnitude of the disrupter and inversely on an aspect of behavior that is analogous to inertial mass in Newtonian mechanics. This mass-like aspect of behavior, measured as resistance to change, may be identified with the traditional psychological construct of response strength.

The tutorial will begin with examples of multiple-schedule research demonstrating that response rate and resistance to change are independent aspects of behavior, where response rate depends on response-reinforcer contingencies and resistance depends on stimulus-reinforcer relations. Data from these examples will be used to illustrate the calculation of the behavioral analog to inertial mass. Then, the metaphor will be expanded to suggest that preference in concurrent chains measures an analog to gravitational mass. Some new data on the relation between resistance and preference will be presented to illustrate convergent measurement of a single construct or state variable corresponding to the strength, value, or mass of learning that results from a history of reinforcement in the presence of a distinctive stimulus.

The tutorial will conclude with discussion of resistance to extinction, the problem of stimulus change, and the use of noncontingent reinforcement in applied settings, with special consideration of procedures that may enable newly established behavior to outweigh previous undesired behavior.

4:00 From Basics to Contemporary Paradigms: Behavioral Economics

Steven R. Hursh, *Johns Hopkins University School of Medicine and Science Applications International Corporation* (steven.r.hursh@cpmx.saic.com)
Chair: Edmund Fantino, *University of California, San Diego* (efantino@ucsd.edu)
Saturday 4:00-4:50 pm Southern Hemisphere I

The concepts of behavioral economics have proven useful for understanding the environmental control of overall levels of behavior for a variety of commodities, including reinforcement by food, water, drugs and non-nutritive saccharin solution. These general concepts are summarized for application to the analysis of factors controlling overall consumption, overall response expenditure, and choice among different commodities.° Major topics covered will be: the demand law, unit price, normalized price, elasticity of demand, the demand equation and how to use it, applications for assessment of abuse liability, choice, definitions of substitutes, complements, and independent commodities, asymmetrical interactions, comparison to the "matching law", implications for behavioral management including treatment of drug abuse, assessment of medications, and extensions for the formulation of empirically based government policy.° These concepts provide a conceptual framework for understanding key factors that can contribute to reductions in consumption and changes in choice. They also provide a basis for generalization from laboratory and clinical research to the development of novel behavioral therapies to reduce behaviors in excess and government policies to limit the illegal consumption of controlled substances.

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At a Glance

Thursday Evening, May 21 — ***The Pool Pavilion***

5:00 - 10:00+ *Registration and Cash Bar*

Friday, May 22 — ***Southern Hemisphere I***

7:00 *Registration, Coffee and Pastries*
7:30 **Breakfast Tutorial** *(Randolph Grace)*
8:35 **President's Introduction** *(John A. Nevin)*
8:45 **Michael Davison & William M. Baum**
9:26 **James S. MacDonall**
10:07 **Armando Machado**
10:48 *Break - Refreshments*
11:03 **William K. Estes**
11:44 **Discussion** *(John A. Nevin)*
12:25 *Lunch Break*
1:45 **Robert W. Allan**
2:26 **Russell M. Church**
3:07 **J. E. R. Staddon**
3:48 *Break - Refreshments*
4:03 **Ralph R. Miller & Hernan Savastano**
4:44 **John H. Wearden**
5:25 *Break*
5:30 **Business Meeting** *(John A. Nevin, President)*
6:00 **Poster Session** / *Cash Bar*
Andrzejewski; Aparicio; Gonzalez; Heinemann; Hopson; Kessel, Lucke, Palya & Walter; Kraft; Milinder; Morris; Schneider; Soto & McDowell; Uchida & Ito; White & Brown.

Saturday Morning, May 23 — ***Southern Hemisphere I***

7:00 *Coffee and Pastries*
7:00 **Breakfast Tutorial** *(Randolph Grace)*
8:00 **Peter Killeen & Lewis Bizo**
8:41 **Valentin Dragoi**
9:22 *Break - Refreshments*
9:37 **Richard S. Sutton**
10:18 **William R. Hutchison**

Saturday Afternoon, May 23 (during ABA) — ***Southern Hemisphere I***

SQAB-Invited Preeminent Tutorials - From Basics to Contemporary Paradigms:

1:00 **Choice** *(William M. Baum)*
2:00 **Signal Detection** *(John T. Wixted)*
3:00 **Behavioral Momentum** *(John A. Nevin)*
4:00 **Behavioral Economics** *(Steven R. Hursh)*