

# SQAB



Society for the Quantitative Analyses of Behavior

## Seattle



35<sup>th</sup> Annual Conference  
Sheraton Seattle, Washington  
May 24-26, 2012



The Society for the Quantitative Analyses of Behavior (SQAB) was founded in 1978 by M. L. Commons and J. A. Nevin to present symposia and publish material which bring a quantitative analysis to bear on the understanding of behavior. This International Society holds its annual meeting in conjunction with the Association for Behavior Analysis International (ABAI). Talks at SQAB focus on the development and use of mathematical formulations to: characterize one or more dimensions of an obtained data set, derive predictions to be compared with data, and generate novel data analyses.

You can retrieve more information about SQAB at our website: [www.sqab.org](http://www.sqab.org)

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Thursday Evening Reception  
and Poster Session  
5:00-8:00 pm

Abstracts for Thursday  
Poster Session begin  
on page 14

# Welcome to ∫QAB 2012

## Friday Morning:

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7:00 – 8:00 Registration, Coffee and Pastries

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8:00– 8:15 President's Introduction

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Alliston K. Reid  
*Wofford College (USA)*

## Special Section on Timing

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8:15– 8:50 Stimulus Compounding Reveals Flexible Temporal Memory Integration at Retrieval

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Matthew S. Matell

*Villanova University (USA)*

We have previously shown that rats trained in a mixed-interval peak procedure (tone = 4s, light = 12s) would respond in a scalar manner at a time in between the trained peak times when presented with the stimulus compound (Swanton & Matell, 2011). In our previous work, the two component intervals were reinforced with different probabilities to equate reinforcement density. Here, we directly examined the influence that different reinforcement probabilities have on the temporal location and shape of the compound response function. We found that the time of peak responding shifted as a function of the relative reinforcement probability of the component cues, becoming earlier as the relative likelihood of reinforcement associated with the short cue increased. However, as the relative probabilities of the component cues grew more dissimilar, the temporal control of behavior shifted from a process well characterized by integration to one of selection. As our previous work has utilized durations and reinforcement probabilities more discrepant than those used here, these data suggest that the processes underlying the integration/selection decision operate on the basis of cue value, and are thus downstream from the operations representing time and probability.

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8:50– 9:25 Timing, Remembering, and the Reinforcement Context

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K Geoffrey White

*University of Otago (New Zealand)*

Remembering and timing are discriminated operants under reinforcer control. Their common element is the passage of time. As noted by William James, however, time cannot be sensed or directly perceived, thus raising the question as to what is discriminated. Both remembering and timing involve a choice response temporally separated from an initial event, for example, the sample to be remembered in delayed matching to sample, or trial onset in the free-operant choice procedure for timing. Accurate remembering or timing is established by the conditions of reinforcement. In this paper I ask whether reinforcement effects vary with the passage of time. I summarize the effects of a range of reinforcement variables on delayed matching to sample and on timing in the free-operant choice procedure. These include the direct effects of the reinforcement contingency as well as the context established by reinforcement of extraneous behaviors. Is the effect of time mediated via changes in the reinforcement context?

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9:25 – 10:00 Break -- Refreshments

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10:00– 10:35    Timing and Choosing

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Michael Davison

*The University of Auckland (New Zealand)*

Responding differentially with respect to elapsed time requires differential reinforcement with respect to elapsed time. While such a differential may be arranged by an experimenter, the controlling variable must be what the animal obtains—and this will be a function of both the experimenter and how the animal's behavior modulates the experimenter's design. I present some data from a situation in which pigeons don't know whether the next food will be after a fixed interval on the left key, or an exponential variable interval on the right key, and model the choice data using a simple constant-CV timing model applied to obtained food rates across time. The model works well for choice over time in this situation, and also for single-fixed-interval-schedule response rates. I will argue that we need to attend rather more to obtained reinforcers the better to understand how elapsed time controls responding and choosing.

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10:35– 11:10    Relative Versus Absolute Control in the Temporal Bisection Task

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Armando Machado

*University of Minho (Portugal)*

A gray square looks darker when next to a white square than to a black square; warm water feels cold after hot water, but hot after cold water. As Wolfgang Kohler argued, perception often is relative. And time, is its perception also relative? Will a specific time interval seem different when "next" to a shorter than a longer interval? And if time perception is relative, what processes may account for it? In this talk, I will review a few studies that suggest that time discrimination in animals is relative. Then I will discuss how the same empirical findings may be explained by the Learning-to-Time (LeT) model without presupposing relative temporal control. Finally, I will present some studies to test the model's account. I conclude that, in the time domain, the difference between absolute and relational control remains rather...gray.

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**11:10– 11:50 Formal Constraints on Decision Processes in Interval Timing**

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J. Jozefowicz

*Universite Lille3-Charles de Gaulle (France) & Univeridade do Minho (Portugal)*

Models of interval timing are composed of three parts: A short-term memory representation of the time elapsed since the time-maker, a long-term representation of the time of reinforcement, and a decision process determining how those representations determine behavior. As far as the decision process is concerned, timing models can be divided into two categories: Models using cognitive decision rules (for instance, SET, MTS,...) on one hand, where behavior is determined by an explicit comparison between the representations of the temporal intervals, and models using associative decision rules (for instance, LeT, BEM,...) on the other hand, where behavior is a function of associations between time-dependent states and responses. In the present talk, I would like to show that, because of Weber's law, the choice of the decision rule heavily constrains the type of representation scheme for time in a model. More precisely, cognitive decision rules work better with a linear representation of time with scalar variability while associative decision rules work better with a logarithmic representation of time with constant variance. This suggests new ways to test current models of timing.

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**12:00 – 1:45 Lunch**

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The SQAB Executive Committee  
and Board will meet during lunch

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**1:45– 2:20 Temporal Informativeness Governs CS-US Associability**

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Ryan D. Ward

*Columbia University (USA)*

In an appetitive conditioning protocol, the onset of the conditioned stimulus (CS) provides information about when to expect reinforcement (unconditioned stimulus; US). There are two sources of information conveyed by the CS in a delay-conditioning paradigm in which the CS-US interval is fixed. The first depends on temporal informativeness, the degree to which CS onset reduces the average expected time to onset of the next US. Temporal informativeness is proportional to the ratio of the cycle time (US-US interval) to the trial time (CS-US interval). The second source of information depends only on how precisely a subject can represent a fixed-duration interval (the temporal Weber fraction). In three experiments with mice, we tested the differential impact of these two sources of information on rate of acquisition of conditioned responding (CS-US associability). In all three experiments, associability was fully determined by temporal informativeness. The increased information provided by fixing the duration of the CS had no impact on associability. These results indicate that notwithstanding the substantial increase in information provided by fixing the duration of the CS, associability is governed entirely by the average rate of reinforcement in the CS compared to the average rate of reward in the context.

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**2:20– 2:55 Is There an Informational Limit Conditioned Response Generation?**

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Douglas A. Williams

*University of Winnipeg (Canada)*

When an unconditioned stimulus (US) is delivered at a fixed time after the onset of a conditioned stimulus (CS), an anticipatory response is normally acquired at the arrival time of the US. Contrary to previously accepted research and thinking, we find random intertrial USs do not undermine timed conditioned responding. In appetitive conditioning, rats display well timed conditioned responses (CRs) even when the probability of the US during the CS is lower than during its absence. However, the nature of the CR is altered in the presence of intertrial USs. Some examples include a) slowed rates of acquisition, b) rightward shifts in peak times, c) less than expected variability, d) greater contextual control, and e) a sometimes biphasic CR (inhibitory and then excitatory). Results are discussed in relation to real-time models of conditioning.

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2:55– 3:30 Investigations of the Neural Substrate of Temporal Differentiation in the Free-Operant Psychophysical Procedure

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S. Body, T.H.C. Cheung, L. Valencia-Torres, C.M. Olarte-Sánchez, C.M. Bradshaw & E. Szabadi  
*University of Nottingham (UK)*

In the free-operant psychophysical procedure (FOPP), reinforcement is provided on a variable-interval schedule for responding on lever A in the first half, and on lever B in the latter half of a trial. Temporal differentiation is conventionally measured from the psychometric function (percent responding on B, %B, versus time from trial onset, t), the principal index of timing being T50, the value of t at which %B=50. Acute treatment with agonists of 5-hydroxytryptamine (5-HT)1A and 5-HT2A receptors and dopamine D1-like and D2-like receptors reduce T50; the effects of agonists can be reversed by selective antagonists. Evidence from indirectly-acting agonists suggests that 5-HT2A and D1 receptors principally mediated the effect of the endogenous neurotransmitters. A synaptic model is suggested to account for these findings. Fos expression (a marker for neuronal activation) is enhanced in the orbital prefrontal cortex and nucleus accumbens following performance on FOPP. Lesions of the nucleus accumbens suppress the effects of a D1-like receptor agonist of T50. These findings differ qualitatively from results obtained with other timing schedules.

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3:30 – 4:00 Break -- Refreshments

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4:00– 4:35 Timing by Coincidence Detection: What's all the Noise About?

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Catalin V. Buhusi & Sorinel Oprisan  
*Medical University of South Carolina & College of Charleston (USA)*

Interval timing is crucial for fundamental cognitive processes like decision making, rate calculation, and action planning. In the vast majority of species and behavioral and neurophysiological manipulations, interval timing is scale invariant: time-estimation errors are proportional to the estimated duration. Time-scale invariance is considered the fundamental property of interval timing, yet its origin and mechanisms are unknown, despite its ubiquity. How does such a specific property of supra-second timing emerge from neurons firing in the milliseconds range? Current behavioral models posit that time-scale invariance derives from convenient computations, rules, or coding schemes. In contrast, neurobiological models attempt to explain timing as a property of neurons and circuits. We discuss the computational properties of a simple neurobiological building block in which time is coded by the pattern of coincidental activation of its inputs, and which shows time-scale invariance.

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**4:35– 5:10 Drift-Diffusion Models of Adaptive Interval Timing Behaviours**

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Francois Rivest, Andre Luzardo, & Elliot Ludvig

*Royal Military College of Canada  
Champalimaud Neuroscience Program (Portugal)  
Princeton University (USA)*

Animals can readily learn the timing between consecutive events. They can even rapidly adapt their response times when exposed to sequences of changing intervals. For example, on some cyclic-interval schedules, animals are presented blocks of trials with one delay, alternating with blocks of trials with a second delay. In this situation, animals adapt their responding to the change in delay within a single trial. Recently, drift-diffusion models (DDM) have been successfully adapted as models of interval timing. DDMs are simple linear, noisy, and bounded accumulators, which have frequently been used for modeling decision-making processes. These DDMs have been shown to reproduce Weber's law for time by adjusting their integration rate (or slope) to learn the time intervals. In this presentation, we show how DDMs can learn either the mean of observed intervals or the reinforcement rate within a fixed number of trials, independent of the timescale of these intervals. We compare DDMs to the multiple-time-scale (MTS) habituation model of interval timing on a number of dynamic timing tasks. We evaluate how well DDMs match the empirical data as well as some novel extensions to more complex situations.



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**5:30- 6:00 Business Meeting - All SQAB members are welcome**

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**6:30–9:00 2<sup>nd</sup> Poster Session / Cash Bar (Abstracts begin page 25)**

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7:30 – 8:30 Registration, Coffee, Pastries

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8:30– 9:05 Dopamine Receptors and the Behavioral Economics of Food Consumption

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Paul L. Soto, Steven R. Hursh, Ming Xu, David K. Grandy, Jonathan L. Katz

*Johns Hopkins University, University of Chicago, Oregon Health and Science University, National Institute on Drug Abuse (USA)*

Dopamine receptors play an important role in reinforcement processes however the precise roles played by different dopamine receptor subtypes are not known. Previous research demonstrated that within an open economy demand curves for food were steeper (i.e., more elastic) for mice lacking dopamine D2 receptors (D2 receptor knockout mice) compared to wild-type (WT) littermates suggesting a role of D2 receptors in the reinforcing effectiveness of food. In recent work, demand for food was assessed using behavioral economic analyses in D2, D3, and D4 receptor knockout (KO) mice under both closed and open economy conditions. Demand curves for D2 KO mice were more elastic than demand curves for D2 WT mice within both open and closed economies. Demand curves for D3 and D4 KO mice did not differ from demand curves obtained in their littermate counterparts. The present findings replicate and extend previous results and indicate that the role of D2 receptors in the reinforcing effectiveness operates in both open and closed economies, and that the role is specific to the D2 subtype of dopamine receptors, as D3 and D4 receptors were not involved in the reinforcing effectiveness of food

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9:05– 9:40 Temporal and Probability Discounting by Humans: Theory and Translation

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Todd L. McKerchar, Leonard Green, and Joel Myerson

*Jacksonville State University & Washington University (USA)*

The discounting of delayed outcomes is well described by a hyperboloid discounting function, a generalized version of the simple hyperbola that incorporates psychophysical scaling principles. The exponent is derived from the assumption that a power function describes the relation between the objective and subjective magnitude of a stimulus (e.g., delay, amount). Importantly, the hyperboloid model addresses key theoretical questions concerning similarities and differences between delay and probability discounting in humans. First, the discount rate parameter of the hyperboloid decreases as amount of delayed reward increases, whereas in contrast, changes in amount of a probabilistic reward have no systematic effect on the rate parameter. Second, with delay discounting, the scaling parameter is frequently less than unity and is relatively insensitive to changes in reward amount, whereas with probability discounting, the scaling parameter is not insensitive to reward amount and tends to increase with amount. These findings challenge a single-process account of discounting and call into question formulations of probability discounting that assume psychophysical scaling of reward likelihood, which has implications for how we both conceptualize and treat impulsive and risky behavior.

9:40 – 10:00 Break -- Refreshments

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10:00 Panel Discussion

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Michael Davison     *The University of Auckland, New Zealand*  
J. Jozefowicz       *Universite Lille3-Charles de Gaulle, France & Univeritade do Minho, Portugal*  
Armando Machado    *University of Minho, Portugal*  
Ryan D. Ward        *Columbia University*

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10:35 Joseph V. Brady Impactful Research Award

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Gregory Madden  
*Utah State University (USA)*

Awardees: Bryan A Jones & Howard Rachlin

The award is given to the authors of the JEAB paper published three-years prior that garnered more citations than any other paper published that year. The award is sponsored by the Society for the Experimental Analysis of Behavior. Drs. Jones and Rachlin's paper was titled "Delay, Probability, and Social Discounting in a Public Goods Game"

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10:45 SQAB 2011 Closing Remarks

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Alliston Reid  
*Wofford College (USA)*



SQAB Preeminent Tutorials will be held in **Rm. 608 Convention Center** as part of the annual meeting of the *Association for Behavior Analysis International*



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### 1:00– 1:50 An Invitation to Probability With Spreadsheet Simulations

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Armando Machado  
*University of Minho (Portugal)*

In this tutorial I will review some fundamental ideas concerning the theory of probability. I will concentrate on the Poisson, Exponential, and Gamma random variables, review their properties, show how they are interrelated, illustrate their uses in modelling behaviour and learning, and simulate them in a spreadsheet. I will conclude with some notes concerning the Poisson Process and apply it timing and concurrent choice.

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### 2:00– 2:50 Behavioral Models of Conditional Discrimination: Detection and Matching to Sample

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John A. (Tony) Nevin  
*University of New Hampshire (USA)*

Quantitative models of conditional discrimination performance, based on well-established behavioral processes such as matching to relative reinforcement, effects of reinforcement on resistance to change, and stimulus generalization, can account for many findings of studies with nonhuman animals in signal-detection and matching-to-sample paradigms. This tutorial will provide a guided tour of these models as they have developed since 1978, explain their quantitative structures, and discuss their strengths and limitations in their confrontation with systematic data sets. The models to be discussed will be available as spreadsheets so that students and researchers can explore their properties and apply them to their own data.

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3:00– 3:50 A Behavioral Analysis of Altruism

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Howard Rachlin

*State University of New York at Stony Brook (USA)*

Altruistic acts may have been defined as costly acts that confer economic benefits on others. (in behavioral terms: punished acts that reward others.) In prisoner's dilemma games, with human players, a significant number of players behave altruistically; their behavior benefits each of the other players but is costly to them. I propose that such altruism is based on a straightforward balancing of undiscounted costs to themselves against discounted benefits to others (social discounting). I will describe two experiments, using prisoner's dilemma games, that test this explanation of altruism. In one experiment, costs were held constant but the number of others (benefiting from cooperation) varied. In another experiment, with only two players, costs were again constant but the amount of other player's benefit varied directly. In both experiments, cooperation increased as benefits to the other player(s) increased.

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4:00– 4:50 Pavlovian Conditioning: It Is Not About the CR But About Modification of a Biobehavioral System

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Michael Domjan

*The University of Texas at Austin (USA)*

Pavlovian conditioning is typically thought of in terms of the common example of a dog salivating to a cue that occurs reliably before the delivery of meat powder. Conditioned salivation (the conditioned response or CR) was viewed as reflecting an association of the cue and the meat powder, and Pavlovian conditioning became a favorite method of scientists whose primary interest was to elucidate the mechanisms of association learning. Investigators worked hard to find situations in which the conditioned response was convenient to measure and occurred reliably. They then focused on identifying experimental conditions which would predictably increase or decrease the target CR. I will argue that this focus on a target conditioned response misses the broader biological significance of Pavlovian conditioning, which is to enable organisms to interact more effectively with significant biological events or unconditioned stimuli (USs). The broader perspective suggests that Pavlovian conditioning produces a wide range of behavioral and physiological adjustments that enable the organism not only to better prepare for the impending occurrence of the unconditioned stimulus but to also deal with the US more effectively at both the behavioral and physiological level. Thus, Pavlovian conditioning produces a reorganization of the biobehavioral system that is activated by the US. This broader perspective will be illustrated with examples from appetitive, aversive, and sexual conditioning.

**1) Finding the Target as a Reinforcer of Saccadic Amplitude Variability in a Visual Search Task**

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Celine Paeye, Laurent Madelain  
*Laboratoire URECA Université Lille (FR)*

We recently showed that part of saccadic amplitude variability may be controlled by operant learning using an arbitrary tone as a reinforcer. We designed a new paradigm involving a visual search task to test whether finding a target among distractors could also be effective to reinforce various saccadic amplitude variability levels. In two successive experimental conditions, the target was visible only after saccades of rare amplitude (to increase variability) and then after saccades of frequent amplitude (to decrease variability).  $U$  values, or 'uncertainty', increased from a baseline of 0.57 on average to 0.86 and then returned to 0.51. This shows that seeing the target is a consequence controlling saccadic properties and further confirms that reinforcement can guide saccadic amplitude variability.

**2) Fixed Interval Schedules and the Temporal Control of Behavior.**

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João Claudio Todorov, Lucas C. Carvalho, Kalliu C. Couto, Gleidson G. Cruz  
*Universidade de Brasília (BR), Centro Universitário IESB (BR), Instituto Walden (BR)*

In single FI schedules the interval begins with the last primary reinforcement and the first response after a given period is followed by primary reinforcement. In chained and in concurrent chained schedules the FI may begin or end with conditioned reinforcement. In previous experiments with chain FR n FI 60s (the interval begins after a conditioned reinforcer) pauses after primary reinforcement (first component) increased with increases in FR requirement, but FI pauses (second component) were atypical or nonexistent. The present work shows that pauses in chained FR 5 FI t-s tended to be a constant percentage of FI length. Results are interpreted as the primacy of time since the last primary reinforcer over discriminative stimuli associated with the FI schedule.

**3) The effect of Relational Training on Slot machine play: Walking the Walk as Opposed to Just Talking the Talk.**

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Gordon Tan, Maree Hunt, Anne Macaskill, David Harper  
*Victoria University of Wellington (NZ)*

A systematic replication of Dixon, Nastally, Jackson and Habib (2009) was carried out to further examine the role of relational framing in attaching meaning to near win stimuli in a slot machine simulation. The original study found that the verbally reported meaning of near win stimuli could be altered through a stimulus equivalence training procedure. Our systematic replication confirmed this finding. Additionally we had participants play on a simulated slot machine to assess if such verbal changes also resulted in a functional change when they were presented with near win outcomes during play. We found that nonverbal responses to near win stimuli were not influenced by the relational training.

**4) Economic Prudence: Savings as a Function of Income Cycles**

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Ana Carolina T Franceschini  
*University of Sao Paulo (BR)*

In Economics, if income amount is above its previous historic peak, it is called Seasonal, if below it is Cyclical income. According to the Economic theory, savings occurring during cyclical periods, called precautionary, is controlled by the reduction of income uncertainty (negative reinforcement) and its reinforcement value is determined by Prudence (motivational operation). Economic prudence was reproduced in a six-session betting game. 24 undergraduate students would bet and earn poker chips, and could deposit part of their chips (individual income) in a savings box. Once deposited, these chips could neither be betted nor lost, mimicking precautionary savings. All deposits occurred during cyclical periods and the reinforcement value of precautionary savings seems to have changed as a function of income variations.

**5) An Affordance Analysis of Lever Pressing in Rats and Hamsters: The Operant Level Revisited**

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Felipe Cabrera, Federico Sanabria, Ángel A. Jiménez, Pablo Covarrubias  
*Universidad de Guadalajara -CUCI (MX), Arizona State University (USA)*

Two experiments were conducted to assess the effect of lever height on operant level responding. Two rodent species (rats and hamsters) served as subjects aiming to compare the behavioral support offered by one lever at various heights relative to the subjects' body size. Results showed that the rate of lever pressing varied similarly for rats and hamsters as a function of lever height relative to body-size. The distribution of inter-response times showed that lever pressing was organized in bouts. This pattern of responding was accurately described by a mixture of two exponential distributions. These findings support an experimental analysis of affordances and highlight the importance of revisiting the operant-level analysis within the ecological framework that the behavioral systems theory provides.

**6) Tolerance to Cocaine after Chronic Administration of a Behaviorally Inactive Dose**

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Vanessa Minervini, Marc N. Branch  
*University of Florida (USA)*

Effects of a series of cocaine doses on pigeons' response rates in a 3-component multiple fixed-ratio schedule before, during, and after chronic administration were assessed. The largest dose that failed to decrease responding acutely was administered chronically. All subjects developed tolerance to doses that had initially caused large rate decreases. The data were fit to monotonic, decreasing logistic dose-response functions, and ED50s were obtained for each fixed-ratio parameter across conditions. Acute ED50s and those obtained after withdrawal were lower than chronic ED50s. Differences in ED50s were related to FR parameter, with tolerance being greater as FR value decreased.

**7) Priming Political Identity Influences Temporal and Social Discounting Rates Associated with Effects of Environmental Disasters**

Derek D. Reed, Brent A. Kaplan  
*University of Kansas (USA)*

The effects of priming have been documented in the social psychology literature. Recent studies (Morris, Carranza, & Fox, 2008) have demonstrated that risky financial decisions – similar to discounting tasks – may be reversed in conservative participants when shown pictures associated with their political identity prior to the decision making event. The goal of this study was to evaluate the effects of such political identity priming in the context of delay and social discounting associated with an environmental disaster. Results indicate significant idiosyncratic effects of priming in self-identified politically conservative, liberal, and independent college students. Interestingly, these effects were congruent with stereotypes concerning each political identity. A relational frame theory perspective is offered as a potential explanation for these results.

**8) Free Birds: Relations between Individual and Group Behavior in a Free-Ranging Social Environment**

Ruby Larisch, Greg Wilkinson, Tim Hackenberg  
*Reed College (USA)*

Five pigeons responded on concurrent variable-interval schedules of food delivery, first in individual operant chambers, and second in an indoor flight cage where all pigeons were housed together continuously and could interact with a single apparatus at any time. Relative response and reinforcement rates for each condition, as well as percent change in response and reinforcement rates between conditions, were recorded for individuals and the group. Sensitivity to schedule change was found in both settings but was somewhat better in the free-ranging social environment. The order found in group aggregate data reflected individual performance in both environments. Further implications of this new method are currently being explored, including social dominance hierarchies and interaction of mating pairs during foraging.

**9) Discounting Environmental Outcomes: Temporal and Probabilistic Gains and Losses**

Scott A. Suggs, Todd L. McKerchar  
*Jacksonville State University (USA)*

Nineteen participants made repeated choices between a smaller/immediate and larger/later change (improvement or worsening) in local air quality as well as between a smaller/certain and larger/uncertain change in air quality. Air quality amounts were expressed as numeric values of the Air Quality Index, a ratio scale developed by the EPA that quantifies the density of air particulate matter (e.g., pollution). The rate of discounting delayed environmental gains and losses did not differ significantly. In contrast, probabilistic environmental gains were discounted significantly and substantially more than probabilistic environmental losses. A hyperboloid accurately described the discounting of temporal and probabilistic environmental gains and losses (median R-square > .93).

**10) Effect of a Single Free food Presentation on Extinction Responding**

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Adam J. Reiss, Matthew C. Bell  
*Santa Clara University (USA)*

Using a two-component multiple schedule, we examined differences in pigeons' extinction responding resulting from a single response-independent food presentation occurring at the beginning of the experimental session (30-s before the first component). One component presented reinforcement according to a VI 45-s schedule and the second presented reinforcement according to a VI 180-s schedule. After baseline training we extinguished responding. We systematically manipulated the presence or absence of the single free food presentation across conditions and found that the free food presentation appeared to increase resistance to change in the VI 180-s component compared to conditions where the additional food presentation was absent. We did not see this effect in the VI 45-s component.

**11) Inter-Trial Delays in an Experiential Discounting Task**

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Anna Greenhow, Maree J. Hunt, David N. Harper  
*Victoria University of Wellington (NZ)*

In standard experimental discounting tasks participants are given hypothetical choices between two alternatives that differ in amount and delay. Typically the procedure uses a concurrent chain with an adjusting delay so that the number of choices possible remains constant and independent of the alternative chosen. This models the effect of some but not all impulsive behaviour. The current study examined the effect of the adjusting delay on rate of discounting in an experiential discounting task. University students completed one of four versions of the same task. Neither measures of fit to discounting functions nor discounting rates differed between conditions. However, more participants were excluded from the adjusting condition based on Johnson and Bickel (2008) exclusion criteria.

**12) The Development of the Anorexia Based Activity Decreases Responding Reinforced by Food in a Progressive Ratio Schedule**

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Angeles Perez-Padilla  
*UNED (Spain)*

Naive female Wistar rats were trained to press the lever to obtain food reinforcer according to a progressive ratio (PR) schedule (Richardson & Roberts, 1996; Barr & Phillips, 1999). When animals developed stable patterns of operant lever pressing, an activity-based anorexia procedure was introduced. The present study showed as a moderate and excessive running activity could reduce the reinforcing effectiveness of food on a progressive ratio schedule with animals in a restricted food presentation over fixed 22 hours wheel activity periods of time along the 24 hours cycles. Each yoked-control animal was maintained by food intake control with the same percentage of normal body-weight reduction that the experimental animal and in absence of a running wheel.

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**13) The Conditioned Value of Stimuli that Signal Wins Control Response Rate in a Pigeon Slot Machine Analogue with Near Wins**

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Nathaniel Rice, Elizabeth Kyonka

*West Virginia University (USA)*

Three pigeons responded in a procedure where keys were lighted red or green following pecks in a 3-peck sequence. Three red lights signaled a win and three green lights signaled a loss. Two red lights followed by a green light was a “near win.” A white “collect” key was illuminated after each sequence; food delivery on winning trials was contingent on a peck to that key. The proportion of near win trials was varied across conditions. Collect key response rate was a monotonically increasing function of the number of red lights presented in the trial, but did not differ as a function of the proportion of near win trials. Thus, the near win effect may be attributable to conditioned reinforcement.

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**14) Group and Individual Choice in a Dynamic Social Environment**

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Frank Sosa, Donald Berg, Dawniris Eversz, Eric Talbot, Lavinia Tan, Timothy Hackenberg

*Reed College (USA)*

Five rats were studied in a social foraging environment with two feeders that delivered food pellets at different amount ratios. Five ratios (1:1, 2:1, 1:2, 8:1, and 1:8) alternated unpredictably every 5-min in each 25-min session. Consistent with the ideal free distribution, the relative distribution of rats at the two feeding stations roughly matched the relative amount of food delivery at the feeding stations ( $R^2 = 0.68$ , Sensitivity= .51). Consistent with the generalized matching law, the time spent by individual rats at the two feeders roughly matched the relative amount of food obtained by those rats ( $R^2 = 0.69$ , sensitivity ranges from .49 to .73). The results show the complementarity of the two models at different levels of analysis.

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**15) Methamphetamine Differentially Affects Behavioral Output in Two Discounting Tasks Dissociating Delay and Magnitude.**

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Travis M. Moschak, Suzanne H. Mitchell

*Oregon Health and Science University (USA)*

Understanding the individual contributions of delay and reinforcer magnitude to delay discounting is an important step in determining the way that manipulations act in delay discounting tasks. In this study, the effects of methamphetamine were examined on rats trained in two adjusting tasks separating the role of delay and reinforcer magnitude. Methamphetamine affected indifference points, reaction times, and extraneous nose pokes differentially for each task, while it increased extraneous lever responding in both tasks. This suggests that methamphetamine’s effects on delay discounting may include changes in sensitivity to reinforcer magnitude, sensitivity to delay, and behavioral effects unrelated to these two processes.

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**16) Instructional Versus Schedule Control: A Translational Investigation of Verbal History Effects on Rule Adherence in Situations of Diminishing Returns**

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Jonathan Miller, Florence DiGennaro Reed, Jason Hirst, Derek Reed, Brent Kaplan  
*University of Kansas (USA)*

Hackenberg and Joker (1994) demonstrated with typical adult humans that rules interfered with optimal responding when contingencies of reinforcement differed from those stated by the rules, but as the disparity between instructed and optimal patterns of behavior increased, participants' responding came under control of programmed reinforcement contingencies. We sought to extend these findings by examining the effects of specific words in the instructions provided to two groups of participants. We provided instructions about the pattern of responding that were either directive ("you must") or nondirective ("you might consider"). Results showed that instruction type influenced response patterns across changing contingencies, in that the directive group showed greater adherence to the rule than the nondirective group when rule-following was not advantageous.

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**17) Lasting Effects of Exponentially Increasing Outcomes: Learning Self Control in a Video Game**

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Jillian Rung, Dr. Michael Young, Dr. Eric Jacobs  
*Southern Illinois University-Carbondale (USA)*

The present study examined lasting effects of exposure to reinforcement that increased in magnitude as a function of time between responses in a first-person shooter video game. When reinforcer magnitude grew exponentially, it encouraged participants to wait longer between responses (shots of a weapon) because firing quickly decreased overall damage and thus lengthened game play. Participants initially trained under such contingencies waited significantly longer to fire their weapons than participants who were trained under linear growth, where long inter-response times were not differentially reinforced. When the disincentive to fire quickly was removed, those with experience in conditions where reinforcement increased exponentially showed persistently longer wait times.

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**18) Reliability of the Sexual Discounting Task in Cocaine-Dependent Individuals**

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Matthew W. Johnson, Natalie R. Bruner  
*Johns Hopkins University School of Medicine (USA)*

To examine the contribution of delay discounting to HIV sexual risk behavior, the Sexual Discounting Task (SDT) assesses preference for unprotected sex now vs. delayed sex with a condom under hypothetical scenarios. A prior study in cocaine-dependent individuals showed the SDT results in systematic data that were significantly associated with self-reported sexual risk behavior. The present study determined the test-retest reliability of the SDT. Cocaine-dependent individuals (n=31) completed the task on two lab visits approximately 7 days apart. Discounting (area under the curve) at the two sessions were positive and significant for all conditions, and discounting did not statistically differ between sessions. Results suggest the SDT to be a reliable measure, supporting its further examination in clinical research.

**19) The Effects of Fear on Clock Processes in Human Timing**

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Erich K. Grommet, Nancy S. Hemmes, Yuliya Ochakovskaya, Paulina Kaczmarczyk, Bruce L. Brown  
*Queens College and The Graduate Center CUNY (USA)*

Fear-evoking and neutral pictures were presented in the temporal-bisection task to replicate Grommet et al. (2011), who observed an effect of emotion with no emotion x duration range interaction. The present procedure used more widely spaced duration ranges, similar to those of Droit-Volet et al. (2010), who observed an emotion x duration range interaction. The extent to which subjective duration of fear pictures was overestimated relative to neutral pictures increased with duration range between the most widely-spaced duration ranges. These results suggest that the difference in observed effects between Grommet et al. and Droit-Volet et al. was due, in part, to differences in magnitude of the spacing of duration ranges, and that fear effects are mediated by an arousal mechanism.

**20) Timing Behavior with High-Frequency Auditory Stimuli**

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Sebastian Reyes, Arturo Bouzas, Vladimir Orduña  
*Universidad Nacional Autonoma de Mexico (MX)*

Three groups of rats were exposed to a fixed-interval peak procedure in which half of the trials were signaled by a light over the response lever and the other half by a tone. The difference among the groups was the frequency of the tone, 2.9 Khz, 8 Khz, or 25 Khz. After 60 sessions of acquisition, subjects experienced 15 sessions in the GAP procedure. The performance in both procedures was analyzed with trial by trial techniques and with the adjustment of a Gaussian function. Measures of timing behavior were not affected by either, the modality of the stimuli or the frequency of the tone. The change in peak time in the gap procedure was also not affected by these variables

**21) Assessing the Nature of Control Across a Clock Fixed Interval Schedule**

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SuPhronia Guinn, Rusty Nall, William Palya  
*Jacksonville State University (USA)*

Two 4-ply multiple schedules were used to examine the distribution of behavior across a clocked fixed-time schedule. From a cognitive perspective, the behavior would be following temporal signposts across the interfood interval. Concomitant variable intervals were used to provide a summation test of the type of control in each of the eleven bins. Experiment 1 used a tone and Experiment 2 used the illumination of a right or left side key light. This aspect of the procedure provided a way of assessing the impact of competing behavior directed at the multiple schedule stimuli. The results indicated that the terminal behavior (designated Bmax in Palya's bipolar model) was qualitatively different from the behavior to the initial stimuli (designated Bmin).

**22) Performance Under an Adjusting Delay Schedule: Further Observations with a Power Spectrum Analysis**

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Lourdes Valencia-Torres, Cristian Olarte-Sánchez, Christopher Bradshaw, Elemer Szabadi  
*University of Nottingham (UK)*

This experiment examined the pattern of oscillation of the adjusting delay to the larger reinforcer (dB) in an adjusting-delay schedule using a power spectrum analysis. The step-size in which dB increased or decreased was tested across two conditions. In Condition 1, dB increased or decreased (according to the rats' choice) by 20% from block n to block n+1. In Condition 2, the step size was 10%. The power spectrum analysis showed that the period of oscillation of the dominant frequency of the spectrum was significantly longer under Condition 2 than under Condition 1. There was a consistent trend for the power of oscillation to be higher in the initial segment of the experiment in both conditions.

**23) A Comparison of the Effects of Static and Dynamic Rates of Reinforcement on Resistance to Extinction**

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Andrew R. Craig, Timothy A. Shaham  
*Utah State University (USA)*

Behavioral momentum theory states that resistance to extinction is a function of the overall reinforcement rate delivered in a stimulus context. This relation has been demonstrated using static reinforcement rates in multiple schedules. The present experiment compared the effects of static and dynamic reinforcement rates on resistance to extinction. Pigeons pecked keys for food in a two-component multiple VI schedule. One component delivered constant reinforcement rates and the other delivered rates that changed both between and within sessions. Average reinforcement rates were the same between components. Resistance to extinction was undifferentiated between the multiple-schedule components. These findings suggest that resistance to extinction in multiple schedules is a function of overall rate of reinforcement regardless of variability in session-by-session rates.

**24) Discounting of Combined Delayed and Probabilistic Outcomes**

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Daniel D. Holt, Bryan K. Saville, Lisa L. Harootunian, Allen K. Porter, Nicole E. Wall  
*James Madison University (USA)*

Research has found separate processes appear to account for discounting of delayed and probabilistic outcomes. In the present study, participants completed separate delay, probability, and combined delay and probability tasks. The hyperboloid function provided a good description of data from the delay and the probability tasks and provided a good description of data from the combined task, but only when done in a step-wise fashion. That is, once we took into account the subjective value, as determined by the typical probability discounting task, the remaining value was discounted as a function of delay. A generalized version of a discount function is suggested to account for the discounting of outcomes that are both uncertain and delayed.

## 25) How Many Elements Define a Category?

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Alba Cruz, R. Emmanuel Trujano

*Universidad Nacional Autónoma de México (MX)*

Soto and Wasserman's model of error-driven categorization by common elements assumes that organisms categorize stimuli relying on a small number of frequent elements common to all members. The purpose of this experiment was to explore how many elements are sufficient to learn a category. Human participants were trained to classify 10 stimuli composed by five binary elements in one of two categories relying on the presence of either 1, 2, 3, 4 or 5 elements across all stimuli, followed by a transfer phase in which 22 new stimuli were introduced. Results show that if humans are trained to rely on 3 elements, categorization accuracy decreases below chance, so 2 elements are sufficient to categorize new stimuli.

## 26) Modeling Preference Using a Logistic Regression with Generalized Linear Mixed Effects Modeling

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Travis Smith, Eric Jacobs, Michael Young

*Southern Illinois University Carbondale (USA)*

A model comparison between the generalized matching law and a logistic regression, using a generalized linear mixed effect model, is explored. The logistic regression model predicts the probability of a response as a function of the cumulative obtained proportion of reinforcement produced by that response. One benefit of the logistic regression is that it allows each individual response to equally inform the model fit, rather than basing the model on steady-state aggregated response ratios. This allows for a model fit with a higher resolution of analysis and allows for fast and easy tests of interactions with other variables. The model comparison will be accomplished using simulated and real data.

## 27) Temporal Learning Transference: Effects of the Differential Signaling of Duration

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Marina Menez, Sarahí Gallardo, Florente López

*Universidad Nacional Autónoma de México (MX)*

Temporal learning transference from fixed time to fixed interval schedules has been extensively reported (López & Menez, 2005; 2012). Findings suggest response-to-response transference as the mechanism involved because the initial lever-press response pattern in the testing phase (FI schedule), resembled the terminal head-entry response pattern in the training phase (FT schedule). This experiment evaluated the possible contribution of characteristics of the temporal marker to this transference. Groups of rats were exposed to differentially signaled training and testing phase and compared with their counterparts exposed to phases signaled by the same stimulus. Parameters of exponential fittings to quarter life indexes were compared in order to determine whether differential signaling of duration affected the trajectory or velocity of the temporal learning transference.

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**28) A Change-Point Approach to Response-Bout Analysis Using Simulated and Real Data Sets**

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Daniel J. Hoffman, M. Christopher Newland

*Auburn University (USA)*

According to conventional response-bout models, behavior is generated by a stationary Poisson process with a constant bout-termination probability, resulting in bi-exponentially distributed inter-response times (IRTs), and exponentially distributed bout lengths. These assumptions are unreasonable for behavior in transition and when muscle fatigue, habituation, or satiation influence behavior. We evaluated the utility of a non-parametric method of partitioning behavior using a change-point (CP) analysis. The two approaches were compared on high-rate operant data, and data simulated from biexponential and bilognormal distributions. The CP method provided good estimates of values for both simulated data sets. The behavioral data showed clear departures from exponentiality. Our results support the utility of the change-point for bout analysis regardless of whether the Poisson assumptions hold.

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**29) Assessing the Independence and Resistance to Change of Response Rate and Accuracy Measures in an Incremental Repeated Acquisition Procedure.**

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Jordan M. Bailey, Blake A. Hutsell, M. Christopher Newland

*Auburn University (USA)*

In an incremental repeated acquisition procedure (IRA) a steady state of acquisition can be examined within-subjects by requiring the acquisition of novel response sequences ('learning' component), and by requiring the execution of a previously learned response sequence ('performance' component). IRA procedures are used to assess the effects of drug-challenges and neurotoxicant-exposure on learning where, sometimes, putative measures of response strength (rate and accuracy) co-vary. Here, we assessed the degree to which different disruptors (e.g., increasing response effort, pre-session feeding and extinction) affect rate and accuracy measures independently. Increasing response effort and pre-session feeding made responding more efficient during both components. That is, the rate of producing incorrect chains was reduced independent of maximum chain length completed in a session.

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**30) Effects of d-Amphetamine on Interval Timing in Mice: A Comparison of Peak Trial Responding in Multiple and Concurrent Schedule Contexts.**

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Blake A. Hutsell, Daniel J. Hoffman, M. Christopher Newland

*Auburn University (USA)*

Recent research has demonstrated that the effects of dopaminergic drugs may selectively affect timing of one interval when subjects are required to time multiple intervals simultaneously. The present study assessed the effects of d-amphetamine on responding maintained by fixed interval 2-s and 8-s schedules. Across conditions, the intervals were presented in multiple and mixed, concurrent schedules, respectively. The effects of d-amphetamine (0.1 – 3.0 mg/kg) were examined on performance in both schedules. Single-trials analyses revealed that d-amphetamine selectively affected measures of timing at the long response alternative. Specifically, d-amphetamine disrupted timing by increasing the mean and variance of stop times on the long response alternative. The lack of covariation across intervals under drug conditions is inconsistent with a dopamine-dependent timer.

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**31) Reinforcement of Eye Gaze to Expand Stimulus Control in Children with Autism**

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Stéphanie Cousin, Vinca Rivière, Jean-Claude Darcheville.

*Lille University (FR)*

The goal of our study was (1) to assess restricted stimulus control in autistic children in a simple simultaneous discrimination task involving facial expressions, and (2) to see if reinforcing eye gazes towards the relevant parts of the face would broaden stimulus control. Three 3 years old autistic subjects had to discriminate facial expressions displayed either by the eyes and mouth, the eyes alone or the mouth alone. Results showed that one subject displayed typical stimulus control and two subjects displayed restricted stimulus control. For these 2 subjects, a training phase where looking at the relevant parts of the face was synchronously reinforced was implemented. Subsequently, improvements in the discrimination task, although not immediate, were observed for the two subjects.

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**32) The Effect of Cloning in the Evolutionary Algorithm on Concurrent Schedule Performance**

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Nick Calvin, Andrei Popa, Jack J McDowell

*Emory University (USA)*

In 2004 the Evolutionary Algorithm was proposed as a Theory of behavior dynamics (McDowell). The theory uses Darwinian principles of selection, recombination, and mutation on a population of potential behaviors. The behavior generated using this algorithm is congruent with the behavior of live organisms in single (McDowell, 2004) and concurrent schedules (McDowell et al., 2008). A neural model of selection by consequences, Neural Darwinism, was proposed by Edelman (1978). Although similar in many regards, the Edelman model does not have a method of recombination (McDowell, 2010). This project assessed whether the Evolutionary Algorithm can generate behavior similar to live organism when recombination is replaced with cloning. Cloning reduced the area of agreement of the theory with live organisms.

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**33) Stereo-Selective Behavioral Effects of the Kappa Opioid Agonist U-50488**

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Amon Manekul, Rodney Clark

*Allegheny College (USA)*

The purpose of the present investigation was to determine the behavioral effects of the enantiomers of U-50488. Rats were trained on under a Mult. FI 90\ \\", FR 10 schedule of water presentation. (+/-)U-50488 produced slight increases at an intermediate dose and all responding was suppressed under the FI schedule. (-) U-50488 suppressed responding under the FR but slightly elevated responding under the FI. The (+)U-50488 suppressed responding at the lowest and highest doses under both schedules.

# End First Poster Session



### 1) Volume Under the Surface: A Three-Dimensional Analogue to Area Under the Curve

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Richard W. Hennigan, Darlene E. Crone-Todd  
*Salem State University - Department of Psychology (USA)*

We construct a method for measuring discounting with more than one independent variable by extending the often used measure of area under the curve into higher dimensions. This method focuses on the three dimensional model, which uses two independent variables, such as magnitude and delay, and describes an algorithm which constructs a surface mesh from measured data. This surface mesh represents the implicit function described by the data and makes no assumptions about theoretical functions which are used to model discounting. The algorithm includes a method for calculating the surface integral in order to give us the total volume under the curve, providing a single-subject measure of total relative discounting.

### 2) The Temporal Context for the Sunk-Time Effect

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Paula Magalhães, K. Geoffrey White  
*University of Otago New Zealand (NZ)*

Sunk Time effect is persistence in a non-preferred option owing to prior investment in that option. By varying intertrial interval (ITI) duration we examined the effect of temporal context on the Sunk Time effect. Pigeons choose between two concurrently available keys -- two Fixed-Interval requirements were arranged on one key, and an escape option on a second (cf Navarro & Fantino, 2005). In this experiment, responses in the long interval were never reinforced. Increasing the duration of the ITI should increase the probability of escape from the long non-reinforced trial, if escaping increases the temporal proximity of the next trial. The effect of ITI, however, seems to depend on the duration of the fixed-interval schedules.

### 3) The Magnitude Effect Contributes to Preference Reversal

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Emma Beeby, K Geoffrey White  
*University of Otago (NZ)*

We show that the magnitude effect contributes to preference reversal. In our experiment, pigeons worked in a concurrent chains schedule to choose between outcomes differing in delay and amount. For a choice between 1-s and 4.5-s rewards, and with overall short delays to reward, the pigeons preferred the smaller-sooner reward. But when delays were increased by 10-s, they reversed their preference to the larger later reward. Sensitivity of choice to variations in the ratio of rewards, including 2- versus 3.5-s reward, increased with increases in overall delay to reward. This interaction between delay and amount was predicted by discounting functions that assumed an inverse relation between rate of discounting and reward amount, that is, the magnitude effect.

#### 4) Neural Basis of Associative Learning

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Susana Maia, Jeremie Jozefowicz.

*University of Minho (PT) and University Lille Nord de France (FR).*

We used magnetoencephalographic recording techniques to investigate brain areas involved in associative learning. Participants were exposed to a variant of Crump et al. (2007)'s streamed trial procedure: They were presented with 100-ms stimuli and had to judge the contingency between a target cue and an outcome, while their brain activity was recorded. The contingency between the target cue and the outcome was manipulated by changing the probability between them while keeping constant the probability between a companion cue and the outcome. Behavioral results show that subjects' ratings were sensitive to the contingencies. Preliminary analysis of the MEG data revealed brain areas specifically sensitive to the manipulation of the contingency between the target cue and the outcome.

#### 5) Psychophysics of Associative Learning

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Susana Maia, Jeremie Jozefowicz

*University of Minho (PT) and University Lille Nord de France (FR).*

We studied the psychophysics of associative learning. Participants were exposed to streams of 100-ms stimuli, had to judge the contingency between a target cue and an outcome, and to indicate how confident they were in their judgment. The contingency varied from a strong negative to a strong positive one. We assumed that a stream of stimuli leads to the creation of an association between the target and the outcome, which strength is a random variable. The subject perceives a contingency between the cue and the outcome when this random variable is above a threshold, accessed here by the degree of confidence. Applying signal detection theory we were able to characterize the shape, means and variances of the associative strength distributions.

#### 6) Behavioral Economic Assessment of Price and Consumption of Cocaine Self-Administration in High and Low Impulsive Rats

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Justin R. Yates, Joshua S. Beckmann, Michael T. Bardo

*University of Kentucky (USA)*

High impulsive animals as measured by an adjusting delay task acquire cocaine self-administration at a faster rate relative to low impulsive animals. However, it is unclear whether sensitivity to magnitude of reinforcement or sensitivity to delay account for differences in rate of acquisition. Rats were used in the current experiment to determine if sensitivity to reinforcer magnitude and/or rate of delay discounting correlates with (1) the rate of acquisition of cocaine (0.3 mg/kg/infusion) self-administration or (2) consumption of cocaine at high unit doses and maximal price paid in a threshold procedure. During the threshold procedure, a descending series of unit doses (0.42-0.002 mg/kg/infusion) were offered during 10-min components.

**7) Effects of Response Contingencies on Resistance to Change**

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Kathryn A. Kouchi, Matthew C. Bell  
*Santa Clara University (USA)*

A two-component multiple schedule of reinforcement, with two-link chain schedules in each, was used to assess the role of response contingent delays on resistance to change in pigeons. Components consisted of a variable interval 120-s initial link schedule followed by a fixed terminal link period. Terminal link transitions were either response contingent or independent across components. There were no significant differences in initial link responding ( $M=66$  resp/min) nor were there differences in terminal link responding ( $M=52$  resp/min). Prefeeding and non-contingent food tests showed no resistance to change differences. Extinction data, however, suggests higher resistance to change for the initial link correlated with the response-dependent terminal link, providing additional evidence for differential effects across disruption procedures.

**8) Pramipexole Disrupts Discrimination Processes Critical for Intertemporal Choice**

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Patrick Johnson, Jeffrey Stein, Rochelle Smits, & Gregory Madden  
*Utah State University (USA)*

Pramipexole (PPX), a dopamine agonist medication, has been associated with impulsive behavior in clinical populations prescribed the drug, as well as increased rates of impulsive choice in nonhuman intertemporal choice studies. Despite these reports, behavioral mechanisms underlying the PPX effect have yet to be described quantitatively. Two experiments assessed rats' discrimination of response-reinforcer contingencies (Experiment 1) and discrimination of different reinforcer amounts (Experiment 2) following chronic PPX (0.18 mg/kg) administration. In both cases, initially high accuracy ( $\log d$ ) in a chronic saline assessment was significantly reduced by PPX, as was bias ( $\log b$ ) in Experiment 2. Although impairments in these discrimination processes are theoretically consistent with increased rates of impulsive choice in nonhumans, they may not contribute to clinical impulsivity.

**9) Behavioral Momentum and Disinhibition of Extinguished Operant Responding**

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Eric A. Threlkill, Timothy A. Shaham  
*Utah State University (USA)*

Disinhibition refers to an increase in responding when a novel stimulus is introduced during extinction. Pigeons responded on a two-component multiple schedule arranging identical VI schedules in each component, but with added response-independent food delivered in one component. Following baseline training, responding was extinguished in both components. Once responding reached low levels, brief presentations of novel stimuli were introduced to assess disinhibition. Relative to baseline, resistance to extinction and disinhibition were greater in the component associated with higher baseline reinforcement rate. A quantitative model of renewal based on behavioral momentum theory provided a good description of the results and suggests that the introduction of novel stimuli changes the experimental context to resemble an earlier point in extinction training.

**10) Why Don't Guiding Cues Always Guide?**

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Alliston Reid, Hannah Rapport, Thien-An Le

*Wofford College (USA)*

We assessed stimulus control by predictive cues while rats learned to complete a Left-Right lever-press sequence. Each panel light could be ON (S+) or OFF (S-) over the respective levers. Experiment 1 measured the ability to complete the sequence, once acquired, without the cues. Experiments 2 and 3 showed a powerful asymmetry: Rats failed to adapt to a Lights ->Reversed-Lights transition, but adapted immediately to a Reversed-Lights ->Lights transition. Experiments 4-6 supported our hypothesis that the difference was due to feature-positive discrimination bias. It is interesting when organisms appear insensitive to cues that should be highly predictive of food, as seen with blocking and overshadowing. Guiding cues in behavior chains do not always guide behavior.

**11) Effects of 8-OH-DPAT, d-Amphetamine, and Prefeeding on Choice in a Variable Environment**

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Takayuki Tanno, Charles France

*University of Texas Health Science Center at San Antonio (USA)*

Twelve rats responded under a variable environment procedure in sessions comprising 5 components, each associated with different (right:left) reinforcer ratios (11:1, 8:4, 6:6, 4:8, and 1:11) that were presented randomly without replacement in daily sessions. Each component ended after 12 reinforcer presentations. Once performance stabilized, rats were tested in different sessions with saline, 8-OH-DPAT (0.032-1 mg/kg), d-amphetamine (0.1-1.78 mg/kg), and after presession feeding (6 g chow 1 hr before the session). Sensitivity to reinforcer ratio gradually increased within individual components. Neither 8-OH-DPAT or d-amphetamine reliably affected sensitivity to reinforcer ratio up to doses that decreased response rate. Prefeeding increased sensitivity and decreased response rate.

**12) Modeling Sequential Choices in a Risky Choice Task**

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Andrew T. Marshall, Kimberly Kirkpatrick

*Kansas State University (USA)*

Two models of sequential choice behavior were compared to data from a risky-choice task conducted in rats. The risky choice study involved presenting a choice between a certain and uncertain outcome under variations of the probability of receipt of the uncertain outcome. Three valuation rules (a hyperbolic and two exponential rules) and two decision rules (a continuous and a categorical rule) were implemented and compared to both molar and molecular dependent measures. The results suggested that both the time-based hyperbolic rule and the trial-based exponential rule, with a categorical decision rule, accounted for choice behavior in risky choice procedures, and that a hybrid model may serve as the best foundation for future models of choice behavior.

**13) Predictors of Impulsive Choice Behavior**

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Aaron Smith, Tiffany Galtress, and Kimberly Kirkpatrick  
*Kansas State University (USA)*

During an impulsive choice task, rats were given a choice between a small magnitude reward available after a short delay (SS) and a larger magnitude reward available after a longer delay (LL). The percentage of LL choices in individual rats was assessed in relation to performance on a differential reinforcement of low rate (DRL) schedule, a progressive ratio task with increasing reward magnitude, and a reduction in incentive motivational state through satiety. Greater DRL efficiency and also incentive motivation to work for increasing reward magnitude were associated with molar reward maximizing, whereas a reduction in incentive motivational state promoted momentary reward maximizing within the impulsive choice task.

**14) Timing, Reward Discrimination, and Impulsive Choice Behavior**

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Tiffany Galtress, Kimberly Kirkpatrick  
*Kansas State University (USA)*

During an impulsive choice task, rats were given a choice between a small magnitude reward available after a short delay (SS) and a larger magnitude reward available after a longer delay (LL). Over separate phases, reward delay was increased on the SS duration and reward magnitude was increased on the LL outcome. In individual rats, the percentage of LL choice during the reward delay manipulation and the reward magnitude manipulation was correlated with timing performance on a temporal discrimination task and reward magnitude discrimination in a reward contrast task. Greater temporal accuracy was associated with molar maximizing and increased reward discrimination was associated with momentary maximizing in the impulsive choice task.

**15) Internal Clock vs Adjunctive Behavior: An Experimental Analysis of How Animals Time Events**

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Francisco Aguilar Guevara, Benjamín Armenta, Daniel García-Gallardo, Claudio Carpio  
*Universidad Nacional Autónoma de México (MX)*

Two important models of timing, SET and LeT, imply differences in the relevance of adjunctive behavior in this process. While for SET it is irrelevant, according to LeT it is determinant. To identify which model better describes empirical evidence, the activity of six pigeons under a FI 60" schedule was analyzed and the experimental space was systematically modified. Two counterbalanced groups were exposed to an experimental space of 9cm, 18cm and 27cm wide. The results showed that reducing the available space brought variability in the pattern of adjunctive behavior and decreases of the mean percentage of earned reinforcements, suggesting that adjunctive behavior is relevant for timing. The theoretical implications of these data for SET and LeT are discussed.

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**16) Effects of Amount on the Discounting of Reward Option Size and Delayed Outcomes**

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Brent A. Kaplan, Derek D. Reed  
*University of Kansas (USA)*

In the current experiment, college participants completed a computerized standard adjusting amount delay discounting procedure and a novel adjusting amount discounting procedure for reward options (i.e., "search costs"). For both procedures, participants were presented with a larger later amount of \$500 and \$10,000. In the case of the delay discounting procedure, a robust magnitude effect was found at the aggregate level, whereas in the case of the discounting of reward option size procedure, no such magnitude effect was found. Results from the discounting of reward option size procedure also replicated previous findings that participants' discounting of options followed a hyperbolic-like shape. The current findings may suggest distinctly similar processes underlying both delay and effort discounting of option size.

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**17) Group and Individual Behavior in a Social Foraging Paradigm: Sensitivity to Changes in Resource Ratios**

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Eric Talbot, Lavinia Tan, Timothy Hackenberg  
*Reed College (USA)*

Five rats were studied in a social foraging context using two feeders (patches) that delivered food pellets in a sequence of different resource ratios that varied across sessions in the order: 1:1, 1:2, 1:8, 8:1, and 2:1. The ratio of pellets delivered at the patches remained constant within each 30-min session. Time spent at each patch was well described by the generalized matching law at both the group and individual level ( $R^2 > .84$ ), with evidence of undermatching (sensitivity ranges from .52 to .58)). The ratio of rats at each patch was well described by the ideal free distribution ( $R^2 = .84$ ), a model formally similar to the GML, but designed to address distribution of group behavior to different resources.

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**18) Differences in Delay Discounting Between Genetically Lean and Obese Zucker Rats**

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Steven R. Boomhower, Erin B. Rasmussen  
*Idaho State University (USA)*

Impulsivity has been implicated in obesity, however, no studies to date have examined delay discounting for food in genetically lean and obese Zucker rats. Lean and obese rats chose between a standard lever, which resulted in one pellet after one or five seconds (two conditions), or an adjusting lever, which resulted in two or three pellets (two conditions) after an adjusting delay. All rats' adjusting delays were longer in the 5-sec condition than the 1-sec condition, and in the 3-pellet condition compared to the 2-pellet condition. Also, obese rats had lower adjusting delays compared to lean in three of the four conditions. These data suggest obese Zuckers behave impulsively in some situations, but not all.

**19) Should I Stay or Should I Go Now?**

Ludmila Miranda Dukoski, Michael Davison, Doug Elliffe  
*The University of Auckland (NZ)*

Pigeons worked on a modified concurrent arithmetic VI schedule where the probability of food on a key varied sinusoidally across time since food. In Experiment 1, food ratio changes were unsignaled. In Experiment 2, a key-colour change was arranged at particular times since food signaling portions of the sinusoid. In Experiment 1, the sinusoid frequency was varied but in Experiment 2 it remained constant at 2-cycles per sinusoid. Our analyses of visit durations (measured in s spent responding at a key-location) and frequency of durations suggest that food deliveries have both strengthening and signaling properties.

**20) Missing Your Step: Local Choice Around Repeated Schedule Reversals**

Sarah Cowie, Michael Davison, Douglas Elliffe  
*The University of Auckland (NZ)*

Six pigeons worked on concurrent exponential variable-interval schedules in which the relative frequency of reinforcement on the two alternatives reversed at fixed times after reinforcement. Across conditions, the point of reversal was 10 s, 20 s, or 30 s, and the overall reinforcer rate was 4/min, 2/min or 1.33/min. Choice generally favored the locally-rich key, but changed sooner than the step-change in the local food ratio. In a subsequent phase, the reversal time was preceded or accompanied by a change in key-light color. The temporal location of this stimulus was varied across conditions. Local choice changed more rapidly, and at different times, depending on the temporal location of the key-light stimuli.

**21) Retrospective Temporal Discrimination at Complex Sequences of Durations: The Importance of the Location of the Retention Interval on the Memory**

Oscar Zamora-Arevalo, Montserrat Vanegas-Chavarría, Arturo Bouzas-Riaño  
*Facultad de Psicología-Universidad Nacional Autónoma de México (MX)*

Notwithstanding the usefulness of the temporal bisection task to evaluate cognitive properties of timing, a recurrent critique to the use of this paradigm is that estimates the duration of a single stimulus. Six rats were training to discriminate between two sequences of durations short or long. Each sequence was composed by three tones. In acquisition the rats learned to discriminate. In the testing phases a retention interval was introduced among the components of the sequences and at the end of these. Results indicated that the retention interval affects the discrimination of the long sequences when is presented within the sequences. When it is presented at the end of the sequences the effect is observed in both, short and long sequences.

**22) Temporal Discounting of Combined Gains and Losses**

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Jonathan E. Friedel, Joseph M. Cottrell, Amy L. Odum  
*Utah State University (USA)*

Temporal discounting of rewards and losses are topics frequently studied, but they are almost exclusively studied in isolation. The goal of this experiment was to understand how people choose between alternatives that have simultaneous monetary gains and monetary losses. Participants were exposed to four separate adjusting amount discounting procedures with identical delays: an adjusting gain procedure, an adjusting loss procedure, and adjusting gain procedure with a fixed loss on both alternatives, and an adjusting loss procedure with a fixed gain on both alternatives. It was expected that the procedures with the similar adjusting values would produce similar effects. Discounting parameters as well as model-free area-under-the curve estimates were obtained. Results and future directions will be discussed.

**23) The Chaining of Unequal Fixed-Ratio Schedules**

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Melissa M. M. Andrews, James W. Becker, Mark P. Reilly  
*Central Michigan University (USA)*

Differentially signaling links of extended tandem schedules of equal-link fixed-interval or fixed-ratio (FR) schedules (i.e., creating chain schedules) has been shown to reduce responding (Gollub, 1958; Jwaideh, 1973). To facilitate understanding of the processes underlying signal functions in extended chain schedules, the present study compares a tandem and chain series of unequal FR links. Pigeons key pecked under either a tandem FR 5, 10, and 20 or FR 20, 10, and 5 series. After stability, the links were differentially signaled. Results replicated previous research; signals reduced run rates and increased post-reinforcement pauses regardless of the order of the FR series. The response-weakening effects of signals in extended chain schedules are best explained by their temporal distance from reinforcement.

**24) Tranposition and Timing**

---

R. Emmanuel Trujano, Oscar Zamora, Alba Cruz  
*Universidad Nacional Autónoma de México (MX)*

Besides their implications for two timing theories, typical results from the double bisection task also suggest that subjects apply the same response rule driven by changes in response keys across all experimental phases; this is an instance of transposition. To test this possibility, 9 rats were trained in a modified version of the double bisection task in which all phases were presented with the same lever features but different temporal markers per bisection type. Results show that when lever features remain constant, temporal discrimination decreases in the homologue of the double bisection phase per se. Furthermore, individual analyses revealed that some rats stopped responding after 3 or 4 sessions. Therefore, there's no transposition when lever features remain constant.

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**25) A Rodent Model for Detection of Oxygen Based Explosives and Propellants**

Marina Vilardo, Ben Katz, Kimberly Kirkpatrick  
*Kansas State University (USA)*

The present study trained rats to discriminate among three acids (Butyric, Acetic, and Propionic) and three ketones (Butanone, Acetone, and Hydrogen Peroxide). Some of these substances are components of or relatives of liquid explosives which are difficult to detect with normal scanning devices. One group of rats ( $n = 4$ ) was trained on acids, and the second group of rats ( $n = 4$ ) was trained on ketones. Each of the compounds was assessed as a target and as a distracter odor. In general, the rats displayed high hit rates for the targets and low false alarm rated for distracters. This indicates that laboratory rats may be a useful model for detecting liquid explosives.

**26) Using concurrent-chains to assess sound preference: An alternative to concurrent schedules.**

Amy Jones, Lewis Bizo, Mary Foster  
*Auckland University of Technology (NZ), University of Waikato (NZ)*

Multiple-concurrent schedules were used previously to assess preferences for sounds. However, the presence of sound during the choice phase confounds response allocation for certain sounds. As an alternative, a concurrent-chains schedule was used to assess six hens' preferences for various sounds that turned on in only one terminal-link. Thus, hens made a choice between sound and no sound alternatives in the absence of sound. The direction of noise biases from responding in the initial-links was the same across hens for one sound only and both the magnitudes and directions of biases varied across hens for the other sounds. This procedure resulted in some conclusions different from and some similar to those drawn using the same sounds under multiple-concurrent schedules.

**27) Using Response Stereotypy to Detect the Emergence of a Habit**

Greg Jensen, Kathleen Taylor, and Peter Balsam  
*Columbia University (USA)*

Initially, goal-directed operant behavior is sensitive to outcome value, but becomes insensitive to value changes as behavior becomes habitual with extended training. We examined the relationship between the features of ongoing behavior and insensitivity to outcome value. Subjects were trained on a VI 30s schedule for 25 days before being given an outcome devaluation test during an extinction session. Rates of responding increased and temporal variability decreased over training. We tracked 6 specific indicators of stereotypy over the course of extended training, and these indicators predict the degree of perseveration during outcome devaluation. This approach may allow for online monitoring of behavior as it transitions between goal-directed and habitual modes of action.

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**28) Preference for Undiscriminated Intervals as a Possible Explanation for State-Dependent Learning**

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Adam E. Fox, Elizabeth G. E. Kyonka

*West Virginia University (USA)*

We trained pigeons on response-initiated fixed-interval (RIFI) 6-s schedules under two conditions, pre-fed and deprivation, each associated with a distinct discriminative stimulus. In a choice session we observed a preference for the stimulus associated with the deprivation condition—consistent with the state-dependent learning phenomenon. We also observed less temporal discrimination during the 6-s delay to food in deprivation training sessions. In a subsequent choice session, after additional training, we found the preference for the deprivation stimulus had disappeared. We also found that temporal discrimination during the 6-s delay was equal in both deprivation and pre-fed conditions during the second training period. These findings suggest that state-dependent learning may be explained by an organism's ability to discriminate delays to food availability.

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**29) Influence of Adolescent Exposure to a High Fat Diet on Adult Performance on the Fixed Minimum Interval (FMI) schedule**

---

Elizabeth Watterson, Federico Sanabria

*Arizona State University (USA)*

Human and non-human animal studies have demonstrated a high fat diet is detrimental to learning and memory. Recent investigations have shown adolescent exposure to a high fat diet produces impairments in conditioned place preference (CPP) learning that persist into adulthood (Privitera et al., 2011). Long-term deficits in operant learning following adolescent high fat diet exposure have not been established. We examined the effect of adolescent high fat diet on adult fixed minimum interval (FMI) schedule performance. The FMI schedule is a modification of the differential reinforcement of low rates (DRL) schedule and is well suited for measuring response disinhibition, timing accuracy, and incentive motivation. Our results provide further insight into the long-term effects of adolescent high fat diet exposure.

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**30) A Change-Point Analysis Can Model the Bout Structure of Behavior During Extinction**

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Daniel J. Hoffman, Blake A. Hutsell, M. Christopher Newland

*Auburn University (USA)*

Bout-analysis methods based on inter-response time (IRT) distributions assume stationarity to justify aggregating IRTs. This assumption is invalid for behavior in transition, necessitating an alternative approach. We used a change-point analysis to partition behavior, allowing an examination of bout structure changes during extinction. Following a baseline of MULT RI 30" (Percentile 10: 0.75): RI 30"(DRH 9:4) schedule, 10 adult male BALB/c mice were exposed to three consecutive extinction sessions. For both schedules, within-session changes in bout structure were similar. The inter-bout interval increased throughout extinction (ie, bout-initiation rate declined). Subsequently, bout length also declined—but to a lesser extent than bout-initiation rate. Changes in the bout-initiation rate and bout length accounted for over 90% of the response rate reduction.

**31) Effect on Fixed Interval Performance of Prior Exposure to Random Interval and Random Time Reinforcement Schedules**

---

Sarahí Gallardo, Florente López, Marina Menez  
*Universidad Nacional Autónoma de México (MX)*

Research indicates that acquisition speed of temporal control depends on training history (López & Menez, 2005). Compared with non-periodic schedules, fixed-time reinforcement induces faster acquisition on subsequent fixed interval schedules. In this study we evaluate whether the acceleration effect is related to differences in reinforcement contingency between training and testing or in the initial rate at the introduction of the FI schedule. During training, groups of rats were submitted to random-time schedules 10s or 45s and random-interval schedules 10s or 45s. Acquisition of temporal control during testing occurred at a faster rate with non-contingent than with contingent training. Findings are discussed in the context of the facilitative effect on temporal control of general search behavior generated during non-contingent training.

**32) Effects of Reinforcer Efficacy on Fixed Ratio Responding in Three Inbred Strains of Mice**

---

Blake A. Hutsell, M. Christopher Newland  
*Auburn University (USA)*

We evaluated the effects of two qualitatively different reinforcers (sucrose pellets and sweetened-condensed milk) on responding maintained by several fixed ratio schedules of reinforcement in three commonly used inbred strains of mice (BALB/c, C57BL/6, & DBA/2). Response rates were generally higher for the BALB/c strain regardless of reinforcer type and higher for each strain when responding was maintained by milk. For the DBA/2, C57BL/6 and to a lesser extent the BALB/c, milk primarily increased response rates at moderate fixed ratios but not at the largest fixed ratios tested. According to Mathematical Principles of Reinforcement (Killeen, 1994), the changes in response rate were due to changes in the minimum response time ( $\delta$ ) produced by each reinforcer type and not value ( $a$ ).

**33) Nicotine and Impulsivity in an Animal Model of ADHD**

---

Gabriel Mazur, Gabriel Wood-Isenberg, Elizabeth Watterson, and Federico Sanabria  
*Arizona State University (USA)*

ADHD is associated with substantially higher levels of smoking, which may be related to therapeutic effects of nicotine on ADHD symptoms. The effect of nicotine on ADHD-related impulsivity was tested on the spontaneously hypertensive rat (SHR), a rodent model of ADHD. Performance of these rats in the fixed minimum interval (FMI) schedule of reinforcement under a range of acute doses of subcutaneous nicotine (0.1-0.6 mg/kg) was compared against a normoactive control strain. Strain-specific effects of nicotine on FMI performance are discussed in light of their contribution to understanding the link between ADHD and tobacco abuse.

### 34) Local Dynamics of a Human Concurrent Choice Preparation

---

Ryan J. Brackney, Charles Wilson, Alison Moritz, Federico Sanabria  
*Arizona State University (USA)*

The stable-state properties of concurrent-schedule performance are well characterized, yet the dynamics of matching acquisition are understudied. Ninety-one undergraduate psychology students were trained on a concurrent choice discrete trial preparation. Reinforcement rates for different choices were changed during the experiment; local changes in choice preference as a function of reinforcement and prior choice selections were examined. The data was fit to three dynamic models of concurrent choice performance. The results indicate the emergence of two distinct sub-populations that vary in terms of sensitivity to reinforcement and response alternation behavior.

### 35) Pigeons Learn to Choose a Large Reinforcer and to Avoid Choosing a Small Reinforcer in a Three-Key Concurrent Schedule

---

Sarah Goode, Shrinidhi Subramaniam, Elizabeth Kyonka  
*West Virginia University (USA)*

When subjects choose between two schedules, preferring the richer is the same as not preferring the leaner. To compare preference and non-preference, pigeons pecked in a three-key concurrent schedule. Pecks to a preselected key produced variable numbers of grain hopper presentations on a variable-interval 15-s schedule. In some conditions, two keys produced a large number (4-5) of hopper presentations per reinforcer and the third produced few (1-2). In others, there was one large-magnitude key and two small-magnitude keys. Relative response rates were high on large-magnitude keys and low on small-magnitude keys in all conditions, which suggests that the behavioral processes involved in avoiding a lean schedule may be the same as those involved in preferring a rich schedule.

### 36) The Effects of Nature on Self-Control

---

Meredith S. Berry, Justice Morath, Amy L. Odum, Kerry Jordan  
*Utah State University (USA)*

The purpose of the present experiment was to investigate the effects of natural environments (e.g., forests) on impulsivity within a delay discounting paradigm. A delay discounting procedure in which human subjects chose between immediate and delayed hypothetical monetary outcomes was used to quantify individual levels of impulsivity. Each subject was exposed to a single condition in which they viewed either photographs of natural environments, built environments (e.g., cities), or geometric shapes before (and between delay blocks) completing the delay discounting procedure. A titrating amount discounting task was employed. Between-subject levels of impulsivity as a function of delay were compared based on the natural, built, or geometric photographs presented. Results showed that viewing photographs of nature resulted in more self-control.

End Second Poster Session



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  - Lanny Fields, Erik Arntzen, Richard Nartey, & Christoffer Eilifsen. Effects of a meaningful, a discriminative, and a meaningless stimulus on equivalence class formation
  - Rachel N. Cassidy & Jesse Dallery. Effects of economy type and nicotine on the essential value of food in rats.
  - John R. Smethells, Andrew T. Fox, Jennifer J. Andrews, & Mark P. Reilly. Immediate postsession feeding reduces operant responding in rats
  - James E. Mazur. Effects of pre-trial response requirements on self-control by rats and pigeons
- Review Article -**
- Olga F. Lazareva. Relational learning in a context of transposition: A review

**- Book Review -**

- John W. Donahoe. Reflections on behavior analysis and evolutionary biology: A selective review of *Evolution Since Darwin—The First 150 Years* edited by M. A. Bell, D. J. Futuyma, W. Earnes, & J. S. Levinton
- Ana Catarina Vieira de Castro & Armando Machado. The interaction of temporal generalization gradients predicts the context effect
- Eric A. Trailkill & Timothy A. Shahan. Resistance to change and relapse of observing
- Jeffrey S. Stein, Jonathan W. Pinkston, Adam T. Brewer, Monica T. Francisco, & Gregory J. Madden. Delay discounting in Lewis and Fischer 344 rats: Steady-state and rapid-determination adjusting-amount procedures
- John M. Roll, Thomas Newton, Joy Chudzynski, Jennifer M. Cameron, Sterling McPherson, Tim Fong, & Matt Torrington. Preference for Gamma-Hydroxybutyrate (GHB) in current users
- Meredith S. Berry, Brian D. Kangas, & Marc N. Branch. Development of key-pecking, pause, and ambulation during extended exposure to a fixed-interval schedule of reinforcement

**Special Article**

- Martti T. Tuomisto & Lauri Parkkinen. Defining behavior–environment interactions: Translating and developing an experimental and applied behavior-analytic vocabulary in and to the national language

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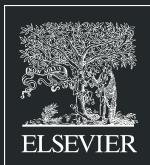
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# *Behavioural Processes*

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*Special issue:*

*SQAB 2011: Extinction*

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## Notes

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# **∫QAB 2012 at a Glance**



## **Thursday Evening May 24**

*Metropolitan Ballroom B, Sheraton Seattle*

5:00 – 8:00 Registration 1<sup>st</sup> Poster Session

## **Friday May 25**

*Metropolitan Ballroom A, Sheraton*

7:00 Registration, Coffee, Pastries  
8:00 Alliston Reid (President's Intro)

### Special Section on Timing

8:15 Matthew S. Matell  
8:50 K. Geoffrey White

9:25 Coffee Break

10:00 Michael Davison  
10:35 Armando Machado  
11:10 J. Jozefowicz

12:00 Lunch Break

1:45 Ryan D. Ward  
2:20 Douglas A. Williams  
2:55 Body, Cheung, Valencia-Torres,  
Olarte-Sanchez, Bradshaw, &  
Szabadi

3:30 Coffee Break

4:00 Buhusi & Oprisan  
4:35 Rivest, Lizard, & Ludvig

5:30 Business Meeting  
6:30 2<sup>nd</sup> Poster Session—until 9:00

## **Saturday Morning May 26**

*Metropolitan Ballroom A, Sheraton*

7:30 Registration, Coffee, Pastries  
8:30 Soto, Hursh, Xu, Grandy, Katz  
9:05 McKerchar, Green, Myerson  
9:40 Coffee Break  
10:00 Panel Discussion  
10:35 Brady Research Award  
10:45 Closing Remarks

## **Saturday Afternoon May 26**

*Rm. 608 Convention Center*

### **∫QAB Preeminent Tutorials**

From Basics to Contemporary Paradigms

1:00 Armando Machado  
2:00 John A. Nevin  
3:00 Howard Rachlin  
4:00 Michael Domjan