Chicago

Society for the Quantitative Analyses of Behavior
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∫QAB

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

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

Board of Directors

5:00 - 8:00+ *Registration and Cash Bar*

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

7:30 - 8:20 Earlybird Breakfast Tutorial

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

8:35 President's Introduction: The Legacy of Nat Schoenfeld

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In the 1950s, Nat Schoenfeld and his students and colleagues embarked upon a program of research on steady-state performance maintained by schedules of reinforcement defined on purely temporal continua. His systematic, parametric research style was a model for all subsequent work in this area. His "t-tau" system of stimulus schedules also incorporated Pavlovian and avoidance conditioning; and, he taught his students to identify continua linking apparently disparate classes of behavioral relations. Above all, he insisted that "Whatever exists, exists in some amount and can be measured."

8:45 A Teleological Theory of Addiction

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A theory, called "relative addiction," is presented to account for addiction, defined as a high rate of consumption of a harmful substance. The theory is teleological and behavioral in the sense that the motivational force it posits lies in the environmental context of behavior—in an economic utility function rather than in an internal physiological or cognitive mechanism. The theory depends on maximization of utility in consumption of two mutually substitutable activities, a potentially harmful one that increases in real price with consumption, and a non-harmful one that decreases in real price with consumption. Evidence for the existence of such a pair of activities (cigarette smoking and social interaction) is discussed.

9:26 Normalized Demand for Different Reinforcers

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The concepts of behavioral economics have proven useful for understanding the environmental control of overall levels of responding for a variety of commodities. In the domain of drug abuse, these general concepts have implications for the assessment of abuse liability and drug abuse interventions. An essential requirement is the ability to compare directly the demand for different drugs and to compare demand for the same drug under different environmental and biological interventions to assess their ability to reduce demand. Such comparisons have been hampered by the confound of varying drug doses and potencies that prevent quantitative comparisons of demand elasticity - sensitivity of consumption and responding to the constraint of price (effort). We now describe a procedure to normalize demand curves that permits dose and potency independent comparisons of demand across drugs. A direct extension permits us to compare demand curves for other reinforcers under different biological conditions. This quantitative methodology based on economic principles is an alternative to choice procedures for comparing the strength of behavior for qualitatively different reinforcers.

10:07 Qualitatively Different Reinforcement and Parameters of Herrnstein's (1970) Hyperbola

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Previous research that compared the estimated parameters (i.e., k and R_e) from Herrnstein's (1970) hyperbolic matching law equation within the same individuals responding for qualitatively different consummatory reinforcers (i.e., water and sucrose solution) found similar asymptotic response rates (k). The present study compared these parameters within subjects responding on levers for consummatory and non-consummatory reinforcers. Male Wistar rats were exposed to the same series of tandem FR 1 VI schedules in an operant conditioning chamber responding on a lever for .1 ml of a .3M sucrose solution and in a running wheel responding on a lever for the opportunity to run for 30 s. Herrnstein's hyperbola was fit to response and reinforcement rates from each session. Results showed that asymptotic rates of responding for the consummatory reinforcer were higher than those for the non-consummatory reinforcer and that responding for the non-consummatory reinforcer rose more quickly toward the lower asymptote than did responding for the consummatory reinforcer. The implications of this finding are discussed.

10:48 *Break - Refreshments*

11:03 The General Stage Model Analytically Measures Hierarchical Task Complexity, and the Rasch and Saltus Models Statistically Measure Corresponding Stage Performance

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Stage is used to explain how acquisition of behavior is sequenced. Traditionally, stage is assessed by scoring performance rather than analyzing the complexity of task demands that are met. To remedy that lack, a notion of hierarchical complexity of tasks is used to define a minimal formal standard by which different systems of stages may be constructed or compared. This General Stage Model axiomatically defines simple tasks as logically primitive elements. Relations defined on these elements recursively and linearly order them into chains of discriminative operants, each requiring an output. The number of recursions is the order of hierarchical complexity. Scaled performance is shown to be a function of hierarchical complexity of task, thereby creating a psychophysics of stage.

11:44 Recursive Bayesian Formulation of Operant Behavior

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If we consider Premack's Principle from a conditional probability viewpoint and recursively apply Bayes' Theorem to update the probabilities of behavior, we are able to obtain the conditions for the increase in the strength of an operant. Given operant behavior *B*, other behavior ~*B* and consummatory response *C*, the Bayesian viewpoint leads to:

$$\frac{Updated\ P(B)}{Updated\ P(\sim B)} = \frac{P'(B \mid C)}{P'(\sim B \mid C)} = \frac{P(B) * P(C \mid B)}{P(\sim B) * P(C \mid \sim B)}$$

For *B* to increase in strength, the updated, posterior probability $P(B)=P'(B \mid C)$ must be greater than the prior $P(B)$, which simply leads to $P(C \mid B)>P(C \mid \sim B)$. The ratio $P(C \mid B)/P(C \mid \sim B)$ can be interpreted as the ratio of two reinforcement rates as typified by the matching law. When the number of reinforcers is fixed, if response rate, $P(B)$, increases, then reinforcement rate, $P(C \mid B)$, decreases, and the same relation holds between $P(\sim B)$ and $P(C \mid \sim B)$. Two consequences follow. First, the updated $P(B)$ and $P(\sim B)$ are functions of both the reinforcement rates and the previous behavior rates. Second, $P(B)$ and $P(\sim B)$ will eventually reach a dynamic equilibrium as shown in the melioration account. The recursive Bayesian approach can formulate a variety of operant characteristics including the relationship between the initial link responding and the terminal link response/reinforcement rates.

12:25 *Lunch Break*

1:45 Who's in Charge? Animal Versus Experimenter Control

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Animals in closed economies do not undergo significant physiological depletion because long intermeal intervals dictated by economics are buffered by anticipatory large intakes. Thus the depletion-repletion, feed-back models that have provided the core concepts of models of motivation are not appropriate to closed economies. Our analysis further suggests that our current reinforcement models of learning, based on results obtained in the session paradigm, are incomplete because the relationships between behavior and its consequences are very different when animals are in charge. Behavior is a function of regulatory outcome rather than immediate consequences. Foraging animals look at the big picture, and economic and regulatory factors are the controllers of bout parameters.

2:26 Optimal Decision Rules: A Model for How Pigeons Categorize Naturalistic Stimuli

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Pigeons categorized rectangles varying in both height and width in an adaptation of a method developed by Ashby, Maddox, Filoteo, and their colleagues, for the cognitive and neuropsychological analysis of human decision rules for ill-defined categories. Estimated decision rules for individual pigeons conformed approximately to the optimal decision rule in each of four tasks. The optimal rules were defined in a perceptual space in which the point *(x,y)* corresponded to a rectangle with width *x* and height *y*. The four optimal rules were: 1), $x=y$ 2), $x=c$, 3), $x=-y$, and 4), $(x-a)^2 + (y-b)^2 = r^2$, where *a, b, c,* and *r* were constants given by a task. The method provided a way 1) to integrate heretofore disparate literatures on ill-defined visual concepts and on optimal performances in nonhuman animals, 2) to compare how humans and nonhuman animals categorize ambiguous, multi-dimensional, configural, stimuli, 3) to model how nonhuman animals categorize naturalistic stimuli, and 4) to infer that pigeons' categorizations of naturalistic stimuli may be remarkably close to optimal.

3:07 Analysis of the Performance of Pigeons in a Complex Discrimination Task

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Pigeons were trained with stimuli A, B, and C to choose A when paired with B, B when paired with C, and C when paired with A. Efforts were made to simulate the data with models incorporating one or another of the three main conceptions of afferent interaction to be found in the literature of compound conditioning — that the components of a compound stimulus are altered by compounding, or that a new (compound-unique) component is added, or that the components disappear entirely in a configurational transformation. Since none of the simulations proved to be satisfactory, the models were supplemented with several different conceptions of learned salience or attention, but again the simulations were unsatisfactory. Some strategic implications of these failures are considered.

3:48 *Break - Refreshments*

4:03 Models of the Subjective Value of Delayed and Probabilistic Rewards

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We will discuss recent findings bearing on whether a single mathematical model can explain discounting of both delayed and probabilistic rewards and implications of these findings for our understanding of decision-making mechanisms. We will show that the same form of hyperbola-like mathematical function describes both kinds of data. However, this does not necessarily mean that the same mechanism underlies both kinds of discounting. Indeed, new data will be presented to show that delayed and probabilistic discounting are affected in opposite ways by variation in the actual amount of the reward. Moreover, findings from a study of the effects of inflation on the subjective value of delayed and probabilistic rewards reveal a selective effect of inflation on temporal discounting only. We will consider several mechanisms that could give rise to the same form of discounting function and their implications for how risk and delay influence decision-making.

4:44 Why the Delay-of-Reinforcement Gradient is Hyperbolic

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A fundamental phenomenon of operant behavior, and arguably the most theoretically distinctive, is the weakened effect of reinforcement caused by its delayed presentation. Reinforcement strengthening generally declines nonlinearly—faster with shorter delays—and undisputed subsidiary relations anchor this conclusion. A contentious empirical generalization is whether the gradient is exponential or nonexponential, with most studies supporting nonexponential. One account, approaching consensus opinion, invokes the hyperbolic function. However, curiously another simple equation has been overlooked which is consistent within experimental error with negative exponential and hyperbolic forms depending upon the parameters of the formula: The sum of two exponentials (STEX) is not analytically reducible and accommodates extant data best. Its two parameters are interpreted and investigated as partially-separable contributions of factors reflected respectively in the long-sparring hedonistic and associationistic traditions of learning theory. Delay seems to weaken reinforcement strengthening because of an additive combination of inhibition (or dissipation) and interference.

5:25 *Break*

5:30 *Business Meeting*

5:30 - 10:00+ ***Poster Session / Cash Bar***

The Geometry of Vocal Behavior in Budgerigars

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Recent work in our laboratory has shown that the vocal topography in Budgerigars can be controlled by differential food reinforcement. This work has relied on factorial analysis of power spectra similarity to classify and compare individual calls and to set reinforcement criteria. Although it has helped to identify arbitrary differences within limited sets of calls, this similarity index alone does not fully capture the continuum of topographical variation. I illustrate the difficulty by showing how the method has failed to differentiate vocalizations to color stimuli. By comparing this data using other spectrographic information, I suggest that budgerigar vocalizations may better classified in a multidimensional space defined by critical acoustic features. In such a space, the full range of calls – natural and arbitrary – can be represented in metric relation to each other, defining a sort of adaptive landscape to be shaped by reinforcement. This framework can provide a quantitative paradigm to the origins and dynamics of the operant units.

Delay of Reinforcement and the Hyperactivity Syndrome

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The delay of reinforcement gradient operates not only when a single response produces a later delayed reinforcer but also when a response sequence ends with a reinforcer. In the latter case, each response in the sequence participates in the reinforcement relation with a weighting that is a function of delay (time from that response to the reinforcer). Delay gradients may vary in the relative weighting of short delays. The gradual emergence of short interresponse times, characteristic of the hyperactivity syndrome is consistent with a sharper delay gradient. Furthermore, observing behavior is maintained by conditioned reinforcers that depend on their temporal relation to primary reinforcers. To the extent that sharper delay gradients slow the development of conditioned reinforcers and therefore attenuate observing behavior, they should also produce attention deficits. Thus, hyperactivity and attention deficit may be correlated because both depend on an atypically sharpened delay gradient.

Is Telling Time the Same as Judging Time?

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Twelve pigeons were exposed to two timing methodologies: temporal production and temporal discrimination of intervals ranging from 0.5 s to 64 s. Pairs of stimulus durations around each base were adjusted with a psychophysical titration technique. The standard deviation and point of subjective equality recovered from Gaussian psychometric functions, when fitted to Killeen and Weiss's (1987) version of Weber's formulation, showed that variability in temporal discrimination increased as a linear function of the mean subjective time, and was much greater for discrimination than production task. Temporal variability in duration judgment and duration production, as a function of the mean judged time, obeys Weber's Law. Since, Weber's fraction was found to be an extremely useful index for measuring and comparing discriminability across different timing tasks and different base durations, a correlation of Weber's fraction, obtained from Killeen and Weiss's fit, with individual subjects for the two timing tasks will enable us to determine if a common or multiple timers governed temporal behavior.

Two Direct Tests of Momentary Maximizing During Concurrent VI Schedules

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Momentary maximizing is the hypothesis that choice behavior is sensitive to the moment to moment probability of reinforcement assigned to a given choice. During concurrent VI-VI schedules pigeons generate sequential patterns of responding and distribute their interresponse times in a manner which appears to support this hypothesis. These results, though, are merely descriptive. That is, they do not directly manipulate the hypothesized, independent variable—momentary reinforcement probability. I present here two experiments that do manipulate this variable during concurrent VI performance. The first experiment uses forced choice probes inserted into a "free operant" schedule. The second experiment uses discrete trials with a variable intertrial interval. Neither experiment finds evidence that momentary maximizing is the mechanism governing choice during concurrent VI-VI schedules.

Behavioral Categorizing Responses to Dilemmas and Analyzing Them with Scaling Techniques

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The General Stage Scoring System is used to form behavioral categories for responses to dilemmas. Psychophysical ratings method as well as traditional verbal responses may be analyzed using this scheme. Both reliability and validity can be demonstrated. By analyzing the properties of the underlying task demands and of settings as well as well as the organization of the acquisition of performance may be elucidated.

Operant Tempo Varies with Reinforcement Rate: Rogue Rats Defy Matching Law

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Under single VI schedules of reinforcement, subjects alternate between working for the experimenter-controlled reinforcement and performing alternate activities such as grooming and resting. In the accounts of single-operant performance provided by Herrnstein and by Heyman, the tempo of responding during work is fixed; response rate increases with reinforcement rate because an increasing proportion of the subject's time is allocated to the experimenter-controlled reinforcer. The fixed-tempo assumption was assessed by examining the streams of inter-response times produced by rats reinforced by rewarding brain stimulation. According to the accounts of Herrnstein and Heyman, such an analysis should normally reveal a mixed distribution consisting of a sample of short inter-response times that correspond to the operant tempo and a sample of longer intervals that correspond to bouts of alternate activity. Moreover, as the reinforcement rate decreases, the mean tempo inter-response time should remain fixed, and the mean alternate inter-response time should increase. In contrast, log survivor analysis failed to reveal two distributions of intervals at moderate to high rates of reinforcement. Operant tempo was not fixed: the mean tempo interval increased as the reinforcement rate decreased. Indeed, the monotonic relationship between tempo and reinforcement rate can explain most of the variance in response strength. Finally, in contrast to the predictions of the Herrnstein/Heyman accounts, time allocation estimates were not scalar functions of response rate. These results contradict the assertion that response strength reflects behavioral choice and provide an alternate explanation for the form of the response strength function.

Pattern Analysis as a Dimension of Individual Differences

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Most studies of operant performance have focused on the use of a single operandum. In order to explore differences in human performance associated with schedules of reinforcement, this study used a multioperand situation. The schedules employed were FI 20 sec, FR 150, and extinction presented in 15-min sessions. Performance of 100 individuals per condition was analyzed. Patterns emerged as a by-product of the exposure to the contingencies. Shannon's index of diversity, as well as a temporal analysis of the pattern was used for characterizing performance for each condition. The results suggested that the multioperand procedure may be a fruitful paradigm for assessing variability of individual performance under different conditions of reinforcement.

Isolation of Life-Span Factors Associated with Orderly Changes in Pattern Diversity in Individual Performance as a Result of a Discrete Exposure to Contingencies

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A concern for the influence of social factors over individual performance pervades the assessment of behavior across the life-span. However, there is insufficient effort among behavior analysts to measure those influences on simple operants maintained by simple contingencies of reinforcement. In order to explore differences in human behavior associated with social factors, age, and academic training, a multioperand paradigm with an FI 20-sec schedule in a video game task was used. Subjects 11 to 65 years of age with different academic and social backgrounds, participated in the study. Performance was analyzed in terms of the response patterns as a function of background factors. Diversity indices showed orderly functions associated with life status variables.

Behavioral Dynamics Driven by Dual VI Bursts

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The behavioral adaptation of pigeons exposed to trials containing two isolated periods of variable-interval (VI) reinforcement, followed by a relatively long period of extinction was assessed. The step function transitions between the VI bursts and extinction were unsignaled as in a mixed schedule. This procedure follows our initial development and evaluation of the analytical and numerical methods necessary to successfully use a transfer function to provide a zero free parameter prediction of behavior in a single step function procedure. The analysis of the present data revealed that: 1) the transfer function is low-pass in character and has an anticipatory rising edge and lagging falling edge, 2) response rates to the extinction period between the two VI periods showed chronic, large amplitude, unstable fluctuation in several birds, and 3) the trial onset immediately following a blackout was a source of artifactual noise.

Quantitative Exploration of Cyclicity in Behavioral Data

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We examine methods of assessing the presence and persistence of behavioral cyclicity. Pigeons chose between an FR 30 schedule of reinforcement and a four-component VR 60 schedule whose distribution of components varied in a parametric fashion, whereby the size of the minimum component of that variable schedule was changed daily, cycling by increments of one between one and fifteen. Prolonged exposure to this procedure resulted in cyclic patterns of choice in all birds. After approximately 240 sessions, changes in the VR distribution were halted and birds continued for an additional 60 sessions. Our analysis focuses upon behavior both during the initial conditions and during that final condition. A discrete Fourier transform was combined with a filtering technique. The relationship between the discrete and functional Fourier transform and band-width filtering provided information on both the magnitude and phase of fluctuations in the birds' choice patterns in a frequency domain. Additionally, a mixed polynomial-trigonometric approximation of the birds' responding in real time was also examined, based on the least squares method of approximation of data restored after filtering.

Molecular and Molar Ideal Free Distribution Analyses of Pigeons Among Two Depleting Resource Sites

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The Ideal Free Distribution (IFD) predicts how a group of foragers distribute between resources. Most investigations of IFD have employed a continuous input of resources (e.g., VI schedules) in tests of IFD, but an alternative would be a "standing crop" situation in which all resource items are presented at the beginning of the trial and the flock consumes resources until depleted. We presented a flock with resources at two sites by pairing chow amounts in 2:1 ratios or 4:1 ratios. The flock distributed in a dynamic fashion very different from the stable distribution of continuous input tests of IFD. A molar level analysis revealed the flock matched resources almost perfectly (s = .98, b = 1.04, r^2 = .98). In a variation of the depletion experiment just described, we investigated whether the flock was matching the within session fluctuating resource ratios on a molecular level. Lagged analysis revealed that the flock was sensitive to fluctuating resources within forty to sixty seconds of a particular resource distribution.

Run Length, Power Functions, and Generalized Matching

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In concurrent choice, reinforcers are delivered either for staying on the present alternative or for switching to the other alternative. The generalized matching law can be expressed as the ratio of run lengths (or visit durations) equaling the ratio of the sum of the reinforcers for staying and switching at each alternative. If run lengths are a function of probability of stay (St) and switch (Sw) reinforcement, or $R1$=f(St, Sw); then $R1_1 / R1_2$ = f(St_1,Sw_1) / f(St_2,Sw_2). Previous experiments showed that run length and visit duration were a power function of the ratio of the probabilities of reinforcement (probability of reinforcement for staying divided by the probability of reinforcement for switching.) That is, $R1=b(St/Sw)^s$. From this expression, generalized matching can be derived. Recent results support this understanding of generalized matching.

Evidence for Oscillatory Processes in Fixed Interval Timing

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We investigated the changes in the response rates during the acquisition of fixed interval (FI) performance (Phase I), and during extinction that followed FI training (Phase II). Two groups of pigeons were trained using FI 40 and FI 80 schedules in Phase I. The initial response rates decreased whereas the terminal response rates increased across sessions. The subjects were exposed to 15 extinction sessions in Phase II. Each session started with reinforced FI trials and ended with extinction trials. Response rate during extinction trials showed the same pattern as that during the reinforced trials. The mean pause-to-pause duration of the cycles produced during the extinction trials was equal to the FI duration that the subjects were trained with. The histograms of cycle durations superposed when plotted in relative time with the duration of the FI value as the standard.

Matching and Rules: Describing How People Allocate Responses in a Group Discussion

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Individuals participated in videotaped conversations with two confederates who provided differing rates of verbal agreement. Each participant was exposed to six different pairs of schedules across three 30-minute sessions. Half the participants were verbally given a rule to speak equally often to the other conversants, and half were given no rule. Results from the first session showed that participants' responses in the no-rule group were allocated to the two confederates according to the generalized matching law (Baum, 1974). These results replicated a 1974 single-session study by Conger and Killeen. The no-rule group spoke more equally to the two confederates than the reinforcement schedules dictated (undermatching), suggesting that these individuals were responding to the rule. No matching relationship was found for either group in the second and third sessions.

A Saltus Analysis of Behavioral Developmental Data from the Balance Beam Task Series

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The balance beam of Inhelder and Piaget (1958) was reconstructed as a series of tasks of increasing order of hierarchical complexity (Commons, Miller & Kuhn,1982). A Saltus analysis (Wilson, 1989; Wilson & Draney, 1995) of cross-sectional behavioral developmental data from a group of 121 adults and 20 children tested the hypothesis that each task was a prerequisite for the next more hierarchically complex task. This analysis showed that the gapiness and systematic shifts in item misfit present in an earlier two-parameter Rasch analysis could be explained as stage change.

A Behavioral Developmental Analysis of the Psychophysics of Stage Using the General Stage Model and a Saltus Analysis of the Laundry Problem Task Series

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In the behavioral developmental analysis of the psychophysics of stage, the key question is whether the Tasks analytically sequence by order of hierarchical complexity also produce sequenced performance. The stimulus dimension is the order of hierarchical complexity. The response dimension is the Saltus scaled difficulty scores for each stage group. Saltus analysis of cross-sectional developmental data gathered from a group of 36 adults and 37 children who completed the Laundry Problem Task Series (Commons, Miller, & Kuhn, 1982) grouped the subjects by highest order of hierarchical complexity task that they completed. Item difficulty increases with item complexity for all subjects but significantly more so for low-stage performing subjects than for high-stage performing subjects.

Measuring Rats' Sensitivity to the Work Costs of Earning Food Using an Adjusting Amount Procedure

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Rats' sensitivity to the work costs of earning food was measured. Six rats earned liquid food reinforcers on a discrete trial, adjusting amount procedure (Richards, Mitchell, de Wit & Seiden, in press). On each trial, animals chose between the EASY side and the HARD side. Choice of the EASY side resulted in the amount of sugar water from the EASY side decreasing by 10%. Choice of the HARD side resulted in the amount of sugar water from the EASY side increasing by 10%. Changes in the amount of sugar water delivered on the EASY side were recorded for 60 trials during each session. Initially amounts changed, indicating a preference for one side. However, amounts usually stabilized within the first 30 trials, indicating that subjects were beginning to alternate between the EASY and HARD sides. Mean amounts from the last 30 trials were used as "indifference points". Hyperbolic discount functions were fitted to the indifference points for each of the 5 work requirements on the HARD side for individuals. The results suggest rats are sensitive to the work costs of reinforcers and that the degree of sensitivity can be estimated using a titration procedure.

Signal Detection Performance in Elderly and Young Adults

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Behavioral detection theory suggests that the detectability of a signal may be enhanced by increasing the differences between the two responses and their consequences, in a way that is functionally similar to increasing signal strength. Seventeen older adults (age 65+) and ten college students served in two Yes-No signal-detection experiments that varied response topography and differential outcomes for correct responses, with effective signal strength equated. There was no effect of differences in topography or outcome type on detectability for either group. Although response allocation was sensitive to the relative frequency of the outcomes, there were no differences based on topography or type of outcome, and no differences between age groups. However, elderly subjects exhibited consistent "conservative" biases away from reporting the signal.

Instructional Determinants of Human Performance on Hypothetical Choice Situations with Delayed Rewards: Preliminary Data and Analyses

Fredy Reyes, Gustavo Esguerra, Alvaro Pacheco, Gynni Luna, Myriam Montero, Paola Moreno, Lida Navarro & Andrea Socarrás
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Six human adults chose between hypothetical amounts of money available either immediately or after a delay. Data obtained indicated that subjects generally preferred the amounts of money available immediately. Rules generated during this initial experimental phase were classified according to control by immediate or delayed consequences. During a second phase, the variables manipulated were: 1) Instructions describing differences between immediate and delayed amounts of money, 2) Instructions describing temporal differences between alternatives and, 3) Instructions describing global amounts of money obtained from the immediate and delayed alternatives. Results obtained showed that instructions describing global amounts of money obtained were most effective.

Instructional Determinants of Human Performance on the Prisoner's Dilemma Game Under Conditions of Varying Strategies: Preliminary Data and Analyses

Fredy Reyes, Mercy Abreo, Alvaro Pacheco, Patricia Coronado, Daniel Gómez, Felipe Gutiérrez, Liliana Moreno, & Stella Valencia
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Four human adults played Prisoner's Dilemma game against four experimental confederates. Experimental participants generally preferred not cooperating under both a random strategy and a tit-for-tat strategy. During the initial phase, rules generated under the random and tit-for-tat strategies were classified according to control by immediate or delayed consequences. During Phase 2, the variables manipulated were: 1) Instructions describing local differences between points earned by each player during the trial, 2) Instructions describing accumulated or global differences between points earned by each player from trial to trial, and 3) Instructions describing the consequences of cooperating during all the experimental session in terms of overall rewards. Data indicated that instructions describing global differences accumulated by each player on all the preceding trials and instructions describing the consequences of choosing cooperation were most effective.

Instructional Determinants of Human Performance on Hypothetical Choice Situations with Probabilistic Rewards: Preliminary Data and Analyses

Fredy Reyes, Mercy Abreo, Alvaro Pacheco, Babian Ardila, Scheherazade Bazzani, Paola Bustos, Mara Garcia, Liliana Munevar & Paola Sánchez
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Six human adults chose between hypothetical amounts of money available with different probabilities. Data obtained indicated that subjects generally preferred the outcomes which occurred with 100% probability. Rules generated during this initial experimental phase were classified according to control by certain and uncertain rewards. During a second phase, the variables manipulated were: 1) Instructions describing differences between certain and uncertain amounts of money, 2) Instructions describing probabilistic differences between alternatives and, 3) Instructions describing global amounts of money obtained from the certain and uncertain alternatives. Results showed that instructions describing global amounts of money obtained were most effective.

Measurement of Delay and Probability Discounting in Humans and Rats Using an Adjusting Amount Procedure

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In order to measure discounting, we use a procedure in which reinforcer magnitude is adjusted as a function of the subjects' choice responses. The overall goal of these studies is to develop analogous human and non-human laboratory models of impulsive behavior. Two specific aims of these studies are, first, to determine if delay and probability discounting in humans and rats is quantitatively characterized by Mazur's hyperbolic discount function, and second, to determine if manipulations which are thought to increase impulsive behavior also cause increased rates of discounting which can similarly be described. The following preparations were used: humans clinically characterized as impulsive, humans in an alcohol and gambling task, and rats with depleting serotonin. In addition, rats were used with delayed reinforcers on DRL schedules.

Paths, Landmarks, and Currencies of Efficiency in Foraging Norway Rats

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We explored how the foraging behavior of Norway rats (*Rattus norvegicus*) was influenced by different arrangements of paths or vertical cues (beacons) in a 3.66 m^2 open arena that contained six food cups. When paths led directly to food cups from a central location, rats spent a mean of 66% of the distance traveled on the paths, even though they could freely leave the paths. In a treatment in which paths led to food but were more costly to follow, the proportion of travel in the open was significantly higher than in a treatment in which paths led to food but were not elongated. Rats initially showed a lower overall yield, and a higher net session-wide efficiency, in the treatment in which paths led directly to food cups than when paths were misaligned. These differences disappeared by the end of the experiment. There was no significant difference in net session-wide efficiency between a treatment in which beacons led to food or were misaligned with respect to food. Therefore, paths had a larger initial influence on the foraging efficiency of rats than beacons, but with experience rats were able to achieve similar net efficiencies.

A Quantitative Analysis of Equity as an Interdependent Choice Process: A Behavioral View of an Old Problem

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The experimental analysis of social interchanges investigates the microregulatory factors which control "equity" behavior as an interdependent choice process. The present research examines the allocation rule which results in an equitable distribution of outcomes between two interacting subjects. Aristotle defined an equitable state for two people as one in which the proportion of one person's outcome to the other person's outcome is equal to the corresponding proportion of their inputs, Anderson (1976) provided a mathematical form for this relationship: $O_i / O_i + O_j = I_i / I_i + I_j$ where O_i and O_j are the values of Person i's and Person j's outcomes; I_i and I_j are the values of their inputs. We evaluated Anderson's model with twelve pairs of 6 to 10 year-old children. In general, the proportional model of equity described data of a constant reinforcement group, but not data of a proportional group. Data are discussed with respect to the conditions of reinforcement and microregulatory elements of reciprocal control among children.

Extreme Choice: Contingency-Discriminability or Generalized Matching?

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Four pigeons were trained on six independent concurrent variable-interval schedules of reinforcement. Extreme ratios of reinforcement (up to an obtained ratio of 532 to 1) were used to test between predictions of the contingency-discriminability model and the generalized matching law. The data obtained were analyzed separately according to four different stability criteria. Regardless of stability criterion, the generalized matching law consistently described the data more accurately than the contingency-discriminability model. Further, the predictions of the contingency-discriminability model deviated systematically from the data at extreme ratios of reinforcement.

The Reinforcement Mountain: Time Allocation as a Function of the Rate and Strength of Rewarding Brain Stimulation

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On the basis of a psychological process model derived from the matching law, allocation of behavior to brain stimulation reward is represented, in a three-dimension (3D) space, as a function of both the rate and strength of the reinforcing stimulation. We dub the resulting 3D structure the "reinforcement mountain." In the 3D analysis, the ("reward-growth") function that translates stimulus strength into the subjective intensity of reinforcement can be recovered from the observed allocation of behavior. If the subjective rate and intensity of reinforcement are combined multiplicatively, the reward-growth function is simply a scalar transform of the contour lines that define the shape of the mountain along the strength and rate axes. Manipulations that shift the reward-growth function horizontally will displace the mountain along the strength axis, whereas manipulations that rescale the reward-growth function vertically will shift the mountain along the rate axis. By determining the direction of the displacement, one can ascertain whether a given manipulation, such as the administration of drugs that alter dopaminergic neurotransmission, acts prior to or beyond the output of the reward-growth function.

Behavior Under Quadratic Organism-Environment Feedback Systems

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The interaction of behavior with environment can be conceptualized as a feedback system wherein changes in behavior produce changes in the environment which subsequently produce changes in behavior which again produce environmental changes and so on. Previous research utilizing feedback functions has concerned attempts to account for traditional schedule data relating response rate and reinforcement rate (McDowell & Wixted, 1988). An alternative approach involves arranging environments through explicit specification of a feedback function. Six pigeons were exposed to environments in which reinforcement rate was a quadratic or hyperbolic function of response rate. Stable state data from the quadratic feedback function environment were not consistent with a hyperbolic form of an organism equation but were consistent with a maximizing account. Stable state data from the hyperbolic feedback function environment were consistent with a hyperbolic form of an organism equation. Possible explanations for the difference in outcomes concern whether a stochastic versus deterministic scheduling method is used as well as the time window over which the feedback function is defined.

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

7:15 - 7:50 Earlybird Breakfast Tutorial

Armando Machado
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This informal, interactive get-together-over-coffee is primarily intended for people with no quantitative background. The target audience includes both students and established researchers. You are encouraged to attend if you feel that an exposure to a few basics would make your attendance at SQAB more productive, or if you feel that you could lend your insights to help others get up and running. The session will be audience driven. It is not a prearranged lecture. Depending on your interests, it could be a question and answer dialogue or we could cover: a brief introduction to the quantitative tools which will be invoked by the subsequent speakers, an extended treatment of some particular quantitative procedure, or a discussion of analytical conundrums.

8:00 Detecting Contingencies of Reinforcement in Concurrent Schedules

Max Jones & Michael Davison
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Five pigeons were trained on concurrent variable-interval schedules in which two intensities of yellow light served as discriminative stimuli. A conditional discrimination task followed reinforcers obtained from both alternatives. A response to the red side-key was occasionally reinforced if the prior (sample) reinforcer was obtained from the dim alternative, and a response to the green side-key was occasionally reinforced if the sample reinforcer was obtained from the bright alternative. Measures of the discriminability between the concurrent-phase alternatives were obtained by varying the conditional-discrimination reinforcer ratio for correct-red and correct-green responses. Varying the conditional-discrimination reinforcer ratio did not affect response allocation in the concurrent-schedule performance, but varying the concurrent-schedule reinforcer ratio did affect conditional-discrimination performance, a finding incompatible with contingency-discriminability models of concurrent-schedule performance. A finer-grain analysis of the results showed that the detection of response-reinforcer relations decreased with time since changing over, providing a partial explanation for the molar results.

8:41 Coalescing of Gambles: A Behavioral Property to Distinguish Some Broad Classes of Utility Theories

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With subjective expected utility widely acknowledged to fail descriptively, a number of modified theories with numerical representations have been proposed. They can be divided into those exhibiting or not the following behaviorally testable property: Suppose a gamble with n alternatives has two identical consequences. Coalescing is said to hold for a person if this gamble is seen as indifferent to the one of order n-1 in which the union of the underlying events having identical consequences is treated as a single event. One of the more important theories that do satisfy coalescing is rank dependent (or cumulative prospect) theory. Moreover, that theory is characterized by coalescing together with two other simple necessary conditions: (i) for a fixed event partition, the consequences have a simple additive representation and (ii) for compound binary gambles the property of event commutativity holds.

9:22 *Break - Refreshments*

9:37 Timing Performance Deficits: Pharmacokinetic-Pharmacodynamic Modeling of Stimulatory and Sedative Effects of Alprazolam on DRL 45-s

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An integrated pharmacokinetic pharmacodynamic (PKPD) model was developed to describe and characterize the effect of alprazolam on shorter-response rate and reinforcement rate of DRL 45-s, using two routes of administration (i.v. and s.c.). A 3-h session allows investigation of onset, peak and disappearance of alprazolam effects in rats. The two peaks of shorter-response rate following s.c. alprazolam were modeled as a stimulation-sedation PD model incorporating two opposing effect-link sigmoid Emax functions. This model suggested that alprazolam possesses both stimulatory and sedative effects in a continuous, but sequential fashion, which corresponded to low- and high-concentration effects reflected by their respective EC50 values. The i.v. dose identified the second peak as a transient, "rebound" phase in the recovery from drug effect, and the first peak (absent following i.v. dose) as the transition phase before onset of the sedative effect. The reinforcement rate, characterized by the indirect response model, is an index for evaluating the deficit in timing performance.

10:18 Logistic Model of Drug and Toxicant Induced Behavior Changes Under Concurrent Schedules

Christopher Newland & Phyllis Reile
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The behavior of rats and monkeys undergoing a transition from one concurrent schedule parameter follows a pattern that can be generally described as "S"-shaped. At times, the leading portion of the S is very short, leading to a curve that appears to be hyperbolic, but when transitions are examined on a visit-by-visit basis, that is, when behavioral measures are recorded every time the animal changes from one schedule to another, an S-shaped pattern often develops. This S shape is especially notable in squirrel monkeys exposed to lead and in rats administered acute doses of haloperidol or amphetamine. Two approaches to characterizing this S shape, a logistic and a Gompertz equation, generally provide better descriptions of the transition than a hyperbolic curve. The logistic equation is symmetric about the inflection point and the Gompertz tapers off more slowly than it rises. It is difficult to distinguish between these two equations at this level of analysis, but the form of the equation has important implications for the model producing it, so other levels of analysis may be helpful.

Association for Behavior Analysis Begins 11:00 AM

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

Bill Palya, Program Chair
Jacksonville State University

∫QAB-Invited Preeminent Tutorials

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

1:00 **From Basics to Contemporary Paradigms: Aversive Events and Behavior**
Philip N. Hineline, *Temple University* (hineline@astro.ocis.temple.edu)
Chair: Marc Branch, *University of Florida* (branch@psych.ufl.edu)
Friday 1:00-1:50 pm Mississippi

Aversive events participate in two major categories of behavioral process: Punishment and Negative Reinforcement. Azrin & Holz's (1966) classic analysis continues to provide the basic framework for our understanding the former, which will be addressed only briefly in relation to an issue of ethics and of the reputed side effects of punishment. Intrusions from ordinary language, which conflate "vengeance" with the behavioral meaning of punishment as concerning response decrement, have complicated the study of punishment and contributed to the difficulty of discerning appropriate from inappropriate practice where punishment is involved. Negative reinforcement has often been addressed through the lens of avoidance theories whose exclusively molecular analyses have masked several of the relationships that are involved. Viewing aversive events as comprising a continuum of frequency enables one type of analysis; focusing upon short- term postponement, irrespective of frequency, enables another. Ironically, the role of warning stimuli is best illustrated by superimposing them on Sidman's classic shock-postponement procedure, whose initial contribution was to show that such stimuli are not necessary for the maintenance of behavior. Superimposed stimuli play an especially important role, however, in enabling the simultaneous operation of negative reinforcement on different but overlapping time scales.

2:00 **From Basics to Contemporary Paradigms: Chaos**
James T. Townsend, *Indiana University* (jtownsen@indiana.edu)
Chair: Jack Marr, *Georgia Institute of Technology* (mm27@prism.gatech.edu)
Friday 2:00-2:50 pm Mississippi

Chaos theory has seemed to take the world by storm. There has been much chaos in the descriptions of, and prognostications for, this admittedly fascinating topic. What is chaos and can it be described in laypersons' terms without lying too much? I will offer a simple tour of some of the main concepts, which can be understood with only a modicum of quantitative background (although, of course, serious research would request much deeper training). Some of the concepts we will touch upon are: 1. A rigorous (comprehensible) definition and its main ideas including "sort of" periodicity and the butterfly effect. 2. Its place as part of dynamic systems theory. 3. The connections to fractals and "weird" fractal dimensions. 4. Lyapunov exponents. 5. Strange attractors. 6. Randomness in deterministic systems. I will also hazard some speculation as to chaos theory's applicability to psychology and biology, with some reference to its usage in philosophy, physics and chemistry

3:00 **From Basics to Contemporary Paradigms: Delay Reduction**

Edmund J. Fantino, *University of California - San Diego* (efantino@ucsd.edu)
Chair: Richard L. Shull, *University of North Carolina - Greensboro* (shullr@goodall.uncg.edu)
Friday 3:00-3:50 pm Mississippi

Delay-reduction theory is a theory of choice which states that the value of an outcome is best gauged by calculating how much of an improvement the outcome represents relative to the value of the prior situation. Delay-reduction theory thus stresses relativistic, rather than absolute, temporal events. It has had application in several areas, including conditioned reinforcement, foraging, memory, and self-control, where it has been used as a means of generating fruitful empirical predictions. The tutorial discusses the basic nature of the theory and examples of how it may be applied.

4:00 **From Basics to Contemporary Paradigms: The Matching Law**

Gene M. Heyman, *Harvard University* (gmh@wjh.harvard.edu)
Chair: Howard Rachlin, *State University of New York - Stony Brook* (hrachlin@psych1.psy.sunysb.edu)
Friday 4:00-4:50 pm Mississippi

Rational choice theory is our best prescription for how to make choices. The matching law is our best description of how choices are made. To test whether matching is compatible with rational choice theory, experimenters have arranged settings in which matching does not yield the highest overall reinforcement rate. The typical result is that despite the loss in reinforcment rate, matching persists. This is surprising in that the subjects appear to have preferred less reinforcement to more reinforcement (which is nonsensical). The purpose of this tutorial is to outline a series of findings that resolves this apparent contradiction. The key result is that any given choice situation can be framed so that matching is a form of economic rationality, and, conversely, economic rationality can be re-framed as a form of matching.

∫QAB Books Available at Conference Prices

The following volumes of **The Quantitative Analyses of Behavior** are available at conference prices. Take this opportunity to fill in your missing volumes or have your library order a set. An order form is included for your convenience.

	List Price	Conference Price
Volume 2 Commons, M. L., Herrnstein, R. J., & Rachlin, H. (Eds.). (1982). Matching and maximizing accounts. Cambridge, MA: Ballinger.	$99.95	$49.95
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Volume 11 Commons, M. L., Grossberg, S., & Staddon, J. E. R. (Eds.). (1991). Neural network models of conditioning and action. Hillsdale, NJ: Erlbaum.	$79.95 (cloth) $39.95 (paper)	$49.95 $31.95

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At a Glance

Wednesday Evening, May 21 — *Parlor C*

5:00 - 8:00+ *Registration and Cash Bar*

Thursday, May 22 — *Sheraton Ballroom #5*

7:00 *Registration, Coffee and Pastries*
7:30 **Breakfast Tutorial** *(Armando Machado)*
8:35 **President's Introduction** *(John A. Nevin)*
8:45 **Howard Rachlin**
9:26 **Steven R. Hursh & Gail Winger**
10:07 **Terry Belke**
10:48 *Break - Refreshments*
11:03 **Michael Commons**
11:44 **Arata Kubota**
12:25 *Lunch Break*
1:45 **George Collier & Deanne F. Johnson**
2:26 **Charles Shimp, Thane Fremouw & Walter Herbranson**
3:07 **M. E. Bitterman & Patricia Couvillon**
3:48 *Break - Refreshments*
4:03 **Joel Myerson & Leonard Green**
4:44 **David Case**
5:25 *Break*
5:30 **Business Meeting** *(John A. Nevin, President)*

5:30 **Poster Session** / *Cash Bar* — ***Sheraton Ballroom #1***

Bentes; Catania, Sagvolden & Aase; Chu, Eld & Killeen; Cleaveland; Commons; Conover & Shizgal; Hernandez-Pozo & Mendez-Ramirez; Kessel, Lucke, Palya & Walter; Khutoryansky, Field & Hineline; Kraft & Baum; MacDonall; Machado & Cevik; Milinder & Baum; Miller & Draney; Miller & Goodheart; Mitchell, Schmitt; Myers & Davis; Nevin, Soederberg & Stine-Morrow; Reyes et al; Richards, Zhang, Crean, Chock, Mitchell & de Wit; Roche & Timberlake; Santoyo V; Schwendiman; Shizgal & Conover; Soto

Friday, May 23 — *Sheraton Ballroom #5*

7:00 *Coffee and Pastries*
7:00 **Breakfast Tutorial** *(Armando Machado)*
8:00 **Max Jones & Michael Davison**
8:41 **R. Duncan Luce**
9:22 *Break - Refreshments*
9:37 **Chyan E. Lau & John L. Falk**
10:18 **Christopher Newland & Phyllis Reile**

Friday, May 23 SQAB-Invited Preeminent Tutorials (during ABA) — *Mississippi*

1:00 **Aversive Events and Behavior** *(Philip N. Hineline)*
2:00 **Chaos** *(James T. Townsend)*
3:00 **Delay Reduction** *(Edmund J. Fantino)*
4:00 **The Matching Law** *(Gene M. Heyman)*