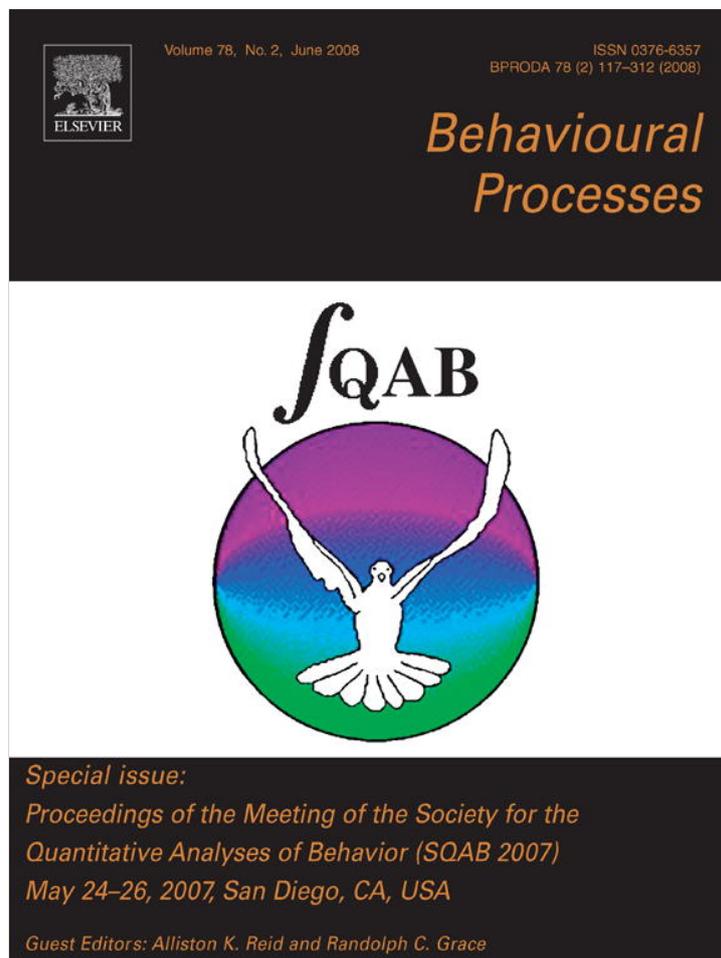


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Preface

SQAB 2007: Completing the circle

The 30th Annual Meeting of the Society for the Quantitative Analyses of Behavior (SQAB) took place at the Manchester Grand Hyatt in San Diego, CA, USA on 24–26 May 2007. Beginning in 1978 as the ‘Harvard Symposium’ held at William James Hall at Harvard University for several years, SQAB has held its annual meeting in conjunction with the Association for Behavior Analysis International since 1993. Chapter-length papers stemming from this conference were originally published in books in the Quantitative Analyses of Behavior Series. Beginning in 2000, an agreement with the journal *Behavioural Processes* allowed SQAB presenters to submit their papers for consideration for publication in a special issue representing peer-reviewed proceedings of the conference. This agreement, along with the diligent work of the authors, editors, reviewers, and Elsevier Press, has produced a rapid 1-year turn around between oral presentation at SQAB and peer-reviewed articles in this special issue of *Behavioural Processes*, delivered into the hands of every SQAB member attending the meeting the following year. Since the special issue for the 2006 conference, an additional category of short communications has been available for researchers presenting posters at SQAB. These manuscripts undergo the same peer-review process as full-length papers. As a result, the number of articles stemming from SQAB presentations and posters has increased, and the quality of these articles is universally high.

Have our quantitative analyses changed over the 30 years of research presented at SQAB? A thorough longitudinal study of our analytic methods would be very interesting. It would also be fascinating to identify changes in the types of behavioral phenomena that have been studied over this period. Although a detailed evaluation is not appropriate here, it is enlightening to compare the quantitative methods employed in this special issue with those represented in the early books in the Quantitative Analyses of Behavior Series. Quantitative analyses have changed over the years, and this change represents the maturation of behavior analysis as an empirical science using well-established methods for the experimental sciences.

The Harvard Symposium began shortly after the development of highly successful quantitative models of Pavlovian conditioning by Rescorla and Wagner (1972), the generalized matching law by Baum (1974), and the marginal value theorem in behavioral ecology (Charnov, 1976). Powerful models of behavioral economics applied to operant behavior were imminent (Green

et al., 1982; Rachlin and Burkhard, 1978; Staddon, 1979). It was clear that mathematical models could describe behavior and make precise quantitative predictions in novel situations. The participants in the Harvard Symposium developed elegant, creative models of behavior that, even 30 years later, continue to have important influences in our field. Some behavior analysts were discouraged by this move to quantitative models, but many more welcomed this approach. As in other mature sciences, the success of mathematical models in describing empirical relationships was compelling, and led to theoretical developments. Behavior analysis could never return to the pre-mathematical baseline.

When the ‘‘SQAB-Invited Preeminent Tutorials’’ began in 1996, William (Bill) Palya spelled out clearly what was meant (at that time) by ‘‘quantitative analysis’’ in his introduction at the beginning of each videotape (now DVDs). Quantitative analysis was different from other techniques of measuring ‘the’ dependent variable because it required taking enough measurements to allow clear specification how the variable changed over time, trials, or whatever the x -axis represented. Measurements of dependent variables should allow the quantitative specification of the dependent variable as a function of the independent variable: $DV = f(IV)$. Of course, the real challenge was to discover this function.

Consider the ‘scientific method circle’ taught in undergraduate methodology courses. As usually depicted, the hypothesis to be tested is located at 12:00, and the 6:00 position represents the point at which the data have been collected, ready for interpretation. The right side of the circle represents the procedures relying on deductive logic, in which the hypothesis makes precise, testable predictions in carefully designed, well-controlled experiments. The left side of the circle represents the procedures relying on inductive logic: apply inferential statistics, decide what the data imply about the hypothesis, evaluate the adequacy of the hypothesis, and so forth. The gap between, say, 9:00 and 12:00 is usually the weak part of the scientific method circle, at least the way it is described in most textbooks. This fuzzy gap represents the logic between the completed inferential statistics on the data, the support or falsification (modification/rejection) of the model/hypothesis, and the design of a new hypothesis to test. After all, how is Popper’s falsification principle actually accomplished in our field?

One improvement in our quantitative analyses over the last 30 years has involved ‘completing the circle’—we fill this gap with techniques that may not have appeared necessary in the early years of SQAB. These include the use of multiple data sets, non-linear regression, and techniques for model selection. They also help us identify additional research that should be done. As the number and accuracy of existing quantitative models has increased over these years, the articles in this special issue are more concerned with model selection than ever before. Selection between competing models sometimes involves the deductive side of the circle: some articles focus on quantitative differences in prediction made by competing models, so they involve precise tests of these predictions. Selection between competing models may also involve the inductive side of the circle: Competing models sometimes account for approximately the same high proportions of variance (VAC) in a single data set, so multiple data sets across experiments must be combined to select between models. Competing models often differ in the number of free parameters, so model selection techniques that have been specifically designed to consider both the number of parameters and the VAC can be found in many of the articles in this special issue, such as Akaike’s information criterion, the likelihood ratio test, and a promising new technique called *residual meta-analysis*. We hope you will notice how the papers in this special issue contribute to ‘completing the circle’ and provide answers to how inference and Popper’s falsification principle can be accomplished in non-trivial ways in our field.

In behavior analysis, we informally adopt the position that behavior = $f(\text{environment})$. When we use the term “Environment,” we usually mean both the organism’s reinforcement history and the current reinforcement contingency (and sometimes more, such as biological constraints). When well-known schedules of reinforcement are used in experiments with rats or pigeons, the ‘current reinforcement contingency’ may be well specified as concurrent schedules, concurrent chains, or progressive ratios, which clearly specify the relation between responding and reinforcement. But this is not the normal situation of human behavior in natural environments where complex contingencies are not accurately categorized into the common reinforcement schedules. The contingencies produced by human social interactions have been particularly difficult to classify into discrete categories that can be studied in the lab. In order to advance behavior analysis further into the applied human realm, we need unambiguous specification of what we mean by ‘current reinforcement contingencies’. The article in this special issue by Francis Mechner provides a powerful beginning of this specification, representing the culmination of years of careful evaluation of natural contingencies.

Following in the footsteps of Skinner (1958) and Snapper et al. (1982), Mechner presents a formal symbolic language designed to codify any behavioral contingency, including the flexibility, richness, and complexities of natural contingencies influencing human behavior, even those involving multiple participants. Its purpose is not to provide another model of the behavior of organisms adapting to reinforcement contingencies (the entire equation above), which of course is the dominant approach in the quantitative analyses of behavior. Instead, Mech-

ner characterizes behavioral contingencies in their own right (the right side of the equation), without consideration of how organisms adapt to these contingencies (the left side). Specifying the characteristics of only the right side of the equation, Mechner carefully specifies the “if . . . then” contingencies (including temporal relationships) imposed on humans in a wide variety of situations, including social, competitive ones and those more familiar to behavior analysts working with rats or pigeons in controlled environments. Even as a first step toward this goal, this is an enormously ambitious project with applications extending from applied behavior analysis to public policy and international affairs. For laboratory researchers, this paper invites consideration as to levels of analysis (e.g., what is a response unit?) and whether it adequately distinguishes between contingencies involving very different time frames. Not only does it make a substantial contribution to applied behavior analysis and game theory, there seems to be something of interest for everyone!

Three articles in this special issue describe interesting research related to behavioral momentum and conditioned reinforcement. Shahan and Podlesnik review an impressive program of research which has investigated whether quantitative models such as the matching law and behavioral momentum theory can be applied to attending, that is, behavior which brings an organism into contact with goal-related stimuli. Many of their experiments have used the observing-response procedure, in which unsignalled periods of reinforcement and extinction alternate on a main key, while responses to a second key produce changes in the stimulus on the main key. These are called ‘observing’ responses because their only consequence is to provide information about the availability of reinforcement. The experiments reviewed by Shahan and Podlesnik show that both the rate and allocation of observing responses are well described by the generalized matching law, as is the relative accuracy of responding in a divided-attention task. Moreover, the persistence of observing responses was found to be related to the rate of primary reinforcement during the unsignalled period on the main key, but not the rate or value of conditioned reinforcers produced by the observing responses, suggesting that in terms of behavioral momentum theory, the strength of observing responses depends on the rate of primary reinforcement in the context in which observing occurs. In addition to demonstrating that the matching law and behavioral momentum theory can provide a useful approach for investigating how attending behavior is controlled by its consequences, Shahan and Podlesnik’s results are also relevant to our understanding of conditioned reinforcement. The finding that rate and allocation of observing behavior depends on parameters of the stimuli produced by the observing responses, whereas resistance to change does not, suggests that the discriminative and strengthening functions of reinforcing stimuli can be dissociated (cf. Davison and Baum, 2006). Identifying the possible conditions in which conditioned reinforcers serve a strengthening role is an important goal and should have implications for the applicability of momentum theory to human behavior.

Matthew Bell and his colleagues have contributed two related papers to this special issue. Both investigate the factors that influence resistance to change in multiple schedules. Early ver-

sions of behavioral momentum theory proposed that resistance to change was determined solely by Pavlovian (stimulus-reinforcer) contingencies. Subsequently, several researchers demonstrated that resistance to change was influenced by other factors unrelated to the Pavlovian contingency, such as reinforcement delay (Grace et al., 1998) and conditioned reinforcement (Bell, 1999), and the model was modified to include the effects of generalization decrement (Nevin et al., 2001). Measurement of resistance to change is a complicated situation that could involve a variety of influences on responding. Baseline responding on a schedule of reinforcement involving at least two stimuli (e.g., multiple schedules) must be disrupted by changes in incentive motivation (e.g., prefeeding or free food) or a change in reinforcement contingency. Even if this change maintains constant stimulus-reinforcer relations, it might involve changes in reinforcement delay, conditioned reinforcement, generalization decrement, and strong changes in the incentive properties of responding. Therefore, separating these potential influences requires the convergence of multiple experiments with carefully controlled procedures.

Following up on the work by Bell et al. (2007), the article by Bell, Gomez, and Kessler asks whether resistance to change in three-component multiple schedules (thus involving several stimuli before and after the change) is influenced by conditioned reinforcement or generalization decrement. Their procedure with pigeons involved chained schedules as components of the multiple schedule, and the terminal stimulus of one component was shifted to another component when resistance to change was assessed. Relative resistance to change increased in the condition potentially involving conditioned reinforcement, rather than decreasing as would be expected in disruption procedures. In this condition, their results implied an influence of conditioned reinforcement on resistance to change because conditioned reinforcement would be predicted to increase responding, whereas generalization decrement would predict a decrement in responding.

The Short Communication by Alana Dulaney and Matthew Bell also investigated generalization decrement as influences on resistance to change during an extinction-based disruption procedure. Nevin et al. (2001) proposed that extinction as a disruption procedure could be understood in terms of additive effects of generalization decrement due to change in reinforcer rate, and suspension of the response-reinforcer contingency. Dulaney and Bell examined the effects of reinforcement magnitude and generalization decrement on resistance to change in two components of a multiple schedule that provided either 2- or 8-s reinforcer duration. Magnitude of generalization decrement was also manipulated across groups of pigeons by providing hopper-associated stimuli or blackout during the extinction condition. As predicted, resistance to change was greater with the larger reinforcer and for the group with hopper-associated stimuli, yet there was an interaction between reinforcement magnitude and the extinction conditions across sessions.

Two Short Communications in this special issue concern the ways in which concurrent choice in pigeons adjusts to rapid changes in concurrent reinforcement contingencies. The first article, by Elizabeth Kyonka, measures adjustment in choice

when reinforcer rate and reinforcer magnitude were manipulated independently across sessions in a concurrent reinforcement schedule. Stabilizing within sessions, the pigeons' response allocations were determined by reinforcer rates and magnitudes from the current session, rather than those from previous sessions. Importantly, reinforcer rate and magnitude did not appear to interact, supporting the assumptions of additivity and independence in Davison and McCarthy's (1988) concatenated generalized matching law, which describes response allocation when outcomes differ on multiple reinforcer dimensions.

The second paper involving rapid changes in reinforcement contingencies, by Darren Christensen and Randolph Grace, explored the changes in initial-link response allocation when initial-link duration changed systematically across sessions. One goal of this research was to extend Grace and McLean's (2006) decision model, which was designed to account for performance in rapid acquisition experiments when the terminal links are frequently changed. Since this model did not address effects of initial-link duration on response allocation, this experiment provided the data necessary to extend the model. As the initial-link duration was systematically increased, preference for one terminal link increased then decreased as a bitonic function, counter to the monotonic functions predicted by existing models for steady-state choice. An extension of the Grace and McLean (2006) decision model was able to account for this bitonic function.

An intriguing paper by Sutton, Grace, McLean, and Baum asks how one should select between two models when they are similar in many ways. The generalized matching law (Baum, 1974; Baum et al., 1999) and the contingency discriminability model (Davison and Jenkins, 1985; Davison and Jones, 1995): (a) make very similar predictions over the ranges of reinforcer ratios typically studied in parametric concurrent schedules (e.g., 10:1 to 1:10); (b) account for approximately the same high proportions of variance (r^2); (c) have the same number of free parameters. Their solution is to create a methodology they call *residual meta-analysis*. Their meta-analysis involved 20 studies of concurrent schedules, but the new feature was that the across-study comparisons were carried out on individual-subject residuals from estimated parameter values for the two models. To test for systematic deviations in the two models' predictions, polynomial regressions were conducted in which the residuals were regressed on the predicted values. *Residual meta-analysis* shows much promise as a new technique of model selection when the models are similar, supplementing other methods of comparing model fits (e.g., the likelihood ratio test, Akaike's information criterion, the Bayesian information criterion, bootstrapping, and cross-validation) (Hélie, 2006). This new technique provides a powerful quantitative method to 'complete the circle'.

The Short Communication by Vladimir Lefebvre and Federico Sanabria explores an alternative account of matching. Whereas the generalized matching law has become the dominant account of matching, Baum et al. (1999) has argued that deviation from matching may be due to a policy of fixing on the preferred schedule and occasionally sampling the alternative schedule. Such fixing and sampling produces a discontinuous matching function. Lefebvre and Sanabria first propose a general

form of this discontinuous model, called the fix-and-sample (FS) model, and then they propose a hypothetical local choice mechanism consistent with observed fix-and-sample choice patterns. They show how this choice model is related to Lefebvre's (2006) Model of Bipolar Choice. An interesting aspect of this choice model is their proposal of the Axiom of Repeated Choices, in which organisms make a preliminary choice, yet with some probability cancel that choice and repeat the choice procedure. Even though the model needs further development before its predictions can be adequately compared to actual data sets, it already produces unique predictions that allow it to be tested.

James MacDonall presents an extension of his 'stay/switch model' to choice between concurrent schedules that differ in reinforcer magnitude. The basic premise of this model is that organisms responding under concurrent schedules face not just two choices, but two pairs of choices depending on which alternative they are currently responding to: Between continuing to respond at that alternative or switching to the other alternative. In MacDonall's procedure, these four schedules can be manipulated independently and their effects on response allocation observed. As he notes, the four schedules are implicit in the traditional concurrent-schedules procedure, except that the reinforcement schedule for staying at one alternative is equal to that for switching to that alternative—which he terms the 'symmetrical' arrangement. Results of MacDonall's experiment show that the generalized matching law can describe choice between different reinforcer magnitudes in the symmetrical conditions, but response allocation in other conditions deviates from predictions of generalized matching in the direction predicted by the stay/switch model. These results are similar to those obtained with concurrent schedules that differ in terms of reinforcer rate (e.g., MacDonall, 2005). MacDonall suggests that the stay/switch model may provide a more comprehensive account of choice than the generalized matching law, but an alternative way of viewing his model is as an extension of generalized matching that predicts deviations from matching when a bias favoring one alternative increases the overall rate of reinforcement. Given the considerable recent progress in understanding how acquisition processes might yield matching in steady-state concurrent schedules (e.g., Davison and Baum, 2000; Crowley and Donahoe, 2004; Schofield and Davison, 1997), it would be interesting to explore how MacDonall's procedure and the stay/switch model could be used to study choice in transition.

Two other Short Communications used human participants. Rothstein, Jensen, and Neuringer investigated whether a concurrent-choice procedure with five alternative responses could be used for the rapid assessment of sensitivity to reinforcement contingencies in humans. In their task, participants responded by making computer mouse clicks in five different wedge-shaped regions. Progress towards earning points was indicated by filled bars for each of the wedges. Rothstein et al. compared conditions in which points made available by an alternative were maintained until collected (hold condition) or decreased over time if not collected (decay condition). Sensitivity of response allocation to relative reinforcement rates was greater in the decay condition. Overall, data from their new pro-

cedure were orderly and suggest that it may be useful in future research on human behavioral choice.

Tamez, Myerson, and Hale report a replication and extension of a provocative study by Williams and Pearlberg (2006), who found that humans' performance on a task which required learning of three-term contingencies was positively correlated with intelligence (as measured by the Raven Advanced Progressive Matrices test; RAPM; Raven et al., 1998) but not with working memory. Tamez et al. found that performance on the three-term task explained about 25% of the variance in RAPM scores, replicating Williams and Pearlberg's result. Taken together, results of these studies suggest that individual differences in learning may play a greater role in performance on intelligence tests than previously thought.

The Short Communication by Pablo Covarrubias and Carlos Aparicio was designed to assess how well the Mathematical Principles of Reinforcement (MPR) model, which predicts performance well on fixed-ratio schedules, can be extended to progressive-ratio schedules of reinforcement. They manipulated both ratio step size (PR 1 or PR 3) and reinforcer type (saccharin or standard pellets). Rats receiving saccharin pellets completed higher ratio values than those receiving standard pellets. They also completed higher ratio values with the larger step size (PR 3) than with the smaller step size (PR 1). Non-linear regression was used to assess fits to MPR, with the goal of identifying how manipulations affected each model parameter. Estimated values of the specific activation parameter, α , which represents the intrinsic properties of the reinforcer, were unexpectedly influenced by step size. Their quantitative analysis represents an interesting technique of 'completing the circle'.

Two papers describe research involving stimulus interactions in Pavlovian conditioning. Wheeler and Miller review recent studies which have shown that some manipulations that retard acquisition of Pavlovian conditioning when presented in isolation, such as overshadowing and latent inhibition, can counteract each other when applied to the same target stimulus. For example, Blaisdell et al. (1998) showed that both latent inhibition and overshadowing reduced responding in a conditioned suppression paradigm when either was presented, but a group of rats that received both latent inhibition and overshadowing showed equivalent conditioned responding to a control group that received neither treatment. These and other similarly surprising results can be explained by the extended comparator hypothesis (ECH; Denniston et al., 2001). According to the ECH, conditioned responding is determined by the degree to which a CS predicts the occurrence of the US relative to other 'comparator' stimuli that were present during training. Comparators can be a punctuate stimulus or the experimental context (in the case of overshadowing and latent inhibition, respectively). To explain counteraction, the ECH assumes that each comparator stimulus – in the case of overshadowing and latent inhibition, the overshadowing stimulus and the context – acts as a comparator for the other, thus reducing their ability to degrade responding to the target CS. With the inclusion of a specific learning rule, the ECH is able to account for an impressive range of basic conditioning phenomena (Stout and Miller, 2007).

In a Short Communication, Bertram Ploog describes an experiment using an autoshaping paradigm with pigeons that tests summation and subtraction processes using elemental and compound stimuli. Although summation did not occur, evidence for subtraction (i.e., in which responding to elements of a configural stimulus combine to equal responding to the configural stimulus) was obtained in some conditions. Ploog evaluates predictions of Pearce's (1987) configural theory, the Rescorla and Wagner (1972) model, and Weiss' (1972) composite-stimulus control model, and concludes that different processes underlie stimulus summation and subtraction.

The Short Communication by Joana Arantes continues a series of studies using Machado and Keen's (1999) double temporal bisection procedure to compare differing predictions of scalar expectancy theory (SET) and the learning-to-time (LeT) model. Previous studies with this procedure have manipulated the duration of a stimulus (e.g., a houselight) and measured responding to two keys in a simultaneous discrimination procedure. Arantes shows how SET and LeT make different predictions in a successive version of the double temporal bisection task, when after the signal duration the pigeon is presented only with one illuminated key (the S+ or the S-), and it must choose between pecking or not pecking the key. Her results provide compelling evidence in favor of the LeT model, and once again demonstrate the power of this procedure.

The research described by Lavinia Tan is related to temporal discrimination studies, but in this case the task actually involved the production of a specific number of responses in a delayed matching-to-sample (DMTS) task. Pigeons were required to peck once to a lighted response key, and the key was presented repeatedly as 'flashes', producing stimulus–response pairs. The procedure is called a numerical reproduction task, because after a delay the subject was required to produce the same number of pecks to this key, followed by a terminating peck on another key (reminiscent of a fixed consecutive number schedule). In time-based DMTS tasks, as the delay duration increases, pigeons tend to choose the key representing the shorter duration (the 'choose-short effect'). The main question of interest is whether the pigeons in this numerical reproduction task would 'produce-short', as one might expect if timing and counting are related processes. The second goal was to test a new prototype category-learning model developed by Tan et al. (2007) which distinguishes between a common representation of time and number based on a continuous, analogical scale of magnitude, and a categorical representation of number based upon comparisons of the current trial and categorical prototypes acquired by exposure to dozens of trials of differing characteristics. Tan observed a number-dependent 'produce-large' effect, which implies that representations of time and number may differ, and provides some support for the prototype category-learning model.

Zentall, Singer, and Miller also describe an experiment using a delayed matching-to-sample procedure with pigeons which tests whether the probability of a comparison response during training affected choice when sample frequency and the number of reinforcements were equated. In their experiment, pigeons were trained with three samples (red, green, and yellow key-

lights), and two comparison stimuli (red and green keylights). For one sample (e.g., green), choice of the corresponding comparison stimulus was reinforced 100% of the time, whereas for the other two samples (e.g., red and yellow), choice of the red comparison stimulus was reinforced 50% of the time. Because all samples were presented an equal number of times, the red comparison stimulus was 'correct' on twice as many trials, although because it was reinforced only 50% of the time, the number of reinforcers obtained for red and green choices were equal. Results showed that matching accuracy declined more rapidly as a function of delay for trials on which the green response was correct, suggesting that pigeons had a bias to respond to the key that was more frequently chosen during training (i.e., the red key). Zentall et al. conclude that their results indicate that DMTS responding is determined by more than just the conditional probability of reinforcement for a response given a sample and the overall probability of reinforcement for a choice response—the frequencies with which samples are presented and comparison choices occur in training also influence test performance (see also Zentall and Clement, 2002). How memories for sample and comparison-response frequencies are to be incorporated into models for DMTS performance remains a task for the future.

In their Short Communication, Elias Robles and Perla Vargas continue their research on procedural variations on the delay discounting task with human subjects (Robles and Vargas, 2007). They note variations in the literature in the amount of effort involved in making choices during estimation of delay discounting. As a result, their goal was to identify the effects that effort during the assessment task might have on the degree of delay discounting in a computerized version of the temporal discounting procedure. By manipulating the number of total choices required to measure indifference points, both groups produced approximately the same delay gradients. Thus, the amount of effort involved in making choices did not seem to influence the obtained gradients. However, the ascending vs. descending adjustment order for immediate reward did affect the gradient, with participants discounting less with a descending sequence than with an ascending sequence.

Three short communications were designed to test predictions made by published computational models or to extend these models into new territories. The paper by Saule Kulubekova and Jack McDowell takes another step (McDowell and Caron, 2007) toward the validation of McDowell's (2004) computational model of selection by consequences. This model implements selection by consequences in a virtual organism with an evolving repertoire of possible behaviors undergoing the Darwinian principles of selection, reproduction, and mutation. The computational experiment in this special issue examined the model's behavior on the molecular level by comparing the virtual organism's evolved IRT distributions on random-interval schedules, measured as log survivor plots, to results from live organisms. The model's log survivor plots did not show the 'broken stick' feature observed in the patterns of bouts and pauses in rats, but the gradual bends in these plots were consistent with data obtained from pigeons. This finding lends further support for this causal model of behavior.

Spatial navigation can logically be divided into two parts, knowledge and action. Spatial knowledge is often described as a ‘cognitive map’, which may be rudimentary or fine-grained. Even assuming the existence of a cognitive map, spatial navigation involves movement from one spatial location to the next, and movement patterns depend strongly upon the organism’s reinforcement history in this spatial area. The Reid and Staddon (1998) Dynamic Route Finder is a deterministic computational model that makes detailed predictions about movement patterns of organisms in environments with any specified reinforcement history and with ‘cognitive maps’ of any specified complexity. Jaime Robles and Cristina Vargas-Irwin test the claim that the dynamic route finder predicts complex movement patterns that are highly sensitive to the initial conditions (which represent the organism’s reinforcement history in this spatial area) and represent an example of deterministic chaos. Their simulation study evaluated whether these predicted movement patterns resemble chaotic patterns. They observed the same complex, non-linear, bifurcation patterns as those generated by chaotic systems, supporting the claim that this deterministic model can produce complex movement patterns beyond those expected by the simplicity of the model’s underlying stimulus generalization process.

Finally, José Burgos and his colleagues continue to explore implications of the Donahoe et al. (1993) selectionist neural network model by conducting simulations of additional phenomena (Burgos and Murillo-Rodríguez, 2007). In this case, Burgos, Flores, Garcia, Diaz, and Cruz show how simultaneous conditioning can facilitate subsequent acquisition of conditioned responding in a forward-delay procedure, compared to training with explicitly unpaired stimuli, in both a neural-network simulation and rats. In addition to a provocative comparison between artificial neural networks and real rats, Burgos et al.’s contribution is noteworthy because it suggests a mechanism for the facilitation effect of simultaneous training in terms of increased connection weights in the neural network—that is, a learning-performance distinction exemplified in a neural network.

There you have it—21 articles plus this preface, representing some of the most interesting research in the quantitative analyses of behavior to whet your intellectual appetite. These articles make important contributions to the individual research areas, and many of them provide quantitative methods for ‘completing the circle’ that can be applied to many research areas. The incorporation of techniques for multiple data sets and model selection is strong indication of the cumulative progress in quantitative analyses over these years. It is notable that research in the quantitative analyses of behavior continues its successful pattern of growth over the last 30 years, both in the number of researchers engaged in quantitative analyses and in the number of presentations at SQAB. Such healthy growth in rigorous science offers much promise for the next 30 years.

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Alliston K. Reid*

Wofford College, Department of Psychology, 429N. Church Street, Spartanburg, SC 29303, USA

Randolph C. Grace¹

University of Canterbury, Department of Psychology, Private Bag 4800, Christchurch, New Zealand

* Corresponding author. Tel.: +1 864 597 4642.

E-mail addresses: Alliston.Reid@Wofford.edu (A.K. Reid), randolph.grace@canterbury.ac.nz (R.C. Grace)

¹ Tel.: +64 364 2987 7996.

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