Proceedings of the Tenth Annual International Conference On Comparative Cognition

Sponsored by the
Comparative Cognition Society*

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Melbourne Beach, Florida

* President: Suzanne MacDonald
Secretary: Marcia Spetch
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Program Committee: Mike Brown (Chair), Suzanne MacDonald, Tom Zentall

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Presenters

NAME		INSTITUTION	EMAIL	PRESENTATION
Ursula S.	Anderson	Georgia Institute of Technology & Zoo Atlanta	Uanderson@zooatlanta.org	32
Francisco	Arcediano	Auburn University	arcedian@binghamton.edu	82
Stephanie	Babb	University of Georgia	sbabb@arches.uga.edu	6
Gordon	Bauer	New College of Florida	bauer@ncf.edu	4
Aaron	Blaisdell	UCLA	Blaisdell@psych.ucla.edu	7
Laurie	Bloomfield	University of Alberta	laurie.bloomfield@ualberta.ca	12
Donald	Blough	Brown Univ	Donald_Blough@brown.edu	49
Jean	Boal	Millersville University	jean.boal@millersville.edu	70
Kent	Bodily	Auburn University	bodilke@auburn.edu	59
Kristin	Bonnie	Emory University	kebonni@emory.edu	45
Sarah	Boysen	Ohio State University	boysen.1@osu.edu	101

Dave	Brodbeck	Memorial University of Newfoundland	brodbeck@swgc.mun.ca	21
Sarah	Brosnan	Emory University	sbrosna@emory.edu	94
Michael	Brown	Villanova University	michael.brown@villanova.edu	19
Thomas	Bugnyar	University of Vermont	tbugnyar@zoo.uvm.edu	92
Catalin	Buhusi	Duke University	Catalin.buhusi@duke.edu	29
Jackie	Chappell	University of Oxford	jackie.chappell@zoo.ox.ac.uk	78
Anthony	Chemero	Franklin and Marshall College	tony.chemero@fandm.edu	26
Russell	Church	Brown University	Russell_Church@Brown.edu	36
Jerome	Cohen	University of Windsor	jcohen@uwindsor.ca	20
Matthew	Collett	Michigan State University	Collettm@msu.edu	15
Robert	Cook	Tufts University	Robert.Cook@tufts.edu	2
Jonathon	Crystal	University of Georgia	jcrystal@uga.edu	87
Martha	Escobar	Auburn University	escobmc@auburn.edu	83
Lanny	Fields	Queens College - CUNY	Lanny_fields@qc.edu	38
Timothy	Flemming	Franklin & Marshall College	Timothy.Flemming@Fandm.edu	57
Andrea	Frank	University of Iowa	Andrea-Frank@uiowa.edu	28
Andrea	Friedrich	University of Kentucky	Deafriedrich@aol.com	8
Jennifer	Gates	Appalachian State University	jg36139@appstate.edu	52
Aleida	Goodyear	University of Nebraska, Lincoln	goodyear@unlserve.unl.edu	23
Kazuhiro	Goto	University of Exeter	K.Goto@exeter.ac.uk	64
Emily	Gray	University of Alberta	Ergray@interbaun.com	18
Paulo	Guilhardi	Brown University	Paulo_Guilhardi@brown.edu	35
Robert	Hampton	NIMH	robert@ln.nimh.nih.gov	80
Heidi	Harley	New College of Florida & Epcot's Living Seas	harley@ncf.edu	10
Erica	Hoy	University of Georgia	ehoy@egon.psy.uga.edu	75
Scott	Husband	University of South Florida	husband@luna.cas.usf.edu	88
Tomoko	Inagaki	Hunter College - CUNY	Tomoko22@aol.com	33
Satoru	Ishikawa	Hokkaido University	ishi_s@complex.eng.hokudai.ac.jp	39
Lucia	Jacobs	University of California at Berkeley	Jacobs@uclink.berkeley.edu	91
Taylor	Johnson	Tufts University	Pamela.Johnson@tufts.edu	67
Alan C.	Kamil	U. of Nebraska, Lincoln	akamil@unlserve.unl.edu	90
Jeffrey	Katz	Auburn University	katzjef@auburn.edu	58
Richard	Keen	Brown University	Richard_Keen@Brown.edu	30
Angela	Kelling	Georgia Institute of Technology, Zoo Atlanta	akelling@zooatlanta.org	62
Debbie	Kelly	University of Nebraska-Lincoln	dkelly@unlserve.unl.edu	17
Emily	Klein	University of Kentucky	edklei0@uky.edu	5
Angie	Koban	Tufts University	Angie.koban@tufts.edu	65
Valerie	Kuhlmeier	Yale University	valerie.kuhlmeier@yale.edu	76
Shannon	Kundey	Yale University	shannon.kundey@yale.edu	27
Olga	Lazareva	University of Iowa	olga-lazareva@uiowa.edu	97
Kang	Lee	Queen's University	kang@psyc.queensu.ca	46
Katherine	Leighty	University of Georgia	kleighty@arches.uga.edu	41
Jody	Lewis	University of Nebraska Lincoln	Jlewis@unlserve.unl.edu	72
Chuck	Locurto	College of the Holy Cross	Clocurto@holycross.edu	37
Suzanne	MacDonald	York University	suzmac@yorku.ca	1
Mika	MacInnis	Brown University	Mika_Macinnis@Brown.edu	34
Hiroshi	Makino	Chiba University	hmakino@Cogsci.L.Chiba-u.ac.jp	66
Helena	Matute	Universidad de Deusto	matute@orion.deusto.es	50

Tammy	McKenzie	University of Western Ontario	tmckenzi@uwo.ca	74
Ralph R.	Miller	SUNY-Binghamton	rmiller@binghamton.edu	81
Britta	Osthaus	University of Exeter, UK	b.osthaus@ex.ac.uk	100
Linda	Parker	Wilfrid Laurier University	lparker@wlu.ca	86
Sarah	Partan	University of South Florida	partan@stpt.usf.edu	93
Tadd	Patton	University of South Florida	tbpatton@helios.acomp.usf.edu	48
Guillermo	Paz-y-Miño C.	University of Nebraska-Lincoln	pazymino@unlserve.unl.edu	43
Matthew	Pizzo	University of Georgia	mpizzo@arches.uga.edu	22
Tyson	Platt	Auburn University	plattty@auburn.edu	84
Amy	Pollick	Emory University	apollic@emory.edu	47
Mary Jo	Rattermann	Franklin & Marshall College	Maryjo.Rattermann@fandm.edu	56
William	Roberts	University of Western Ontario	Roberts@uwo.ca	68
Karen L.	Roper	Wake Forest University	roperk@wfu.edu	54
Carrie	Rosengart	University of Georgia	crosenga@arches.uga.edu	9
James	Rowan	Bridgewater College	jrowan@bridgewater.edu	40
Nestor	Schmajuk	Duke University	nestor@duke.edu	25
Bennett L.	Schwartz	Florida International University	schwartb@fiu.edu	3
Sara J.	Shettleworth	University of Toronto	Shettle@psych.utoronto.ca	14
Shannon	Skov-Rackette	University of Toronto	Shannon.Skov.Rackette@Utoronto.Ca	24
Denise	Smith	Kent State University	dpsmith@kent.edu	89
Michael	Snyder	University of Alberta	mrsnyder@ualberta.ca	16
Marcia	Spetch	University of Alberta	mspetch@ualberta.ca	61
Janice	Steirn	Georgia Southern University	jsteirn@gasou.edu	51
Fred	Stollnitz	National Science Foundation	fstollni@nsf.gov	42
Jennifer	Sutton	University of Toronto	sutton@psych.utoronto.ca	60
Bridgette	Szekeres	University of Western Ontario	baszeker@uwo.ca	71
Sabine	Tebbich	University of Cambridge	st281@cam.ac.uk	77
Sayaka	Tsutsumi	Kyoto University	stsutsumi@bun.kyoto-u.ac.jp	96
Claudia	Uller	University of Louisiana – Lafayette	uller@louisiana.edu	44
Jennifer	Vonk	University of Louisiana at Lafayette	Jxv9592@louisiana.edu	31
Edward	Wasserman	University of Iowa	ed-wasserman@uiowa.edu	98
Shigeru	Watanabe	Keio University	swat@flet.keio.ac.jp	85
Cynthia	Wei	Michigan State University	weicynth@msu.edu	73
Alex	Weir	Department of Zoology, Oxford University	alexander.weir@zoo.ox.ac.uk	79
Ronald	Weisman	Queen's University	ron@psyc.queensu.ca	11
Whitney	Werstlein	Appalachian State University	ww38372@appstate.edu	53
Bill	Whitlow	Rutgers University	bwhitlow@camden.rutgers.edu	99
Robert	Willson	University of Greenwich	R.Willson@gre.ac.uk	95
Tony	Wright	University of Texas Medical School at Houston	anthony.a.wright@uth.tmc.edu	55
Clive	Wynne	University of Florida	wynne@ufl.edu	69
Kumiko	Yokoyama	Hunter College, CUNY	Yokoko202@hotmail.com	63
Shaowu	Zhang	Australian National University	swzhang@rsbs.anu.edu.au	13

Co-Authors and Discussants

NAME		INSTITUTION	EMAIL
Robert	Batsell	Kalamazoo College	rbatsell@kzoo.edu
John	Batson	Furman University	john.batson@furman.edu
Shelley	Batts		MixScarlet@aol.com
Robert	Biegler	NTNU	robert.biegler@svt.ntnu.no
Sheila	Chase	Hunter College – CUNY	schase@hunter.cuny.edu
Tricia	Clement	University of Kentucky	triciaclement@hotmail.com
Jennifer	Davis	University of Southern Mississippi	whitewave03@aol.com
James	Denniston	Appalachian State University	dennistonjc@appstate.edu
Steve	Fountain	Kent State University	sl9@statelinenine.com
Jennifer	Fugate	Emory University	jbinzak@emory.edu
Leonard	Green	Washington University of St. Louis	lgreen@artsci.wustl.edu
Eric	Heinemann	Hunter College - CUNY	eheinma@hunter.cuny.edu
Michelle	Hernandez	Auburn University	calipzzo@hotmail.com
Sharon	Himmanen	Lehman College - CUNY	romana@mindspring.com
Megan	Hoffman	Florida International University	
Brooke	Huntley		huntleybm@hotmail.com
Miranda	Karson	Michigan State University	karsonmi@msu.edu
Lauren	Lanza	Franklin & Marshall College	Lauren.Lanza@fandm.edu
Kristen	Keller	Franklin & Marshall College	kkeller@fandm.edu
Radhika	Makecha	CUNY	radluds@hotmail.com
Tamo	Nakamura	University of Texas Medical School at Houston	tamo.nakamura@uth.tmc.edu
Shannon	Rackette		SI_Skov_Rackette@hotmail.com
Amanda	Reaves	Auburn University	reaveal@auburn.edu
Jacquelyne	Rivera	University of Texas Medical School at Houston	Jacquelyne.J.Rivera@uth.tmc.edu
Rosalind	Sadleir	University of Florida	sadleir@ufl.edu
Brosnan	Sarah	Emory University	sbrosna@emory.edu
Todd	Schachtman	University of Missouri	schachtmant@missouri.edu
Toru	Shimizu	University of South Florida	shimizu@chuma1.cas.usf.edu
Christopher	Sturdy	University of Alberta	csturdy@ualberta.ca
Francys	Subial		fsubial@aol.com
Peter	Sugarman	University of Southern Mississippi	petersu@msn.com
William	Suits	Georgia Southern University	lonelyone411@hotmail.com
Karyl	Swartz	CUNY	kswartz@lehman.cuny.edu
Rachel	Thames	University of Southern Mississippi	rachel_bio@yahoo.com
Kristen	Totonelly	Franklin & Marshall College	litllion8@yahoo.com
Roger	Thompson	Franklin & Marshall College	roger.thompson@fandm.edu
Sylvana	Yelda		syelda@tampabay.rr.com

Opening Comments

1-10 ***Comparative Cognition: Past, present and future***
Suzanne MacDonald (York University : President, Comparative Cognition Society)

Memory

Chair, Suzanne MacDonald

6:00
2-10 ***Mechanisms of recognition and recall in pigeons***

Robert Cook, Richard Chechile, & Shelley Roberts (Tufts University)
Testing concurrent recognition and a recall-analog tasks, the short-term memory of four pigeons for compound stimuli comprised of two colored blocks was tested. Using multinomial process tree modeling for obtaining estimates of successful retrieval, sufficient storage, partial storage, and no storage, the effects of delay were examined in the two tasks. The effects of delay were most pronounced on the storage estimates of retention in each bird, while the retrieval process seemed little affected by time. Implications for the modeling of avian memory will be discussed.

6:15
3-10 ***Trial-unique learning and episodic-like memory in gorillas***
Bennett L. Schwartz , Christian A. Meissner (Florida International University), Sian Evans (DuMond Conservancy), Megan Hoffman, & Leslie D. Frazier (Florida International University)
Trial-unique learning and episodic-like memory were examined in an adult male gorilla (Gorilla gorilla gorilla). We addressed if gorillas can retrieve and communicate information about the past. The gorilla witnessed a series of unique events, involving a familiar person (Experiment 1), an unfamiliar person (Experiment 2), or a novel object (Experiment 3). Following a five to ten-minute retention interval, a tester gave the gorilla three photographs mounted on wooden cards. One of these photographs represented the target object or person of the event, whereas the other two were distractors. The gorilla responded by handing back a particular photograph. If correct, he was rewarded with food. In all three of these experiments, the gorilla was significantly above chance at remembering the target. In Experiment 4, at a 24-hour retention interval, the gorilla was not significantly different from chance. The results are interpreted in light of theories of episodic memory.

6:30
4-5 ***The serial position effect in honeybees***
Gordon B. Bauer, Prentiss L. McNeill (New College of Florida), & Shelley A. Batts
Twenty-five honeybees, *Apis mellifera*, were trained individually in a five position, color-cued, forced choice sequence over 15 trials. On every trial a subject fed from each of five differently colored targets arranged in a pentagon formation. Each subject was trained on a single color/location sequence, counterbalanced across subjects. Memory was measured by a ten-minute extinction test in which all contacts with targets were counted. Primacy and recency effects were demonstrated as indicated by a significant quadratic trend, indicating a greater numbers of contacts with targets at the beginning and end of the sequences. No preference effects were observed for the color/location of targets independent of position order. Although the number of errors decreased significantly over learning trials, no memory for sequences was indicated during extinction tests.

6:35
5-5 ***Sample matching in pigeons: Divergent retention functions may result from ambiguity between delay and inter-trial interval***
Emily D. Klein & Thomas R. Zentall (University of Kentucky)
Gaitan & Wixted (2000) found that when 0- and 10-sec samples were associated with one comparison and a 2-sec sample was associated with a different comparison, pigeons appeared to respond based on the presence versus the absence of the 2-sec sample. As a result, a choose-long bias was observed. However, it is also possible that the pigeons were demonstrating a "choose-nothing" bias due to confusion between the dark inter-trial interval (ITI) and the dark delay interval (DI). The present experiment explored this hypothesis by clearly distinguishing between the ITI and the DI. Consistent with results obtained by Gaitan & Wixted (2000), pigeons in the Dark-Dark group demonstrated a clear choose long effect. However, pigeons in the Lit-Dark group demonstrated symmetrical forgetting for all sample durations across delays.

6:40
6-5 ***Episodic-like memory in the rat***
Stephanie J. Babb & Jonathon D. Crystal (University of Georgia)
We investigated episodic-like memory in rats (n = 5) using an eight-arm radial maze. The rats received daily training consisting of forced-choice visits to four baited arms; one randomly chosen arm contained chocolate each day. The second phase consisted of the availability of all eight arms. After a short (30 min) retention interval (RI), the four arms that were not available in Phase 1 provided food. After a long (4 hr) RI, the four remaining arms plus the arm containing chocolate provided food (i.e., the chocolate arm replenished). The rats visited the chocolate location after the long RI more than after the short RI. Next, chocolate was paired with lithium chloride, and subsequent testing used the long RI. The rats visited the chocolate location less after the taste aversion manipulation than in previous training, demonstrating that the rats had knowledge of what, when, and where components of episodic memory.

6:45 Discussion: Presentations 4, 5, & 6

6:50
7-5 ***Assessing the content of retrospective and prospective memory in rats using a 12-arm radial maze.***
Aaron P. Blaisdell & Laura H. Corbit (UCLA)
To investigate the content of working memory, we used a variant of the 12-arm radial maze procedure of Cook, Brown, & Riley (1985). Access to a different set of 4 of the 12 arms was blocked on each trial, while the remaining 8 arms each contained a single food pellet. On interpolation trials, rats were removed from the maze after their 2^{nd}, $4^{th,}$ or 6^{th} arm entry and were returned 15 minutes later to deplete it. In addition, on occasional probe trials, rats returned to the maze after the delay were provided with only two open arms, one of which had been blocked prior to the delay. The other test arm was a previously open arm that the rat had not yet entered or one that the rat had entered prior to the delay. These tests interrogate the content of retrospective and prospective memory.

6:55
8-5 ***Differential outcomes based on feeder location can serve as an effective cue for comparison choice***
Andrea M. Friedrich & Thomas R. Zentall (University of Kentucky)
Pigeons were trained on two identity matching tasks (hues and lines) with differential outcomes based on feeder location (a correct response following one sample from each task resulted in presentation of the left feeder, whereas a correct response following the other sample from each task

resulted in presentation of the right feeder). Transfer tests involving samples from one task (e.g., hues) and comparisons from the other (e.g., lines) produced positive transfer. Thus, the expectation of reinforcement at different locations can serve as an effective choice cue.

7:00
9-5 ***The A-not-B error in object permanence: recognition and recall errors in capuchin monkeys (Cebus apella)***
Carrie R. Rosengart & Dorothy M. Fragaszy (University of Georgia)
According to Piaget, human infants at a certain stage of object permanence can correctly find an object at an original (A) location, but continue to search at A when the object is hidden at a different (B) spot. Eight capuchin monkeys were tested to determine if they show the A-not-B error and if it is expressed differently in a recognition task (lifting a cup) versus a recall task (digging in a sandbox). Additionally, the delay period was manipulated so that the B trials were either 10s (the same as the delay on A trials) or 30s in order determine the role of memory in the A-not-B error. The monkeys showed the A-not-B error in both the recognition and recall conditions, but only when the time delay was longer on the B trials than on the A trials. The A-not-B error may be accounted for by memory demands.

7:05 Discussion: Presentations 7, 8, & 9

Echoic and Auditory Stimulus Discrimination
Chair, Tony Wright

7:25
10-10 ***Echoic object feature extraction by a bottlenose dolphin***
Heidi E. Harley (New College of Florida; Epcot's Living Seas)
Echolocating dolphins extract object feature information from echoes, but the features that are extracted have not been clearly defined. In the current study, a dolphin performed a three-alternative delayed matching-to-sample task in which objects that varied on single dimensions (material, texture, shape, size) were presented in a variety of conditions (cross-modally: visual sample to echoic alternatives, echoic sample to visual alternatives; intra-modally: visual sample to visual alternatives, echoic sample to echoic alternatives), and performance across dimensions and conditions was analyzed. Object material and texture appeared to be discriminated mostly echoically, however, information about shape and size appeared to be extracted by both sensory systems.

7:45
11-10 ***Sorting absolute pitches: Are humans special?***
Mitchel Williams, Jerome Cohen (University of Windsor), & Ronald Weisman (Queen's University)
The absolute pitch ranges in birdsongs and human speech can provide cues for recognition. When songbirds and humans are trained to sort contiguous pitches into 3 or 8 ranges, based on associations between the ranges and reward and nonreward (see Weisman et al., 1998), (a) songbirds discriminated 3 ranges to a much higher standard than humans, and (b) songbirds discriminated 8 ranges with precision whereas humans acquired only a crude discrimination of the lowest and highest of 8 ranges. Here, we tested another mammal, *Rattus norvegicus*, and found that rats' discriminations of absolute pitch ranges are highly similar to those of humans. The results suggest that songbirds are superior to mammals in their use of absolute pitch to sort frequencies into ranges.

8:00
12-5 ***The Chick-a-dee call of the Mountain Chickadee (Poecile gambeli)***
Laurie L. Bloomfield (University of Alberta), D. Archibald McCallum (Applied Bioacoustics) & Christopher B. Sturdy (University of Alberta)
All chickadees produce a call commonly referred to as the 'chick-a-dee' call. Because of this and other similarities in vocal repertoires, chickadees have been the subject of extensive comparative research. A common nomenclature for calls and call note types would facilitate the comparison of vocalizations among chickadee species. The vocalizations of the black-capped chickadee are the most well studied of any chickadee and could serve as a common reference for the classification of vocalizations (e.g., calls and note types) produced by other chickadees. Here we (1) classify the call notes in mountain chickadees' chick-a-dee calls into types using the note categories found in black-capped chickadee's chick-a-dee calls as a guide and (2) provide a detailed bioacoustic analysis of mountain chickadee chick-a-dee calls, thus providing a solid foundation for further comparative studies of chickadee vocalizations.

8:05 Discussion: Presenation 12

Cognitive Mechanisms of Spatial Navigation
Chair, Bill Roberts

8:25
13-20 ***Small Brains and Smart Minds***
S.W. Zhang (Australian National University) & M.V. Srinivasan (Australian National University)

The brain of the honeybee has a volume of about a cubic millimetre, weighs less than a milligram, and carries fewer than a million neurons. However, recent research is revealing that insects, and in particular bees, may not be the simple, reflexive creatures that they were once assumed to be. Over the past few years we have explored honeybees' learning capability and examined whether honeybees can learn strategies or principles for solving complex tasks. In this short review paper we summarise recent progresses in our laboratory in study of honeybees learning to negotiate mazes, learning delayed matching-to-sample tasks (DMTS), learning concept and so on. The evidence clearly showed that i). The information stored

in honeybees' memory actively participates in visual information processing; ii). Honeybees are able to learn rules to negotiate maze; iii). Honeybees are able to group stimuli and to form concept. iv). Honeybees do communicate food source information by waggle dances.

8:50

14-10 ***Homing with dead reckoning and visual cues by food-carrying rats: tests of competition between spatial learning mechanisms***

Sara J. Shettleworth & Jennifer E. Sutton (University of Toronto)

We tested the notion suggested by some ethological literature that dead reckoning (path integration) is employed continuously, in parallel with learning stable visual spatial cues. Rats searched for pieces of food randomly scattered in a large circular cue-controlled arena and carried them straight back to a dark home box concealed behind one of 16 identical doors on the periphery. For each session of five trips into the arena, the home was relocated and the rats were disoriented, forcing them to home by dead reckoning with respect to the home and/or by using a visual cue in a consistent position relative to the home door (a beacon or a landmark). Consistent with other research, rats trained with a visual cue homed just as accurately when the cue was removed (i.e., by dead reckoning). We also tested whether extensive dead reckoning experience blocks learning to home with a visual cue.

9:05

15-10 ***Do familiar landmarks reset the global path integration system of desert ants?***

M.Collett (Michigan State University), T.S.Collett (University of Sussex), S.Chameron (Université Paris Nord) & R. Wehner (University of Zürich)

It is often suggested that animals may link landmark memories to a global co-ordinate system provided by path integration, thereby obtaining a map-like representation of familiar terrain. Experiments were performed to test whether desert ants (Cataglyphis fortis) recall a long-term memory of a global path integration vector on arriving at a familiar food-site. Ants were trained to a feeder along L-shaped routes within open channels that obscured all natural landmarks, but which were marked with conspicuous artificial landmarks. The homeward vectors of ants accustomed to the route were tested after a foodward route either as in training or with the length of the first leg altered. If a familiar route or food-site triggers the recall of an accustomed home vector, the home vectors would be the same. The actual home vector reflected the immediately preceding outward journey, suggesting that landmark memories do not prime the recall of long-term global path integration memories.

9:20

16-10 ***Avoiding the middle route in a spatial navigation task in carp***

Michael R. Snyder & Alexza Rojas (University of Alberta)

When faced with a linear array of items, humans show a tendency to select an item from the middle of the array. Christenfeld (1995) suggests this "centrality premise" is adopted because choosing a middle option requires less cognitive effort, whereas Shaw et al. (2000) advocate an attentional explanation. Regardless, the centrality premise is regularly violated by humans engaging in pencil-and-paper and real-world spatial navigation tasks. When faced with otherwise equivalent routes going to the same place accessible off one linear path, subjects avoid the middle option(s), picking either the first or last route. By way of a cross-species comparison, we tested the centrality premise with goldfish in a water maze. Starting in one corner of the maze the goldfish had to reach the goal-box in the diagonally opposite corner by travelling along one of three equidistant routes. Goldfish avoid the middle route in the maze, showing behavioural agreement with human results.

9:35

17-5 ***Effects of goal-landmark distance on error by Clark's nutcrackers***

Debbie M. Kelly & Alan C. Kamil (University of Nebraska, Lincoln)

Clark's nutcrackers (*Nucifraga columbiana*) use spatial memory to relocate previously cached food items. Several experiments have shown that nutcrackers use landmarks surrounding the cache site for successful cache retrieval. The relationship between a landmark and goal location, such as a cache site, may be defined in terms of distance and directional information. The purpose of our experiment was to measure the effects of goal-landmark distance on search accuracy for distance and direction estimation. Three groups of nutcrackers were trained to locate a hidden goal at a fixed distance due north of a single landmark. The groups differed in goal-landmark distance (i.e., 40, 90 and 140 cm). We hypothesized that search accuracy should be lowest for the group with the largest goal-landmark distance and that distance error should increase more rapidly than directional error as goal-landmark distance increases.

9:40

18-5 ***Thinking inside the box: Pigeons encode relative distance from walls***

Emily R. Gray, Marcia L. Spetch, & Angela Nguyen (University of Alberta)

Recent studies have investigated whether animals use absolute or relative distances to find a hidden goal. In several previous studies, pigeons have been trained to find a goal in the center of a square array of four identical landmarks. When subsequently tested with an expanded array, pigeons did not search in the center but instead searched at locations that maintained the same absolute distance from the landmarks as in training. In this study, pigeons were trained to search for food in the center of an enclosed square arena designed to block external cues. When tested in a larger arena, the pigeons predominantly searched the center of the enclosure, indicating that they had learned the relative distances from the walls to locate the center. Apparently, encoding of spatial location from walls of an enclosure differs from encoding of spatial location from discrete landmarks.

9:45 Discussion of Presentations 17 & 18

Thursday Afternoon

Spatial Representation
Chair, Robert Cook

1:30
19-10 ***Patterns of spatial pattern exemplars II***
Michael F. Brown, Sara Fabian, & Kelly DiGian (Villanova University)
A previous experiment (Brown, DiGian, & Smith, CO3-2002) showed that rats can be controlled by a serial pattern of spatial pattern exemplars – sessions of three trials in which a patterned sequence of rows of locations in a 5 X 5 matrix of locations is baited. The present experiment replicated and extended this result. However, although there was clear evidence that both the (within-trial) row pattern and the (across-trials) pattern of rows controlled choices, there was no evidence that the pattern of rows was extrapolated beyond the domain in which the rats were trained.

1:45
20-10 ***Spatial arm configurations and rats' performance in the enclosed radial maze: Maps and lists***
Jerome Cohen & Joseph Tremblay (University of Windsor)
When forced to sample three of four arms in the radial maze (study segment), rats learn and maintain accurate performance in finding the final arm (test segment) when the relative configuration of arm cues remain constant than varied. Rats initially acquired this task with two different sets of four arm cues (full arm inserts; objects at doorways) and then were able to learn four different configurations when adjacent and opposite pairs of arm cues from each set were combined into new configurations. Post acquisition varying of two of these configurations did not affect accuracy within the constant configurations. Over training, however, rats increased their accuracy on the randomly varied configurations suggesting that they had developed a list-like representation of those two sets of arm cues.

2:00
21-10 ***A purely geometric module in human spatial cognition?***
David R. Brodbeck (Sir Wilfred Grenfell College – Memorial University of Newfoundland) Andrea E. Pike (Memorial University of Newfoundland) & B.Cory Spracklin (Sir Wilfred Grenfell College – Memorial University of Newfoundland)
A series of experiments were conducted to test whether humans use a purely geometric module in spatial cognition. Based on Cheng's (1986) work on rats, subjects were shown a rectangle on a computer screen. They were shown a goal (suing a dot) and asked to touch the screen. Once they had touched the screen the rectangle rotated a number of times as the dot (goal) faded. Subjects were then required to point to where the goal was before the rotation. Tests included cued and uncued rectangles as well as squares. Results are compared to Cheng (1986) and recent work with humans.

2:15
22-5 ***Time-place learning in the eight-arm radial maze***
Matthew J. Pizzo & Jonathon D. Crystal (University of Georgia)
Rats (n=4) searched for food on an eight-arm radial maze during daily 56-min sessions. Sessions were divided into eight 7-min time zones, during which a different location provided food; locations were randomized across subjects before training. Rats obtained multiple pellets within each time zone by leaving and returning to the correct location after a 10-sec delay. A high rate of responding occurred at active locations. We tested the hypothesis that rats had knowledge about the temporal and spatial features of the task. Anticipatory visits occurred at each location before it became active. On occasional probe sessions, one of the locations was inactive (i.e., no food was available). The inactive location had more visits than other locations. More visits were made to locations that had not yet become active relative to those that already provided food

2:20
23-5 ***Clark's nutcrackers' (Nucifraga columbiana) use of absolute and relative bearings in spatial search***
Aleida J. Goodyear & Alan C. Kamil (University of Nebraska, Lincoln)
The Kamil-Cheng multiple bearings hypothesis emphasizes the role of directional information, or bearings, in the use of landmarks while locating a hidden goal. Absolute bearings use the compass direction from the goal to each landmark while relative bearings are measured as the angle between two landmarks as seen from the goal location. When a landmark array is rotated, relative bearings remain the same, but absolute bearings are altered. Three groups of nutcrackers were trained with the same five landmark array, but differing degrees of rotation, allowing us to test for the use of absolute and relative bearings.

2:25
24-5 ***Geometric knowledge in the rat: Tests with exploratory behaviour***
Shannon I. Skov-Rackette & Sara J. Shettleworth (University of Toronto)
Animals may acquire spatial knowledge through exploration and reveal this knowledge by renewing exploration when objects are moved. Previous research has demonstrated increased exploration to novel landmark positions, but most experiments have failed to control for factors such as orientation within the larger, extra-arena environment or use of non-geometric intramaze cues, which may indicate environmental positional changes. In a novel paradigm, disoriented rats encountered one or more objects while searching for randomly scattered food in a large arena that was devoid of landmarks. Their investigation of single objects, which underwent positional changes, showed that they encoded the location of such objects relative to the arena. A series of experiments asked whether rectangular arrays are encoded as a single arrangement, or as four independent components, and examined the rat's geometric capabilities to make positional judgments.

2:30 Discussion of Presenations 22, 23, & 24

Associative Processes and Stimulus Control
Chair, Ralph Miller

2:45

25-10 ***A neural network model of pre-pulse inhibition***
Nestor Schmajuk (Duke University) & Roger Smith (Cisco)
Pre-pulse inhibition (PPI) refers to the inhibition of a startle reflex (R) produced by preceding the startling stimulus (S) with a weak pre-pulse (PP). We offer a formal theory of PPI in the form of a real-time neural network model. The network assumes that attention to S is proportional to total novelty, which is defined as the sum of the absolute value of the difference between the predicted and observed amplitudes of all environmental events. Attention to S determines the size of R. The model describes PPI because total novelty and, therefore, attention to the S decreases after presentation of the PP. This explanation is similar to that offered for latent inhibition by a related neural network model. Computer simulations demonstrate that the neural network correctly describes most of the behavioral properties of PPI.

3:00
26-10 ***A neural network model of entropy discrimination in pigeons***
Christopher Silansky & Anthony Chemero (Franklin and Marshall College)
A series of simulation experiments show that a three-layer, feedforward artificial neural network (ANN) can model the entropy discrimination abilities of pigeons. A training routine was developed for ANNs based closely on the training regimes Young and Wasserman used with real pigeons. Initially, the training routine was applied to two-layer ANN. The two-layer ANN was able to make discriminations based on entropy levels in arrays of 16 icons, performing perfectly on the set of training arrays and at levels well above chance on novel arrays. Unlike pigeons, however, the two-layer ANN was unable to subsequently learn to discriminate among entropy levels in smaller arrays. A computationally more powerful three-layer ANN was able to make entropy discriminations in arrays of 16 icons, and subsequently did learn to make entropy discriminations in smaller arrays.

3:15
27-5 ***Further evaluations of elemental versus configural accounts of Pavlovian conditioning***
Shannon M.A. Kundey & Allan R. Wagner (Yale University)
Two experiments are reported relevant to the continuing debate between elemental versus configural accounts of associative learning. Using eyeblink conditioning in the rabbit, there was greater generalization between components and compounds of components than predicted by the configural theory of Pearce (1987), and than observed in similarly-designed prior studies of autoshaping in the pigeon. The data from the two experiments are consistent with the elemental account of Rescorla and Wagner (1972). The difference in results from those previously observed in autoshaping are consistent with other data from the two situations, and consistent with the replaced-element account offered by Wagner (2001).

3:20
28-5 ***Associative symmetry in the pigeon***
Andrea J. Frank & Edward A. Wasserman (University of Iowa)
If an organism is explicitly taught an A→B association, then might it also spontaneously acquire the symmetrical B→A association? Remarkably little evidence attests to such "associative symmetry." Using a symbolic go/no go matching-to-sample procedure, we report for the first time a successful case of associative symmetry in the pigeon. Indeed, the strength of the B→A association can actually equal that of the A→B association. Our success may be due to the fact that the single-key go/no procedure avoids confounding the spatial locations of the sample and choice stimuli in choice matching procedures. We avoided an analogous temporal confounding with the symbolic go/no go procedure by having the A and B stimuli serve as both sample and test stimuli on intermixed identity matching trials. We plan to extend this research to include training and testing for transitivity, thereby assessing the species generality of stimulus equivalence, as defined by Murray Sidman.

3:25 Discussion of Presentations 27 & 28

Counting and timing
Chair, Jonathon Crystal

3:50
29-20 ***Time and time again: An integrative approach to interval timing***
Catalin V. Buhusi & Warren H. Meck (Duke University)
The fine structure of the internal clock can be revealed by examining a paradigm in which rats (*Rattus norvegicus*), mice (*Mus musculus*) or pigeons (*Columba livia*) have to filter out the gaps (breaks) that (sometimes) interrupt timing. Several lines of study in our lab will be discussed. First, results suggest that "stop"/"reset" mechanism of interval timing is controlled by sharing of attention. Secondly, attention sharing was found to be affected by dopaminergic drugs, hippocampal lesions, and genetic manipulations. Finally, computational modeling examined whether time is represented as a unique value or as a distributed pattern. The latter view predicts that the effect of a gap depends on the ratio between the duration of the interruption and the criterion interval. This prediction was confirmed experimentally in the above species.

4:15
30-10 ***Reexamination of interpretations of memory for temporal intervals***
Richard Keen & Russell Church (Brown University)
Does memory for stimulus duration change as a function of retention interval? Twelve rats were presented with short (2s) and long (10s) stimuli and reinforced with left and right lever presses, respectively. Testing consisted of inserting delays between the stimulus-termination and choice. An initial choose-long effect was observed (i.e., performance on long trials deteriorated less than on short trials as a function of delay). After extended exposure to the testing trials, the choose-long effect disappeared. Two hypotheses are tested against the data. The first assumes that the animal learns the duration of the signal and that the memory for that duration decays, or shortens, over time (i.e., subjective shortening). The second assumes that the animal learns multiple durations (signal-onset to –termination, signal-onset to food, etc.) and then uses these durations to make a choice.

4:30
31-5 ***Numerical Estimation by an Orangutan (Pongo abelii) in a Matching Task***
Jennifer Vonk (University of Louisiana at Lafayette)
An adult male orangutan (*Pongo abelii*) was presented with a series of delayed matching-to-sample (DMTS) tasks in which he was to match images based on a) the number of individuals depicted in the photograph (from 1-4), b) the number of abstract shapes presented in the stimulus (from 1-4), or c) the number of dots presented in the stimulus (from 1-4, 4-7, and 7-10). The size of the dots was manipulated to control for overall ratio of foreground to background. In addition, the spatial arrangement of the dots and the background color of the stimuli varied within each set of stimuli depicting the same number of dots. The orangutan showed a high degree of transfer to novel numerosities and performed at 100% correct on the first session with 7 to 10 dots, indicating that orangutans are capable of numerical estimation for a greater number of items than can presumably be subitized.

4:35
32-5 ***Discrete Quantity Discrimination in Gorillas (Gorilla gorilla gorilla)***
Ursula S. Anderson[1,2], Terry L. Maple[1,2], Mollie A. Bloomsmith[1,2], M. J. Marr[1], Tara Stoinski[2], & Anderson D. Smith[1] (Georgia Institute of Technology[1] & TECHlab, Zoo Atlanta[2])
Two experiments with gorillas (Gorilla gorilla gorilla) demonstrated their ability to discriminate discrete quantities. In both experiments, we simultaneously presented each subject with two quantities in two wells (e.g., two grapes in the 1st well and four in the 2nd). A correct response was defined as the subject selecting the well containing the greatest quantity. The first experiment used a non-corrective method to test spontaneous discrimination ability. Statistical analyses indicated that the subjects (N = 11) were discriminating between quantities and that age, sex, subject testing order, and the ratio between the two quantities were significant predictors of a correct response. In the second experiment subjects were trained to respond correctly using a corrective method and a learning criterion of 80% correct responses for two testing days. Statistical analysis indicated that the number of testing days each subject required to reach the criterion was not predicted by age or sex.

4:40
33-5 ***Numerical ability in pigeons***
Tomoko Inagaki (Hunter College/The CUNY Graduate Center and University Center)
A series of experiments with four pigeons suggested that the pigeons could discern quantities based on relative differences in discrete elements, and their numerical decisions were different when a stimulus did not consist of discrete elements, such as color filled horizontal bar stimuli. Four pigeons trained with a row of five red rectangles and five green rectangles were then tested with different numbers of red and green rectangles in order (Ex1) or randomly arranged (Ex2) within a row. Accuracy decreased as the number of same colored elements within a row decreased (Ex1). There was no significant effect of ordinal position of different colored elements within a row (Ex2). When tested with horizontal bar stimuli consisting of red and green color components, the pigeons' accuracy significantly decreased (Ex3).

4:45 Discussion of Presentations 31, 32, & 33

4:50
34-5 ***Timed performance in simple conditioning procedures***
Mika MacInnis (Brown University)
The problem was to determine whether a simple timing theory is able to account for a rat's performance in delay, trace, and backward conditioning procedures. Using a Latin square design, each of 18 rats was trained on instrumental appetitive head entry conditioning procedures consisting of a 20-s stimulus and a 100-s ITI. Within a phase, food was available only at a single time following stimulus onset. In each phase, it was delivered directly after the first head entry occurring 10, 20, 30, 50, 110, or 120 s following stimulus onset. These conditions are traditionally known as delay, trace, and backward conditioning procedures. In all cases, performance was determined by the time from relevant events (stimulus on, stimulus termination, and food delivery). A simple model based on the expected time to reinforcement was used to predict the observed performance.

4:55
35-5 ***The cross-validation method for the evaluation of the adequacy, complexity and generality of timing theories***
Paulo Guilhardi (Brown University)
Standard procedures of model evaluation and selection are based on measures of the adequacy of models, such as goodness-of-fit measures, calculated on all available data. Other measures are necessary to assess the complexity and generality of a model. The cross-validation method involves estimation of parameters of a model from some of the data, and the use of these parameters for goodness-of-fit measures on other data. This method is typically used to avoid overly complex models and to establish that the model applies to other samples of the data. It may also be used to determine whether a model is restricted to a particular dependent variable or procedure, or whether it is a general model of a process. The cross-validation method will be applied to evaluate the generality of the predictions of scalar timing theory with respect to different samples, different dependent variables, and different fixed-interval procedures.

5:00 Discussion of Presentations 34 & 35

Individual Differences
Chair, Nestor Schmajuk

5:25
36-10 ***Individual Differences in the Behavior of Rats.***
Russell M. Church, Paulo Guilhardi, & Laura Armstrong (Brown University)

Although rats often behave in a similar manner under similar conditions, they may be readily identified by their behavior. Twenty-four rats were trained for 20 sessions in a delayed conditioning procedure with four different 30-s stimuli that were separated by an interval with a mean of 2.5 min. Food was delivered at the end of two of the stimuli, and there was no food at the end of the other two stimuli. The time of occurrence of head entries were recorded. Although all rats developed stimulus and temporal discriminations, reliable differences among rats were readily identified by measuring characteristics of the performance in half the sessions, and testing for these differences in the other half of the sessions. These individual differences would be particularly important if reliable patterns were identified on dimensions such as pattern and rate.

5:40
37-10 ***The structure of individual differences in olfactory cognition in mice***
Chuck Locurto (College of the Holy Cross)
We have previously reported that when mice (Mus musculus) are given a battery of visio/spatial problem solving tasks the resultant factor structure is more congenial to a modular rather than a general solution, meaning there was no evidence for the presence of a powerful first factor that accounted for a large proportion of matrix variance. There are reasons to think that olfactory tasks might yield more evidence for a general solution. In two experiments we explored the structure of individual differences in olfactory problems that were embedded within a battery that also contained spatial tasks. The results of both experiments suggest that in some cases olfactory tasks possess higher covariance than is found in spatial tasks, but it is doubtful that a general solution of the type often found in human problem solving is appropriate for these data.

Stimulus Categories, Classes, and Patterns
Chair, Marcia Spetch

6:05
38-20 ***Linked perceptual classes: Bridging perceptual and equivalence classes***
Lanny Fields (Queens College and the Graduate School of CUNY)
A linked perceptual class exists when members of two distinct perceptual classes occasion the mutual selection of each other. An example would be the infinite images of cats and the sounds they emit. These classes are more complex than those typically studied in animal cognition. Their formation has also not been studied in humans. MTS based procedures were used to measure class formation and identify three variables that influenced class formation by humans. Linked perceptual class formation was an inverse function of the number of conditional discriminations used to link the classes, an interactive function of the particular class members used as samples and comparisons in the trained relations that linked the classes, and an inverse negatively accelerated function of the number of different probes presented in the test blocks that documented class formation. Similar procedures procedures and variables might also induce linked perceptual classes in infrahumans.

6:30
39-10 ***Multiple category learning in capuchin monkeys***
Satoru Ishikawa (Hokkaido University), Hika Kuroshima, & Kazuo Fujita (Kyoto University)
Three Capuchin monkeys (*Cebus aperra*) were examined to acquire four categories and two higher-order categories with matching-to-sample (MTS) task and/or conditioned position discrimination task. In the initial phase, monkeys acquired to discriminate four categories having 100 exemplars in each category and transferred to the novel 100 ones under the both training task. In the second phase, they were trained to discriminate two higher-order categories having 100 exemplars half of which were derived from previous four categories and the other exemplars were prepared as new ones, using MTS task. Subjects also acquired this discrimination and transferred to the novel exemplars. Analyzing the error responses, it was indicated that the monkeys reconstructed boundaries among four categories and set these categories more plausible way through acquisition learning of the higher-order categories.

6:45
40-10 ***Bringing down the hierarchy: Evidence that hierarchical patterns are processed in a linear fashion***
James D. Rowan, Warren J. Neiland & Gopica Rasiah (Bridgewater College)
Findings of an experiment that required human subjects to learn 48 item serial patterns supported earlier findings (Fountain & Rowan, 1995) which demonstrated that a 3 level hierarchical pattern is learned faster than a modified version of the pattern with the hierarchical structure violated. The performance of four additional groups of subjects, however, brings into question the idea that they somehow encode a representation of the multilevel hierarchical structure. Subjects in these groups learned serial patterns, which consisted of 2, 24 item, 2-level hierarchically structured arranged in a liner fashion. The results suggest a more linear representation of the pattern structure is encoded instead of the accepted structural tree representation as proposed by Fountain and Rowan (1995) and others.

7:00
41-5 ***The influence of familiarity on the recognition of object images from novel perspectives in capuchin monkeys (Cebus apella)***
Katherine A. Leighty (University of Georgia), Hika Kuroshima (Kyoto University) & Kazuo Fujita (Kyoto University)
Two capuchin monkeys were tested to determine the impact of object familiarity on the recognition of object images from novel perspectives on a touchscreen monitor. Twelve novel objects served as stimuli, six of which were presented in manipulation sessions prior to testing to make them "familiar". Upon achieving criterion performance on MTS trials, subjects were presented with sample stimuli from novel vantages and four orthogonal comparison stimuli in probe trials. Performance exceeded chance on both familiar and unfamiliar object probe trials. While individual subjects demonstrated the trend of improved performance with familiar objects, neither did so significantly. When data from the two subjects were combined, a significant effect of familiarity was found ($F=258.14$, $p<.05$). These results support previous findings with humans and pigeons that familiarity with objects improves the ability to recognize their images from novel perspectives.

7:05 Discussion of Presentation 41

Funding Opportunities for Research and Teaching Programs in Comparative Cognition: Chair, Marcia Spetch

7:10
42-10 ***Opportunities at the National Science Foundation***
Fred Stollnitz (National Science Foundation)
The National Science Foundation (www.nsf.gov) supports research and education in comparative cognition, as it does in nearly all fields of science that are not disease-oriented. Research in comparative cognition is supported primarily in the Directorate for Biological Sciences; projects may be small, single-investigator projects or large, multifaceted projects (e.g., Frontiers in Biological Research). Education projects may involve teacher enhancement; course, curriculum or laboratory improvement, or informal education of the general public through zoo or museum exhibits, films or TV programs, etc. Projects that integrate research and education are particularly welcome, as in Research in Undergraduate Institutions, Faculty Early Career Development, Research on Learning and Education, Research Opportunities for Teachers, Research Opportunities for Undergraduates, and Undergraduate Mentoring in Environmental Biology (defined broadly enough to include comparative cognition!). Opportunities to serve as a program officer or as a reviewer are available in many NSF programs.

Friday Morning

Social Cognition I
Chair, Heidi Harley

8:00
43-10 ***Inference formation and social cognition in Pinyon Jays***
Guillermo Paz-y-Miño C., Alan B. Bond & Alan C. Kamil (University of Nebraska-Lincoln)
We report preliminary results on the ability of pinyon jays (Gymnorhinus cyanocephalus) to track dyadic dominance relationships between conspecifics (i.e. A>B, B>C) and use this information to infer the outcome of further dominance encounters (i.e. A>C). The data is interpreted in the context of the social complexity hypothesis which indicates that animals that live in large, social, stable groups have evolved substantial cognitive abilities that allow them to evaluate and categorize individuals according to their social rank, reproductive status, and/or foraging success.

8:15
44-10 ***Goal/desire attribution in human babies and infant chimpanzees***
Claudia Uller (University of Louisiana at Lafayette)
Does the chimpanzee attribute goals to others? The question of the capacity for theory of mind in human children and nonhuman primates continues to haunt researchers. Two experiments with 4-12 month old infant chimpanzees and 9-12 month old human babies show that the capacity for goal attribution may be a precursor of theory of mind present in infant chimpanzees and infant human babies. The experiments were closely modeled on 12 month old infant experiments developed by Gergely and colleagues (1995). The infant chimpanzees performed as well as human infants, which suggests that they also attribute goals and hence that precursors of this capacity may not be distinctively human.

8:30
45-5 ***The influence of social context and reward on stimulus enhancement in brown capuchin monkeys***
Kristin E. Bonnie & Frans B.M. de Waal (Emory University/Yerkes National Primate Research Center)
The influences of social relationship and reward on social learning of a stimulus enhancement task were investigated in brown capuchin monkeys (Cebus apella). Subjects were paired with models that varied in terms of their dominance relationship and kinship with the subject. Subjects first observed trained models search one of three uniquely colored and patterned boxes, presented in randomized locations directly in front of the animal. On the next trial, subjects were then given the opportunity to explore the same, but randomly rearranged, boxes. The total number of responses, latency to respond and success in matching the model's choices were assessed under three experimental conditions: a) neither model nor subject is rewarded, b) only the model is rewarded, and c) both are rewarded, for correct choices. Preliminary results reveal that significant differences exist between reward conditions, and also suggest that the subject may not need to be rewarded for social learning to occur.

8:35
46-5 ***Mind-reading and probability learning under uncertainty: Animal triangulation paradigm applied to homo sapiens***
Kang Lee (Queen's University), Connie Poon (Waterloo University), & Darwin Muir (Queen's University)
Humans' use of gaze cues to make predictions about probabilistic events was tested using a triangulation paradigm commonly used to study primate mental state attribution. Participants viewed an animated actor hiding an item under one of three cups in the presence of two witnesses: one looking at the display (looker) and the other looking away. Afterwards, each witness indicated the baited cup correctly either 70% or 30% of the time. Participants guessed the location of the bait and received feedback for 100 trials. Unlike rats and chimpanzees studied to date, human participants were strongly biased by the information provided by the looker over that of the non-looker for the first 70 trails, after which their responses matched the actual probability. However, in a post-test, participants still over-estimated the probability that the looker was correct, suggesting that when humans make judgments under uncertainty, they use the heuristic: "seeing leads to knowing".

8:40 Discussion of Presentations 45 & 46

8:45
47-5 ***Audience effects on food call rate and structure in brown capuchins***
Amy S. Pollick, Frans B.M. de Waal & Harold Gouzoules (Emory University)
Brown capuchins (Cebus apella) give contextually distinct calls upon encountering food. Previous studies on other species suggest audience effects for such calls and we predicted that capuchins would adjust their food calling to both the amount of food and the nature of their audience. Twelve female capuchins underwent two food conditions (large and small amounts) and three audience conditions (single, with one other, with group). Subjects gave more calls for larger rather than smaller amounts of food. Subjects also called more for a group audience over any other condition regardless of food quantity. Preliminary acoustic analyses indicate that certain audiences influence amplitude and pitch of the calls in addition to rate of calling. This suggests that food calls take audience into account, possibly reflecting a cost/benefit calculation related to the potential for food sharing and competition.

8:50
48-5 ***Courtship displays of male pigeons can be triggered by video-taped and computer-animated pigeons***
Tadd Patton[1], Sylvana Yelda[1], Jens-Uwe Buschmann[2], Nikolaus Troje[2], & Toru Shimizu[1] ([1]University of South Florida, [2]University of Bochum)
Male pigeons show species-specific courtship displays in front of female pigeons. The present study examined whether visual information, without auditory or tactile input, could trigger such courtship displays. The study also examined which technical measures could be used to present the visual stimuli. We studied the behaviors of male pigeons in response to video-taped and computer-animated stimuli presented on a computer monitor. The subjects did show courtship displays in front of video-taped and computer-animated females. However, they showed little or no such behavior when empty cages or upside-down views of females were presented on the monitor. Thus, subjects selectively reacted to the visual stimuli, suggesting that the artificial pigeons can be used as stimuli to represent a viable potential mate.

8:55 Discussion of Presenations 47 & 48

Stimulus Value, Reinforcement, and Extinction
Chair, Jeff Katz

9:10
49-10 ***Reaction-time signatures of discriminative processes: Stimulus identity versus stimulus value***
Donald S. Blough (Brown University)
Experiments compared reaction times (RTs) to stimuli differing in similarity with RTs to stimuli differing in probability of reinforcement. On each trial a pigeon pecked a small spot that could assume any one of 5 hues. A peck to a red S+ always brought food, whereas pecks to any of 3 other reds, similar to S+, went unreinforced. A peck to a green spot brought food with a probability that changed between blocks of sessions. Differential RT patterns emerged: Similarity along the red dimension affected the number of responses emitted but left the position and shape of RT distributions relatively constant. Reinforcement changes to the green stimulus reversed this pattern, shifting the RT distributions while little affecting the number of responses emitted. RTs thus seem to distinguish discriminative decisions that may usually be confounded: (1) "is this stimulus the same as S+" and (2) "of what value is this stimulus."

9:25
50-10 ***Extinction does not occur in humans when they are not allowed to respond during training.***
Helena Matute, Sonia Vegas & Miguel A. Vadillo *(Universidad de Deusto)*
Despite extinction being such a universal finding, it is not always observed in human research. As an example, if humans are not allowed to respond during the training phases, they show no extinction at test. This and other similar results can be interpreted as suggesting that current learning theories cannot explain extinction in the human species. This also suggests that different processes could be at work when humans learn something without responding than when they learn something while responding. Our experiments, however, indicate that this is not the case. For example, if contextual cues for extinction are introduced at test in the no-response condition, extinction is observed. We suggest that the absence of extinction observed when humans are not allowed to respond can be interpreted as a renewal effect: If the subject is not responding during training, the test phase (requesting a response) is perceived as a new context.

9:40
51-5 ***Value Transfer in Conditioned Inhibition***
Benjamin G. Simpkins, William T. Suits & Janice N. Steirn (Georgia Southern University)
This pair of experiments tests the associatively-based Value Transfer (VT) model in the autoshaping of pigeons. Value transfer has been demonstrated primarily in operant choice procedures. The current studies examine it in a classical conditioning conditioned inhibition procedure. Previous studies on VT have shown that a stimulus not associated with an appetitive outcome can acquire associative value when presented alongside an appetitive stimulus. The first experiment focuses on the transfer of appetitive value to stimuli that indicate non-occurrence of reinforcement (conditioned inhibitors). The second experiment tests VT to conditioned inhibitors associated with a nonpreferred food color from stimuli associated with a preferred food color. The results are examined for both value transfer and contrast effects.

9:45
52-5 ***The effect of trial spacing on extinction of Pavlovian responding***
Jennifer M. Gates, Whitney B. Werstlein, Marshall G. Miller, & James C. Denniston (Appalachian State University)
Thirsty rats were used to investigate the effect of trial spacing on experimental extinction. Subjects received Pavlovian training intended to condition a fear to two separate audiovisual stimuli (CSs X and Y) through pairings with an aversive footshock. Following acquisition training, subjects

received either massed or spaced extinction treatment of CS X. Subjects in Group Spaced received 10 X-noUS trials during each of 5 daily 120-min extinction sessions, whereas subjects in Group Massed received all 50 X-noUS trials during the 5th extinction session. At test, both groups exhibited strong conditioned responding to CS Y, the nonextinguished CS. Of greater interest, behavioral testing with CS X revealed attenuated conditioned responding to CS X in Group Spaced, relative to Group Massed. Thus, spaced extinction treatment produced a greater attenuation of conditioned fear than did massed extinction treatment. Results will be discussed in terms of contemporary theories of extinction and stimulus processing.

9:50 Discussion of Presentations 51 & 52

9:55
53-5 ***The effect of CS duration on extinction of Pavlovian responding.***
Whitney B. Werstlein, Jennifer M. Gates, Marshall G. Miller, & James C. Denniston (Appalachian State University)
Thirsty rats were used to investigate the effect of CS duration on the extinction of Pavlovian responding. Subjects received Pavlovian training intended to condition a fear to two separate audiovisual stimuli (CSs X and Y) through pairings with an aversive footshock. Following acquisition training, subjects in Group Short received 10 1-min exposures to CS X during each of 5 daily sessions, whereas subjects in Group Long received a single 50-min exposure to CS X during the 5th extinction session. At test, both groups exhibited strong conditioned responding to CS Y, the nonextinguished CS. More importantly, testing with CS X revealed attenuated conditioned responding to X in Group Short, relative to Group Long. These results stand in contrast to timing models of Pavlovian conditioning (i.e., Gallistel & Gibbon, 2000) which propose that CS duration has no effect on the rate of experimental extinction.

10:00
54-5 ***Wheel-running under different conditions of effort: Extinction effects***
Karen L. Roper & Caleb Masland (Wake Forest University)
Male albino rats were trained on a progressive ratio (PR4) schedule to run in a wheel for a sweetened milk reward under one of two force requirements (7 or 30 gram loadings). Once a "breakpoint" number of revolutions had been achieved (determined separately for each rat), both groups ran in the wheel without reward and were compared to control rats for which running had never been reinforced. Rats from both groups completed equivalent ratios (modal PR at breakpoint = 24) when reinforced; however, rats with the greater force applied to the wheel showed the least resistance to extinction. One explanation for this result is that rewards following increased effort are more valued. Rats with contrasting effort requirements are being trained to determine if the effect of an effort comparison process would enhance this effect.

10:05 Discussion of Presentations 53 & 54

Stimulus Identity and Same/Different Concept Learning
Chair, Ed Wasserman

10:20
55-20 ***Abstract-concept learning and list-memory processing***
Anthony A. Wright (University of Texas Medical School at Houston), Jeffrey S. Katz (Auburn University), Jacquelyne J. Rivera, & Jocelyne Bachevalier (University of Texas Medical School at Houston)
Three capuchin (Cebus apella) monkeys were trained in a same/different task to touch the lower of two pictures for same or a white rectangle for different. Abstract-concept learning increased from 52% to 87% with expansion of the training set size from 8 to 128 pictures. Rhesus monkeys (Macaca mulatta) trained similarly were at a disadvantage, but three others trained to touch the top picture before making a choice were similar to the capuchin monkeys. In list-memory learning, rhesus monkeys trained to touch the top picture showed an initial advantage but later were similar to the capuchin monkeys. Serial position functions from both monkey species were similar in shape and changes with retention delays. Pigeons and humans were qualitatively similar to the monkey species but showed quantitatively different time-courses. In abstract-concept learning, the set-size functions for capuchin monkeys, rhesus monkeys, and pigeons eventually show complete concept learning. This complete concept learning for the three species is evidence of qualitative similar processes, whereas differences in the slopes of these set-size functions are evidence of quantitative differences. Qualitative similarity is evidence for a general-process account as opposed to a modular account of these cognitive abilities.

10:45
56-10 ***Is identity special? The implicit perception of identity/non-identity relations in adult humans***
Mary Jo Rattermann, Kirsten Keller, & Lauren Lanza (Franklin & Marshall College)
Using the methodology developed by Wasserman and Young (Wasserman, Fagot & Young, 2001;Young & Wasserman, 2001) a touchscreen Imac was used to present human adults with either a display of 16 identical icons or a display of 16 non-identical icons. Subjects received an equal number of identity and non-identity trials, but were only rewarded for touching the screen in the presence of identity (or non-identity, depending upon condition). To create an ambiguous situation, only half of the trials that contained the relevant identity relation were rewarded. As expected, the subjects reinforced for responding to identity touched the screen more for identity displays. Contrary to our expectations, the subjects reinforced for responding to non-identity also touched the screen more for identity displays. These findings suggest a predisposition to respond based on identity – a predisposition so strong that subjects respond to the presence of identity, even when reinforced for non-identity.

11:00
57-5 ***Implicit stimulus control by same-versus-different relations among mutiple arrays by macaque monkeys (Macaca mulatta)***
Timothy Flemming, Anna Follensbee, Kerry McAuliffe & Roger K. R. Thompson (Franklin and Marshall College)
Comparative investigations of the implicit discrimination of same/different relations are confounded by methodological differences. A procedure developed by Wasserman et al (2002) is applicable to both primates and birds. Macaque monkeys were trained to respond on a FI-15" schedule of reinforcement to each of four stimulus arrays consisting of either 16 identical (same) or 16 nonidentical (different) stimuli drawn from two separate

sets of icons (Same1, Same2, Different1, & Different2). One of the four stimulus arrays was designated as S+ for each animal after baseline training. Changes in cumulative response frequencies to the S+ and 3 S-s disclosed whether the animals spontaneously attended to the physical features of individual icons or the same/different relations between and among the displays. Results from more than fifty 48-trial sessions indicate that the abstract relational dimensions of the stimulus arrays were less salient for these monkeys than for pigeons on this particular task.

11:05
58-5 ***Abstract-concept learning differs when vertical and horizontal stimulus panels are used in MTS by pigeons***
Jeffrey S. Katz, Kent D. Bodily, Michelle Hernandez (Auburn University), & Anthony A. Wright (University of Texas Medical School at Houston)
Wright (1997, 2001) found that pigeons (Columba livia) completely learned an abstract concept in a matching-to-sample task when required to peck a sample stimulus 20 times (FR20). When pigeons did not learn the concept (e.g., FR0 or FR1) discrimination was controlled by configural, as opposed to if-then rule learning. Those experiments were conducted in an operant chamber using a horizontal panel. A replication of this study with the same stimuli and display size but using a traditional vertical stimulus panel was conducted. Under such conditions pigeons (FR1 or FR20) did not learn the abstract concept. Instead, they learned by if-then rules. The implication of these findings will be discussed.

11:10
59-5 ***A display size effect on matching-to-sample strategies by pigeons***
Kent D. Bodily, Jeffrey S. Katz, (Auburn University), & Anthony A. Wright (University of Texas Medical School at Houston)
Three strategies that can be used to successfully perform matching-to-sample have been examined in pigeons: if-then rule learning, configural learning, and relational learning. The first two strategies are stimulus specific, that is, successful performance is based on memorizing a response to each stimulus, whereas relational learning transcends the stimuli used to train it. Using a vertical stimulus panel, our present study used the Wright (1997) method to distinguish between strategies and explores the effect of display size on which strategy is learned. Decreasing display size increased relational learning.

11:15 Discussion of Presentations 57, 58, & 59

Friday Afternoon

Visual Discrimination Learning
Chair, Michael Brown

1:30
60-10 ***Attention to what, where, and when in pigeons***
Jennifer E. Sutton & Sara J. Shettleworth (University of Toronto)
Given that animals have a limited amount of attention to allocate to the large amount of information encountered on a moment to moment basis, our experiments explored whether spatial, temporal, and identity information compete for processing resources or are processed in parallel. In one experiment, pigeons were trained on a discrimination task where either location or duration of a sample stimulus could be used to respond correctly to a subsequent comparison stimulus. On probe trials, either the spatial or the temporal information was made ambiguous, or the two sources of information were put in conflict. Spatial information dominated temporal processing on probe trials, suggesting an asymmetrical allocation of attention to the two dimensions. Further experiments exploring other combinations of stimulus location, duration, and identity will also be reported

1:45
61-10 ***A rose from any other view is still a rose: Viewpoint effects in pigeons' object recognition***
Marcia Spetch, Alinda Friedman & Anne Ferrey (University of Alberta)
Effective interaction with the environment often requires the ability to recognize important objects from different viewpoint, but the processes by which animals and humans recognize rotated objects are not fully understood. In previous comparative studies, we found that pigeons' recognition of depth-rotated objects was similar to that of humans except in two respects. First, pigeons, unlike humans, showed as much viewpoint dependence for objects that contained a single distinctive geon as for objects that contained multiple geons. Second, pigeons did not show interpolation effects. As is typical of studies of object recognition in both animals and people, pictures of objects, rather than real objects served as the stimuli in our previous studies. In the present studies we used real objects to explore whether object recognition processes or picture interpretation processes, underlie the species differences.

2:00
62-5 ***Simple visual discrimination training of the giant panda***
Angela S. Kelling (Georgia Institute of Technology, Zoo Atlanta), Rebecca Snyder (Zoo Atlanta), Jack Marr (Georgia Institute of Technology), Mollie Bloomsmith (Zoo Atlanta), & Terry Maple (Georgia Institute of Technology, Zoo Atlanta)
The giant pandas (*Ailuropoda melanoleuca)* at Zoo Atlanta are being trained on simple visual discrimination by adapting a method used to train juvenile American black bears (*Ursus americanus*). Initial training has provided insights into giant pandas and about the challenges of training them. The subjects have demonstrated the ability to learn simple visual contrast discriminations. Currently, the pandas are being trained on reversal contrast discriminations and future training will investigate their ability to learn several color discriminations.

2:05
63-5 ***How do pigeons respond when presented with conflicting information?***
Kumiko Yokoyama & Sheila Chase (Hunter College, CUNY)
Four pigeons were trained on alternate days to discriminate between two forms and two colors. After they mastered both discrimination tasks a form and a color were presented together on probe trials during regular training sessions. When the color and the form required different responses, the

birds tended to respond on the basis of color. This was true for both color and form sessions.

2:10
64-5 ***Examination of global and local visual processing in pigeons and humans***
Kazuhiro Goto & Stephen E. G. Lea (University of Exeter School of Psychology)
Two experiments have been conducted in pigeons (Columba livia) and humans (Homo sapiens) to examine the relative precedence of global and local visual processing. First, precedence was examined by comparing acquisition rates for a categorization of geometric hierarchical stimuli. Categorization based on global features was achieved faster than that based on local features in both species examined. The second experiment examined global and local processing in the discrimination of two perceptually similar categories, cats and dogs. Following acquisition, the stimuli were manipulated in two different ways: mosaicisation conserved some global information but lost high frequency information, whereas scrambling conserved high frequency but lost global features. Despite the global precedence found in the previous experiment, humans recognized scrambled cats better than mosaicized cats though the reverse was true for dogs. Results from pigeons, unlike humans, indicated that they recognized mosaicized images better than scrambled images of both dogs and cats.

2:15 Discussion of Presentations 62, 63, & 64

2:20
65-5 ***Directional motion categorization by pigeons***
Angie Koban, Robert Cook (Tufts University), & Joel Fagot (Center for Research in Cognitive Neurosciences)
Six pigeons were trained to discriminate between videos of object stimuli rotating either left or right around a central axis. The objects consisted of a red cube, tube, cone, torus, or differently organized groups of small disks. The animals readily learned the directional discrimination and transferred to changes in surface characteristics, but showed little direct transfer to new objects. Featural versus object-based interpretations of these motion data will be discussed.

2:25
66-5 ***Pigeon's recognition of static and dynamic images of human faces***
Hiroshi Makino(Chiba University)
In Experiment 1, pigeons were trained to discriminate frontal views of two positive and two negative human faces in a go/no-go discrimination procedure and then tested for transfer to novel viewpoints over the range of ±90°. The pigeons showed substantial transfer to the novel views, but their responses decreased systematically as the positive faces were rotated away from the trained view. In Experiment 2, the pigeons were trained to discriminate one positive and one negative face dynamically rotating in depth. Their initial performances revealed the failure of transfer from the static to dynamic views. Although the pigeons eventually learned to discriminate the dynamic stimuli, the dynamic-view training failed to broaden the range of testing performance with the static stimuli, thus there was no indication of transfer between the static and dynamic views. With naïve pigeons as subjects, transfer from the dynamic to static stimuli was reevaluated in Experiment 3.

2:30
67-5 ***Object localization in picture stimuli by pigeons***
P. Taylor Johnson & Robert Cook (Tufts University)
A new procedure for exploring object perception in pigeons was described. Pigeons were trained to locate a target "object" within a larger picture of assorted objects in a conditional discrimination procedure. Preliminary data for task acquisition and transfer will be presented. Implications for object perception and visual cognition in birds will be discussed.

2:35 Discussion of Presentations 65, 66, & 67

Spatial Learning and Spatial Cues
Chair, Jerry Cohen

2:55
68-10 ***Effects of carrying food versus encountering food on caching and retrieval behavior in rats***
William A. Roberts, Tammy L.B. McKenzie, Leanne R. Bird, & Jason Rice (University of Western Ontario)
The ability to accurately retrieve hidden food items was compared on a radial maze in two groups of rats, one that cached food and one that encountered food. Rats that cached food learned to retrieve it accurately faster than rats that encountered it. In a second experiment, all cached or encountered food was pilfered before the retrieval test. Rats that cached food continued both to cache and to visit cache sites before non-cache sites, but rats that encountered food lost their preference for cache locations. These findings provide support for the argument that the behavior of carrying food to hidden locations on the radial maze and later retrieving it involves a biologically specialized module.

3:10
69-10 ***Detour behavior in the quokka (Setonix brachyurus)***
Clive D. L. Wynne (University of Florida) & Benoit Leguet (Ecole Polytechnique)
Four wild-living quokkas (an herbivorous macropod marsupial) were tested for their ability to find a goal by progressing around a transparent barrier. Barriers tested were either symmetrical or L-shaped. Left-right location of the arm of L-shaped barriers was randomized. One quokka chose the shorter route around an L-shaped barrier on first exposure (spatial reasoning); the other three gradually acquired a tendency to select the shorter route (spatial learning). These three quokka also showed a characteristic preference to turn either left or right around the L barrier. This preference declined as the side-arm of the barrier was extended from 70 cm to 2.1 m.

3:25

70-10 ***Spatial Learning in Cephalopods***

Jean Geary Boal (Millersville University), Miranda A. Karson (Michigan State University) & Roger T. Hanlon (Marine Biological Laboratory)

Field data suggest that cephalopods are capable of spatial learning. To investigate this learning explicitly, maze experiments were performed using *Octopus bimaculoides* and *Sepia officinalis* as subjects. Octopus movements within a novel arena decreased with time, consistent with an interpretation of exploratory learning. Octopuses remembered the location of an open burrow after 24 h away from the test arena. In a six-choice, open-field maze, octopuses learned the location of a burrow, retained that memory for at least a week, and showed savings in learning a 180^{o} reversal task. Cuttlefish also appeared to explore a novel arena, and learned to exit a simple runway maze. Cuttlefish learned to exit a two-choice maze using either right/left or pattern cues with equal facility, and showed improvement in learning over a series of reversals. We conclude that both octopuses and cuttlefish show exploratory behavior, learning, and retention of spatial information.

3:40

71-5 ***Spatial orientation and landmark use in black-capped chickadees***

Bridgette A. Szekeres & David F. Sherry (University of Western Ontario)

A series of experiments examined landmark use by black-capped chickadees (*Poecile atricapilla*). Birds were trained to locate food at the midpoint between two identically shaped but differently coloured landmarks 40cm apart. Search was analysed on probe trials in which no food was available. In the first experiment, chickadees searched accurately in the geometric centre between the two landmarks at the 40cm inter-landmark training distance. At novel inter-landmark distances of 10cm and 70cm, the birds adjusted their search patterns and continued to search at the geometric centre between the landmarks. In a further experiment, one or other of the landmarks was removed. On probe trials, birds consistently searched on the same side of the single available landmark, suggesting they did not distinguish the landmarks by colour but did treat members of the landmark pair differently for distance estimation.

3:45

72-5 ***Proactive interference in the recall of serially presented spatial items by Clark's nutcrackers, Nucifraga columbiana***

Jody L. Lewis & Alan C. Kamil (University of Nebraska Lincoln)

We tested the spatial memory of Clark's nutcrackers (Nucifraga columbiana) after presentation of either one or two lists of locations and obtained evidence for proactive interference. Performance was better following one list than following two lists. When items in the two lists were located close to each other, nutcrackers made errors by visiting first list locations during recall of the second list.

3:50

73-5 ***Benefits of performing learning flights in honeybees, Apis mellifera***

Cynthia A. Wei & Fred C. Dyer (Michigan State University)

Upon discovering new sources of food, honeybees perform learning flights to memorize visual landmarks that can guide their return. The durations of such flights vary and are influenced by various factors. These include prior experience at the food source, delay between arrival at the location and receipt of food, sucrose concentration of the food, and the visual complexity and stability of spatial relationships of features in the surrounding environment. The modulation of learning flights seems to reflect a trade-off between the costs of performing a learning flight and the gains in foraging efficiency conferred by improved spatial foraging patterns. A series of experiments explores the relationship between performance of learning flights and accuracy in spatial patterns of foraging and reveals a positive correlation. Effects of learning flight duration are also explored and may suggest that longer flights lead to increased accuracy in pinpointing the location of food upon the bee's return.

3:55 Discussion of Presentations 71, 72, & 73

4:00

74-5 ***Effects of pilfering, food degradation and food devaluation on food carrying and retrieval in rat.***

Tammy L.B. McKenzie, Leanne R. Bird, Jason Rice, & William A. Roberts (University of Western Ontario)

Ten naïve male Long-Evans rats were used to examine the effects of pilfering, substituting a less preferred food, and degrading food on food carrying and retrieval behavior on an eight-arm radial maze. Food carried to one side of the maze was left unaltered, whereas food on the other side was altered by one of the three methods described above. It was found that rats did not come to prefer hoarding on the side of the maze that was unaltered versus the side that was altered. During retrieval, rats returned to arms that had not been altered before arms that had been altered. These findings lend support to the idea of a food carrying and retrieval module.

4:05

75-5 ***The effects of presentation order and difficulty level on the ability of capuchin monkeys (Cebus apella) to solve two-dimensional mazes***

Erica A. Hoy & Dorothy M. Fragaszy (University of Georgia)

The planning abilities of capuchin monkeys were investigated by examining the kind and number of errors produced while solving two-dimensional computer mazes. Three maze-naïve monkeys were presented with 16 maze sets. Difficulty level of the mazes was a function of the total number of choice points and the number of "non-obvious" choices. Each maze set consisted of 12 novel mazes of varied difficulty that were presented in random order. Errors made by these subjects were compared with errors made by three capuchins that were previously presented with the same mazes in order of increasing difficulty. The performance of capuchins in the random order condition will also be compared to data collected previously from chimpanzees in order to determine if cross-species differences in planning abilities are present.

4:10

76-5

Chimpanzees and young children face similar difficulties using scale models in a search task

Valerie Kuhlmeier (Yale University)

Many recent studies have explored young children's ability to use information from physical representations of space to guide search within the real world. In one commonly used procedure, children are asked to find a hidden toy in a room after observing a smaller toy being hidden in the

analogous location in a scale model of the room. Children at 2.5-years often have difficulty with this task, while 3-year-olds readily find the hidden toy. The present series of three experiments examined the causes of 2.5-year-olds' difficultly with the scale model task, using task procedures previously designed for tests with chimpanzee subjects (Pan troglodytes). Results indicate that the poor performance stems from a difficulty recognizing the model/room representational relationship *and*, similar to chimpanzees, from the use of an alternative, perseverative search strategy.

4:15 Discussion of Presentations 74, 75, & 76

Problem Solving and Tool Use
Chair, Mary Jo Rattermann

4:40
77-10 ***Finch physics: Cognitive abilities related to tool-use in the woodpecker finch Cactospiza pallida***
Sabine Tebbich & Redouan Bshary (Cambridge University)

Finch physics: Cognitive abilities related to tool-use in the woodpecker finch Cactopiza pallida
Woodpecker finches are famous for their tool-use behaviour. They use twigs or cactus spines to pry arthropods out of crevices and use this ability more than any other tool-using species hitherto known. In the present study we investigated the cognitive abilities related to tool-use in a comparative, experimental approach. We chose 3 experimental designs that have been used in earlier studies to test several primate species (the trap-tube task and a modification task) and New Caledonia Crows (tool length task). One out of 6 woodpecker finch was able to solve the trap-tube task and several individuals modified tools and chose twigs of appropriate length. Most of our individuals learned these new tasks quickly but we found no clear evidence for a mental representation of the underlying physical problems. The findings for primates and New Caledonian in theses task were very much alike. We therefore conclude that the cognitive demands imposed by tool-use seem to result in similar learning mechanisms among these species.

4:55
78-10 ***Folk physics for crows: do New Caledonian crows understand gravity?***
Jackie Chappell, Alex A. S. Weir, Ben Kenward & Alex Kacelnik (University of Oxford)
When humans use tools, knowledge about the properties of materials and fundamental facts about physics guide our behaviour. However, animals lacking these insights could generate tool behaviour that looks superficially identical. One female New Caledonian crow was tested on a trap tube task, similar to those used with primates. The subject learned to retrieve food successfully in 100% of trials, within a number of trials equivalent to that required by primates, despite the fact that the task was more complicated (the tool could be used either to pull or push the food from either end of the tube). She also developed her own, reliable technique to remove the food, by combining two actions. However, the subject did not alter the frequency of her responses when the trap tube was inverted, suggesting that she had learnt to displace food away from the trap without reference to the principle of gravity.

5:10
79-5 ***Hook shaping in New Caledonian crows***
Alex A. S. Weir, Jackie Chappell, & Alex Kacelnik (Oxford University)
In an experiment investigating tool choice in New Caledonian crows (Corvus moneduloides), one subject spontaneously modified the shape of the inappropriate tool to form a hook, and used this successfully in the task. The initial task, which the subjects were familiar with, was to retrieve a bucket containing meat from the bottom of a vertical Perspex tube. Two pieces of wire were provided: one straight (the inappropriate tool, since it could not be used to retrieve the bucket) and one hooked. In the fifth trial of the experiment, the male subject removed the hooked wire, and the female subject subsequently bent the straight one into a hook and used this successfully. When later presented with straight wire only, she repeated this behavior on 9/10 trials. This is the first demonstration of spontaneous, novel tool modification without trial-and-error learning in any non-human.

5:15
80-5 ***Ignorant rhesus monkeys collect information before acting***
Robert R. Hampton & Aaron Zivin (National Institute of Mental Health)
Rhesus monkeys (Macaca mulatta) were allowed to choose among four possible locations where a candy could be hidden. The location containing the candy varied randomly from trial to trial. On a given trial, the monkeys either observed the placement of the candy or were kept ignorant by blocking their view during baiting. Most monkeys that knew the location of the candy chose that location without hesitation. In contrast, when ignorant of the location, monkeys often made the effort required to learn the location before choosing. This difference in behavior between trials on which the monkeys knew, and trials on which they were ignorant, is consistent with the hypothesis that they can discriminate between knowing and not knowing.

5:20 Discussion of Presentations 79 & 80

Associative Learning and Cue Competition
Chair, Aaron Blaisdell

5:35
81-20 ***Biologically significant cues are relatively immune to cue competition***
Ralph R. Miller (SUNY-Binghamton)
We define "biologically significant" cues as stimuli that control or did control behavior because they have or have had either inherent or acquired motivational value. We will review data demonstrating that biologically significant target cues are relatively immune to the induction of cue

competition through manipulation of other stimuli that were present while it was being trained (i.e., companion cues; e.g., overshadowing, forward blocking, backward blocking, relative stimulus validity effect, and degraded contingency effect), whereas target cues lacking biological significance are subject to all of these effects. In contrast to this asymmetry in indirect effects, behavioral control by the target cue is readily attenuated through direct treatment, such as reinforcement, extinction, and conditioned inhibition training. New data will be presented in which cues, that were trained in compound with a companion stimulus, were perfectly matched other than for their biological significance. Posttraining decreases in the associative status of the target cue's companion stimulus increased the associative status of the target cue regardless of the biological significance of the target cue, whereas posttraining increases in the associative status of the target cue's companion stimulus decreased the associative status of the target cue only if the target cue was of low biological significance. We will suggest a functional interpretation of this asymmetry.

6:00
82-10 ***Responding to a blocking stimulus is reduced by compound reinforced training***
Francisco Arcediano, Martha Escobar (Auburn University), & Ralph R. Miller (Binghamton University)
Traditional associative learning theories assume that stimulus competition (e.g., blocking; X-US, then XY-US results in attenuated responding to Y) reflects a deficit in acquiring an association between Y and the US, and that the associative strength of Y cannot be changed without additional Y-US trials. This perspective is challenged by models that assume that stimulus competition is a performance, rather than an acquisition deficit, as well as acquisition models that allow modifications in the associative strength of absent stimuli. Consistent with a performance account, we found in a blocking paradigm that responding to both Y and X are mutually attenuated due to their having been trained in compound.

6:15
83-10 ***Irrelevant stimulation interpolated between preexposure and conditioning disrupts latent inhibition in a conditioned fear preparation with rat subjects***
Martha Escobar, Francisco Arcediano (Auburn University), & Ralph R. Miller (Binghamton University)
Escobar, Arcediano, and Miller (2002) suggested that obtaining latent inhibition in unmasked tasks with adult human participants has proven difficult because the usual human procedure involves interpolating instructions between preexposure and conditioning. Potentially, this disruption is related to interpolation of verbal information or to cognitive processes unique to human participants. The present studies use a nonhuman (rat) analog of Escobar et al.'s human procedure in a conditioned fear preparation. We observed that interpolation of audiovisual stimuli disrupted latent inhibition. Apparently, the interpolated stimulation makes the context of preexposure and of conditioning different, attenuating latent inhibition through mechanisms potentially similar to those underlying attenuation of latent inhibition when the context is changed between phases.

6:30
84-5 ***Dissociation of the effects of interpolating a retention interval versus instructions between preexposure and conditioning in a human unmasked latent inhibition paradigm***
Tyson Platt, Martha Escobar (Auburn University), & Ralph R. Miller (Binghamton University)
Numerous reports suggest that obtaining latent inhibition in human adults requires the use of a masking (i.e., distracting) task. However, Escobar, Arcediano, and Miller (2002) observed latent inhibition in human adults using an unmasked task. Obtaining latent inhibition in these conditions required that the preexposure and conditioning phases occur without interruption. Such interruptions are usually necessary to provide participants with instructions regarding the requirements of the conditioning task. The present study dissociates the effects of interpolating instructions between preexposure and conditioning from the effects of a simple retention interval between phases. Our results suggest that interpolation of instructions disrupts latent inhibition to a greater extent than interpolation of a retention interval.

6:35 Discussion of Presentation 84

Saturday Afternoon

Biological Substrates of Cognitive Processes
Chair, Ron Weisman

1:40
85-20 ***Cognitive flexibility in birds***
Shigeru Watanabe (Keio University)
Cognitive flexibility was analysed from three points. 1) Application of knowledge to new situation. 2) Modification of knowledge through experience. 3) Flexible knowledge. The example of the first point is demonstrated by concept discrimination by quails. The modification of knowledge is demonstrated by experiments with scrub jays. The flexible knowledge is demonstrated by pigeon experiments. Finally, brain mechanisms of cognitive flexibility particularly flexible cognition are examined by lesions of Wulst-LPO system in pigeons.

2:05
86-10 ***Effects of cannabinoids on extinction of place conditioning***
Linda A. Parker (Wilfrid Laurier University) & Raphael Mechoulam (Hebrew University of Jerusalem)
Recent evidence suggests that CB1 knockout mice display impaired extinction of Pavlovian fear conditioning. In a series of experiments, we explored the potential of the two principle components of marijuana, the psychoactive cannabinoid, Δ-9-tetrahydrocannabinol (THC), and the nonpsychoactive cannabinoid, cannabidiol (CBD), to modulate the extinction of place preference and place aversion learning. Both cannabinoids potentiated extinction of place conditioning without producing conditioning on their own. Our results support previous reports that the endogenous cannabinoid system plays a role in the modulation of extinction.

2:20
87-5 ***Cannabinoid modulation of sensitivity to time***
Jonathon D. Crystal, Kenneth W. Maxwell, & Andrea G. Hohmann (University of Georgia)

We examined the effect of cannabinoids on temporal processing. Rats trained to discriminate 2- and 8-s (Experiment 1, *n*=72) and 4- and 16-s (Experiment 2, *n*=60) intervals were tested with intermediate durations. Psychophysical functions (p(long) vs. duration) were characterized by measures of central tendency (point of subjective equality, PSE) and variability (Weber fraction, WF). The potent cannabinoid agonist, WIN55,212-2 (1-3 mg/kg), produced a dose-related decrease in sensitivity to time (i.e., increase in WF) without systematically affecting PSE (Experiments 1 and 2). The central cannabinoid CB1 antagonist, SR141716A (1-3 mg/kg), did not alter WF or PSE (Experiments 1 and 2). Coadministration of SR141716A with WIN55,212-2 blocked the effect of the agonist on WF (Experiment 2), suggesting that the WF effect is mediated by actions at cannabinoid CB1 receptors. Simulations with an information-processing theory of timing suggest that the reduction in sensitivity to time can be attributed to a disorder of attention.

2:25
88-5 ***Reversal learning after lesions in the presumptive nucleus accumbens in pigeons***
Scott Husband & Toru Shimizu (University of South Florida)
The nucleus accumbens plays a critical role in attention and reinforcement in mammals. In birds, chemistry and connection studies suggest that the medial part of the lobus parolfactorius (LPO) is the avian equivalent of the nucleus accumbens. However, little is known about the function of this area since only a few behavioral studies in birds have been conducted. In the present study, lesions were made in the medial LPO of pigeons to examine behavioral effects. Pigeons with lesions did learn to successfully discriminate visual patterns. However, when they were tested on reversal learning of the discrimination task, they had more errors than the control animals. The results are consistent with the notion that the medial LPO is functionally analogous to the mammalian nucleus accumbens.

2:30
89-5 ***Medial frontal cortex lesions and rat serial pattern learning***
Denise P. A. Smith & Stephen B. Fountain (Kent State University)
Recent research in our lab has shown that MK-801, an NMDA receptor antagonist, disrupts serial pattern learning. Rats learned a highly-structured serial response pattern consisting of eight 3-element chunks with one element that violated pattern structure. Rats treated with MK-801 learned within-chunk elements as fast as controls, but showed apparently permanent inability to learn the violation response and, to a lesser degree, chunk boundaries. In a follow-up study, we found that dorsal hippocampal lesions do not produce these profound deficits. In the present study, rats received medial frontal cortex lesions, and then were trained on the same pattern as in the earlier studies. Medial frontal rats learned all elements of their pattern as fast as controls. The results of this andearlier studies indicate that hippocampus and medial frontal cortex play little role in acquisition of this task, and that other structures impacted by MK-801 are critical for pattern acquisition.

2:35 Discussion of Presentations 87, 88, & 89

Natural Selection and Cognition
Chair, Sara Shettleworth

2:55
90-20 ***Natural History and Cognition***
Alan C. Kamil & Alan B. Bond (University of Nebraska, Lincoln)
The major theme of our laboratory is to integrate psychological, evolutionary and ecological approaches in our studies of animal cognition. This leads to a very broad-ranging research program with implications for several disciplines. At the current time, we are concentrating on three problems, spatial cognition in seed-caching corvids, social cognition in group-living corvids and the detection of cryptic prey by blue jays (Cyanocitta cristata). In this talk I will concentrate on our cryptic prey work, demonstrating how the study of mechanism and function can be integrated in a series of studies in which the psychological characteristics of predators strongly influence the evolution of their (virtual) prey.

3:20
91-20 ***The evolution of the cognitive map***
Lucia Jacobs (University of California at Berkeley) & Francoise Schenk (University of Lausanne)
How the vertebrate brain sees, understands and maps its external world is an important question in comparative cognition. The *parallel map theory* offers a novel explanation for the evolution, function and neural basis of the cognitive map in vertebrates. In this theory, we propose that the mammalian hippocampus maps space with two independent representations that are mediated by two hippocampal structures, the 'old' (dentate gyrus) and the 'new' (CA1, Ammon's horn). Because the bearing and sketch maps work in parallel, the impairment of one map reveals residual learning by the other. The coactivation of these parallel maps leads to the cognitive map, an emergent property of this activity. The parallel map theory integrates evidence from the physiology and structure, development, ecology and evolutionary history of the hippocampus into a unified theory of hippocampal function.

Social Cognition II
Chair, Alan Kamil

4:10
92-10 ***Gaze following in ravens***
Thomas Bugnyar (University of Vermont), Mareike Stöwe (KLF Gruenau) & Bernd Heinrich (University of Vermont)
Experiments with ravens (Corvus corax) demonstrate for the first time that birds are able to follow the gaze (i.e. head and eye direction) of other individuals. Hand-raised ravens were confronted with a human experimenter looking up vs. looking at the bird (control a), and looking behind an

opaque wall that blocks the view of the bird vs. looking in the opposite direction (control b). Juveniles visually co-orientated with the experimenter's look-ups significantly more often than in the control. As subadults, birds also repositioned themselves to follow the experimenter's looks behind the wall significantly more often than in both controls. This suggests that the ravens' gaze following is not a simple behavioral response but depends on the position of the involved individuals, i.e. whether a bird can or cannot see. This raises the question whether ravens have some appreciation of the mental state of others.

4:25
93-10 ***Multisensory perception of social signals in monkeys and birds***
Sarah Partan, Sylvana Yelda, Virginia Price, & Toru Shimizu (University of South Florida)
Multisensory communication signals, such as vocalizations accompanied by visual postures, can be classified by whether the components of the signal are redundant or nonredundant. The degree of redundancy can be determined by examining the behavioral response of subjects to presentations of the signals in their whole (multisensory) or component (unisensory) form. The responses of rhesus macaques (*Macaca mulatta*) and Carneaux pigeons (*Columba livia*) to multi- and unisensory signals of their conspecifics will be discussed. Aggressive and affiliative multisensory signals of macaques were studied in a naturalistic habitat in Puerto Rico. The pigeons are housed in a laboratory and are currently the subjects of a video playback study to examine the effects of visual and vocal components of male courtship signals on female responsiveness

4:40
94-5 ***Observational learning includes a social component in brown capuchin monkeys (Cebus apella)***
Sarah F. Brosnan (Emory University) & Frans B. M. de Waal (Emory University)
To tease apart if brown capuchin monkeys (Cebus apella) learn information socially (requiring a conspecific model) or observationally (from information in the environment), we tested if capuchins could learn the value of novel tokens in a familiar task, either by watching a conspecific perform a series of 10 exchanges with each token, or by watching each token paired the same number of times with its associated reward. Apart from the presence or absence of a conspecific, both procedures were the same. Capuchins did learn to favor the higher value token when watching a partner exchange, but not if a partner was absent. Thus, in this task the involvement of a conspecific helped capuchins learn observationally. We speculate that this is due to increased attention towards objects being manipulated by conspecifics rather than a lack of information in the non-social situation.

4:45
95-5 ***Observational learning in African Grey Parrots***
Robert J. Willson, Aaron Olivera (The University of Greenwich) & Andrew Whiten (The University of St. Andrews)
An experiment using a domesticated demonstrator and a wild-caught observer showed that African Grey Parrots are capable of learning object and response choices by observing the choices of a conspecific. Using a variation of the two-object-two-action task, the demonstrator was trained to choose a particular object and perform a particular directional response on that object. Once the task had been mastered, the demonstrator performed the task in view of the observer for a series of four sessions. Each session consisted of five correct object and directional choices. The observer was tested following the third and fourth session, with each test consisting of five trials. The results showed a significant tendency for the observer to match both the object and directional choices of the demonstrator. Although the results do not constitute a demonstration of 'true' imitation, they are consistent with the idea that parrots can learn from each other by observation.

4:50
96-5 ***Interspecies attention reading in wild vervet monkeys***
Sayaka Tsutsumi, Kazuo Fujita (Kyoto University), & Jason Mwenda (Institute of Primate Research, National Museums of Kenya)
There are two categories of wild animal species in the world; one that choose their habitat near human residence, and the other that avoid contact with humans. The former need to know the following: 1) cost and benefit of choosing humans as a neighbor, 2) when and where it is safe / dangerous to get in contact with humans, and 3) how to predict human behavior, or, how to read the attention of humans.
Here we examined how wild vervet monkeys, a primate species known to live closely with humans, read the attention of human neighbor using a field experiment method. The task was to take a piece of food which was located in front of a human actor being engaged in 4 different behaviors with different directions / qualities of attention. The results showed that the vervet monkeys behave differently according to the direction and quality of human's attention.

4:55
Discussion of Presentations 94, 95, & 96

Causal reasoning
Chair, Tom Zentall

5:10
97-10 ***Transitive responding in pigeons with reinforcement history controlled***
Olga F. Lazareva & Edward A. Wasserman (University of Iowa)
Solving a transitive inference (TI) problem requires the ability to deduce that if $b > c$ and $c > d$, then $b > d$. In our previous research, we found that crows responded transitively only when post-choice feedback stimuli were dimensionally ordered. In the present study, we tested pigeons on TI tasks involving dimensionally ordered or non-ordered feedback stimuli. As with crows, the pigeons could see the feedback stimuli only after their choice between the primary discriminative stimuli. For half of the birds the feedback stimuli were ordered by size, whereas for the other half of the birds they were not. Special training further guaranteed that Stimulus D had a richer reinforcement history than Stimulus B. Nevertheless, the pigeons strongly preferred B over D regardless of the nature of the feedback stimuli. Follow-up simulations showed that these results cannot be explained by linear operator models or value transfer theory.

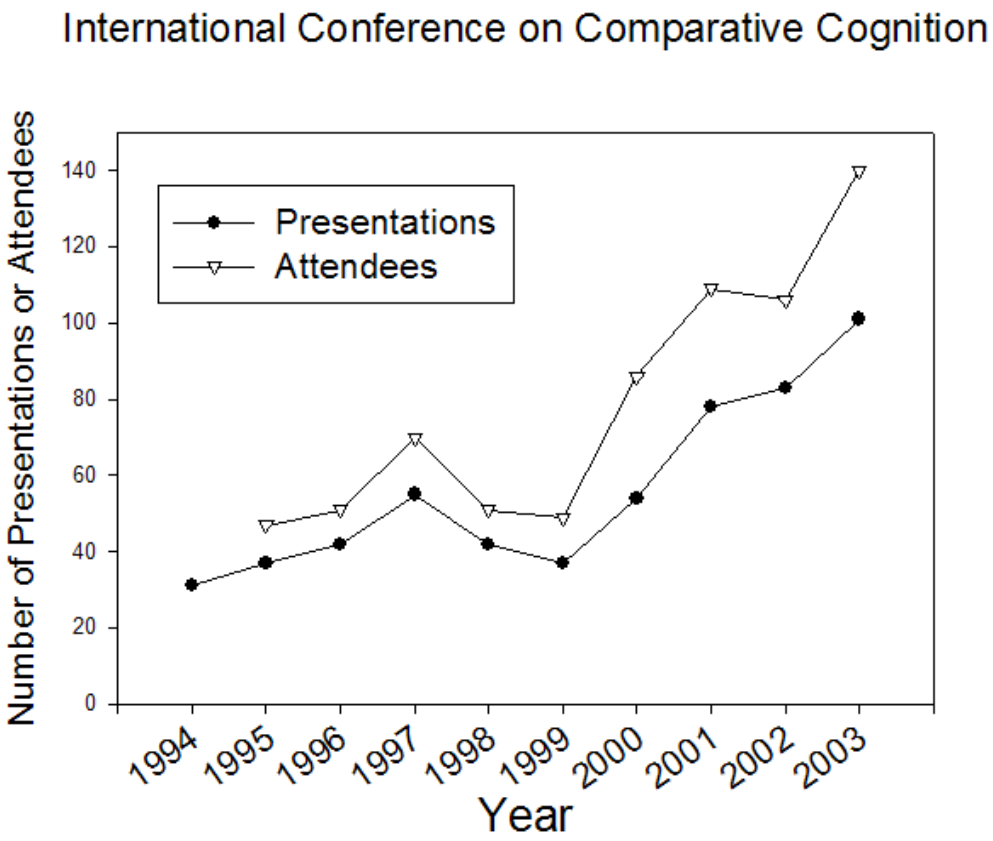
5:25
98-10 ***Transposition in pigeons***
Olga F. Lazareva & Edward A. Wasserman (University of Iowa)
In Experiment 1, we trained four pigeons to discriminate two pairs of white circles of different diameters: 1+ 2- and 5+ 6-, or 1- 2+ and 5- 6+ (where larger numbers correspond with larger diameters and plus and minus signs denote reinforcement and nonreinforcement). In Experiment 2, we trained six pigeons to discriminate four pairs of circles: 1+ 2-, 1+ 3-, 4+ 6-, and 5+ 6-, or 1- 2+, 1- 3+, 4- 6+, and 5- 6+. In both experiments, testing included five new pairings—1/5, 2/3, 2/6, 3/4, and 4/5—that clearly distinguish absolute and relational theories of transposition. Pigeons responded relationally to all of the test pairings. Simulations showed that neither absolute nor relational theory could fully explain these pigeons' data. But, a weighted average yielded a remarkably good fit, suggesting that both relational and absolute factors may govern pigeons' choice behavior, with relational control greatly exceeding absolute control.

5:40
99-10 ***What Accumulates in Causal Reasoning?***
J.W. (Bill) Whitlow, Jr. & Kathleen Brogan (Rutgers University-Camden)
Associative learning models have been used successfully to predict a number of results in human causal reasoning, but several types of evidence raise questions about a key underlying assumption of such theories, namely, that there is an accumulation of associative strength or information. However, it is difficult to interpret empirical data on information accumulation without a theory of how information is represented. Using the connectionist modeling approach of LEABRA, we describe our initial explorations in developing a unified account of the role of causal relations in animal conditioning and the role of associations in human causal reasoning.

5:55
100-10 ***Dogs do not understand means-end connections via a string***
Britta Osthaus, Stephen E.G. Lea & Alan M. Slater (University of Exeter, UK)
Domestic dogs (Canis lupus) were tested in three experiments for their understanding of means-end connections. Results showed that dogs can solve the problem of pulling food into their reach as long as the connecting string is laid out in a straight line. When the string is laid out in an acute angle with the barrier the dogs produce so-called proximity errors, i.e. they ignore the accessible end of the string and try to reach the food instead (Experiment 1). Given the choice between a baited and a non-baited string, the animals chose the baited one significantly more often than the other one (Experiment 2). In the third experiment, a combination of Experiments 1 and 2, the dogs were tested with two crossed strings, of which only one was baited. They performed below chance level, which indicates that they were unable to understand the means-end properties of the connections

6:10
101-10 ***Causal understanding by chimpanzees: The trap-tube revisited***
Jill E. Koehler (Arizona State University), Carmen J. Owens (The Ohio State University) & Sarah T. Boysen (The Ohio State University)
Nine chimpanzees were tested for an understanding of causality using a trap-tube task. The apparatus consisted of a transparent tube with a hole (or trap) in the middle. To obtain a reward, the chimp had to insert a wooden dowel into the end farthest from the reward and push the candy out. Five subjects reached criterion. As a control, the tube was rotated, with the hole now on top. Two chimps employed a new strategy suggesting understanding of causality between use and outcome. The same subjects were tested further by flipping the tube back with the original position. Both chimpanzees were again successful with the trap tube. Their ability to revert to the correct strategy suggested an appreciation of causality over a distance-based strategy.

HAPPY 10th Anniversary CO3 !!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20
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60
80
100
120
140
Presentations
Attendees
1994
1995
1996
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