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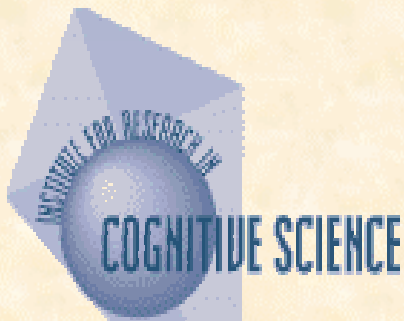
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Institute for Research in
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University of Pennsylvania

Editors: Lila R. Gleitman and Aravind K. Joshi

**Proceedings of the
Twenty-Second Annual Conference
of the
Cognitive Science Society**

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Institute for Research in Cognitive Science
University of Pennsylvania
Philadelphia, PA

Foreword

This volume contains the final drafts of the papers and posters selected for presentation at the 22nd Annual Meeting of the Cognitive Science Society in Philadelphia, PA, August 13-15, 2000. A glance through the Table of Contents shows that this meeting reflects the eclectic and forward-looking character of Cognitive Science as it comes into its own at the turn of the Millennium. “CogSci2000” embodies a set of scholarly contributions that range from psychological and neuroscientific experimentation through computational modeling to philosophical musings about the foundations of the field. In our view, the coherence and range of these contributions characterize the emergence of Cognitive Science from the status of an interdisciplinary field to a full-blown discipline with its own formalisms, methods, techniques, and overarching goals: to find a computational theory of Intelligence.

Having just offered a description of cognitive science that has the smell of a definition, we hasten to back off from that designation: Hardly any scientific discipline, not even speaking of the humanistic ones, succumbs readily to such definition. We offer the phrase as one that suggests and encompasses many of the themes that underlie the specific research questions taken up in this collection and that recur elsewhere in the cognitive science literature.

Coherent as our field seems when described in one grand phrase, it is not easy to subdivide it into proper parts. Categorization is itself one of the most vexed unsolved issues in our field (and thus the topic of several sessions at this meeting). Yet as a matter of practicality, as the hosts of this conference, we were forced to try, if only to cobble together paper and poster sessions that would have maximum organization and minimal overlap, allowing the conference attendees to choose among parallel sessions with a minimum of handwringing and regret. We hope that the attendees will be satisfied that the sessions are productive, lively, informative, and, in general, a lot of fun.

We turn now to acknowledging and thanking the many people, groups, and institutions that made this conference as successful as it was.

The COGNITIVE SCIENCE SOCIETY BOARD, for inviting us to host CogSci2000 and for providing the framework, backup and advice from prior conference organizers.

The PROGRAM COMMITTEE that stewarded the review process, farming out the papers, personally reviewing many of them, nagging the reviewers until they sent their reports, and finally making their recommendations to us. There were 319 submissions requiring about 1000 reviews. 95 paper submissions (out of 248) and 130 posters were accepted. The poster presentations include those paper submissions that were converted to posters based on the recommendations of the program committee.

The VOLUNTEER REVIEWERS from the cogsci community who carried out the difficult task of reviewing quite wonderfully. This allowed us to provide at least two, in most cases three, reviews to each author whether or not the submission was accepted for presentation. Although these reviews were perforce short and sometimes there were partial mismatches between reviewer and reviewee, our impression is that the process – compressed into a few short weeks – worked very well. There were a few complaints, to be sure, so when appropriate we obtained yet more reviews at the last minute. We also received very many gratifying letters from authors both successful and unsuccessful expressing their overall satisfaction with the process.

Our POSTDOCTORAL FELLOWS and ADVANCED GRADUATE STUDENTS who were repeatedly pressed into service for a host of tasks.

TOBY MINTZ and IONE FINE for organizing the Tutorials, BONNIE WEBBER for the solicitation and selection of symposia, and MARK STEEDMAN for assembling the Panel on Education.

Our PROVOST ROBERT BARCHI for his useful opening welcome and remarks.

Our PLENARY SPEAKERS, JAMES ALLEN and RANDY GALLISTEL, for their talks which in addition to the scientific content set the intellectual tone for these meetings.

Our very special thanks go to TRISHA YANNUZZI who in essence “is” CogSci2000 from the beginning to the end in all administrative aspects including the automation of the very efficient and smoothly run submission and review process. We wish we had the wordsmithery to express our gratitude to her, but we must settle for a resounding and heartfelt THANK YOU to TRISHA and to her small, but incredibly efficient staff, ANN BIES, LAUREL SWEENEY, JENNIFER MACDOUGALL, NICOLE BOLDEN and LEE LEIBER (IRCS Technical Staff).

For financial support: NATIONAL INSTITUTES OF HEALTH, MICROSOFT CORPORATION, the COGNITIVE SCIENCE SOCIETY, and the INSTITUTE FOR RESEARCH IN COGNITIVE SCIENCE at the UNIVERSITY OF PENNSYLVANIA.

And, of course, the AUTHORS of paper and poster submissions without whom there would be no CogSci2000. We thank them and applaud them for their efforts in the preparation of these submissions and placing them before their peers, thereby furthering knowledge in the field of Cognitive Science and inspiring its practitioners – certainly including us.

Welcome to CogSci2000!

Lila Gleitman and Aravind Joshi
Hosts, CogSci2000
Co-Directors, Institute for Research in Cognitive Science
University of Pennsylvania

Table of Contents

Foreword from the Conference Co-Chairs.....	iii
Conference Page.....	xvi
Cognitive Science Society.....	xvii
Tutorial Program	xviii
Symposia	xix
Special Session on Undergraduate Education in Cognitive Science.....	xx
Reviewers for the Twenty-Second Annual Conference	xxi

Invited Speakers

<i>Spoken Language Systems and Human Communication</i>	
James F. Allen	1
<i>The Symbolic Foundations of Conditioned Behavior</i>	
Randy Gallistel	1

Education Panel

<i>Special Session on Undergraduate Education in Cognitive Science</i>	
Mark Steedman... ..	2

Symposia

<i>Perspectives on Conceptual Change</i>	
David Kaufman	5
<i>The Role of the Cerebellum in Cognition and Affect</i>	
Natika Newton.....	10
<i>Bayesian Approaches to Cognitive Modeling</i>	
Michael C. Mozer and Joshua Tenenbaum	16
<i>The Nature of Human Errors: An Emerging Interdisciplinary Perspective</i>	
Jiajie Zhang.....	17

Papers

<i>Induction of Causal Chains</i>	
Woo-kyoung Ahn and Martin J. Dennis.....	19
<i>Evaluating the Effectiveness of a Cognitive Tutor for Fundamental Physics Concepts</i>	
Patricia L. Albacete and Kurt A. VanLehn	25
<i>Memory in Chains: Modeling Primacy and Recency Effects in Memory for Order</i>	
Erik M. Altmann.....	31
<i>Computational Explorations of the Irrelevant Sound Effect in Serial Short-Term Memory</i>	
C. Philip Beaman.....	37
<i>Sex, Syntax, and Semantics</i>	
Lera Boroditsky and Lauren A. Schmidt.....	42
<i>In Search of the Minority Default: The Case of Arabic Plurals</i>	
Sami Boudelaa and M. Gareth Gaskell	48
<i>Representing Categories in Artificial Neural Networks Using Perceptually-Derived Feature Networks</i>	
Robert B. Branstrom.....	54
<i>A Sensorimotor Map of Visual Space</i>	
Bruce Bridgeman.....	60

<i>Unity of Consciousness: What it is and Where it is Found</i>	
Andrew Brook	65
<i>Are Retrievals from Long-Term Memory Interruptible?</i>	
Michael D. Byrne	71
<i>Hemispheric Specialization During Episodic Memory Encoding in the Human Hippocampus and MTL</i>	
Daniel J. Casasanto, William D. S. Killgore, Guila Glosser, Joseph A. Maldjian, and John A. Detre	77
<i>A Connectionist Single-Mechanism Account of Rule-Like Behavior in Infancy</i>	
Morten H. Christiansen, Christopher M. Conway, and Suzanne Curtin	83
<i>Committing to an Ontology: A Connectionist Account</i>	
Eliana Colunga and Linda B. Smith	89
<i>An Exemplar Model of Classification in Single and Combined Categories</i>	
Fintan Costello	95
<i>A Six-Unit Network is All You Need to Discover Happiness</i>	
Matthew N. Dailey, Garrison W. Cottrell, and Ralph Adolphs	101
<i>Addressing the Learnability of Verb Subcategorizations with Bayesian Inference</i>	
Mike Dowman	107
<i>Hidden Markov Models for Coding Story Recall Data</i>	
Michael A. Durbin, Jason Earwood, and Richard M. Golden	113
<i>A Rarity Heuristic for Hypothesis Testing</i>	
Aidan Feeney, Jonathan St. B. T. Evans, and Simon Venn	119
<i>Modeling Orientation Effects in Symmetry Detection: The Role of Visual Structure</i>	
Ronald W. Ferguson	125
<i>Visual Learning for a Mid Level Pattern Discrimination Task</i>	
I. Fine and Robert A. Jacobs	131
<i>Decoding Syntactic Parameters: The Superparser as Oracle</i>	
Janet Dean Fodor and Virginia Teller	136
<i>Lexical Contact During Speech Perception: A Connectionist Model</i>	
Eric Forbell and Eric Chown	142
<i>The Resemblance of One-Year-Old Infants to their Fathers: Refuting Christenfeld & Hill (1995)</i>	
Robert M. French, Serge Brédart, Johanne Huart, and Christophe Labiouse	148
<i>Memory versus Perceptual-Motor Tradeoffs in a Blocks World Task</i>	
Wai-Tat Fu and Wayne D. Gray	154
<i>Babies, Variables, and Relational Correlations</i>	
Michael Gasser and Eliana Colunga	160
<i>Resource-Adaptive Selection of Strategies in Learning from Worked-Out Examples</i>	
Peter Gerjets, Katharina Scheiter, and Werner H. Tack	166
<i>A Neural Network Model of Concept-Influenced Segmentation</i>	
Robert L. Goldstone	172
<i>The Determinants of Basic-Level Performance</i>	
Frédéric Gosselin and Philippe G. Schyns	178
<i>Latent Semantic Analysis Captures Causal, Goal-Oriented, and Taxonomic Structures</i>	
Arthur Graesser, Ashish Karnavat, Victoria Pomeroy, and Katja Wiemer-Hastings	184
<i>Rational Assessments of Covariation and Causality</i>	
Gustaf Gredebäck, Anders Winman, and Peter Juslin	190
<i>Function-Follows-Form Transformations in Scientific Problem Solving</i>	
Todd W. Griffith, Nancy J. Nersessian, and Ashok Goel	196
<i>Teacakes, Trains, Taxicabs and Toxins: A Bayesian Account of Predicting the Future</i>	
Thomas L. Griffiths and Joshua B. Tenenbaum	202

<i>Vagueness in Context</i>	
Steven Gross.....	208
<i>Simulating Causal Models: The Way to Structural Sensitivity</i>	
York Hagmayer and Michael R. Waldmann	214
<i>The Problem with Logic in the Logical Problem of Language Acquisition</i>	
Petra Hendriks.....	220
<i>Memory-Based Problem Solving and Schema Induction in Go</i>	
Alex Heneveld, Alan Bundy, Michael Ramscar, and Julian Richardson.....	226
<i>Toward an Integrated Account of Reflexive and Reflective Reasoning</i>	
John E. Hummel and Jesse M. Choplin.....	232
<i>Constituent Structure in Mathematical Expressions</i>	
Anthony R. Jansen, Kim Marriott, and Greg W. Yelland	238
<i>Algorithm, Heuristic or Exemplar: Process and Representation in Multiple-Cue Judgment</i>	
Sari Jones, Peter Juslin, Henrik Olsson, and Anders Winman	244
<i>Influences on Attribute Selection in Redescriptions: A Corpus Study</i>	
Pamela W. Jordan.....	250
<i>Verb Meanings, Object Affordances, and the Incremental Restriction of Reference</i>	
Edward Kako and John C. Trueswell.....	256
<i>Learning the Use of Discourse Markers in Tutorial Dialogue for an Intelligent Tutoring System</i>	
Jung Hee Kim, Michael Glass, Reva Freedman, and Martha W. Evens	262
<i>Are Structural Principles Useful for Automatic Disambiguation?</i>	
Alexandra Kinyon	268
<i>Dynamic Extension of Episode Representation in Analogy-Making in AMBR</i>	
Boicho Kokinov and Alexander Petrov.....	274
<i>Controlled Exploration of Alternative Mechanisms in Cognitive Modeling</i>	
Rita Kovordányi	280
<i>Modeling Infant Learning via Symbolic Structural Alignment</i>	
Sven E. Kuehne, Dedre Gentner, and Kenneth D. Forbus	286
<i>An Optimality-Theoretic Model of Acquisition of Tense and Agreement in French</i>	
Géraldine Legendre, Paul Hagstrom, Marina Todorova, and Anne Vainikka	292
<i>Infinite RAAM: A Principled Connectionist Basis for Grammatical Competence</i>	
Simon Levy, Ofer Melnik, and Jordan Pollack.....	298
<i>The Acquisition of Lexical and Grammatical Aspect in a Self-Organizing Feature-Map Model</i>	
Ping Li.....	304
<i>Irregularization: The Interaction of Item Frequency and Phonological Interference in Regular Past Tense Production</i>	
Christopher J. Long and Amit Almor.....	310
<i>A Computational Level Theory of Similarity</i>	
Bradley C. Love	316
<i>Viewpoint Dependent Facial Expression Recognition: Japanese Noh Masks and the Human Face</i>	
Michael J. Lyons, Andre Plante, Miyuki Kamachi, Shigeru Akamatsu, Ruth Campbell, and Mike Coleman.....	322
<i>Is Lexical Retrieval in Speech Production like Recall or Recognition? The Effects of Word Frequency and Neighbourhood Size</i>	
Siobhan B. G. MacAndrew, Trevor A. Harley, and Sheila Colgan.....	328
<i>A Generative Connectionist Model of the Development of Rule Use in Children</i>	
Stuart Marcovitch and Philip David Zelazo	334
<i>Transfer along a Continuum: Differentiation or Association?</i>	
I. P. L. McLaren and M. Suret.....	340
<i>Regularity and Irregularity in French Inflectional Morphology</i>	
Fanny Meunier and William Marslen-Wilson.....	346

<i>Neighborhood and Position Effects Interact in Naming Latency</i>	
Jeanne C. Milostan, Garrison W. Cottrell, and Victor Ferreira.....	352
<i>Individual Differences in Exemplar-Based Interference During Instructed Category Learning</i>	
David C. Noelle and Garrison W. Cottrell	358
<i>Deep Learning in Virtual Reality: How to Teach Children That the Earth is Round</i>	
Stellan Ohlsson, Thomas G. Moher, and Andrew Johnson.....	364
<i>ANCHOR: A Memory-Based Model of Category Rating</i>	
Alexander A. Petrov and John R. Anderson	369
<i>The Area Activation Model of Saccadic Selectivity in Visual Search</i>	
Marc Pomplun, Eyal M. Reingold, Jiye Shen, and Diane E. Williams.....	375
<i>The Use of a High-Dimensional, "Environmental" Context Space to Model Retrieval in Analogy and Similarity-Based Transfer</i>	
Michael Ramscar and Daniel Yarlett	381
<i>Organising Principles in Lexical Representation: Evidence from Polish</i>	
Agnieszka Reid and William Marslen-Wilson.....	387
<i>From Studying Examples to Solving Problems: Fading Worked-Out Solution Steps Helps Learning</i>	
Alexander Renkl, Robert K. Atkinson, and Uwe H. Maier.....	393
<i>Measuring Verb Similarity</i>	
Philip Resnik and Mona Diab	399
<i>The Advantages and Disadvantages of Semantic Ambiguity</i>	
Jennifer Rodd, Gareth Gaskell, and William Marslen-Wilson	405
<i>Attention to Action: Securing Task-Relevant Control in Spoken Word Production</i>	
Ardi Roelofs	411
<i>Non-Linguistic Constraints on the Acquisition of Phrase Structure</i>	
Jenny R. Saffran	417
<i>Attentional Biases in Artificial Noun Learning Tasks: Generalizations Across the Structure of Already-Learned Nouns</i>	
Larissa K. Samuelson.....	423
<i>Phrases as Carriers of Coherence Relations</i>	
Holger Schauer and Udo Hahn.....	429
<i>Syntactic Priming in German Sentence Production</i>	
Christoph Scheepers and Martin Corley	435
<i>Hypertext Navigation and Conflicting Goal Intentions: Using Log Files to Study Distraction and Volitional Protection in Learning and Problem Solving</i>	
Katharina Scheiter, Peter Gerjets, and Elke Heise	441
<i>Clarifying Word Meanings in Computer-Administered Survey Interviews</i>	
Michael F. Schober, Frederick G. Conrad, and Jonathan E. Bloom	447
<i>Seeking Coherent Explanations – A Fusion of Structured Connectionism, Temporal Synchrony, and Evidential Reasoning</i>	
Lokendra Shastri and Carter Wendelken.....	453
<i>Infant Familiarization to Artificial Sentences: Rule-Like Behavior Without Explicit Rules and Variables</i>	
Thomas R. Shultz and Alan C. Bale.....	459
<i>Simulation of Self-Affirmation Phenomena in Cognitive Dissonance</i>	
Thomas R. Shultz and Mark R. Lepper.....	464
<i>Linguistic Labels and the Development of Inductive Inference</i>	
Vladimir M. Sloutsky and Ya-Fen Lo.....	469
<i>Problem Representation in Experts and Novices: Part 2. Underlying Processing Mechanisms</i>	
Vladimir M. Sloutsky and Aaron S. Yarlas.....	475

<i>Prosodic Choice: Effects of Speaker Awareness and Referential Context</i>	
Jesse Snedeker, Lila Gleitman, Michael Felberbaum, Nicora Placa, and John Trueswell...	481
<i>Eye Movements During Comprehension of Spoken Scene Descriptions</i>	
Michael J. Spivey, Melinda J. Tyler, Daniel C. Richardson, and Ezekiel E. Young	487
<i>Heterogeneous Reasoning in Learning to Model</i>	
Keith Stenning and Melissa Sommerfeld	493
<i>Inducing Hybrid Models of Task Learning from Visuomotor Data</i>	
Devika Subramanian	499
<i>Ungrammatical Influences: Evidence for Dynamical Language Processing</i>	
Whitney Tabor and Bruno Galantucci	505
<i>Mapping the Syntax/Semantics Coastline</i>	
Whitney Tabor and Sean Hutchins	511
<i>Word Learning as Bayesian Inference</i>	
Joshua B. Tenenbaum and Fei Xu	517
<i>Aspectual Coercion and the Online Computation of Sentential Aspect</i>	
Marina Todorova, Kathy Straub, William Badecker, and Robert Frank	523
<i>Talking through Graphics: An Empirical Study of the Sequential Integration of Modalities</i>	
Ichiro Umata, Atsushi Shimojima and Yasuhiro Katagiri	529
<i>The Dynamics of Simple Prediction: Judging Reachability</i>	
Iris van Rooij, Raoul M. Bongers, and W. F. G. (Pim) Haselager	535
<i>Goal Specificity and Learning with a Multimedia Program</i>	
Regina Vollmeyer, Bruce D. Burns, and Falko Rheinberg	541
<i>Human Belief Revision and the Order Effect</i>	
Hongbin Wang, Jiajie Zhang, and Todd R. Johnson	547
<i>Situating GOMS Models Within Complex, Sociotechnical Systems</i>	
Robert L. West and Gabriella Nagy	553
<i>Motivation in Insight versus Incremental Problem Solving</i>	
Mareike Wieth and Bruce D. Burns	559
<i>Making Inferences and Classifications Using Categories that are not Linearly Separable</i>	
Takashi Yamauchi and Arthur B. Markman	565
<i>Structure-Mapping Theory and Lexico-Semantic Information</i>	
Daniel Yarlett and Michael Ramscar	571
<i>Selective Advantages of Syntactic Language – A Model Study</i>	
Willem H. Zuidema and Paulien Hogeweg	577

Posters

<i>A Natural Bias for the Basic Level?</i>	
Annie Archambault, Frédéric Gosselin, and Philippe G. Schyns	585
<i>Subgoal Learning and the Effect of Conceptual vs. Computational Equations on Transfer</i>	
Robert K. Atkinson and Richard Catrambone	591
<i>A Comparative Study of Unsupervised Grapheme-Phoneme Alignment Methods</i>	
Timothy Baldwin and Hozumi Tanaka	597
<i>Discovering and Describing Category Differences: What Makes a Discovered Difference Insightful?</i>	
Stephen D. Bay and Michael J. Pazzani	603
<i>Harmonia Loosely Praestabilita: Discovering Adequate Inductive Strategies</i>	
Hilan Bensusan and Christophe Giraud-Carrier	609

<i>Path and Manner Priming: Verb Production and Event Recognition</i> Dorrit Billman, Angela Swilley, and Meredyth Krych	615
<i>Reasoning from Shared Structure</i> Sergey Victor Blok and Dedre Gentner	621
<i>Problem Solving: Phenomena in Search of a Thesis</i> Bruce D. Burns and Regina Vollmeyer	627
<i>The Representational Effect in Complex Systems: A Distributed Representation Approach</i> Johnny Chuah, Jiajie Zhang, and Todd R. Johnson	633
<i>Precursors to Number: Making the Most of Continuous Amount</i> Peter Drake, Kelly Mix, and Melissa Clearfield	639
<i>Subjacency Constraints without Universal Grammar: Evidence from Artificial Language Learning and Connectionist Modeling</i> Michelle R. Ellefson and Morten H. Christiansen	645
<i>Reflective Introspective Reasoning through CBR</i> Susan Eileen Fox	651
<i>The Chinese Room: Just Say "No!"</i> Robert M. French	657
<i>The Influence of Source and Cost of Information Access on Correct and Errorful Interactive Behavior</i> Wayne D. Gray and Wai-Tat Fu	663
<i>Practices of Questioning and Explaining in Learning to Model</i> James G. Greeno, Melissa C. Sommerfeld, and Muffie Wiebe	669
<i>Work at the Interface between Representing and Represented Worlds in Middle School Mathematics Design Projects</i> Rogers Hall	675
<i>Four Letters Good, Six Letters Better: Exploring the Exterior Letters Effect with a Split Architecture</i> John Hicks, Jon Oberlander, and Richard Shillcock	681
<i>Eye-Tracking and Conceptual Combination</i> Dietmar Janetzko	687
<i>The Role of Mental Imagery in Understanding Unknown Idioms</i> Armina Janyan and Elena Andonova	693
<i>Does Collaborative Learning Lead to the Construction of Common Knowledge?</i> Heisawn Jeong and Michelene T. H. Chi	699
<i>Learning from a Computer Workplace Simulation</i> Heisawn Jeong, Roger Taylor, and Michelene T. H. Chi	705
<i>A Dynamical Model of Insightful Memory Retrieval</i> Koji Jimura, Hisaaki Komazaki, Takashi Matsuoka, Masanori Nakagawa, and Takashi Kusumi	711
<i>Declarative and Procedural Learning in Alphabetic Retrieval</i> Todd R. Johnson, Hongbin Wang, and Jiajie Zhang	717
<i>A Process Model of Children's Early Verb Use</i> Gary Jones, Fernand Gobet, and Julian M. Pine	723
<i>Handedness and Heterogeneity in Cognitive Science</i> Gregory V. Jones and Maryanne Martin	729
<i>Using Referential Communication to Study Mental Models</i> Julia Kalmanson and Arthur B. Markman	735
<i>Was Apatosaurus a Vegan? Dinosaur Knowledge Rocks When Learning about Evolution</i> David R. Kaufman, Michael Ranney, Eric Lewis, Anna Thanukos, and Sarah Brem	741
<i>Evaluating Competition-Based Models of Word Order</i> Frank Keller	747

<i>The Précis of Project Nemo, Phase 2: Levels of Expertise</i>	
Susan S. Kirschenbaum and Wayne D. Gray	753
<i>Visual and Spatial Representations in Relational Reasoning</i>	
Markus Knauff and P. N. Johnson-Laird	759
<i>Constraints of Embodiment on Action Coordination</i>	
Günther Knoblich and J. Scott Jordan.....	764
<i>SEQL: Category Learning as Progressive Abstraction Using Structure Mapping</i>	
Sven E. Kuehne, Kenneth D. Forbus, Dedre Gentner, and Bryan Quinn.....	770
<i>Learning-Based Constraints on Schemata</i>	
Peter C. R. Lane, Fernand Gobet, and Peter C-H. Cheng	776
<i>Retrospective Effects in Human Causality Judgment</i>	
M. E. Le Pelley, D. L. Cutler, and I. P. L. McLaren	782
<i>A Constructivist Model of Robot Perception and Performance</i>	
Joseph A. Lewis and George F. Luger	788
<i>Point-Light Displays Illuminate the Abstract Nature of Children's Motion Verb Representations</i>	
Jing Liu, Roberta M. Golinkoff, Kim Piper, He Len Chung, Kathy Hirsh-Pasek, Christopher H. Ramey, and Bennett I. Bertenthal.....	794
<i>Learning at Different Levels of Abstraction</i>	
Bradley C. Love	800
<i>The Direct Route: Mediated Priming in Semantic Space</i>	
Will Lowe and Scott McDonald.....	806
<i>Zen in the Art of Language Acquisition: Statistical Learning and the Less is More Hypothesis</i>	
David Ludden and Prahlad Gupta	812
<i>Two Views are Better than One: Epistemic Actions May Prime</i>	
Paul P. Maglio and Michael J. Wenger	818
<i>Preschool Children's Use of Category Information to Interpret Negations</i>	
Bradley J. Morris.....	823
<i>An Inquiry into the Function of Implicit Knowledge and its Role in Problem Solving</i>	
Timothy J. Nokes and Stellan Ohlsson	829
<i>Hypothesis-Testing Method in a Community of Psychologists</i>	
Takeshi Okada and Takashi Shimokido.....	835
<i>Fast and Frugal Use of Cue Direction in States of Limited Knowledge</i>	
Magnus Persson and Peter Juslin	841
<i>Effects of Presentation Format on Memory for Order</i>	
Margaret J. Peterson and Erik M. Altmann.....	847
<i>Teaching and Supporting the Use of Qualitative and Quantitative Concepts in Classical Mechanics</i>	
Rolf Ploetzner and Sieghard Beller.....	853
<i>The Implications of Cognitive Science for the Significance of Experimentation in Science Teaching</i>	
Athanassios Raftopoulos and Constantinos P. Constantinou	859
<i>Evidence for the Processing of Re-representations during the Mapping of Externally Represented Analogies</i>	
Michael Ramscar.....	865
<i>Searching for Alternatives in Spatial Reasoning: Local Transformations and Beyond</i>	
Reinhold Rauh, Cornelius Hagen, Christoph Schlieder, Gerhard Strube, and Markus Knauff	871
<i>Memory for Continually Changing Information: A Task Analysis and Model of the Keeping Track Task</i>	
Wolfgang Schoppek	877

<i>Motivating Base-Rate Sensitivity (Sometimes): Testing Predictions of the RCCL Framework</i> Christian Schunn and Thuy L. Ngo.....	883
<i>Now They See the Point: Improving Science Reasoning through Making Predictions</i> Christian D. Schunn and Christine J. O'Malley.....	889
<i>Dueling Theories: Thought Experiments in Cognitive Science</i> Sam Scott.....	895
<i>Temporal Progression of the Cortical Potential Distribution for the AEP P300 Component in Mild Traumatic Brain Injury</i> Robert D. Sidman, Lan Ke, and Martin R. Ford	901
<i>What are Fallacies Good for? Representational Speed-Up in Propositional Reasoning</i> Vladimir M. Sloutsky.....	907
<i>The Primacy of One-to-One Generalization in Young Children's Induction</i> Vladimir M. Sloutsky and Ya-Fen Lo.....	912
<i>Simulating Conditional Reasoning Containing Negations: A Computer Model and Human Data</i> Jacques Sougné	918
<i>A Dynamic Field Model of Location Memory</i> John P. Spencer and Gregor Schöner	924
<i>A Simple Categorisation Model of Anaphor Resolution</i> Andrew J. Stewart and Frederic Gosselin	930
<i>Category Induction for Ordinary Facts</i> Roman Taraban and Matt Hayes.....	936
<i>Learning and Generalizing New Concepts</i> Jean-Pierre Thibaut	942
<i>Rules versus Statistics in Biconditional Grammar Learning: A Simulation Based on Shanks et al. (1997)</i> Bert Timmermans and Axel Cleeremans	947
<i>Representational Scaffolding during Scientific Inquiry: Interpretive and Expressive Use of Inscriptions in Classroom Learning</i> Eva Erdosne Toth.....	953
<i>From Dipsy-Doodles to Streaming Motions: Changes in Representation in the Analysis of Visual Scientific Data</i> Susan B. Trickett, Wai-Tat Fu, Christian D. Schunn, and J. Gregory Trafton.....	959
<i>Blobs, Dipsy-Doodles and Other Funky Things: Framework Anomalies in Exploratory Data Analysis</i> Susan B. Trickett, J. Gregory Trafton, and Christian D. Schunn	965
<i>Reaction Times and Predictions in Sequence Learning: A Comparison</i> Ingmar Visser, Maartje E. J. Raijmakers, and Peter C. M. Molenaar	971
<i>A Constructivist Dual-Representation Model of Verb Inflection</i> Gert Westermann.....	977
<i>Contextually Representing Abstract Concepts with Abstract Structures</i> Katja Wiemer-Hastings and Arthur C. Graesser	983
<i>Adding Syntactic Information to LSA</i> Peter Wiemer-Hastings	989
<i>Categorization and the Ratio Rule</i> A. J. Wills, Mark Suret, and I. P. L. McLaren	994
<i>Strategies and Tactics in Sentential Reasoning</i> Yingrui Yang, Jean-Baptiste van der Henst, and P. N. Johnson-Laird	1000
<i>Problem Representation in Experts and Novices: Part 1. Differences in the Content of Representation</i> Aaron S. Yarlas and Vladimir M. Sloutsky.....	1006

Member Abstracts

<i>Accentuation of Category Differences: Revisiting a Classic Study</i>	
Janet K. Andrews and Kenneth R. Livingston	1015
<i>Training and Transfer of Foreign Word Identification at Three Speeds</i>	
Anita R. Bowles and Alice F. Healy	1016
<i>Temporal Tuning in the Acquisition of Cognitive Skill</i>	
Richard A. Carlson and Lisa M. Stevenson	1017
<i>Hemispheric Effects in Fusiform Gyrus across Face Encoding Tasks</i>	
Daniel J. Casasanto and John A. Detre	1018
<i>Detecting Animals in Point-Light Displays</i>	
Leslie Cohen, Thomas F. Shipley, Eve Marshark, Kathy Taht, and Denise Aster	1019
<i>Familiarity and Categorical Inference</i>	
David Collister and Barbara Tversky	1020
<i>How Words Get Special</i>	
Eliana Colunga and Linda B. Smith	1021
<i>Information Processing Speed During Functional Neuroimaging of Sentence Comprehension</i>	
Ayanna Cooke, Christian DeVita, David Alsop, James Gee, John Detre, and Murray Grossman.....	1022
<i>Experimentally Uncovering Hidden Strata in English Phonology</i>	
Lisa Davidson.....	1023
<i>Language after Hemispherectomy: Effects of Seizure Control</i>	
Stella de Bode, Susan Curtiss, and Gary W. Mathern.....	1024
<i>Compositional Functions in Nominal Combination</i>	
Zachary Estes	1025
<i>Eye Movements in Human Face Learning and Recognition</i>	
Richard J. Falk, Andrew Hollingworth, John M. Henderson, Sridhar Mahadevan, and Fred C. Dyer	1026
<i>Comprehension of Active and Passive Sentences in Portuguese and English: The Prototypicality Effect</i>	
Rosângela Gabriel and Kim Plunklett	1027
<i>Stages of Phonological Processing in Spoken Production</i>	
Matthew Goldrick, Brenda Rapp, and Paul Smolensky	1028
<i>Why Are Some Problems Easy? New Insights into the Tower of Hanoi</i>	
Glenn Gunzelmann and Stephen Blessing	1029
<i>Of Words, Birds, Worms, and Weeds: Infant Word Learning and Lexical Neighborhoods</i>	
George J. Hollich, Peter W. Jusczyk, and Paul A. Luce	1030
<i>Modelling Language Acquisition at Multiple Temporal Scales</i>	
Steve R. Howell and Suzanna Becker	1031
<i>Perceptual and Experience-Dependent Influences on Location Memory Processes</i>	
Alycia M. Hund and John P. Spencer	1032
<i>A Study of Age-of-Acquisition Ratings in Adults</i>	
Gowri K. Iyer, Cristina M. Saccuman, Elizabeth A. Bates, and Beverly B. Wulfeck	1033
<i>The Development of Word Recognition: The Use of the Possible Word Constraint by 12-Month-Olds</i>	
Elizabeth K. Johnson, Peter W. Jusczyk, Anne Cutler, and Dennis Norris	1034
<i>Familiarity for Nouns and Verbs: Not the Same as, and Better than, Frequency</i>	
Natalie Kacinik, Connie Shears, and Christine Chiarello	1035

<i>Random Indexing of Text Samples for Latent Semantic Analysis</i>	
Pentti Kanerva, Jan Kristoferson, and Anders Holst	1036
<i>Auditory and Visual Continuity Perception: A Unifying Theory</i>	
Leah M. Knightly	1037
<i>The Role of Working Memory in Homograph Recognition</i>	
Yuki Kobayashi	1038
<i>Attentional Perseveration after the Inverse Base-Rate Effect</i>	
John K. Kruschke, Mark K. Johansen, and Nathaniel J. Blair	1039
<i>Do Readers Make Predictive Inferences about Conversations?</i>	
R. Brooke Lea, Patrick A. Kayser, Elizabeth J. Mulligan, and Jerome L. Myers	1040
<i>A Model of Prefrontal-Hippocampal Interactions in Strategic Recall</i>	
Jean C. Lim and Suzanna Becker	1041
<i>An Adaptive Model of Simple Communication</i>	
Michael Matessa and John R. Anderson	1042
<i>Morphological Influences on Phonetic Categorization</i>	
Kerstin Mauth	1043
<i>Unique Entropy as a Model of Linguistic Classification</i>	
Toben H. Mintz	1044
<i>Analogical Priming in a Word Naming Task</i>	
Robert G. Morrison, Keith J. Holyoak, and Barbara A. Spellman	1045
<i>Finding Common Ground in Children's Referential Communication</i>	
Aparna Nadig and Julie Sedivy	1046
<i>If Robots Make Choices, are they Alive?: Children's Judgments of the Animacy of Intelligent Artifacts</i>	
Milena K. Nigam and David Klahr	1047
<i>Effects of Visualization on Familiar Motion Problems</i>	
Matia Okubo	1048
<i>The Problem of Relevance in Blended Mental Spaces</i>	
David Paxman	1049
<i>Interpreting Eye-Movement Protocols</i>	
Dario D. Salvucci and John R. Anderson	1050
<i>Learning to Learn by Modular Neural Networks</i>	
Akio Sashima and Kazuo Hiraki	1051
<i>Modeling Embodied Cognition in a Complex Real-Time Task</i>	
Michael J. Schoelles and Wayne D. Gray	1052
<i>Does Human Memory Reflect the Environment of Early Hominids?</i>	
Lael Schooler, Juan Carlos Serio Silva, and Ramon Rhine	1053
<i>Knowledge Construction Links: Cues and Trajectories as Prior Experience and Knowledge</i>	
Kathy L. Schuh	1054
<i>A Delay-Dependent Switch in the Information Children Use to Remember Locations</i>	
Anne R. Schutte and John P. Spencer	1055
<i>19-Month-Olds' Sensitivity to Negation/Tense Dependencies</i>	
Melanie Soderstrom, Peter Jusczyk, and Kenneth Wexler	1056
<i>Scaling and Testing for Non-Euclidean Spaces</i>	
Jesse Spencer-Smith	1057
<i>Variation in Children's Word Production: Can 'Competence' Models Deal with Young Children's Truncation Patterns?</i>	
Helena Taelman and Steven Gillis	1058
<i>Is Musical Ability Related to the Prosody Learning of Second Language?</i>	
Akihiro Tanaka and Yohtaro Takano	1059

<i>Main Idea Identification: A Functional Imaging Study of a Complex Cognitive Process</i>	
Lêda Maria Braga Tomitch, Marcel Adam Just, and Patricia A. Carpenter.....	1060
<i>Schema Acquisition and Solution Strategy in Statistics Problem Solving</i>	
David Trumpower	1061
<i>Management of Multiple Goals on the Basis of Situational Urgency</i>	
Takafumi Tsuchiya.....	1062
<i>Transformational Analyses of Visual Perception</i>	
Douglas Vickers and Adrian K. Preiss.....	1063
<i>Use of Agent and Object-Oriented Information in Language Acquisition</i>	
Laura Wagner	1064
<i>Domains, Knowledge, and Constraints on Classification</i>	
William D. Wattenmaker, Kathleen A. Filak, and Josephine A. Mendoza.....	1065
<i>Knowledge Effects, Conceptual Structure, and Incidental Learning</i>	
William D. Wattenmaker, Josephine A. Mendoza, and Vanessa K. Nieves	1066
<i>Using Cognitive Models in the Design and Evaluation of Team Structure</i>	
Monica Z. Weiland and James L. Eilbert.....	1067
<i>Scene Context and Change Blindness: Memory Mediates Change Detection</i>	
Carrick C. Williams, Andrew Hollingworth, and John M. Henderson	1068
<i>Sequential Probability as a Segmentation Cue for Cantonese</i>	
Michael C. W. Yip	1069
<i>The Effect of Languages on Children's Use of Action Information</i>	
Hanako Yoshida and Linda B. Smith	1070
Author Index	1071

Twenty-Second Annual Conference of the Cognitive Science Society

August 13-15, 2000

Institute for Research in Cognitive Science

University of Pennsylvania

Philadelphia, PA

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This conference was supported by the Cognitive Science Society, the National Institutes of Health, Microsoft Corporation, and the Institute for Research in Cognitive Science at the University of Pennsylvania.

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August 11-12, 2000

The Two Visual Systems and their Interactions

Bruce Bridgeman, University of California, Santa Cruz

An introduction to the COGENT Cognitive Modelling Environment

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Cognitive Modeling and Simulation in Real-Time/Multi-tasking Domains Using the COGNET Framework

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Symposia

Perspectives on Conceptual Change

David Kaufman, University of California, Berkeley

The Nature of Human Errors

Jiajie Zhang, University of Texas, Houston

The Role of the Cerebellum in Cognition and Affect

Natika Newton, Nassau Community College

Bayesian Approaches to Cognitive Modeling

Michael C. Mozer, University of Colorado at Boulder and
Joshua Tenenbaum, Stanford University

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Special Session on Undergraduate Education in Cognitive Science

Cognitive Science presents unique opportunities and problems as a component of the undergraduate curriculum. The opportunity is to provide a view of natural and artificial minds that is relevant to a wide range of careers in research, technology and the professions. The problem is to present this material in a form that coheres as a subject, and to ensure sufficient background to teach it in sufficient depth. The symposium presents a series of short lectures by distinguished educators and researchers from Europe and North America who will explore recent developments and future directions for the subject.

Among those participating are:

Andrew Brook, Carleton University
Nils Dahlback, Linköping University
Randy Jones, Colby College
Keith Stenning, University of Edinburgh
John C. Trueswell, University of Pennsylvania

Special Session Chair

Mark Steedman, University of Edinburgh

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Invited Speakers

Spoken Language Systems and Human Communication

James F. Allen, University of Rochester

A conversational agent is a system that can engage in natural language conversation in order to further its goals. Such a system requires a concerted effort to bring work in natural language understanding, dialog modeling, knowledge representation and reasoning into a single coherent system. The TRIPS system is a specific agent that can support unconstrained dialogue in order to assist the user in problem solving tasks. Significant effort has been made to make the system robust, so that it can perform well even in the face of inevitable speech recognition errors, and can continue the dialogue in a natural way under any circumstances. This talk will discuss the overall project and its accomplishments so far, and then focus on a few specific mechanisms that enable robust interaction. It will also review some recent evidence on the nature of human language comprehension and discuss the implications of this work for future dialogue systems.

The Symbolic Foundations of Conditioned Behavior

Randy Gallistel, University of California, Los Angeles

The concept of associative learning has been central to psychology for more than a century. In the 60s and 70s, the associative conception of mind was challenged by the rise of the information processing approach, which emphasizes the construction of a symbolic representation of experience by means of computational operations. This latter conception has come to dominate thinking about sensory processing and perception at both the psychophysical and the neurobiological levels of analysis, but it has remained largely alien to our thinking about learning and memory. Conditioning paradigms – Pavlovian and operant conditioning protocols – were created in order to establish the laws of association formation, and it is widely assumed that the results of conditioning studies are in fact explainable on associative grounds. However, long neglected quantitative features of the data from conditioning experiments pose strong challenges to fundamental assumptions, such as that temporal pairing is a sine qua non for association formation or that reinforcement strengthens and non-reinforcement weakens associations. These assumptions are central not only to associative theories of conditioned behavior but also to connectionist models of behavioral processes and to efforts by neuroscientists to determine the cellular and molecular bases of learning and memory. The findings that challenge associative assumptions are readily explained by information processing theories of conditioning in which subjects measure and record intervals, estimate conditional rates of occurrence, and make decisions based on noisy decision variables computed from these remembered estimates. The success of information processing models on the home ground of associative models suggests that the brain is truly a symbol processing organ, whose operation must be understood in information processing terms.

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Chair

Mark Steedman, University of Edinburgh

Abstracts

The Cognitive Science Programme at Carleton University

Andrew Brook, Carleton University

Carleton University in Ottawa offers free-standing, fully-integrated Cognitive Science programmes at both the undergraduate and the doctoral level. The undergraduate programme was recently reviewed by two senior Canadian cognitive researchers. Some of their findings and recommendations might be of interest to other cognitive science educators. In this presentation, I will describe some of the strengths and weaknesses of both our programmes, summarize some of the key findings and recommendations about the undergraduate programme, and discuss the implications of the latter.

The Three Cultures of Cognitive Science

Nils Dahlback, Linköping University

When designing an educational program for cognitive science, it is important to base this on some coherent view of the field. If not, there is a risk that the students are presented with a haphazard selection of courses that is more a reflection of the interests of the current available faculty than anything else. Lacking an integrative framework, it will be difficult for the students to relate the different topics and perspectives presented to each other, and it will be difficult for prospective employers in both industry and academia to know which competence the students bring with them. In this talk, an alternative view of cognitive science as neither one unified cognitive science nor just a multidisciplinary field of a number of sciences (psychology, AI, linguistics, philosophy, neuroscience, etc.) is presented. It is argued that cognitive science is best described as a matrix of two dimensions, a content or domain dimension (e.g., language, problem solving etc., and subsets of these) and a methods dimension, comprising three basic approaches to research: empirical, formal, and model building. The latter are seen not only as methods per se, but rather as scientific 'cultures,' carriers of differing explicit and implicit views of what constitutes 'good research.' Since cultural knowledge to a large extent can be acquired only by 'living' in the culture, the Linköping Cognitive Science Master's program is built on the assumption that the students should early in their studies learn all three scientific traditions, both the theoretical and methodological aspects, on an equal footing, before specializing in a particular sub-field. The talk presents the 'three cultures' view of cognitive science, how this has influenced the general design of the program, and describes theoretical and applied courses which illustrate our approach to supporting the students acquiring their own perspective of a multicultural but still unified field of cognitive science.

Using Project Work in Teaching Cognitive Science

Randy Jones, Colby College

In recent years I have developed and taught introductory undergraduate courses in cognitive science and artificial intelligence, as well as one graduate-level course on cognitive science. In developing my courses, I have strongly subscribed to a proposition that I assume most of us (as teachers and cognitive scientists) believe: an effective form of education requires students to participate actively in constructive projects that exercise the material they are learning in class. This presentation describes a set of class projects I have developed, in the hopes that others will find them useful in teaching courses on cognitive science. Some of the projects are directly applicable to a cognitive science course. Others I have developed for a course on artificial intelligence, but would also be appropriate for cognitive science, depending on the emphasis of the course. Among other topics, the projects include study of knowledge representation, learning, production systems, cognitive modeling, and interactive systems. Project descriptions and executable code are available on-line at <http://www.cs.colby.edu/~rjones/courses/cs397/projects/> and <http://www.cs.colby.edu/~rjones/courses/cs353/projects/>.

Teaching Multiple Disciplinary Perspectives: A First Year Course in Cognitive Science

Keith Stenning, University of Edinburgh

First year Edinburgh undergraduate students arrive knowing little of AI, computer science, linguistics, logic, philosophy, psychology – the component disciplines of cognitive science. They don't even know whether these component disciplines are of interest to them. For the last four years we have been teaching a half-year course on Human Communication which is designed to give students from all departments in the university a grasp of what cognitive science is, and how the component disciplines contribute to it. This talk will describe some of our experiences. Are we best teaching single disciplines first, and integrating only after? Or is it better to start by treating disciplines as merely perspectives on a common subject matter?

Cognitive Science Education at Penn and the Undergraduate Summer Workshop

John C. Trueswell

In this talk, I will try to convey the flavor of cognitive science education from the perspective of the group at the University of Pennsylvania. Over the years, Penn has maintained a loose federation approach to cognitive science, in the sense that the departments that make up the participating subdisciplines of cognitive science have used the Institute for Research in Cognitive Science (IRCS) as a gathering place and intellectual-exchange center, but also as a catalyst for interdisciplinary course offerings at the undergraduate and graduate level. I'll discuss the pros and cons of such an educational system, and emphasize how it leaves open the definition of cognitive science, recognizing the current dynamics of the field. As an illustration of this, I will focus on a recent educational initiative stemming from IRCS: The Undergraduate Summer Workshop in Cognitive Science and Cognitive Neuroscience. Each year, IRCS brings together a select group of undergraduate students from around the world who are interested in pursuing graduate work within some area of cognitive science or cognitive neuroscience. The workshop provides students with an intense two-week introduction to Penn's perspective on these emerging disciplines. Penn faculty offer day-long seminars and labs in their area of specialization, permitting in depth discussion of a particular research topic. Each week ends with a panel discussion by the faculty, relating the topics of that week, and providing spontaneous discussion of where the field of cognitive science might be headed in the coming years. By acknowledging and educating students that cognitive science is still an ill-defined rapidly changing field, we stimulate students to learn more about cognitive science, and entice them to contribute to its development and definition.