

INVITED SPEAKER AND SYMPOSIA ABSTRACTS

The Cognitive Development Society Fifth Biennial Meeting Program includes two plenary invited talks, two plenary invited symposia, and four symposia sessions with three concurrent symposia.

Friday, October 26

8:45 - 9:45	Plenary Talk in Anasazi Ballroom Language and the Infant Brain: How Children Learn Patricia Kuhl, University of Washington		
10:15 - 12:30	Invited Symposium in Anasazi Ballroom In Memory of Esther Thelen		
	<u>Anasazi North</u>	<u>Anasazi South</u>	<u>Zia Ballroom</u>
2:00 - 3:45	New Directions in Social Cognitive Development: It's More than Theory of Mind	Computational Approaches to Language Acquisition: Connectionist, Dynamical Systems and Bayesian Perspectives	Attention to Language: The Interaction between Language and Cognition
4:00 - 5:45	Interactions between Social Cognition and Object Cognition	Rational Statistical Inference in Cognitive and Language Development	The Function of Action in Perceptual and Cognitive Development

Saturday, October 27

8:45 - 9:45	Plenary Talk in Anasazi Ballroom Learning to Perceive to Learn Rob Goldstone, Indiana University		
10:15 - 12:30	Presidential Symposium in Anasazi Ballroom Children's Learning		
	<u>Anasazi North</u>	<u>Anasazi South</u>	<u>Zia Ballroom</u>
2:00 - 3:45	Cognitive Developmental Perspectives on Social Categorization and the Implications for Intergroup Bias	The Role of Comparison in the Development of Relational Representations and Structured Thought	To Model or Not To Model – Is That a Central Question?
4:00 - 5:45	New Directions in Pretend Play Research	Knowing about Ignorance: Children's Judgments and Nonverbal Behavior in the Face of Uncertainty	Learning by Doing: The Role of Exploratory Play in Cognitive Development

FRIDAY, OCTOBER 26, 2007: 8:45 AM – 9:45 AM

PLENARY TALK: LANGUAGE AND THE INFANT BRAIN: HOW CHILDREN LEARN

Patricia Kuhl, University of Washington

Some of the most revolutionary ideas in brain science are coming from cribs and nurseries. In this talk I will focus on the new discoveries about early learning and the neural coding of learned information with special attention to language. Infants are born ‘citizens of the world’ and can acquire any language easily. But by the end of the first year of life, they’ve developed a specialty in one language, and their ability to discern sounds from other languages declines. Research on infants is showing that they use computation to crack the speech code, and that a social interest in language plays an important role in language learning. “Motherese,” the exaggerated, high-pitched language we use to speak to infants and children is used in virtually every language studied, and infants’ interest in it also contributes to their ability to learn. These precursors to language in typically developing infants are leading to the identification of children at risk for developmental disabilities involving language, such as children with autism. In the next decade, the techniques of modern neuroscience will play a significant role in our understanding of how infants learn.

FRIDAY, OCTOBER 26, 2007: 10:15 AM – 12:30 PM

INVITED SYMPOSIUM: IN MEMORY OF ESTHER THELEN

ORGANIZER: Linda Smith, Indiana University

SUMMARY: Esther Thelen—through extraordinarily inventive experiments—changed the field’s understanding of motor development. She showed developments such as reaching and walking not to be pre-specified but to be the self-organizing products of many heterogeneous processes interacting in a complex system of brain, body, and world. Thelen saw the broader value of these ideas beyond motor development. In celebration of her contributions, the presentations in this symposium consider the broader themes in Thelen’s work as they apply to the problem of development generally, and to cognitive development in particular.

THINKING ABOUT DEVELOPMENT: REFLECTIONS ON ESTHER THELEN’S ASSUMPTIONS AND THEIR APPLICATION TO DEVELOPMENTAL INQUIRY

Robert Lickliter, Florida International University

This talk considers the development of intersensory perception. The talk will briefly review how Esther’s basic assumptions about developmental inquiry are being applied to the study of early perceptual development and more broadly to our understanding of the development of “species-typical” behavior.

DYNAMICS IN STATISTICAL LEARNING

Rebecca Gomez, University of Arizona

This talk will present research suggesting that learning is a dynamically guided process, arising in the interaction of internal and external pressures. Moreover, learners, and the structure they can acquire, change as a function of experience, and are constrained by fundamental processes of memory. In contrast to “knowledge” constraints traditionally proposed in the literature on development and learning, the constraints proposed here arise naturally from the mechanics of learning and memory processes themselves.

BRAIN DEVELOPMENT AS THE ULTIMATE DYNAMIC SYSTEMS

Joan Stiles, University of California-San Diego

From the complexities of genetic variation and transcription, to the variable paths of neural development and its dependence on experience, brain development is far more complex and dynamic than is often assumed in debates about nature vs. nurture, nativism vs. cultural learning. Inherited and experienced factors interact constantly in an ever-changing organism. This is a complex, dynamic and self-organizing system.

WEIRD LOOPS: FROM OBJECT RECOGNITION TO SYMBOLIC PLAY TO LEARNING NOUNS AND BACK*Linda Smith, Indiana University*

Cognitive development is also far more complex and dynamic than our usual debates allow. Developmental change is multi-causal in nature, with weird loops of causes which are also consequences and consequences that are causes, with considerable and nontrivial causal spread. The interdependencies among developmental changes in visual object recognition, object substitution in play, and object naming learning are presented as an example.

FRIDAY, OCTOBER 26, 2007: 2:00 - 3:45 PM**NEW DIRECTIONS IN SOCIAL COGNITIVE DEVELOPMENT: IT'S MORE THAN THEORY OF MIND****ORGANIZER:** Kristina Olson, Harvard University

SUMMARY: Social cognitive development has long been a topic of interest within cognitive development. Most textbooks and handbooks have chapters devoted to the study of social cognition in young children, though examining these chapters one often leaves with a feeling that social cognitive development is limited to the study of theory of mind and intentionality. It is rare to see core topics in social development or social psychology studied from a cognitive developmental perspective.

In this symposium we examine questions that are social, cognitive and developmental in nature and that are derived from other ongoing work in social cognition, social development, comparative psychology and cognitive development. We examine four unique topics—attachment, cognitive dissonance, social attitudes and preference development—using methods and theories derived from cognitive development. Finally, our discussant, Carol Dweck, will provide perspectives on the field of social cognitive development more broadly, emphasizing where the area of social cognitive development has been and where it is headed.

EVIDENCE FOR INFANTS' INTERNAL WORKING MODELS OF ATTACHMENT*Susan C. Johnson, Carol S. Dweck, and Frances S. Chen, Stanford University*

Nearly half a century ago, psychiatrist John Bowlby proposed that the instinctual behavioral system that underpins an infant's attachment to its mother is accompanied by "internal working models" of the social world—models based on the infant's own experience with her caregiver (Bowlby, 1958, 1969/1982). These mental models were thought to mediate, in part, the ability of an infant to use her caregiver as a buffer against the stresses of life, as well as the later development of important self-regulatory and social skills.

The current study reports the first direct evidence for human infants' "internal working models" of attachment. We used a standard visual habituation technique to assess infants' expectations of a caregiver's responsiveness to bids of attention from an infant during an abstractly depicted separation event. Securely attached infants, relative to insecurely attached infants looked significantly longer when the depicted parent ignored the child's cry and moved farther away from, rather than returning to the child, as though the securely attached infants, but not the insecurely attached infants were surprised to see a parent act unresponsively. These results are clear evidence that infants' interpretations of the social world are influenced by their own histories with their caregivers, as predicted by Bowlby.

THE ORIGINS OF COGNITIVE DISSONANCE*Louisa Egan, Laurie Santos, & Paul Bloom, Yale University*

The motivation to reduce cognitive dissonance (CD) between divergent beliefs, attitudes, and behaviors impacts adult cognitions in domains ranging from consumer consumption to morality. Previous work on the origins of CD has relied on induced behaviors, rather than behaviors generated by an individual, and has failed to employ simple and direct tests.

Our work explores CD in young children and capuchin monkeys through a non-verbal variant of Brehm's (1956) free choice paradigm. Children chose between two equally preferred stickers, A and B. Children then chose between the unchosen alternative and sticker C, which was originally rated as preferred as A and B. Children significantly chose sticker C over the unchosen A/B. In a control condition, children saw both A and B and received one of the two. Children then chose between the unreceived sticker and sticker C. In this condition, preference for C is absent.

Similarly to children, in the experimental condition, monkeys chose between M&Ms of equally preferred colors A and B, and then between the unchosen color and C. In the control condition, monkeys saw both A and B and received one of them. Then,

monkeys chose between the unreceived color and C. Monkeys preferred C to the unreceived alternative in the experimental condition, but preferred the unreceived alternative in the control condition.

These results are the first evidence of decision rationalization in young children and animals. They indicate a higher degree of motivational complexity in young children and capuchin monkeys than they are commonly believed to possess.

WHEN DO CHILDREN BEGIN TO SEE LUCKY PEOPLE AS NICER THAN UNLUCKY PEOPLE?

Kristina Olson, Mahzarin Banaji, Elizabeth Spelke (Harvard University), & Carol Dweck (Stanford University)

Random or lucky and unlucky events happen everyday—people win lotteries and lose their houses in hurricanes. We know that young children have a limited understanding of random events (Weisz, 1980) and that even as adults people sometimes blame others for the random or unlucky events that happen to them (e.g., Lerner, 1971). Recent developmental research has indicated that school-aged children demonstrate a preference for lucky people compared to unlucky people (Olson, Banaji, Dweck, & Spelke, 2006).

The current work investigates how preschoolers (aged 2.5-5 years old) think about lucky and unlucky people. In two studies with differing methods we demonstrate that children as young as 3 view the lucky as nicer than the unlucky. The presence of this evaluation at such an early age sheds doubt on explanations provided by social and developmental psychology such as the Belief in a Just World (Lerner, 1980) or Immanent Justice (Piaget, 1932/1965). Other, more cognitive explanations such as affective-tagging or valence matching must be explored to explain this phenomenon.

Positive evaluations of lucky compared to unlucky individuals are important to examine both theoretically and practically. Understanding the mechanism underlying this “preference for the lucky” can help us understand how children develop preferences and attitudes more generally. Practically, we hypothesize that young children’s preference for the lucky might lead to other social group attitudes given that some groups (e.g., the poor) tend to experience more unlucky events than others.

SOCIAL INFLUENCES ON CHILDREN’S PREFERENCES

Lori Markson & Christine Fawcett, University of California, Berkeley

Successfully navigating the social world demands that we moderate the influence of others on our own behavior, without ignoring the importance of others as sources of information in an uncertain world. Even infants are skilled at seeking information from others, especially in the face of unfamiliar events (Campos & Stenberg, 1981). Do young children look to others as resources when determining what to value and developing their own subjective preferences?

The current research investigates whether desirability and scarcity influence children’s choices when choosing between novel or unknown items. In one study, we demonstrate that 18-month-old infants’ preferences are influenced by the observation that others desire or prefer that entity to another. Further studies are investigating whether infants are differentially influenced by familiar, trusted individuals (e.g., parents), or more similar others (e.g., siblings or peers). A second study asks whether children’s choices are influenced by the perception that a given good is scarce. We found that when faced with different quantities of unknown options to select from, three- and four-year-old children tend to choose one of the less abundant item, suggesting they assign higher value to the scarce good. This bias was observed in the absence of a social context. Further studies are examining whether children’s choices may have been influenced by implicit social cues (e.g., “If there are fewer of these, other children must have chosen them.”). Taken together, these findings highlight the impact of the social world on children’s preferences.

DISCUSSANT: *Carol Dweck, Stanford University*

COMPUTATIONAL APPROACHES TO LANGUAGE ACQUISITION: CONNECTIONIST, DYNAMICAL SYSTEMS AND BAYESIAN PERSPECTIVES

ORGANIZER: Sarah Sahni, University of Wisconsin, Madison

SUMMARY: The goal of this symposium is to review the merits of computational approaches to research in language development. There is a rich history of using computational methods to create formal models of behavior which instantiate and test crucial aspects of psychological mechanisms. This approach is powerful because it forces researchers to try to understand the roots of behavior and not simply describe it. It is especially relevant to issues in development as many of these models address acquisition and learning.

As computational research has evolved, connectionist, dynamical systems, and Bayesian models have all emerged as popular approaches. Each is well-suited to investigate learning problems, although they lend themselves to different scientific theories. The symposium will consist of three presentations that: 1) Describe a line of work in language acquisition that has emerged from one of these approaches, and 2) Discuss unique aspects of a particular model and the approach. Each of the speakers is an expert in their field: Eliana Colunga (connectionism), Larissa Samuelson & John Spencer (dynamical systems), and Amy Perfors & Josh

Tenenbaum (Bayesian framework). The discussant, Linda Smith, will draw comparisons among the three approaches and highlight challenges faced by any computational model.

The topic of this symposium is important and timely as computational approaches are once again gaining attention in the field. This symposium will give members the opportunity to understand the unique merits of computational approaches as well as to clarify the different types of models, thereby providing insights concerning the relative strengths of each approach.

LEARNING TO LEARN WORDS: A CONNECTIONIST ACCOUNT

Eliana Colunga, University of Colorado - Boulder

Young children's seemingly effortless ability to learn new words, which emerges sometime in the second year of life, provides an interesting puzzle in developmental psychology. The main idea of the Attentional Learning Account of early word learning is that children learn to learn words as they learn words, and that they do so by extracting second-order generalizations from the statistical regularities present in the structure of the vocabularies they are acquiring. The computational model I will present embodies two general principles we know to be part of human cognition and of connectionist models that are well-suited for testing this hypothesis: associative learning and generalization by similarity. Through a series of simulations and experiments with young children, I will show how this model lends insight into how children's rapid word learning develops across different contexts and across different languages. The strengths of this model include its relative simplicity, its modeling of real world regularities, its attempt to make the task of the model approach that of children in the lab, and its ability to make testable (and tested) predictions. I will discuss these strengths in the context of the different computational approaches showcased in this workshop. At the end, I will suggest that 1) computational modeling lends particularly well to the understanding of developmental phenomena, and 2) the choice of computational paradigm and its potential to provide insights may depend more on the hypothesis to be tested than on the relative strengths and limitations of the different approaches.

LANGUAGE ACQUISITION IN A BAYESIAN FRAMEWORK

Amy Perfors & Josh Tenenbaum, Massachusetts Institute of Technology

On the basis of noisy and impoverished input, language learning infants must acquire both semantic generalizations (how to map world experience onto the words in the input) and syntactic ones (how to group those words into sentences). This mastery, especially in syntax, requires the ability to reason probabilistically about structured representations: grammatical rules depend upon the hierarchical organization of phrases, and knowledge of these rules is not all-or-none. Mastery also requires the ability to learn at multiple levels of abstraction. We see this clearly in the acquisition of the shape bias: on a specific level an infant must realize that toys called 'ball' may have little in common aside from their shape, and on a more abstract level, she must learn that count nouns in general tend to be well-organized by shape and not other features.

Bayesian methods are particularly suited to exploring the mastery of these two important abilities. The Bayesian approach naturally integrates statistical learning and structured representations and incorporates both into a normative framework for rational inference; this allows us to investigate the role of different types of representational structure in a principled and rigorous manner. Hierarchical Bayesian models also learn on multiple levels, making simultaneous inferences about both specific and more abstract hypotheses: as a result, they explain generalizations in a way that single-level learning cannot. We explore these advantages in the context of a model applied to learning about both the shape bias as well as aspects of verb argument constructions.

KEEPING IT REAL: A DYNAMIC SYSTEMS APPROACH TO WORD LEARNING

Larissa Samuelson & John Spencer, University of Iowa

In this talk we will illustrate how we have used a particular computational approach based on Dynamic Systems Theory—Dynamic Neural Field Theory—to understand how young children's knowledge of names and categories is brought to bear in a task in a moment in time. We suggest that only by understanding how individual behaviors at this real timescale accumulate to create later behaviors, can we make progress in understanding the development of word learning biases and cognitive development more generally.

Our recent modeling work captures developmental changes in children's attention to shape from 1.5-to 4-years-of-age in forced choice and yes/no tasks. Our model instantiates differences in the tasks presented to young children—differences that drive comparison and decision-making processes, resulting in different patterns of noun generalization in the two tasks. Further, our model captures changes in the patterns of performance over development. Thus, the DNFT has implications at both real-time and developmental timescales.

This illustrates three unique aspects of the DNFT approach. First, the DNFT is a process-based account of behavior, learning and development. From this perspective, real-time, contextually grounded decisions constrain what is learned and what develops. Second, the DNFT represents a strong commitment to neuronal principles. This provides constraints for processes that underlie

decision-making as well as for hypotheses about developmental change. Third, the DNFT involves a commitment to an embodied view of cognition which is critical to grounding word learning in a real sensorimotor system.

DISCUSSANT: *Linda Smith, Indiana University*

Computational models both describe and predict, allowing the model to account for the underlying structures in a dataset and to show transfer (or not) to novel inputs. Each of the computational approaches summarized by the three presentations – connectionist, dynamical systems, and Bayesian – have advantages and disadvantages in meeting these descriptive and predictive goals as they are applied in different sub-domains of language and cognitive development. Among the challenges that will be highlighted are: (a) how the input is encoded, (b) the architecture used to instantiate the flow and compression of information between levels, (c) the ability of the model to adapt to changes in the distributional properties of the input, and (d) whether models that solve a particular learning problem can also be deployed to solve other problems, or must of necessity be domain- and task-specific.

ATTENTION TO LANGUAGE: THE INTERACTION BETWEEN LANGUAGE AND COGNITION

ORGANIZER: Banchiamlack Dessalegn, Johns Hopkins University

SUMMARY: Many in the cognitive sciences agree that there is an interaction between language and nonlinguistic cognition. The current symposium will address the consequence, mechanism and development of such interactions across development. Specifically, the papers will focus on two questions. First, how does language influence spatial cognition when language or spatial cognition is impaired? Are typical developmental patterns observed? The first two presenters will address this question by looking at spatial cognition in individuals with limited spatial language (deaf users of Nicaraguan Sign Language) and individuals with severely impaired spatial abilities but relatively spared language (people that have the developmental genetic disorder Williams syndrome). The presenters argue that knowledge of spatial terms is crucial in developing adult-like spatial representations. Second, what is the nature of the mechanisms by which language and space interact across development? Does language simply selectively direct attention towards certain spatial representations or does language qualitatively change the nature of non-linguistic representations, and if so, how? The third presenter shows that directional spatial terms (e.g., left) help children and adults form a robust spatial representation, and proposes a specific hypothesis as the possible mechanism underlying the language effect. The final presenter shows that nonlinguistic mechanisms, e.g., attentional cues, can guide linguistic processes both in children and adults.

Overall, the symposium draws from a range of methodologies, populations and age groups to investigate the consequence, mechanism and development of interaction between language and nonlinguistic cognition -- thus yielding critical information about the structure of cognition over development.

DOES SPATIAL LANGUAGE GUIDE SPATIAL REPRESENTATION? EVIDENCE FROM NICARAGUAN SIGN LANGUAGE

Anna Shusterman, Wellesley College; Jennie E. Pyers, Wellesley College; Ann Senghas, Columbia University; Karen Emmorey, San Diego University; Elizabeth Spelke, Harvard University

How does limited language affect spatial representation? Past research suggests a role for language in the ability to use landmark cues in disorientations tasks, and that the acquisition of terms like left of and right of facilitates the use of landmark cues in these tasks. Does failure to acquire linguistic constructions like left of have a long-term impact on spatial representation? Furthermore, is language similarly related to other aspects of spatial cognition?

To address these questions, we examined spatial language and cognition in deaf users of Nicaraguan Sign Language. Senghas previously found that older signers, who learned early-emerging, less developed forms of the language, lacked left-right expressions, while younger signers, who learned a more developed form of NSL, linguistically marked left and right. Accordingly, older (Mage=30 years, n=7) and younger (Mage=21 years, n=8) signers were participated in tests of spatial language and non-linguistic spatial tasks including reorientation, mental rotation, map reading, and map drawing. Consistency in linguistic marking of left-right relations was correlated with superior performance on the reorientation task ($r=.67$, $p=.02$), suggesting a role for language in spatial representation even in adulthood. Older signers' performance on non-verbal tasks was above chance but worse than younger signers. This profile suggests that adults with limited spatial language achieve spatial abilities beyond those observed in young children, but that specific linguistic experience is necessary for fully developed spatial cognition. Variations in errors, reaction times, and cross-task performance shed further light on the nature of spatial representations in individuals with limited language.

A ROLE FOR LANGUAGE IN REORIENTATION? EVIDENCE FROM WILLIAMS SYNDROME

Laura Lakusta, Harvard University; Banchiamlack Dessalegn & Barbara Landau, Johns Hopkins University

One critical aspect of navigating the environment is being able to reorient oneself when disoriented. How is this task accomplished? Research has shown that species as diverse as rats, chicks, human toddlers and adults all reorient themselves by using the overall geometric structure of a layout. Surface featural cues (e.g., color) are also used, although use of these cues is more variable, depending on age, task conditions, and, most notably, language ability. The finding that language ability influences reorientation provides a case of interaction between language and non-linguistic thought. In this paper, we probe the nature of this interaction by testing reorientation in individuals with Williams syndrome - a rare developmental genetic deficit in which language is preserved but spatial representations are severely and selectively impaired.

We find that Williams syndrome individuals show a highly unusual pattern of performance in reorientation tasks, with failure to reorient using geometry alone, but success when geometry can be combined with surface featural cues. The results will be discussed in the context of current theories of modularity in reorientation, and the relevance of language in modulating spatial representations over development.

THE ASYMMETRIC RECODING HYPOTHESIS: HOW LANGUAGE MIGHT RECODE VISUAL REPRESENTATIONS

Banchiamlack Dessalegn & Barbara Landau, Johns Hopkins University

On several accounts language plays a powerful role in many cognitive processes. But what is the mechanism underlying such effects? We describe one language effect and lay out a hypothesis and some evidence to explain the underlying mechanism.

In previous work we found that providing specific directional terms to children enhanced their ability to match a visual target and avoid foils in which color and location were varied. Non-linguistic attentional manipulations did not show these effects, nor did linguistic instructions that did not include the directional terms.

We hypothesized that language provided the crucial figure-ground asymmetry as well as the specific directional information required for an accurate match. If this is true, then adults might be expected to show impairment if language is disabled by verbal shadowing.

We gave 60 adults the same task as the children in one of three conditions: No Shadow, Verbal Shadow, and Rhythm Shadow. Adults performed at ceiling in the No Shadow and Rhythm Shadow conditions, but fell to 4-yearold levels in the Verbal Shadow condition.

Thus, for both adults and children language appears to play a crucial role in carrying out this task. We lay out the Asymmetric Recoding Hypothesis which states that given an object without an inherent figure and ground, language forces the creation of an asymmetry between the parts, and thus enables the formation of a robust representation of spatial relationship. The details of the hypothesis, its predictions, and empirical test of the predictions will be discussed.

ATTENTIONAL ALIGNMENT GUIDES LANGUAGE LEARNING

Rebecca Nappa, University of North Carolina; John C. Trueswell & Lila R. Gleitman, University of Pennsylvania

Visual attention contributes to the process of event apprehension, such that the way a scene is explored influences the way it will ultimately be interpreted. Thus, the locus of speakers' attention as they interpret events guides their eventual descriptions of these events. This, in turn, causes speakers to produce cues, indicating their perspectives (such as the location of the speaker's gaze, and attention-directing gestures like pointing). Thus, the visual attention of a speaker influences both his own conceptualizations and descriptions of events and the listener/learner's conceptualizations of the same events, by way of attention-directing cues.

A set of experiments will be outlined demonstrating that this leads to significant conceptual alignment between speaker and listener, and guides the interpretation of complex events and ambiguous language (with particular emphasis on interpreting complex verbs). Specifically, when examining scenes depicting events that can be interpreted various ways, it will be demonstrated that the location of speakers' attention influences the way these scenes are ultimately described. This same effect can be seen when a speaker's attention is manipulated via gaze-direction cues (indicating that attention-directing cues from the speaker are utilized when interpreting complex events). Moreover, such attention-directing cues (gaze and pointing gestures) influence the way complex utterances (containing unfamiliar nonce verbs) will be interpreted by both adults and children in such a visual context. Through this attentional alignment, speakers and listener/learners arrive at aligned conceptual and linguistic representations of events.

DISCUSSANT: *Dedre Gentner, Northwestern University*

FRIDAY, OCTOBER 26, 2007: 4:00 - 5:45 PM

INTERACTIONS BETWEEN SOCIAL COGNITION AND OBJECT COGNITION

CO-ORGANIZERS: Kristin Shutts & Katherine Kinzler, Harvard University

SUMMARY: The goal of this symposium is to ask how children integrate their perceptions of the social world with their evaluations of the physical world. For example, how do properties and past behaviors of other individuals influence children's own preferences for different kinds of objects? To whom do children look when seeking information about unfamiliar objects, and when reasoning about physical events?

The first two papers in the symposium (presented by K. Kinzler and K. Shutts) provide evidence that infants and children attend to social category information (e.g., about spoken language, gender, and age) when reasoning about their own preferences for foods and artifacts. The third paper (presented by C. Fawcett) presents data showing that when children are given the opportunity to choose among objects hidden from view, they trust opinions of individuals who have shown concordant object preferences in the past. The fourth paper (presented by V. Jaswal) shows that young children are able to use testimony from adults in order to overcome errors in reasoning about physical events involving objects. Together the findings suggest that infants and children are able to use knowledge in one domain (e.g., the social realm) in order to solve problems in other domains (e.g., object preferences and object mechanics).

INFANTS' SELECTIVE PREFERENCE FOR "NATIVE OBJECTS"

Katherine D. Kinzler (presenter), Emmanuel Dupoux, & Elizabeth S. Spelke, Harvard University

From birth, humans display a remarkable sensitivity to language and linguistic differences. Neonates prefer their native language to a foreign language, and even discriminate two foreign languages provided that they have sufficiently different rhythmic properties.

The present paper questions whether 1) infants demonstrate a social preference for a speaker of a native language over a speaker of a foreign language, and 2) whether this early social preference influences infants' early understanding of and preference for objects. In Experiment 1, 5-6 month-old infants demonstrated a visual preference for people who previously spoke in their native language with a native accent. In Experiments 2 and 3, 10-month-old infants preferred to accept one of two identical toys when offered, and one of two different toys when modeled, by a speaker of a native language rather than a speaker of a foreign language. These effects obtained even though language was never directly paired with the objects. Experiment 4 provides evidence that 12-month-old infants preferentially choose foods that are first eaten by a native speaker rather than a foreign speaker.

Together, these findings suggest that infants attend to social information to inform their early preferences among objects, including preferences for some objects over others, differential willingness to accept one of two identical objects when offered by individuals of different social categories, and even preferences among foods that they have previously tasted and enjoyed.

SOCIAL CATEGORIES GUIDE YOUNG CHILDREN'S PREFERENCES FOR NOVEL OBJECTS

Kristin Shutts (presenter), Mahzarin R. Banaji, & Elizabeth S. Spelke, Harvard University

Humans as a species are extraordinarily gifted at learning information from other humans in their social group. From language to dance to dress, humans come to act like those around them. This "cultural learning" begins at an early age; even infants look where others, and do what others do (e.g., Meltzoff & Moore, 1977; Scaife & Bruner, 1975; Tomasello, Kruger, & Ratner, 1993).

In the present work, we ask whether children are selective in whom they learn from, by investigating the influence of social categories on young children's preferences for novel objects. In two experiments, three-year-old children were introduced to pairs of unfamiliar individuals, each of whom stated a preference for a different novel object. Members of pairs differed according to gender (male, female), race (White, Black), and age (child, adult). In Experiment 1, children demonstrated robust preferences for objects endorsed by same-gender individuals, but did not use race information as reliably as a basis for inferring their own preferences. In Experiment 2, children again selected objects favored by same-gender individuals, and also demonstrated a preference for items endorsed by same-age peers over adults.

These data provide a window into the social categories that children deem to be meaningful, and their influence on the development of the child's own object preferences and choices.

YOUNG CHILDREN UNDERSTAND THE SUBJECTIVE NATURE OF PREFERENCES*Christine Fawcett (presenter) & Lori Markson, University of California, Berkeley*

How do we decide whose recommendation to trust? Trusting others with preferences similar to our own is often a good heuristic, but equally important is knowing how to extend that trust. To address this question, we have been exploring how children's sensitivity to shared preferences influences their determination of who is a reliable source of information about objects.

In a series of experiments, two-year-old children learned two actors' contrasting preferences for various items in a particular category (e.g., foods). One actor shared the child's preference and the other did not. Children were then tested on their use of preference information when making inferences about the two actors' preferences for new items in categories that varied in relevance to the original category. Children were more likely to select an unseen item described by one of the actors as "her favorite" if that person had previously demonstrated a shared preference with the child for other items in the same category. Interestingly, children were more likely to extend their trust in a person's preferences across related categories (e.g., toys and books) compared to unrelated categories (e.g., television programs and foods).

The findings demonstrate that two-year-old children view a person who shares their preference as a reliable source of subjective information, at least within a designated category. This work further informs our knowledge of how children's understanding of the social world influences their reasoning about the physical world.

TRUST IN TESTIMONY ABOUT THE PHYSICAL WORLD*Vikram K. Jaswal, University of Virginia*

The physical world seems largely knowable from personal experience. In two studies, we investigated toddlers' willingness to revise a belief about the physical world—in particular, about the trajectory of a falling object—on the basis of what an adult tells them.

In Study 1, 30-month-olds saw an apparatus consisting of three chimneys affixed atop three cups. Opaque, curved tubes connected each chimney to a non-adjacent cup below. The experimenter dropped a ball through one of the chimneys and invited children to search for it. Children had a robust "gravity bias," incorrectly searching the cup directly beneath the chimney where the ball had been dropped 76% of the time (see also Hood, 1995). However, if the experimenter mentioned the actual cup where the ball landed before inviting children to search, they made the gravity error just 25% of the time (and searched correctly 67% of the time).

In Study 2, we explored the limits of toddlers' deference by using clear rather than opaque tubes. Children made the gravity error just 11% of the time (and searched correctly 84% of the time). However, if the experimenter mentioned the gravity cup before allowing children to search, they made the gravity error 52% of the time (and searched correctly just 41% of the time).

In short, children expect that adults will provide them with veridical information: They frequently weighted an adult's testimony more heavily than expectations based on naïve physics, or even than what they had just seen with their own eyes.

SYMPOSIUM DISCUSSANT: *Susan Carey, Harvard University***RATIONAL STATISTICAL INFERENCE IN COGNITIVE AND LANGUAGE DEVELOPMENT****ORGANIZER:** Fei Xu, University of British Columbia

SUMMARY: Researchers in cognitive development tend to be either nativists or empiricists. Nativists emphasize innate concepts and knowledge whereas empiricists emphasize learning mechanisms. This symposium presents a new approach to the study of cognitive and language development, integrating domain-specific prior knowledge and rational statistical inference mechanisms within a Bayesian framework. The four participants will present a set of papers illustrating how this approach has generated both new empirical findings and new computational models. Two of the participants, Xu and Denison, will present empirical studies on word learning, property induction, and infant statistical inference. The other two participants, Kemp and Griffiths, will present models of causal learning, word segmentation, and how learners acquire abstract causal schemata and semantic knowledge. We aim to go beyond the nature-nurture dichotomy by presenting a concrete proposal on how to integrate statistical information in the input with prior knowledge.

RATIONAL STATISTICAL INFERENCE IN WORD LEARNING AND PROPERTY INDUCTION*Fei Xu, University of British Columbia*

Research in language and cognitive development has discovered both powerful learning mechanisms and early concepts and knowledge in infants and young children. However, it remains unclear how statistical learning mechanisms interact with conceptual biases. I present two case studies illustrating how a Bayesian framework provides us with the tools for integrating

statistical information with prior knowledge. In the first set of experiments, we show how children and adults integrate their prior knowledge about words (e.g., count nouns tend to refer to kinds of objects) with input statistics (e.g., the number of exemplars and the perceptual span of the exemplars) in learning words at multiple hierarchical levels (subordinate-level, basic-level, and superordinate-level). In the second set of experiments, we show how children and adults' generalization of novel properties are modulated by a prior bias (i.e., some properties are generalizable but some are not) using the same statistical information as in the word learning studies. Together we provide evidence that the same statistical inference mechanism is employed in multiple domains but its application is modulated by prior biases.

STATISTICAL INFERENCE IN HUMAN INFANTS

Stephanie Denison and Fei Xu, University of British Columbia

Two sets of experiments investigated whether basic statistical inference mechanisms are available in infancy so they may potentially guide learning later on, using a violation-of-expectation looking-time procedure. In the first set of experiments, we asked 8-month-old infants to generalize from a small sample to a larger population using basic principles of probability. For example, infants were presented with either 4 red and 1 white Pingpong balls or 1 red and 4 white Pingpong balls being pulled out of a box, and they were then shown a box filled with many red Pingpong balls and a few white ones. If infants can use basic principles of probability in this task, they would find the 1 red and 4 white Pingpong ball sample unexpected. Results showed that infants looked longer at the unexpected outcome. In a second set of experiments, we asked if 11-month-old infants were sensitive to whether the sample was a random sample from the box or not. Results showed that given random sampling, infants showed the same pattern of looking as the 8-month-old infants in the first set of experiments. But in the non-random sampling condition where the experimenter expressed a preference for a certain color balls then looked into the box while pulling out the sample, the looking time pattern was predicted by the experimenter's expressed preference and not by the proportions of red vs. white balls in the box. These studies suggest that basic statistical inference mechanisms may be available early in infancy.

BAYESIAN MODELS AS A TOOL FOR REVEALING INDUCTIVE BIASES

Tom Griffiths, University of California at Berkeley

Many of the central problems in cognitive development - from making inferences about causal relationships to learning language - are inductive problems, requiring children to generalize beyond the observed data. Research in mathematical statistics indicates that one of the most important factors involved in successfully solving inductive problems is having appropriate inductive biases, limiting the set of possible solutions to those problems. Understanding how children make generalizations thus requires understanding their inductive biases. I will argue that computational models based on the principles of Bayesian statistics provide a tool for revealing the inductive biases of human learners. I will demonstrate the value of this approach through two case studies: analyzing the knowledge about causal systems that guides learning about blinket detectors, and examining how different assumptions about the nature of words determine the output of statistical models for extracting a lexicon from unsegmented speech. These case studies show how Bayesian models can be used to reveal the inductive biases that allow children to learn so much about the world from small amounts of data.

THE ACQUISITION OF INDUCTIVE CONSTRAINTS

Charles Kemp, Massachusetts Institute of Technology

Inductive learning relies critically on constraints, and psychologists have described many constraints that appear to guide children's learning. Most of these constraints are usually assumed to be innate, but hierarchical Bayesian models help to explain how some of these constraints can be learned. Hierarchical Bayesian models include representations at many levels of abstraction, and the representations at the upper levels can be viewed as constraints on the representations at the lower levels. The probabilistic nature of these models allows them to make inferences at many levels of abstraction. In particular, these models demonstrate how knowledge can be acquired at levels quite remote from the data of experience---levels where the learning problem amounts to the problem of learning inductive constraints.

The hierarchical Bayesian approach has been applied to problems from several different domains, including word learning, grammar learning, causal learning, and the acquisition of semantic knowledge. I will describe a model that learns causal schemata---systems of abstract causal knowledge that constrain inferences about sparsely observed causal relationships. I will also describe a model that discovers structural constraints on semantic representations. One such constraint is the M-constraint, which states that ontological knowledge is better described by a tree structure than a set of arbitrarily overlapping clusters.

THE FUNCTION OF ACTION IN PERCEPTUAL AND COGNITIVE DEVELOPMENT

CO-ORGANIZERS: Jessica Cicchino and David Rakison, Carnegie Mellon University

SUMMARY: Children are not passive observers of the world around them; rather, what they encounter and encode is dictated largely by the actions they produce. In recent years a substantial number of research programs have begun to recognize the role that experiences producing and observing action play in how infants and children interpret their surroundings. The goal of this symposium is to bring together the latest research regarding how these early action experiences shape the development of cognition in a variety of domains. To this end, the first two papers discuss the influence of infants' exploratory behaviors on their perception and integration of object features. The next paper explores how children equate their own actions with the actions performed by others and investigates how these experiences influence how children imitate. Finally, the last two papers consider links between infants' ability to produce actions and identify these same actions or motion types when performed by other people or entities.

Bringing together findings from a variety of areas within early cognition in which action experience bears on development will allow for consideration of multiple mechanisms by which early action and cognition are connected. Additionally, the research presented here will shed light upon the nature of action representations early in life and the origins of knowledge regarding objects, motion, and people. Thus, this symposium will result in a better understanding of how and why action experience influences cognitive and perceptual development.

THE RELATION BETWEEN MOTOR DEVELOPMENT AND INFANTS' REPRESENTATION OF THE SURFACE FEATURES OF OBJECTS

Lisa M. Oakes, University of California, Davis, and Sammy Perone, University of Iowa

Consider the following event: a hand reaches toward a round purple object, squeezes it, and then the object squeaks. What do infants learn about this event? There are several reasons why the surface features of the objects might be less salient than the action and sounds in these events; one possibility is that object appearance is intimately tied to the actions performed on the objects. Actions and object features are represented together in the human adult brain. We will present data revealing a developmental trajectory from 7-month-old infants representing only the sound and the action to 10-month-old infants representing the appearance as well as the sound and the action. At 10 months, infants link the actions to object appearances in this type of event—learning, for example, that purple objects are rolled and yellow objects are squeezed. Infants' sensitivity to object appearance may therefore be related to their developing motor skills. Indeed, we observed that between 6 and 7 months attention to the surface features of the objects was significantly related to infants' motor skills. When assessed in an object-exploration task, infants who were more effective at picking up objects, and who successfully picked up a wider variety of objects, represented object appearance in the multi-modal, dynamic events just described. Infants who were less motorically skilled failed to represent appearance. The possible bases of this relation, and potential mechanisms of development, will be discussed.

OBJECT EXPLORATION AND DETECTION OF ATTRIBUTE CHANGE IN INFANCY

Amy Needham and Klaus Libertus, Duke University

Object exploration is action in the service of learning about the attributes of an object: mouthing an object allows you to determine its texture; looking at an object allows you to determine its color (Gibson 1988). Infants' exploration of objects undergoes important changes over the first several months of life. For instance, Rochat (1989) showed striking changes in infants' exploratory behaviors over the first five months of life: two- and three-month-old infants tend to show relatively more oral exploration; four- and five-month-old infants show relatively more visual exploration. These changes should have consequences regarding which object attributes are detectable or salient to infants while they explore them, which should in turn have functional consequences for the attributes of objects that infants respond to. This possibility was investigated in the current research.

Using a method devised by Ruff (1984), 4-, 5-, and 7-month-old infants' detection of a change in either texture or color was assessed. A textured teether or colored spoon was presented to the infant on three consecutive trials, and on the fourth trial an object that was the same except for one attribute (the teether's texture; the spoon's color) was presented instead. Infants' visual and manual exploration time was measured and the percent change in the amount of exploration is shown above. Our results show that the younger infants, whose exploration is primarily oral in nature, showed a large increase to the change in texture. In contrast, the older infants, whose exploration is primarily visual in nature, showed a large increase to the change in color. Additional evidence of a control condition involving no change between trials three and four will also be presented.

These findings support the conclusion that infants' tendency to engage in oral or visual exploration of objects influences the information they obtain. In this sense, we can think of infants' visual and oral exploration as reflecting the aspects of the objects to which they have attended. Further, these results indicate that infants' decisions about whether to explore an object by mouth or by eye determines much about how they will perceive that object. Implications for perceptual-motor relations will be discussed.

PICKY IMITATORS: 'PRIOR EXPERIENCES' OF SELF AND OTHER INFLUENCE CHILDREN'S IMITATION

Rebecca Williamson and Andrew Meltzoff, University of Washington

Our recent research shows that preschoolers' imitation varies as a function of their own prior action experience. We showed that if children have had a difficult time with a task, they are more likely to adopt the distinctive action they observe another use. Here we investigate whether 3-year-olds also use another person's difficult prior experience as a guide to imitation. Can the prior difficulties of others substitute for the prior difficulties of the self in rendering children more open to learning and imitating novel acts they see?

The children (N=16) saw two experimenters each take a turn at completing a straightforward task (e.g. opening a drawer to get a toy). E1 either had an easy or a difficult experience with the task. E2 then modeled using a distinctive means (such as flipping a switch) to complete the task easily. When E1 had a difficult time with the task using ordinary means, children were more likely to imitate E2's novel action (M = 75%) than when E1 succeeded using ordinary means (44%). These preliminary results suggest that action imitation is not a blind process but is influenced by the prior experiences of both self and other. If children have a self-experience or observe from others that ordinary means are not efficacious, they are significantly more likely to adopt the novel means they observe. Human children are not blind imitators of action; prior experience influences what and when they imitate.

PRODUCING AND PROCESSING SELF-PROPELLED MOTION IN INFANCY

Jessica Cicchino and David Rakison, Carnegie Mellon University

Self-propelled motion, or movement that begins without apparent external force, is a nearly irrefutable cue to animacy; by and large only people and animals, but not inanimate objects, are self-propelled. Because of the essential role that self-propelled motion plays in the development of early concepts of animates, there has been interest among researchers regarding the origins of the ability to recognize self-propulsion. In this talk we will explore the possibility that experience producing self-propelled motion by crawling influences infants' ability to process the self-propelled motion of other objects.

To investigate this issue, 5-, 6-, 7-, and 8-month-old infants were tested in a paradigm similar to that used by Markson and Spelke (2006) in which their preferential looking to self-propelled and caused-to-move objects was measured. Our results revealed that 5- and 6-month-olds attended to objects that engaged in a different type of motion than did 8-month-olds; crucially, the looking patterns of 7-month-olds with crawling experience paralleled that of older infants, and the looking patterns of non-crawling 7-month-olds mirrored that of younger infants. These findings indicate that infants' processing of self-propelled motion changes between 6 and 8 months of age and that the onset of self-locomotion is a factor that underlies this developmental progression. Furthermore, this discovery suggests that the close coupling between infants' action production and action perception may be more abstract than previously realized, as action experience in the current study facilitated perception of the movement of animated geometric shapes rather than the action of another person.

ACTING AND UNDERSTANDING ACTION: POTENTIAL DEVELOPMENTAL RELATIONS

Amanda Woodward, Sarah Gerson, and Neha Mahajan, University of Maryland, College Park

Fundamental to human experience is the fact that we live in a world of perceived intentional agents. To adult eyes, the actions of others are not simply motions through space, but instead structured by goals, intentions, and perceptions. In the past decade, research has revealed that this aspect of social perception can be traced to early in the first year of life. Infants selectively attend to the goals of actions, responding more strongly to changes in actions goals than to changes in motion.

The existence of this ability early life raises the question of how it originates. Here, I consider the possibility that infants' own emerging ability to coordinate their actions in service of goals provides representational structure for the perception of others' goal-directed actions. Three kinds of evidence support this possibility. (1) There are correlations between infants' own abilities to produce goal-directed actions and their perception of others' actions as goal-directed; (2) Interventions that enable new modes of goal-directed action in infants also affect perception of those same actions in others; (3) Infants' analysis of others' actions as goal-directed is evident not only in their looking times, but also in their own overt actions. Taken findings indicate that infants' action analysis is rooted, at least in part, in their own experience as agents. The dramatic changes that occur in infants' motor competence during the first year are linked to developments in action perception.

