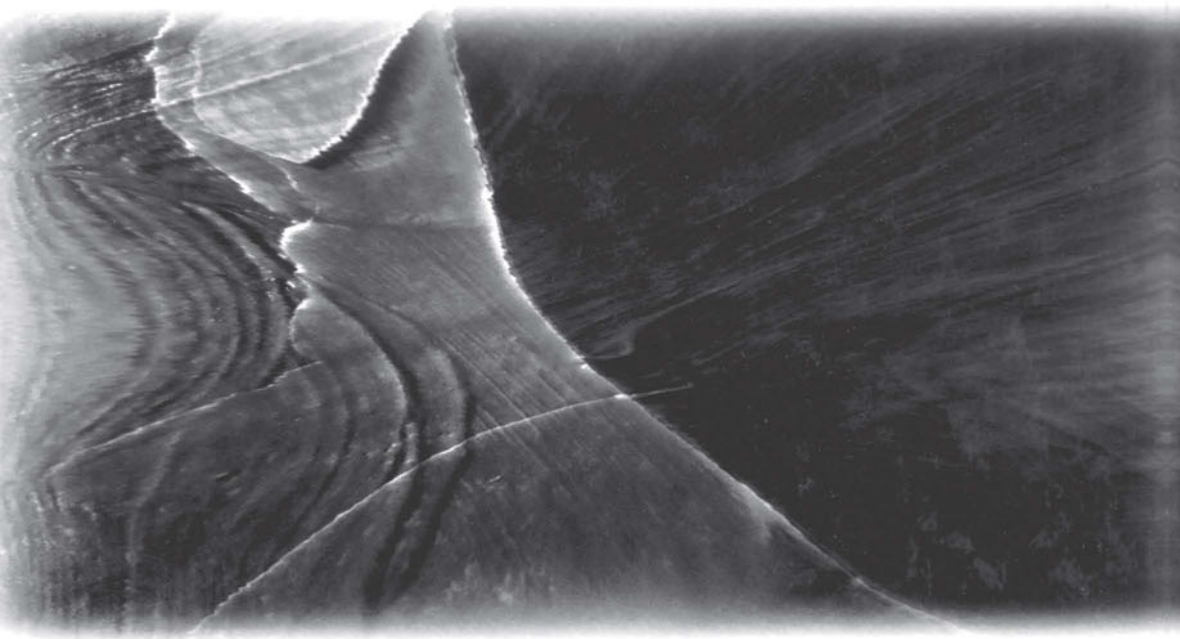
Representation, Memory, and Development

Essays in Honor of Jean Mandler



Edited by
Nancy L. Stein • Patricia J. Bauer
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Dedication

To Jean

In the process of putting together this volume for Jean, we could not help but be struck by the breadth of topics and ideas that the contributors considered and discussed. The variety is indicative of Jean's wide-ranging, yet deep interests in the field of psychology, in particular, and her interest in ideas, in general. The fact that Jean entered the field of psychology carrying out animal discrimination and learning studies, that with George Mandler, she wrote a book on Thinking (from Association to Gestalt), and that she became involved in the Children's Gifted Association in San Diego, as her children proceeded through the San Diego-La Jolla School system, made her an ideal collaborator, mentor, colleague, and friend to all the contributors in this volume.

Although we all have mentors in the field, and clearly we have colleagues and friends, rarely do we find a person that can play all of these roles equally well. She does each of these things with little effort. Part of her ability lies in a keen intelligence, coupled with a wit that has been known to save many of us from ourselves, an empathic stance (even when she was in the process of giving up smoking), and an ever present sense of morality-even when faced with circumstances that might have driven most of us insane, or at least crazy enough to commit outra-

geous acts. She has the ability to take a risk, to make a stance, to create an idea, especially when data beg for an alternative interpretation. She is able to move on to different areas and to navigate unknown territories, with a sense of excitement that might be daunting to many of us.

Each of the chapters in this volume was written by an individual that Jean has touched deeply. In editing the contributions, in organizing a symposium at the International Conference on Infant Studies (July 2000, Brighton, England), and in hosting a dinner in Jean's honor after the symposium, a sense of enthusiasm and affection was always present. All of us had the desire to honor Jean for her contributions and the many times she has reached out, helped us, or engaged in an act of friendship.

To Jean, we wish only the very best to come. She embodies what most of us hope we become—a good scientist, a friend with deep understanding, a person with boundless curiosity, and most of all, a person with a discriminating eye that recognizes the very best in just about everything.

—Nancy Stein
—Patricia Bauer
—Mitch Rabinowitz
September 2001

Preface

Jean

Jean Matter was born on the 6th of November, 1929, in Oak Park, IL, to a traditional upper middle-class family—an intellectual, but authoritarian, father who was a prominent Chicago bond lawyer, a caring housewife mother, and an older brother. The family traveled widely, and Jean proudly related having visited all 50 states except Alaska. An extended family provided many tales—her grandmother's memory of her great uncle James Fenimore Cooper and crossing the prairie in a covered wagon, and encountering Native Americans as homesteaders in Nebraska. In her immediate family, Jean chafed from early on as the undervalued female "minority" member of the family. After a successful career at the renowned Oak Park & River Forest High School, she followed family advice and entered Carleton College. Jean enjoyed the Carleton classes and particularly flourished in the Carleton drama department, but she was unhappy about the homogeneity of the student body and the resulting stultifying and conservative atmosphere. After 2 years—the highlight of which was acting in the world premiere of Brecht's *The Caucasian Chalk Circle*—she transferred to Swarthmore College in 1949, and a new world opened up to her. The Swarthmore honors program instigated Jean's intellectual coming of age as she discovered new frontiers and congenial friends, among them two young intellectually stimulating faculty members—Henry Gleitman and Sidney Morgenbesser. Jean had majored in philosophy at Carleton and continued that at Swarthmore but also wanted to minor in psychology, for which she had to pass a test covering the missed freshman and

sophomore years. Given the appropriate text she was off to Europe for the grand tour, psychology book tucked under her arm, and passed her test into a psychology minor in the fall.

The seminars at Swarthmore provided her with a vision of the excitement of scholarly pursuits. She remembers reacting to Wolfgang Kohler's and Hans Wallach's seminars with wonder that some "philosophical" questions about perception might actually have empirical answers. That idea made her decide to go on in psychology. In 1951, Jean received the BA *summa cum laude* from Swarthmore, and she entered graduate school in the department of Social Relations at Harvard, initially in clinical psychology working with George Klein. In part, she picked psychology rather than philosophy and clinical rather than experimental psychology because of the scarcity of positions for women in these other fields. She soon realized that her real interests were in research, and she started doing animal research, on the effects of high drive, with Jerry Bruner, who also became her thesis advisor.

Jean greatly enjoyed her social life in Cambridge with good friends such as Carolyn Cohen in biophysics, Alice (Timmie) Kohler in philosophy, and Lotte Lazarsfeld Bailyn (a Swarthmore friend) in psychology. Her work with Bruner produced several publications, and she continued her rat work for her PhD thesis. She decided to study the effects of early experience on behavior, and soon took her thesis prospectus oral, which was the major hurdle on her way to the PhD. As the orals proceeded, one young faculty member kept raising questions and making suggestions. At the conclusion of the examination, Jean wondered to Jerry who the committee member was who gave her so much trouble. Jerry told her not to worry, that the young faculty member was fresh out of Yale and still wet behind the ears. Jean's thesis, eventually published in *Science*, showed that irregular feeding schedules in infant rats produced excessive eating and hoarding behavior in adulthood.

Although some of the Yalie's misgivings and suggestions had proved helpful, she did not have much contact with him until some time later when he offered her a research assistantship, working on autonomic nervous system reaction to stress and related topics. Their friendship developed during repeated trips to Quincy, MA, where their new polygraph was being built. Eventually, she married the troublemaker in 1957.

After receiving her PhD in 1956 and the arrival of son Peter in 1958, the family spent 1959 to 1960 in California. After that, it was time to look for new pastures, except that in the mode of the 1950s, little if any attention was paid to Jean's professional needs—a sin shared by both Jean and George. They ended up at the University of Toronto where Jean was given a nonsalaried research position. She continued her animal research and was supported by research grants, including some

partial salary. Soon after arriving in Canada, Michael joined his brother Peter. For the next several years, Jean showed that a working mother could also be a loving and beloved mother. However, she still did not have a regular faculty appointment and chafed at the secondary position in which her female social role had placed her. She did some research at Toronto and for a few years in California that was concerned with discrimination learning with special reference to overtraining.

Some of Jean's intellectual restlessness during this period motivated her to venture outside the narrow confines of rat running. Her early interest in philosophy and Gestalt psychology at Swarthmore motivated several undertakings in collaboration with George. The first was *Thinking*, a book on the historical development of research on thought, and the second an account of the fate of the German-speaking psychologists after the advent of Hitler.

In 1965, Jean happily seconded the family's move to La Jolla, CA, and the University of California at San Diego (UCSD). Because of the strict nepotism rules at the time, and with her spouse being chair of psychology, she was given a part-time appointment in the Department of Biology, as a research psychologist, and continued her rat work. At the same time, she enjoyed the California environment, and in particular her garden, which she treasures to this day. However, still she had no regular faculty ladder appointment.

The atmosphere of the 1960s, together with her unhappiness at her second-class academic position, made her a committed feminist. She was determined to enter into a regular academic career. The family went on a sabbatical leave in Oxford in 1971 and 1972 and, in the course of the year, an inquiry from Columbia and Barnard suggested the possibility of a move and an entry into a proper academic career. But then, UCSD finally decided that her appointment should be regularized. She was eventually appointed as an associate professor in psychology in 1973 and promoted to professor in 1977. Despite the fact that Jean's career was truncated at its beginning, she very quickly caught up with the academic progression and made important and path-breaking contributions. However, the field in which she was to shine most brightly was still in her future. With the start of her regular appointment there also came important changes in the content of her work.

Jean was bored with rat research and was looking for a more demanding and interesting area of work. She was influenced—as was nearly everybody else—by the so-called "cognitive revolution" and wanted to work on human thought and cognition—an interest since Swarthmore. Nancy Stein had come to UCSD as a postdoctoral fellow but was dissatisfied with her situation and was looking for new challenges in directions similar to Jean's. Nancy had some background in

developmental psychology and the two of them set to work in joint mutual education and research—starting at the beginning, that is, in perception. They published several articles on children's perception, emphasizing recognition of patterns and figures. Clearly, Jean had found her niche in psychology, she now had a regular appointment, she had started on a trajectory on children's cognition, and she had benefitted from the change in women's status in the academy. After Nancy left La Jolla to enter into her own distinguished career, Jean continued research on picture perception with Nancy Johnson and other creative graduate students, essentially working on some of the 1,000 words a picture is worth.

From a study of perception and pictorial representation, the next obvious step was to look at the understanding of written material—a step up on the scale of human cognition. Jean's next shift led to the work on people's understanding of and memory for stories, inspired by the research on schemas by David Rumelhart. That work led to story analyses and recall and—to bring some structure into the understanding of story representation—the development of a widely used story grammar. Her work on story and event structures, with Mitch Rabinowitz, Robyn Fivush, Tamar Murachver, among her students and postdoctorates, carried on until the mid-1980s, resulting in various excursions into cross-cultural problems, aspects of temporal order, story memory, and developmental studies. In 1984, she published the book, *Stories, scripts and scenes*, on these efforts.

Having explored the young mind, Jean naturally looked toward origins, and she became interested in the wellsprings of children's thought—specifically, the mind of the infant. The arrival of a postdoctoral fellow, Pat Bauer, and a graduate student, soon to be postdoctoral associate, Laraine McDonough, created a highly productive and ingenious research program. This period, stretching to the present, saw numerous important publications on cognitive development, starting with the first "How to build a baby" article in 1988 and followed by the second one in 1992.

Starting in the early 1990s when the family spent increasing time in London, Jean benefitted from and enjoyed her association with John Morton, Annette Karmiloff-Smith, and Alan Leslie at the Medical Research Council's Cognitive Development Unit until its demise at the end of the decade. By the middle 1990s, Jean's research had concentrated on the conceptual development of the human infant. She helped create the Department of Cognitive Science in 1986 and joined its interdisciplinary program as more appropriate for a study of the infant mind. She joined other psychologists, anthropologists, neuropsychologists, and linguists in the move to the new department.

Drawing on the various cognitive sciences, in particular cognitive linguistics, Jean developed a major theoretical picture of the development of the infant mind. Her particular emphasis has stressed the distinction between perception and conceptual thought and the processes of categorization and inductive inference. In her retirement, she is writing a book that will summarize her contribution. Having started with work on infant animals and discrimination in simple organisms, Jean has provided us deep insight about the most complex discriminations of the human infant.

Jean's achievements were recognized by her peers, with her elections to the Society of Experimental Psychologists and the American Academy of Arts and Sciences. For the past decade, she and George have spent half a year in London, and delight in having both their sons and their grandchildren living in the same town.

—George Mandler

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1

Being There Conceptually: Simulating Categories in Preparation for Situated Action

Lawrence W. Barsalou
Emory University

A constant theme in Jean Mandler's work is that a child's developing knowledge is grounded in sensory–motor experiences of events (e.g., Mandler, 1987, 1992). Rather than being detached from events, knowledge remains grounded in them. Rather than being amodal, knowledge retains its sensory–motor origins. The essay to follow arises in the tradition of this work and reflects its influence.

THE SITUATED VIEW OF CONCEPTS

According to the view developed here, people conceptualize a category differently across situations, with each conceptualization embedded in a background situation. A single situation-independent concept does not represent the category; the concept does not represent the category in isolation, independently of the situations in which it occurs. Consider the category of *chairs*. According to the situated view, different conceptualizations of *chairs* are represented in their respective situations. Thus, one situated conceptualization might represent

office chairs in business environments, another might represent easy chairs in homes, another might represent theater chairs in theaters, another might represent airline chairs in jets, and so forth. A single situation-independent concept does not represent chairs across situations, and the conceptualizations do not represent isolated chairs. As the category is encountered in different situations, a situated conceptualization develops for each, linked together in a radial concept, as described later.

EVIDENCE FOR THE IMPORTANCE OF SITUATIONS

Findings across diverse areas demonstrate the importance of situations in intelligence and behavior. In developmental psychology, the Vygotskian approach has stressed the importance of situations in acquiring cognitive and social skills (e.g., Vygotsky, 1991). From this perspective, Jean Mandler illustrated the importance of situations in children's ability to remember stories and events (e.g., Mandler & Johnson, 1977; Mandler, 1987). In the social and personality literatures, situations predict behavior at least as well as traits (e.g., Mischel, 1968). In perception, situations greatly facilitate object recognition when an object occurs in a predicted context (e.g., Biederman, 1981), with Jean Mandler and her collaborators providing some of the earliest demonstrations (e.g., Mandler & Parker, 1976; Mandler & Ritchey, 1977; Mandler & Stein, 1974). In memory, situations play a central role in elaborating perceived scenes (e.g., Intraub, Gottesman, & Bills, 1998) and in retrieving information from memory (e.g., Tulving & Thomson, 1973). In language comprehension, texts can be incomprehensible when the relevant situation is not known (e.g., Bransford & Johnson, 1973). Indeed, language comprehension can be viewed as preparation for situated action (Barsalou, 1999a). In pragmatics, situations are central to establishing common ground between communicators, both human (e.g., Clark, 1992) and nonhuman (e.g., Smith, 1977). In problem solving and reasoning, it may be difficult to draw valid and useful conclusions without the support of a concrete situation (e.g., Cheng & Holyoak, 1985; Gick & Holyoak, 1980; Johnson-Laird, 1983). In linguistics, the importance of situations has motivated the theory of construction grammar, where syntactic structures evolve out of familiar situations (e.g., Goldberg, 1995). In philosophy, the importance of situations has motivated the theory of situation semantics, where logical inference is optimized when performed in the context of specific situations (e.g., Barwise & Perry, 1983). At a more general level, arguments about the central role of situations in cognition can be found in Barsalou, Yeh, Luka, Olseth, Mix, and Wu (1993), Clark (1997), Glenberg (1997), and Greeno (1998).

Across these diverse areas, the common theme is that situations are fundamental to cognition. By incorporating situations into a cognitive task, processing becomes more tractable than when situations are ignored. Because specific entities and events tend to occur in some situations more than others, capitalizing on these correlations constrains and facilitates processing. Knowing the current situation constrains the entities and events likely to occur. Conversely, knowing the current entities and events constrains the situation likely to be unfolding.

By focusing on situations, the cognitive system simplifies many tasks. Rather than having to search everything in memory across all situations, the cognitive system focuses on the knowledge and skills relevant in the current situation. As a result, it becomes easier to recognize objects and events that may be present; it becomes easier to remember relevant information and skills; it becomes easier to resolve the ambiguities of language; it becomes easier to solve problems and perform reasoning; it becomes easier to predict the actions of other agents. For all these reasons, it would not be surprising if situations turned out to be central for concepts.

CURRENT THEORIES OF CONCEPTS

Most current views implicitly view concepts as *unsituated*, assuming that concepts have been abstracted from the situations in which they occur. Although these theories could be readily extended to represent situated concepts, they typically do not.

Consider classical theories, which typically assume that rules describe the objects in a category independently of situations (e.g., Bruner, Goodnow, & Austin, 1956). For example, a rule might attempt to capture the physical properties of *chairs* that are necessary and sufficient for membership. Although such rules could also attempt to capture situational properties, they typically do not. Instead, classical theories abstract across situations, rather than establishing rules for subsets of chairs within particular situations. Classical theories to date represent the extreme view of unsituated concepts.

Prototype theories similarly tend to assume that unsituated abstractions represent categories (e.g., Hampton, 1979; Rosch & Mervis, 1975). Rather than being definitional, however, these abstractions are statistical, representing the most frequent properties across situations, with situation-specific properties canceling themselves out. Although subprototypes could develop for concepts in particular situations, this possibility has not been explored.

The view that categories are embedded in intuitive theories similarly tends to ignore situations (e.g., Murphy & Medin, 1985). Although in-

tuitive theories constrain the form that concepts take, situations have not played a central role in these accounts. Even when concepts are constrained by intuitive theories, they are nevertheless assumed to remain constant across situations (but see Gelman & Diesendruck, 1999, for an account of intuitive theories that is compatible with situated concepts).

Exemplar models have much potential for implementing situated concepts but typically have not. Many exemplar models assume that the entire set of exemplars stored in memory for a category represents it on each occasion (e.g., Lamberts, 1994; Nosofsky, 1984). Thus, a fixed representation stands for the category on all occasions, not a situation-specific one. Furthermore, exemplar representations typically only include physical properties of exemplars, not properties of associated situations. Notably, some exemplar models have more of a situated character. For example, Nosofsky and Palermi's (1997) random-walk model assumes that only a subset of exemplars is retrieved in the current context, such that the category representation changes across contexts (also see Barsalou, Huttenlocher, & Lamberts, 1998). Similarly, Medin and Schaffer's (1978) context model assumes that context is important in categorization, although context is typically implemented as other properties in the objects being categorized, not as their situational properties. As these theories illustrate, exemplar models can implement situated conceptualization if two conditions are met: (a) situational information is represented in exemplars along with object properties, (b) situation-specific subsets of exemplars are retrieved during categorization.

In contrast to the previous four classes of models, connectionist models clearly implement situated conceptualization. Not only do they represent a category differently across situations, they include situational information in these representations. Consider Rumelhart, Smolensky, McClelland, and Hinton's (1986) account of the *room* schema. In an auto-associative net, subsets of object properties are linked to subsets of room properties, such that correlated sets of object and situational properties form attractors. When a subset of object properties is activated, related situational properties become active, thereby situating the object. Conversely, when situational properties become active, relevant properties of the object become active, resulting in a situation-specific representation of it. Connectionist models have been explicitly formulated to implement situated conceptualization, and they do so elegantly.

CONCEPTS AS GROUNDED IN PERCEPTUAL SIMULATION

The importance of situations for concepts follows from the proposal that people represent concepts with perceptual simulations (Barsalou,

1999b). This next section briefly outlines the theoretical assumptions of perceptual symbol systems, and then reviews some of the empirical evidence for this approach. The following section then illustrates how viewing concepts as grounded in perceptual simulation predicts the importance of situations in concepts.

The first assumption of this view is that selective attention focuses on components of experience. During perception of sensory events, people focus on shapes, colors, sounds, smells, etc.; during perception of proprioceptive events, people focus on movements, facial expressions, vocalizations, etc.; during perception of introspective states, people focus on emotions, cognitive operations, beliefs, etc. Once attention selects a perceived aspect of experience, associative areas in the brain capture the respective pattern of activation in the relevant perceptual, proprioceptive, or introspective area. Later, these associative areas partially reactivate these perceptual representations in the absence of perceptual input, thereby simulating the experience of what an external or internal event was like. Using such simulations, people conceptualize objects, external events, and internal events in their absence.

Barsalou (1999b) illustrated how these simulation mechanisms implement a fully-functional conceptual system, including the type-token distinction, categorical inference, the productive construction of novel simulations, the representation of propositions, and the representation of abstract concepts. Also illustrated are how these simulation mechanisms could underlie the knowledge that supports basic cognitive processes, including perception, categorization, memory, language, and thought. Additional articles extend this theory (Barsalou, 1993, 1999a; Barsalou & Prinz, 1997; Prinz & Barsalou, 2000; Prinz & Barsalou, in press). In one of the earliest articles to champion this theme, Jean Mandler highlighted the importance of sensory–motor knowledge in children's developing concepts (Mandler, 1992). Glenberg (1997) offered a related proposal.

Empirical Support for Perceptual Simulation in Conceptual Tasks

Several lines of empirical inquiry implicate perceptual simulation in the representation and processing of concepts (for a review, see Barsalou, Solomon, & Wu, 1999; also see Goldstone & Barsalou, 1998). Solomon and Barsalou (2001a) demonstrated that when individuals attempt to verify a property of a concept, they search for the property in a perceptual simulation of the respective object. To verify that a house has a roof, for example, individuals simulate a house and a roof, and then search the simulated house for a region that matches the simulated

roof. Under conditions that ensured conceptual processing, perceptual predictors, such as the size and perceptual salience of properties, predicted verification times and errors better than other factors, such as associative strength and word frequency. Furthermore, neutral participants not instructed to use any particular strategy performed the same as imagery participants who received explicit instructions to use imagery. The results of these experiments support the a priori prediction that neutral participants adopt perceptual simulation spontaneously to represent and process concepts.

Solomon and Barsalou (2001b) similarly found that the specific perceptual forms of properties predict whether they prime each other during property verification. For example, verifying *mane* for *pony* benefits from previously verifying *mane* for *horse* but not from verifying *mane* for *lion*. Control conditions ruled out the explanation that higher similarity between horses and ponies overall, relative to less similarity between lions and ponies, was responsible. Instead, the detailed perceptual similarity of the two properties was critical. Because perceptual details that are difficult to verbalize predicted conceptual priming, it appeared that participants adopted perceptual simulations spontaneously to represent concepts. Accounting for such results is difficult and post hoc without adopting perceptual simulation as the basis of performance.

Wu and Barsalou (2001) explored similar issues in the property generation task. Analogous to Solomon and Barsalou (2001a), neutral participants produced essentially the same distributions of properties as imagery participants, suggesting that both groups scanned perceptual simulations to produce properties. For example, both groups produced essentially the same detailed distribution of properties for *lawn*, unlike participants instructed to produce word associations, who produced a different distribution. Furthermore, the perceptual factor of occlusion affected performance for both neutral and imagery participants, again implicating perceptual simulation. When participants produced properties for *lawn*, they rarely produced occluded properties like *roots* and *dirt*. In contrast, when other participants produced properties for *rolled-up lawn*, they produced *roots* and *dirt* much more frequently, because these properties were no longer occluded in simulations.

The empirical evidence just reviewed suggests that people run perceptual simulations to represent concepts. When participants list the properties of a concept, they simulate an instance, scan across it, and report the properties attended. When participants verify a property of a concept, they simulate an instance and the property, and then attempt to locate the property in the instance.

PERCEIVED SITUATIONS AND SIMULATED SITUATIONS

If perceptual simulation underlies the representation of concepts, it places an important constraint on them: If a conceptualization attempts to simulate a perceptual experience, then it should typically simulate a situation, because situations are intrinsic parts of perceptual experiences. To make this critical assumption more concrete, consider the nature of perceptual experience. At a given point in time, people perceive the immediate space around them, including any agents, objects, and events within it. Some of these entities and events may be external, whereas others may be internal. Furthermore, this experience is multimodal; it is not just visual, but also auditory, tactile, gustatory, olfactory, proprioceptive, and introspective. Thus, a *perceptual situation* is a perceived region of space that contains agents, objects, and events, both external and internal. Most importantly, even when people focus attention on a particular entity or event in perception, they continue to perceive the background perceptual situation—the situation does not disappear.

If perceptual experience takes the form of a situation, and if a conceptualization is essentially an attempt to simulate perceptual experience, then the form of a conceptualization should take the form of a situation. When people construct a simulation to represent a category, they should tend to envision it in a relevant perceptual situation, not in isolation. When people conceptualize *chair*, for example, they should attempt to simulate not only a chair but a more complete perceptual situation, including the surrounding space and any relevant agents, objects, and events. In principle, it is possible to simulate a chair independently of a situation, and indeed, the ability to focus attention on aspects of situations is a central part of perceptual symbol systems (Barsalou, 1999b). When we actually perceive chairs in the world, though, we never perceive them in a vacuum. Although we focus attention on them, we nevertheless continue to perceive the background situation. This observation motivates that claim that conceptualizations are similarly situated, at least much of the time. Although the simulation of a chair may typically focus attention on the simulated object, the background situation nevertheless tends to be simulated along with it.

THEORETICAL FRAMEWORK

Following Yeh and Barsalou (2001), the following assumptions underlie the view that concepts are situated:

1. A conceptualization of a category typically includes a background situation.

2. Each conceptualization represents a category in a way that is relevant to the background situation, such that different conceptualizations represent the category differently.
3. The different conceptualizations of a category become linked by analogy or by an essence (real or imagined) to form a radial concept.

The first assumption is the one just described, namely, conceptualizations do not simulate a category's members in isolation but simulate them against background situations. For example, people do not simulate chairs in isolation, but tend to simulate them in their background situations (e.g., living rooms, classrooms, jets, theaters, etc.). The second assumption follows naturally from the first: If conceptualizations include background situations, then each simulated form of a category should include information appropriate for the respective situation. For example, the simulation of a chair in a living room should simulate a living room chair, whereas the simulation of a chair on a jet should simulate a jet chair. As a result, the different conceptualizations of a category differ, not just in situational information, but also in information about category members per se. Although some properties may be relatively common across conceptualizations, others are likely to vary (Barsalou, 1982).

The third assumption is necessary to explain how different conceptualizations of the same category become linked together. For example, how do the various conceptualizations of *chairs* become integrated into a single category? One possibility is by analogy. When a perceived entity accesses a structurally analogous conceptualization in memory, the two become linked (e.g., Brooks, 1978; Gentner & Markman, 1997; Holyoak & Thagard, 1989; Nosofsky, 1984). Perceiving a dining room chair, for example, may activate the conceptualization of an office chair via their shared physical structure, or via the common actions performed on them. As a result, the two conceptualizations become linked in memory. As chairs are increasingly encountered in other situations, the respective conceptualizations become related to similar conceptualizations, thereby forming linked chains. Although core properties could ultimately become established across the various conceptualizations of a concept, they need not be. When they do not, the linked chains of conceptualizations form a radial concept, whereby each conceptualization is closely related to at least one other (Lakoff, 1987; Malt, Sloman, Gennari, Shi, & Wang, 1999).

Essences constitute another possible linking mechanism. If all known conceptualizations of a category are believed to share a common essence, they become linked around the essence, even when their

physical appearances differ (e.g., Gelman & Diesendruck, 1999). Depending on the category, the essence could reflect a real essence that actually exists across instances, or it could simply reflect the belief that an essence exists, even when one does not. Regardless, the point is that the situated conceptualizations for a category could become linked in several ways. Following Barsalou (1999b), the result is a simulator capable of producing many situated simulations of a category.

This proposal does not simply boil down to the fact that a category has subordinates; the claim is significantly stronger. A category does not simply take different subordinate forms. Instead, these forms arise to accommodate the constraints of different situations. Conceptualizations of *chairs*, for example, take different forms because the constraints on having a place to sit vary from situation to situation. Furthermore, the heart of this proposal is that conceptualizations are represented against background situations—they are not simply subordinates represented in isolation. Finally, this framework extends well beyond subordinate categories. Consider *cars*. This framework predicts that a single subordinate, say *sedans*, will be conceptualized in a variety of situations, such as driving a sedan, seeing a sedan drive by, repairing a sedan, filling a sedan's gas tank, and so forth. Rather than conceptualizing sedans in a generic situation-independent manner, people conceptualize them in these various situations, focusing on different perspectives and properties in each. Thus, the theoretical proposal here extends beyond the fact that categories have subordinates.

Barsalou et al. (1993) presented the functional specifications of the aforementioned theory, which remains to be implemented computationally. As described earlier, existing connectionist theories offer one natural approach. Implementing this theory as a perceptual symbol system, however, constitutes a significant challenge that lies considerably beyond existing connectionist models (Barsalou, 1999b).

EMPIRICAL SUPPORT FOR SITUATED CONCEPTS

Yeh and Barsalou (2001) reviewed a wide variety of evidence that concepts are situated. Not only do people represent concepts in background situations, they represent them from subjective perspectives. In representing a concept, it is as if people were *being there* with one of its instances. Rather than representing a concept in a detached isolated manner, people construct a multimodal simulation of themselves interacting with an instance of the concept. To represent the concept, they prepare for situated action with one of its instances (Barsalou, 1999a). This final section briefly illustrates this point with two empirical findings.

Generating Category Members From Situations

Vallée-Tourangeau, Anthony, and Austin (1998) illustrated how participants imagine themselves in situations to produce exemplars of concepts. These researchers asked participants to generate exemplars from common taxonomic categories, such as *furniture* and *fruit*, and from ad hoc categories, such as *things dogs chase* and *reasons for going on a holiday*. After participants finished generating exemplars, they were asked to describe the strategies that they had used. Each strategy was classified as one of the following:

1. Experiential mediation—retrieving an autobiographical memory of a situation that contains individuals from the target category, and then reporting the categories to which these individuals belonged. When generating types of *fruit*, for example, this might involve retrieving a memory of a grocery store, scanning across it, and reporting the types of *fruit* perceived in the produce section. Similarly, when generating types of *furniture*, this might involve retrieving a memory of a residence, scanning across it, and reporting the types of *furniture* perceived in the living room.

2. Semantic mediation—retrieving a detached taxonomy that contains the target category, and then reporting its subcategories. When generating exemplars of *fruit*, for example, this might involve retrieving the *fruit* taxonomy and reporting subtypes, such as *tropical fruit*, *dried fruit*, and *citrus fruit*. Similarly, when generating exemplars of *furniture*, this might involve retrieving the *furniture* taxonomy and reporting subtypes, such as *decorative furniture*, *storage furniture*, and *seating furniture*.

3. Unmediated retrieval—accessing exemplars unconsciously and not being aware of any obvious strategy. On such occasions, participants often made remarks such as, "I just thought of them."

Vallée-Tourangeau et al. (1998) reported that their participants used experiential mediation about *3 times* as often as semantic mediation for both common taxonomic and ad hoc categories (unmediated retrieval was used even more rarely). Typically, experiential mediation included situations, namely, memories of events in environmental contexts. One might well expect that participants would report situations for ad hoc categories, given that these categories arise out of goal-directed activity in specific contexts (Barsalou, 1983, 1991). Much more surprising is the finding that situations were reported just as often for common taxonomic categories, suggesting that they, too, are organized around situations.

Bucks (1998) reported the same pattern of results as Vallée-Tourangeau et al. (1998), again showing that participants used experiential mediation most often to generate the instances of both common taxonomic and ad hoc categories. Related results have been reported by Walker and Kintsch (1985).

Together, all of these studies show that participants represent concepts in background situations. When participants receive a concept, they do not process its meaning in isolation. Instead, they often activate a background situation, and then establish the concept's meaning within this context.

Generating Features From Situated Instances of Categories

As the next studies illustrate, participants also situate concepts with respect to subjective perspectives when asked to produce the features of a single concept. Wu and Barsalou (2001) asked participants to list properties for individual concepts, such as *apple*, and for conceptual combinations, such as *sliced apple*. The instructions explicitly stated that participants should produce properties of the target objects per se. Nevertheless, participants produced many other properties that described background situations and subjective perspectives on these situations. The importance of situations can be seen in the types of properties that participants produced:

1. Taxonomic concepts—neighboring concepts in a taxonomy that contains the target concept. For example, generating the concepts *fruit*, *banana*, and *Granny Smith* for the target concept *apple*.
2. Entity properties—properties that describe the target object's surface properties and components. For example, generating *smooth*, *red*, *stem*, and *seeds* for *apple*.
3. Situational properties—properties that describe a physical setting or event in which the target object occurs. For example, generating *grocery store*, *fruit basket*, *slicing*, and *picnic* for *apple*.
4. Introspective properties—properties that describe an agent's subjective perspective on the target object. For example, generating *delicious* and *"I like them"* for *apple*.

It is not surprising that participants generated entity and taxonomic properties in the feature listing task. After all, this is what they were instructed to do. What is surprising is how often they described situational and introspective properties. Participants frequently described the physical settings and events in which the target objects are typically found (i.e., situational properties). Furthermore, participants often de-

scribed these situations from their subjective perspectives (i.e., introspective properties). Across four experiments, the proportion of situational and introspective properties combined ranged from 26% to 50%. In a given study, roughly two thirds of these properties were situational, and about one third was introspective. These findings illustrate that participants did not simply represent the target objects as detached and isolated. Instead, participants typically imagined *being there* with the objects, situating the objects in the environment, and viewing them from their subjective perspectives. Once participants had constructed these situated simulations, they scanned across them, producing a variety of properties in the process. Although participants were asked to process isolated concepts, they nevertheless represented them in background situations from subjective perspectives.

These findings are consistent with the importance of thematic relations in concepts. Not only do people represent a concept's structural properties relevant to a taxonomy, they also represent its thematic relations relevant to related situations. It has long been believed that thematic relations are primarily important for children and not for adults (cf. Inhelder & Piaget, 1964; Luciarello, Kyratzis, & Nelson, 1992; Markman, 1981, 1989; Nelson, 1977). However, recent work illustrates the central importance of thematic relations in adult concepts as well (Lin & Murphy, 2001). This importance may further reflect people's spontaneous inclination to represent concepts in situations.

SUMMARY

These findings illustrate the importance of situations in the representation of concepts. They also point toward future research that could illuminate the roles of situations in concepts, and the roles of concepts in situations. The human conceptual system probably did not evolve to represent concepts in isolation, or in detached taxonomies. Instead, the human conceptual system probably evolved to support human action in the environment.

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