The Situated Nature of Concepts

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Abstract

For decades the importance of background situations has been documented across all areas of cognition. Nevertheless, theories of concepts generally ignore background situations, focusing largely on bottom-up stimulus-based processing instead. Empirical research on concepts typically ignores background situations as well, not incorporating them into experimental designs. A selective review of relevant literatures demonstrates that concepts are not abstracted out of situations but instead are situated. Background situations constrain conceptual processing in many tasks (recall, recognition, categorization, lexical decision, color naming, property verification, property generation), across many areas of cognition (episodic memory, conceptual processing, visual object recognition, language comprehension). A taxonomy of situations is proposed in which grain size, meaningfulness, and tangibility distinguish the cumulative situations that structure cognition hierarchically.

One of the most potent factors in cognition is the background situation that frames a stimulus (also referred to as context). In virtually every task—from early perception to high-level reasoning—background situations have been shown to exert powerful effects on performance. Although a comprehensive review of situation effects has never been attempted, these effects are no doubt ubiquitous and substantial. Consider some prominent examples. In language comprehension, texts can be incomprehensible when the relevant situation is not known (e.g., Bransford & Johnson, 1973). During conversations, situations are central to establishing common ground between speakers (e.g., H. Clark, 1992), and also in non-human communication (e.g., W. Smith, 1977). Widespread evidence indicates that people use situation models to represent the meanings of texts (see Zwaan & Radvansky, 1998, for a review). Across many levels of analysis, language comprehension is a heavily situated process (Barsalou, 1999a). In problem solving and reasoning, it is often difficult to draw valid conclusions without the support of concrete situations (e.g., Cheng & Holyoak, 1985; Gick & Holyoak, 1980; Johnson-Laird, 1983). In developmental psychology, the Vygotskian tradition stressed the importance of situations in acquiring cognitive and social skills (e.g., Vygotsky, 1991). In social psychology and personality theory, situations predict behavior at least as well as traits (e.g., Mischel, 1968; E. R. Smith & Semin, 2004). In linguistics, the importance of situations motivated the theory of construction grammar, where syntactic structures evolve out of familiar situations (e.g., Goldberg, 1995). In philosophy, the importance of situations motivated the theory of situation semantics, where logical inference is optimized when performed in the context of specific situations (e.g., Barwise & Perry, 1983). In artificial intelligence, situating action in physical environments greatly enhances robotic intelligence (Brooks, 1991; Kirsh, 1991). General arguments about the central role of situations in cognition can be found in A. Clark (1997), Dunbar (1991), Glenberg (1997), Greeno (1998), Barsalou, Yeh, Luka, Olseth, Mix, and Wu (1993), and Barsalou (2003b).

Across these diverse areas, background 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 thereby facilitates processing. Rather than having to search through everything in memory across all situations, the cognitive system focuses on the knowledge and skills relevant in the current situation. 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. It becomes easier to recognize objects and events; it becomes easier to remember relevant information and skills; it becomes easier to understand language; it becomes easier to solve problems and perform reasoning; it becomes easier to predict the actions of other agents.

The Absence of Situations in Theories of Concepts

Although concept researchers would probably agree with everything stated so far, their theories largely ignore situation effects, failing to incorporate mechanisms that process situations. Moreover, most empirical research on artificial category learning fails to include meaningful situations or to manipulate situations as a variable. The implicit assumption in this work is that categorization is primarily a bottom-up stimulus-based process. As we will see, however, many findings across diverse literatures indicate powerful top-down effects of situations on conceptual processing. The purpose of this review is to motivate the inclusion of background situations in future theories, as well as in the research that accompanies them. Acknowledging the presence of situation effects and then ignoring them does not do justice to the wide-spread effects of situations on conceptual processing.[1]

To appreciate the absence of background situations in current theories, consider how these theories construe the learning process (e.g., Gluck & Bower, 1988; Homa, 1984; Krushke, 1982; Nosofsky, 1984; Posner & Keele, 1968; Rosch & Mervis, 1975; Shanks, 1991; Trabasso & Bower, 1968). During category learning, such theories assume that selective attention isolates critical information in a category’s exemplars, stores it in memory, and discards irrelevant information. Over time, information abstracted for the category accumulates, providing an increasingly rich concept that represents the category during perception, memory, language, thought, and action. Regardless of whether theories adopt exemplar, prototype, connectionist, or rule representations of concepts, they typically assume that selective attention isolates critical information in perception, leaving behind background situations. As theorists have noted, the abstraction of category knowledge is essential for explaining the productive nature of cognition (e.g., Barsalou, 1999b, 2003a; Dunbar, 1991). Without the abstraction of concepts, it would be impossible to explain how people combine units of conceptual knowledge to form novel complex concepts whose instances have never been experienced. Some sort of abstraction almost certainly underlies the conceptual system.

A key issue, though, is just how much abstraction takes place. Current theories typically assume implicitly that once the properties of an exemplar have been abstracted from the background situation, information about the situation is discarded. In establishing the concept of *chair*, for example, the cognitive system accumulates properties of chairs per se (e.g., *seats, back, legs*), discarding properties of the situations in which they occur (e.g., offices, living rooms, class rooms).[2] Contrary to this view, our thesis will be that the abstraction process stores extensive information about background situations while establishing concepts in memory. Later, during all forms of conceptual processing, these situations become active and have considerable impact on performance.

The Importance of Situations in Embodied Cognition

The importance of background situations follows naturally from the view that the human conceptual system is grounded in the brain's modality-specific systems (e.g., Barsalou, 1999b, 2003a; Glenberg, 1997; Goldstone & Barsalou, 1998). According to this view, people represent a category by simulating experiences of its members. To represent *chairs*, for example, people simulate the experience of a chair. Besides representing how a chair might look and feel, people might simulate actions taken towards chairs, introspective evaluations about their aesthetics and comfort, etc.

If simulation underlies conceptual processing, it places an important constraint on concepts: If a conceptual representation attempts to simulate a perceptual experience, it should typically simulate a *situation,* because situations are intrinsic parts of perceptual experiences. To see this, consider the content of perception. At a given moment, people perceive the immediate space around them, including agents, objects, and events present. Furthermore, this experience is multimodal. It is not just visual but also auditory, tactile, gustatory, olfactory, proprioceptive, and introspective. Most importantly, even when people focus attention on a particular entity or event in perception, they continue to perceive the background situation—the situation does not disappear.

If perceptual experience takes the form of a situation, and if a conceptual representation simulates perceptual experience, then the form of a conceptual representation should take the form of a perceived 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.[3]

Definitions

Our approach to situated conceptualization is both similar to and different from current research on situated cognition (e.g., Brooks, 1991; Greeno, 1998; Suchman, 1987). It is similar in stressing the importance of background situations in cognitive activity. It differs in focusing on cognitive representations of situations, whereas much work in situated cognition does not, relying instead on unmediated mappings between the physical environment and goal-directed action. We remain convinced that representations play central roles in situated cognition, and therefore focus on them here (A. Clark, 1997; Dietrich & Markman, 2000; Prinz & Barsalou, 2000).

Concepts. We define a *concept* as the accumulated information in memory abstracted for a category, where a *category* is a set of things in the world perceived as the same type of thing (for one of many possible reasons). Following Barsalou (1999b), we assume that a multimodal simulator underlies a concept, where a simulator is an organized body of knowledge that produces specific simulations of a category's instances (cf. Barsalou, 1987, 1989, 1993). For example, the simulator for *chair* might simulate a *stuffed chair*, a *wooden chair*, a *swivel chair,* etc. All of these different conceptualizations of *chair* are linked together by virtue of being produced by a common simulator.

It is essential to note that a simulator for a category does not include background situations within it—the simulator only represents information abstracted from category exemplars per se. As described shortly, however, other simulators for settings and events become linked to simulators for objects, thereby situating them.

Situations. We define a *situation* as a region of perceived space that surrounds a focal entity over some temporal duration, perceived from the subjective perspective of an agent. The region of space surrounding the entity may include a variety of entities and events, and the agent's subjective perspective on the region may contain a variety of mental states. For a detailed list of situational content, see the coding scheme in Wu and Barsalou (2005) and Cree and McRae (2003).[4]

We assume that simulators for settings, events, mental states, and so forth combine to represent background situations (e.g., Barsalou, 2003b; Barsalou, Niedenthal, Barbey, & Ruppert, 2003). If someone conceptualizes sitting in living room chair feeling relaxed, simulators for the setting (*living room*), the action (*sitting*), and the mental state (*relaxed*) all contribute simulations to the overall representation of the background situation for *chair*. As the exemplar of the category changes, so do the simulations that combine to form the background situation. Thus, if someone conceptualizes sitting in a classroom chair and studying, simulators for *classroom* and *studying* would contribute to the background situation, and the simulator for *sit* would contribute a different simulation of sitting.

Linkages between concepts and simulations. As can be seen from our definitions, we agree with concept theorists that information about concepts is abstracted. Where we disagree is that once concepts are abstracted, their background situations become irrelevant. To the contrary, we believe that concepts become linked tightly to their background situations. As we shall see shortly, these linkages constantly come into play during conceptual processing, thereby invoking ubiquitous effects of background situations. Again, our point is that these linkages should figure more centrally in theories of concepts than they have thus far.

Theses about the Situatedness of Concepts

Shortly we will review a wide variety of situation effects. As we will see, these findings strongly suggest that concepts are situated, namely, that concepts are closely coupled with situational information. We will argue that these findings support three specific theses about the situatedness of concepts, as well as several additional corollaries.

Insert Table 1 about here

As Table 1 illustrates, Thesis 1 and its corollaries state that situational information is linked to concepts, and that situations and their associated concepts mutually activate each other. Concepts do not typically become active in isolation, as most current theories assume implicitly. Because chairs are stored with living rooms, encountering living rooms activates chairs, and encountering chairs activates living rooms, with these co-activations being central to conceptual processing

Thesis 2 and its corollaries state that a concept produces different conceptualizations in different situations, with each form being relevant to a particular situation. Thus, the concept *chair* may be represented as a large stuffed chair in a living room, or as a swivel chair in an office. Conversely, encountering living rooms tends to activate large stuffed chairs, whereas encountering large stuffed chairs tends to activate living rooms.

There are two views of how Thesis 2 could be implemented computationally. According to one view, all the information in a concept is active in every situation, with the relevant information for the current situation weighted more heavily than the irrelevant information. According to a second view, only a small subset of a concept's content is activated in a given situation (Barsalou, 1987, 1989, 1993). Partial content is active for two reasons: First, people have so much knowledge for a particular category—much of it at low levels of accessibility—that all of it becoming active simultaneously is unlikely. Second, it would be counter-productive for all this information to be active at once. While reasoning about a living room chair, for example, activating information about office chairs, jet chairs, and theater chairs would be distracting and potentially misleading. In the review to follow, the evidence discussed does not distinguish between these two views. Both views, however, endorse the crux of Thesis 2, namely, that the information most functional for a concept varies across situations. Just how this functionally relevant content is implemented remains an important issue but is not critical to our claims.

Finally, Thesis 3 and its corollaries state that situation effects occur across many tasks as long as the following condition is met: Familiarity alone is not sufficient for successful task performance (cf. Glaser, 1992; Jacoby, 1991; Kan, Barsalou, Solomon, Minor, & Thomspon-Schill, 2003; G. Mandler, 1980; Solomon & Barsalou, 2004). To see this, consider a recognition test on words studied earlier, where the distracters are non-presented words. In such an experiment, participants can respond solely on the basis of word familiarity—they need not access the conceptual meanings of the words constructed during learning. Whenever participants perceive a familiar word form, they can respond old; whenever they perceive an unfamiliar word form, they can respond new. Most importantly, situation effects do not occur because participants need not access conceptual knowledge that contains situational information. In contrast, imagine that participants study two lists and later have to indicate which words on a recognition test came from the first list. Because all test items were recently studied, familiarity is not a valid cue for responding. Instead, participants must search for situational information that will indicate whether the word was presented in one particular list. Under such conditions, situation effects occur. Thesis 3 is necessary to explain interesting absences of situation effects in the literature.

Accuracy, guessing, and overall optimization. As we will see, situations generally improve performance. When participants can later reinstate the original learning situation, they remember more target material than when they cannot reinstate it. When participants perceive an object in a relevant situation, they categorize it better than when they perceive it in isolation. When participants verify that a property is true of a concept, they verify it faster in a relevant situation than in an irrelevant one.

Situations could produce these improvements in two ways. First, situations could increase performance by enhancing basic cognitive abilities (e.g., perceptual acuity, memory sensitivity). In signal detection terms, situations increase d′ (Green & Swets, 1966). Second, situations could increase performance by enhancing the ability to guess intelligently (e.g., top-down inferences about entities likely to have been present in a situation). In signal detection terms, situations increase beta.

In our review, we assume that sensitivity and/or intelligent guessing could be responsible for a given situation effect, and we will not try to disentangle them. Instead, we are only interested in the overall effects that situations have on performance, regardless of whether sensitivity and/or intelligent guessing are responsible. Importantly, we do not view intelligent guessing as an uninteresting, irrelevant aspect of performance. To the contrary, intelligent guessing helps agents interact optimally with their environments. Because the same situations occur over and over again, the ability to predict their contents is highly useful, at least on many occasions. Because these predictions are often born out, they optimize goal achievement.

Specifying the mechanisms that underlie situation effects is important. Nevertheless, our goal here is to document people's ubiquitous use of situations while processing concepts, and to demonstrate the benefits that follow. Should we convince other researchers that these effects are central to conceptual processing, an account of the underlying mechanisms would hopefully follow.

A Taxonomy of Situation Effects

Taxonomizing phenomena often lays the groundwork for mechanistic models. In that spirit, we develop a taxonomy of the situation effects we review. To our knowledge, no one has previously attempted to organize situation effects within a taxonomic framework. The framework here attempts to impose at least some sense of order on this large and diverse class of effects, using three factors: *grain size, meaningfulness,* and *tangibility*. Each factor is addressed in turn.

Grain size. As we will see in the studies reviewed shortly, the situations that affect conceptual processing range from a large to a small grain size. On the one hand, a situation can be an entire physical setting over an extended period of time, such as the classroom in which a word list is learned during a ten minute period. On the other hand, a situation can be the stimulus immediately adjacent to a target stimulus for a few moments, such as the word that primes a target word momentarily.

Grain size reflects both spatial and temporal extent. Spatially, a situation can range from an entire physical setting (e.g., a park), to the computer display that presents a stimulus (e.g., a pictured scene containing a target object), to an adjacent stimulus within a display (the object next to a target object in a scene). Temporally, a situation can range from the entire learning phase of an experiment, to the sequential presentation of several stimuli, to a trial that contains a single stimulus configuration.

Thus a situation can range from a large region of space over an extended period of time, down to a small region of space for a brief moment. As a result, a given stimulus typically exists in a hierarchically-organized set of situations across many levels of grain size simultaneously. There is not just one situation for a stimulus—typically there are many. Moreover it is difficult to specify the potential space of situations exhaustively. A physical object can potentially occur in an infinite number of situations, and be viewed from an infinite number of mental perspectives. Thus, the situations that pervade cognition are open ended and difficult to enumerate. In the General Discussion, we suggest that some of these situations become established automatically, whereas others become established strategically.

In the studies reviewed shortly, situations at many grain sizes produce situation effects. Whatever situations are salient during the processing of a stimulus are likely to become important. Although no studies to our knowledge address the cumulative effects of multiple situations at different grain sizes, we suspect that cumulative effects exist. Because a given stimulus has many potential situations at many grain sizes, cumulative situation effects that aggregate individual effects are likely.

Meaningfulness. The relation between an object and a situation can range from arbitrary cooccurrence to meaningful interdependence. In an arbitrary cooccurrence, it is difficult to explain why an object occurs in a situation and vice versa. Moreover, it is typically difficult to predict that the situation will contain the object. For example, when participants learn random words in a particular classroom, the relations between the words and the classroom are arbitrary. Knowing the situation does not explain or predict the critical target elements.

At the other extreme, the relationship between an object and a situation can be highly meaningful and predictable. In these cases, the object and situation typically belong to a coherent system whose parts have strong dependencies between them. In a classroom that contains chairs, desks, and blackboards, people can explain why these entities belong together.

As we will see, both arbitrary and meaningful situations produce situation effects. Even when an object bears an arbitrary relation to its situation, associations develop between them that produce the situation effects in Corollaries 1a and 1b. Nevertheless, situation effects tend to be larger in meaningful situations, because stronger relations develop between situations and objects. Furthermore, meaningful situations appear necessary for producing the effects associated with Thesis 2, namely, that concepts take specific forms in particular situations. These effects do not occur in arbitrary situations, when particular properties of concepts are not dependent on situations.

Tangibility. Finally, situations vary in the extent to which they are physically present versus imagined. For any stimulus, some situation is always physically present. While learning a word in a class room, a physical situation at a large grain size is the class room, whereas a physical situation at a small grain size is an adjacent word.

However, participants also *imagine* background situations for target stimuli, as many studies will illustrate. While recalling a word list in a new room, for example, a participant might imagine the original room in which the list was learned. As we will see, imagining earlier learning situations in this manner can produce situation effects.

In many studies, a target stimulus induces participants to imagine a background situation that is meaningfully related to the stimulus. For example, participants might see a hat above a shirt and imagine that a non-depicted person is wearing them. Or a participant might see a picture of an office chair and imagine a background office surrounding it. Many situation effects we review result from imagined situations that target stimuli elicit. Consistent with Corollary 1b, perceiving a stimulus triggers an imagined situation, which becomes fused with the physical stimulus (Barsalou, 1999b, Section 2.4.7).

Literatures Reviewed

Situation effects are so ubiquitous that reviewing them all in a single paper is impossible. Instead we focus on literatures that demonstrate situation effects in conceptual processing. Although many of the findings we review are well-known classics, they have never been reviewed together, nor integrated in a single framework. As described earlier, we also believe that theorists have not fully appreciated the significance of these findings for theories of concepts.

We begin with situation effects from the episodic memory literature. Findings from episodic memory are relevant to a review on concepts, because concepts enter centrally into memory during encoding, storage, and retrieval. People do not just store and retrieve surface stimuli (e.g., words, pictures), they also store and retrieve the conceptual representations that these stimuli activate. At encoding, background knowledge about situations elaborates the conceptual representation that a surface stimulus activates. At retrieval, this background knowledge produces reconstructive memory. Memory phenomena provide a rich window on situation effects in conceptual processing.

We then review research that assesses conceptual processing more directly. When people perform classic conceptual tasks, such as categorization, lexical decision, property verification, and property generation, they exhibit the same pattern of situation effects as in episodic memory. Because conceptual knowledge evolves out of episodic memories, such parallels are not surprising. Because episodic memories exhibit a situated character, so does the conceptual knowledge that develops from them. During their abstraction from experience, concepts do not discard their situational histories.

Although we organize our review around episodic memory and conceptual processing, two nested literatures provide a secondary level of organization: visual object processing and language comprehension. When we review literature on episodic memory, we will see extensive situation effects as people perceive objects and comprehend language. Similarly, when we review the literature on conceptual processing, we will again see extensive situation effects for both object perception and language comprehension.[5]

Focus on physical objects. Because the literature on situation effects focuses on object concepts, we do so as well. Nevertheless, we assume that Theses 1, 2, and 3 extend to other concepts. For example, increasing numbers of researchers argue that situations are central to representing abstract concepts such as *truth* (e.g., Schwanenflugel, 1991; Barsalou, 1999b; Barsalou & Wiemer-Hastings, 2005). There are also many reasons to believe that background situations are central to verb concepts (e.g., Ferretti, McRae, & Hatherell, 2001).

Situation Effects in Episodic Memory

Three areas of research demonstrate that the conceptual representations in episodic memories are situated. The first demonstrates that physical environments moderate memory for word lists. The second shows that scene schemata moderate memory for visual objects. The third illustrates that word and sentence contexts moderate memory for words.

Episodic Memory in Environmental Contexts

Word recall. The physical environment in which people learn information determines their ability to remember it later. In general, participants perform better if the original learning environment is reinstated at retrieval than if it is not (Tulving & Thomson, 1973). For example, Godden and Baddeley (1975) had divers study words either on a beach or 20 feet underwater, and then later asked them to recall the words in either the same environment or in the other. The divers recalled the words better in the same environment than in a different one. Many other studies have reported similar effects (e.g., S. Smith, Glenberg, & Bjork, 1978). Even asking participants to imagine the learning room enhances memory, as does viewing photos of the room (e.g., S. Smith, 1979). Consistent with Thesis 1, people store target materials together with situational information. Consistent with Corollary 1a, reinstating the learning situation activates information encoded there, improving recall.

Word recognition. Even when words become associated with situations during learning, participants may not use these situated memories during test. If stimulus familiarity is a sufficient cue for correct performance, participants may ignore any other information stored for the words (Thesis 3, Corollary 3a). Such findings occur in environmental context studies when participants use familiarity on recognition tests to bypass situational knowledge. For example, Godden and Baddeley (1980) ran a recognition version of their experiment, with divers learning words on a beach or underwater, and found that recognition was no higher in the same situation than in a different one. Consistent with Corollary 3a, however, familiarity was a valid cue for making correct responses, given that the old items were familiar and the new items were not. Similarly, in S. Smith et al. (1978), situational benefits on recognition did not occur in classroom environments when familiarity was available as a cue. As we will see shortly, recognition tests can be designed that block the use of familiarity. Under these conditions, situation effects appear for recognition, as Corollary 3b predicts.

Arbitrary vs. meaningful situations. Earlier we drew a distinction between arbitrary and meaningful situations. The research described so far for environmental context effects exemplifies arbitrary situations, namely, the words studied were not meaningfully related to their learning situations (e.g., beaches, underwater, classrooms). Notably, the fact that situation effects still occurred attests to the strength of these effects. As we will see next, situation effects are even larger in meaningful situations, resulting from the greater coherence between target items and situations.

Eich (1985) illustrated the meaningfulness benefit. Participants in the integrated-imagery condition related target words to the physical environment by constructing images that integrated each word's meaning with the decoration of the room. On receiving "kite," for example, participants might imagine a diamond-shaped kite on top of a nearby table. Conversely, in the isolated-imagery condition, participants simply imagined the meaning of each word in isolation. On a recall test two days later, the integrated-imagery group recalled more words than the isolated-imagery group. Furthermore, the integrated-imagery group performed better when tested in the original learning room than in a different room. In contrast, the isolated-imagery group performed equally poorly in both rooms. Although this experiment failed to show an environmental context effect in the isolated-imagery group, it nevertheless demonstrates that situation effects are stronger when target items are meaningfully integrated with situations than when they simply cooccur arbitrarily. Later studies will further demonstrate that meaningfulness enhances situation effects.[6]

Episodic Memory of Visual Scenes

In the studies reviewed thus far, situation effects occurred for physical situations at a large grain size (e.g., beaches, class rooms). In this section and the next, we begin examining situations that are smaller in grain size and that are often at least partially imagined. We also consider memory for visual objects as well as memory for the meanings of words.

Object memory in scenes. The construct of a *scene schema* is central to the studies that follow, where a scene schema is conceptual knowledge about the typical layout of a physical setting and the objects in it. J. Mandler and Stein (1974) presented children with a pictured set of objects arranged according to the spatial properties of a real-world scene, or arranged randomly. For example, several pieces of furniture might be arranged as they would normally appear in a living room, or they might be scrambled. When the children were later asked to recall the objects, they remembered more from the meaningfully organized sets than from the randomly organized sets. Furthermore, when children performed recognition tests on old and new scenes (i.e., subtly modified old scenes), they were more accurate for scenes of meaningfully related objects than for scenes of randomly arranged objects. Mandler and Stein concluded that the sets of meaningfully organized objects activated scene schemata, which the participants imagined and integrated with the objects. Because of the integration and elaboration that followed, participants were later able to remember the objects and their positions better than when they had not imagined situations for the scrambled scenes. J. Mandler and Parker (1976) replicated these findings with adults.

Interestingly situation effects in these studies occurred not only in recall but also in recognition. Consistent with Corollary 3b, these recognition effects occurred when the experimental conditions blocked the familiarity strategy. In these particular tests, the same objects occurred in both the old and new scenes, with subtle differences in object position and size distinguishing them. As a result, familiarity was not diagnostic for responding correctly. Instead participants had to evaluate conceptual representations of the remembered scenes to reach decisions, such that situational elaboration came into play. In contrast, situation effects on recognition disappeared when new scenes contained more substantial changes that made them unfamiliar (e.g., substitutions of objects).

Boundary extension in scene memory. In an extensive series of studies, Intraub and her colleagues have provided further evidence that people situate pictures in scene schemata—people do not simply store isolated memories of the surface pictures (e.g., Intraub, Gottesman, & Bills, 1998). For example, when participants studied a picture of a trashcan in an alley, they did not simply store a memory of the physical stimulus. Instead, they activated a scene schema and fused it with the picture, thereby establishing a wide-angle representation of the depicted scene.

Intraub and her colleagues have demonstrated this fusion process in a variety of boundary extension effects. For example, when participants drew a photo seen earlier, they included more of the background situation than was actually present. Similarly, on a forced-choice recognition test of a photo seen earlier, participants were less likely to choose the original photo than a new photo that was identical except for showing more of the background. These boundary extension effects occur for a wide variety of perceptual stimuli (e.g., photos, drawings) under a wide variety of conditions (e.g., perception, imagery). Together, they offer further support for the conclusion that when people see a picture, they situate it in a background setting and store the fused representation.

Episodic Memory in Word and Sentence Contexts

Thus far, we have seen situation effects in non-linguistic contexts, such as physical environments and imagined scenes. In this next section, we will see that situation effects also occur extensively in linguistic contexts that typically describe physical contexts.

Basic situation effects in sentence contexts. In McNamara and Diwadkar (1996), participants studied individual sentences one at a time such as:

The stewardess unpacked her bags. (1)

The class had to return to school late because the driver hit a mule. (2)

On a later recognition test, participants received a target word, preceded by a priming word, and indicated whether the target word had occurred in an earlier sentence. The critical manipulation was whether the prime came from the same sentence as the target or from a different sentence. When tested on the word “bags” from sentence (1) above, participants might receive “stewardess” as a same-sentence prime, or they might receive “mule” as a different-sentence prime.

Consistent with Thesis 1, same-sentence primes produced greater recognition accuracy than different-sentence primes, and also faster RTs. Reinstating the earlier context of a word improved its memory. These findings provide our first evidence for Corollary 1b, along with further evidence for Corollary 1a. It is likely that a prime activated the meaning of its sentence, which in turn activated the meaning of the target. In other words, one element of the situation activated the larger situation (Corollary 1b), which in turn activated the target element of the situation (Corollary 1a).

Situation-specific representations of concepts. Thus far we have only considered evidence for the basic situation effects of Thesis 1. Across a variety of different situations, people store target stimuli with multiple levels of situational information that vary in grain size and meaningfulness. The studies in this next section offer our first evidence for Thesis 2, namely, that the representation of a concept varies from situation to situation. Rather than taking a constant form across different situations, a concept takes different forms, where each form highlights situationally-relevant information. We will also see evidence for Corollaries 2a and 2b, namely, specific situations activate specific forms of a concept, and vice versa.[7]

Consider an experiment from Barclay, Bransford, Franks, McCarrell, and Nitsch (1974). Participants studied a word such as “piano” in a sentence that either stressed a piano’s *weight*:

The man lifted the piano. (3)

or that stressed a piano’s *sound*:

The man tuned the piano. (4)

At test, participants received a cue word for recalling the critical noun in the sentence (e.g., “piano”). On some trials, the cue word was related to the specific meaning of the target noun in the sentence, and on other trials it was unrelated. Thus, the related cue for sentence (3) was “heavy,” whereas the related cue for sentence (4) was “with a nice sound.” Conversely, the unrelated cues were “with a nice sound” for sentence (3), and “heavy” for sentence (4). Consistent with Thesis 2, the related cues produced better recall than the unrelated cues. As Corollary 2a predicts, the specific meaning stored for a critical noun was related to the situation that its sentence described. As Corollary 2b predicts, a related cue activated the relevant situation, which in turn activated the elements of that situation (Corollary 2a), thereby enabling recall of the critical nouns. Anderson and Ortony (1975) and Greenspan (1986, Experiment 1) reported similar findings, again using sentence contexts. Many related findings have been reported by memory researchers using paired associate learning (e.g., Light and Carter-Sobell, 1970; Reder, Anderson, & Bjork, 1974; Tulving and Thomson, 1971).

Situation effects in recognition revisited. Many of the studies reviewed in this section employed recognition tests and found strong situation effects. Several factors may explain why situation effects are so robust in the recognition tests here, compared to the weaker or non-existent recognition effects in environmental context studies. First, the target materials and situations here were meaningfully related, suggesting that situations exert strong effects on recognition when target materials and situations are well integrated in memory. Second, when meaningful situations are used, they activate situation-specific representations of the target materials (Corollary 2a). If the same situations are not later reinstated on a recognition test, the target materials may be represented differently, thereby failing to match the representations established during learning. In this manner, meaningful materials again produce situation effects on recognition tests. Finally, most of the recognition tests here used designs that discouraged using stimulus familiarity as a response cue. In particular, these experiments typically used familiar materials on both old and new trials, such that familiarity was not diagnostically useful in selecting responses (Thesis 3b).

Situation Effects in Conceptual Processing

Cognitive theories typically assume that conceptual knowledge evolves from the individual learning events that produce episodic memories. Although theories differ in the ultimate form that this knowledge takes—exemplars, prototypes, frames, neural nets, and rules—they typically agree that knowledge develops from learning episodes. Thus, if situations are central to episodic memory, they should also be central to knowledge, given that the latter develops from the former.

Three areas of research support this prediction. The first demonstrates that scene schemata facilitate object categorization in vision. The second shows that sentences activate situation-specific meanings for words during language comprehension. The third illustrates that people situate themselves while generating knowledge of categories.

Object Categorization in Visual Scenes

Similar to J. Mandler's experiments on scene memory, Biederman (1972) compared object categorization in coherent versus scrambled scenes. The coherent scenes were photographs of real world settings, such as streets, kitchens, and offices. To form the scrambled scenes, the coherent scenes were cut into pieces and rearranged randomly. On each trial, a coherent or scrambled scene was flashed briefly and then masked. A fixation point appeared immediately where an object had been, and participants chose which of four objects had occupied that position. Across a wide variety of conditions, participants were more accurate at identifying objects in coherent scenes than in scrambled scenes. Even when the position cue and the four object choices were presented *before* the scene, a coherence effect occurred. Consistent with Thesis 1 and its corollaries, situation-object relations in memory facilitated object categorization. As participants perceived a scene, its components projected in parallel to memory. If the arrangement of components matched a situation in memory, it began feeding back on object concepts in an interactive manner, increasing the likelihood that the target object was categorized, relative to when less activation to and from a situation occurred in the scrambled condition (McClelland & Rumelhart, 1981).[8]

Five relations underlying scene schemata. In later papers, Biederman developed a theory of scene processing (Biederman, 1981; Biederman, Mezzanotte, & Rabinowitz, 1982). Similar to the theories of J. Mandler and Stein (1974) and Intraub et al. (1998), scene schemata are central to his account of situational effects. When people view a familiar scene, a scene schema becomes active that contains conceptual knowledge about the physical setting and the objects typically found in it. According to Biederman, two physical relations and three semantic relations underlie this knowledge. We review these relations briefly, because they structure our review of the studies to follow.

The two physical relations—*support* and *interposition*—reflect the general physical constraints of gravity and opaque solid objects, respectively. When the support relation is satisfied, objects do not float in the air but are supported; when the interposition relation is satisfied, an opaque solid object occludes objects behind it. For example, the scene schema for a living room might specify that a sofa should rest on the floor, and that it should occlude a wall behind it. The three semantic relations—*probability*, *position*, and *size*—reflect the content of particular scene schemata. When the probability relation is satisfied, an object occurs in an expected scene; when the position relation is satisfied, an object occurs in its expected position; when the size relation is satisfied, an object takes its expected size. For example, the scene schema for a living room specifies that such rooms are likely to include a sofa, that a coffee table should appear in front of the sofa, and that the sofa should be larger than the coffee table. Overall, Biederman's studies found that the ease of processing a scene reflected the number of relations satisfied. The more relations satisfied, the easier a scene was to process.

Biederman further suggested that physical relations might be processed faster than semantic relations because physical relations are processed in early vision prior to accessing conceptual knowledge. Conversely, because semantic relations reside in knowledge, they may not come into play until later conceptual processing. Contrary to this intuition, however, Biederman (1981) found that semantic relations were available as quickly as physical relations. Participants detected semantic violations in visual scenes as fast as physical violations. The early presence of semantic relations in scene perception implicates the presence of scene schemata early in visual processing.

Further evidence for probability relations. Using a different paradigm than Biederman, Palmer (1975) demonstrated the importance of probability relations in object categorization. Palmer presented participants with a real world scene for 2 sec (e.g., a kitchen counter). After a short delay he presented an object that occurred with a high probability in the respective scene schema (e.g. a loaf of bread), or an object that occurred with a low probability (e.g., a drum). Palmer found that participants were much more likely to name an object correctly when a high probability scene preceded it than when no scene preceded it. Consistent with Corollary 1a, perceiving the scene activated concepts for highly probably objects, which then facilitated their categorization.

Boyce, Pollatsek, and Rayner (1989) demonstrated that scene-to-object relations—not object-to-object relations—are primarily responsible for these probability benefits. In earlier work, Henderson, Pollatsek and Rayner (1987) had argued that object-to-object relations were critical for situation effects. However, Boyce et al. demonstrated that placing associated objects beside a target object produced no additional benefit beyond that of knowing the situation. So long as a teddy bear appeared in a bedroom scene, for example, this situation facilitated categorizing the bear, regardless of whether the adjacent objects were associated (e.g., doll, alarm clock) or not associated (e.g., milk bottle, egg carton). Thus scene schemata—not object-to-object relations—appear primarily responsible for probability relations.

Finally, Murphy and Wisniewski (1989) demonstrated that the probability benefit occurs, not only for basic level categories (e.g., *chair*), but even more strongly for superordinates (e.g., *furniture*). Previous research had shown that people categorize isolated objects faster at the basic level than at the superordinate level (e.g., categorizing a stimulus as *chair* faster than as *furniture*; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). However, Murphy and Wisniewski found that when participants categorized objects in high-probability scenes, they categorized superordinate categories as fast as basic level categories (e.g., categorizing a stimulus in a living room as *furniture* as fast as *chair*). Although both types of categories benefited from high-probability scenes, the superordinate categories benefited more. Murphy and Wisniewski suggest that superordinate categories contain rich information about how objects are spatially related in situations. Because scene schemata also represent these particular object configurations, they prime superordinates robustly.[9]

Further evidence for position relations. Bar and Ullman (1996) reported further evidence for Biederman's position relation. On the critical trials, participants saw pairs of objects that were either in the correct relative positions (e.g., a hat above a leg) or in incorrect relative positions (e.g., a leg above a hat). One object was always drawn clearly, whereas the other was drawn ambiguously, being confusable with other similar objects. On some trials, both objects in a pair were presented; on others, only one object was presented in isolation. Participants' task was to name whatever objects were presented as rapidly as possible. Bar and Ullman found that participants were faster and more accurate when two objects satisfied the position relation than when they violated it. Furthermore, ambiguous objects were categorized more poorly when they appeared in an incorrectly positioned pair than when they occurred in isolation. Thus, expected positional information facilitated categorization, whereas unexpected positional information interfered with it. Furthermore, situation effects occurred on recognition tests in these studies, because familiarity of the surface stimuli was not sufficient for correct responding (Thesis 3 and its corollaries).

Conceptual Priming in Language

In the previous section, we saw that scene schemata produce situation effects during the categorization of physical objects. We focused on evidence for Thesis 1 and its corollaries, illustrating that situations and concepts are stored together, and that they activate each other. In this section, we will see that conceptual knowledge in language produces these effects as well. We will also see evidence for Thesis 2, namely, that concepts take specific forms in particular situations.

Basic situation effects in sentence contexts. A tremendous amount of research has shown that words are identified better in sentences than in isolation. For example, Miller and Isard (1963) asked participants to identify spoken words masked by noise. When the words belonged to a sentence that described a meaningful situation, participants identified them better than when they belonged to an anomalous sentence. Many other studies have since shown that meaningful sentences facilitate word recognition (e.g., Ehrlich & Rayner, 1981; Fischler & Bloom, 1979; Schuberth & Eimas, 1977; Stanovich & West, 1983; Tulving, G. Mandler, & Baumal, 1964). In a parametric study, Marslen-Wilson and Tyler (1980) varied the type of context (semantic, syntactic, lexical) and the amount of context (i.e., the number of sentence words that preceded the target). Both syntactic and semantic contexts facilitated word recognition, with increasing amounts of context producing increasingly large benefits. Such findings indicate that the conceptual knowledge used during language comprehension represents words and their meanings in syntactic and semantic contexts (Thesis 1). The more of a word's context encoded in a sentence, the easier the word becomes to identify (Corollary 1a).

Dynamic conceptualization in lexical processing. In the section on episodic memory, we saw that memory for the meaning of a word does not take a constant form across situations. Consistent with Thesis 2 and its corollaries, word meanings take different forms in different situations, with each meaning highlighting properties relevant for its respective situation. In the next several sections, we see that such effects also occur during the processing of words in conceptual tasks.

In many conceptual tasks, participants receive isolated words for the exemplars of categories (e.g., “chair” from *furniture*). Under these conditions, individual participants typically exhibit considerable variability in how they represent exemplars conceptually. For example, McCloskey and Glucksberg (1978) asked participants to determine the category membership of the same exemplars in two sessions separated by one month. For atypical exemplars, participants frequently disagreed with each other on whether a given exemplar belonged to a particular category. Furthermore, individual participants frequently changed their minds about the same exemplar across the two sessions. These results suggest that how participants conceptualized categories varied between and within participants.

Barsalou (1987, 1989) observed similar variability in other conceptual tasks. When participants judged the typicality of a category’s exemplars, the average correlation between pairs of participants across exemplars was only around .40. When the same participant judged the typicality of the same category’s exemplars on two occasions separated by a two-week interval, judgments in the two sessions only correlated around .80. Such variability in performance again implicates variability in how people represent categories. Similarly, when participants generated the properties of a concept, only about 40% of the properties in one participant's protocol occurred in another participant's protocol on the average. Furthermore, only about 67% of the properties in an individual participant's protocol occurred in his or her second protocol for the same concept two weeks later. Kahneman and Miller (1986) review similar variability in decision making, and L. Smith and Samuelson (1997) review such variability in children’s word learning.

Perhaps the variability in these conceptual tasks reflects differences in the conceptual knowledge of individual participants. Perhaps participants differ in their conceptual performance because they have different knowledge of the same category. A study described in Barsalou (1993) contradicts this hypothesis. When the properties produced by different participants for a concept were pooled into a single master set, a new group of participants agreed highly on whether each property was potentially true (between-participant agreement 97%, and within-participant agreement 98%). Thus, people's conceptual knowledge of a category appears remarkably similar, and differences in their knowledge do not appear responsible for the variability in how they represent it. Instead, this variability appears to result from highlighting different subsets of category knowledge. Although different participants have roughly the same knowledge, they highlight different subsets on a given occasion. Similarly, even though a given participant's knowledge remains relatively constant, different subsets become salient over time.

The account of this variability that we increasingly favor is that this variability reflects the situated nature of concepts (Barsalou, 1993; 2003b; Barsalou et al., 1993). When conceptualizing a category on a given occasion, a participant imagines being in a particular situation. On one occasion, a chair might be situated in a living room, but on another might be situated in a classroom. According to this account, between-participant variability results from different participants situating the same concept differently on a given occasion. Within-participant variability results from the same participant situating the same concept differently over time. Because concepts take different forms in different situations (Thesis 2), variability results.

Evidence for this hypothesis comes from another study described in Barsalou (1993). One group of participants received the same situation while judging the typicality of a category's instances. When judging the typicality of *vehicles*, for example, these participants judged them in the situation of *taking a vacation in the rugged mountains of Mexico*. Agreement increased substantially, relative to participants who received no situations. Between-participant agreement increased from .45 to .70, and within-participant agreement increased from .81 to .88. Consistent with the view that the variability in representing isolated concepts results from participants situating the same concept differently, constraining the situation increased agreement substantially.

Property priming during language comprehension. Much further support for this conclusion comes from studies that show situation-specific priming for properties during language comprehension. As background situations change in these studies, the properties primed for lexical concepts change as well. In Barsalou (1982), participants read a sentence that described a situation and verified a property that was true or false of a target concept in the sentence. On true trials, the property was sometimes relevant to the situation, and sometimes not. For example, some participants verified that *can be walked upon* is a property of *roof* after reading about a relevant situation:

The *roof* creaked under the weight of the repairman. (5)

whereas other participants verified *can be walked upon* after reading about an irrelevant situation:

The *roof* had been renovated prior to the rainy season. (6)

Properties were verified faster in relevant situations than in irrelevant situations. Tabossi and Johnson-Laird (1980) obtained similar results. Consistent with Thesis 2, the representation of a concept varies across situations. Consistent with Corollary 2a, specific situations highlight properties relevant in the current situation.[10]

Other investigators have demonstrated similar situation effects in a variety of other paradigms. In the cross-modality priming paradigm, participants heard a spoken sentence and then made a lexical decision on a visually-presented property word (Greenspan, 1986; Tabossi, 1988). Across trials, different sentences primed different properties of the same sentence-final word. For example, the following sentence primed the property *yellow* for the concept *gold*:

In the light, the blond hair of the little girl had the luster of *gold*. (7)

whereas a different sentence primed *malleable* for *gold*:

In the shop, the artisan shaped with ease the bar of *gold*. (8)

The pattern of priming was essentially the same as in the property verification paradigm. Participants performed lexical decisions faster on “yellow” after (7) than after (8), but were faster for “malleable” after (8) than after (7). In a study that assessed same-modality priming, Kellas, Paul, Martin, and Simpson (1991) presented the context sentences visually at a participant's normal reading speed and obtained situational priming on visual lexical decisions. Consistent with Corollary 2a, specific situations in all of these studies primed situation-specific properties in concepts.

Still other investigators reached the same conclusion using a modified Stroop procedure. In these studies, participants listened to a sentence and then named the ink color of a visually-presented property word (Conrad, 1978; Paul, Kellas, Martin, & Clark, 1992; Whitney, McKay, Kellas, & Emerson, 1985). If a sentence primes situation-specific properties in the sentence-final concept, this priming should interfere with naming the ink color of related property words. Thus, hearing sentence (7) should prime the property *yellow*, which should interfere with naming the word “yellow” in blue ink. The results from these studies supported this prediction, with the time to name the ink color of primed property words being slower than the time to name unprimed property words. Again, the properties salient for a concept depended on the background situation.

Finally, Wisniewski (1995) obtained situation effects in studies that investigated how people predict the functions of fictional concepts. Participants were asked to evaluate novel artifacts used to clean up pollution. If a novel artifact had the property, *uses a large vacuum,* participants judged it as a better example of the concept *pollution cleaner* in the situation, *near roadside trash,* than in the situation, *near an ocean spill*. Conversely, if a novel artifact had the property, *uses gigantic sponges*, participants judged it as a better example of *pollution cleaner* in the situation, *near an ocean spill*, than in the situation, *near roadside trash*. Participants represented the concept of *pollution cleaner* differently as a function of the background situation, consistent with Thesis 2 and its corollaries.

Exemplar priming. In the studies just reviewed, situations primed relevant properties in concepts, thereby causing the same concept to take different forms in different situations. However, a situation could also prime exemplars that are relevant in a particular situation, not just their properties. If so, the exemplars that become active for a category should vary across situations. Roth and Shoben (1983) demonstrated this effect. After reading about a particular situation, participants read exemplars of a category that were relevant in the situation faster than exemplars that were irrelevant. For example, participants read *tea* faster than *milk* after reading the following sentence about *beverages*:

During the midmorning break, the two secretaries gossiped as they drank the *beverage*. (9)

Conversely, participants read *milk* faster than *tea* after reading:

Before starting his day, the truck driver had the beverage and a donut at the truck stop. (10)

Consistent with Thesis 2 and its corollaries, participants read exemplars that were relevant in the situations faster than exemplars that were not. Exemplar accessibility varied across situations, indicating that participants represented the categories dynamically.

In another set of studies, Barsalou and Sewell (1984) asked participants to judge the typicality of exemplars from different points of view (also described in Barsalou, 1987, 1989, 1993). For example, participants judged the typicality of *birds* from various cultural points of view, such as Americans, Chinese, Emory undergraduates, and Emory faculty. As the point of view changed, so did the typicality of exemplars. For example, *robin* was typical from the American point of view and atypical from the Chinese point of view; conversely, *peacock* was typical from the Chinese point of view and atypical from the American point of view. Overall, the highly salient exemplars for a category varied substantially across perspective, again indicating that specific situations primed specific exemplars.

Situation Effects in Knowledge Generation

Exemplar generation. In this final section, we review situation effects in the generation of knowledge from memory. In Vallée-Tourangeau, Anthony, and Austin (1998), participants generated exemplars from common taxonomic categories (e.g., *furniture*, *fruit*) and from ad hoc categories (e.g., *things dogs chase*, *reasons for going on a holiday*). After generating exemplars, participants were asked to describe their strategies, which were classified as one of the following three types:

(1) **Experiential mediation.** Retrieving an autobiographical memory of a situation that contains exemplars of the target category, and then reporting these exemplars. When generating exemplars of *fruit*, for example, retrieving a memory of a grocery store and reporting exemplars from the produce section.

(2) **Semantic mediation.** Accessing an abstract taxonomy that contains the target category, and then reporting its exemplars by subcategory. When generating exemplars of *fruit*, for example, retrieving a taxonomy that includes *fruit* and then reporting exemplars by sub-cluster, such as *citrus fruit*, *dried fruit*, and *tropical fruit*.

(3) **Unmediated retrieval.** Simply having exemplars come to mind and not being aware of any obvious strategy. On such occasions participants often made remarks such as "I just knew them," or "Whatever came to my mind."

Vallée-Tourangeau et al. found that participants adopted experiential mediation about *three times* as often as semantic mediation for both common taxonomic and ad hoc categories (unmediated retrieval was even less frequent). Notably, experiential mediation almost always included situations, that is, the memories that participants retrieved typically described events in physical settings. Bucks (1998) reported the same pattern of results, again for both common taxonomic and ad hoc categories. Walker and Kintsch (1985) also found that participants relied heavily on experiential strategies to generate category exemplars. Consistent with Corollary 1b, these studies show that concepts activate 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.

Property generation. Evidence from the property generation task further demonstrates that processing a concept activates a background situation. Wu and Barsalou (2005) had participants generate properties for individual concepts, such as *apple*, and for conceptual combinations, such as *sliced apple*. Even though the instructions stated explicitly that participants should produce properties of the target objects per se, participants nevertheless produced many properties that described background situations. Overall, participants produced four types of properties:

(1) Taxonomic concepts. Neighboring concepts in a taxonomy that contains the target concept. For example, generating the concepts *fruit*, *banana*, and *Winesap* 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, 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*.

Not only did participants represent the objects in physical settings and events (i.e., situational properties), they also framed them in the subjective perspectives of agents (i.e., introspective properties). Across four studies, the total proportion of situational and introspective properties combined ranged from 26% to 50% (roughly two thirds of these properties were situational, and one third was introspective). Thus, participants did not simply represent isolated objects. Instead, participants typically situated objects in physical settings viewed from subjective perspectives. Once these situated representations were in place, participants scanned across them to produce a variety of properties. Consistent with Corollary 1b, receiving isolated concepts to process activated background situations.

General Discussion

Robust Patterns Across Episodic Memory and Conceptual Processing

Across the episodic memory and conceptual processing literatures, the same pattern of results emerges. Consistent with Thesis 1, concepts are not stored in isolation but remain closely coupled with their background situations. Thus, when situations become active, they activate their associated concepts (Corollary 1a). Conversely, when concepts become active, they activate their associated situations (Corollary 1b). Consistent with Thesis 2, a concept does not take the same form across different situations—it takes different forms that are situationally relevant. When a concept is processed in a particular situation, properties become salient that are relevant in the situation (Corollary 2a). Conversely, on accessing a specific form of a concept, the associated situation becomes active (Corollary 2b). Consistent with Thesis 3, situation effects occur across diverse tasks, as long as conceptual knowledge is accessed. When the familiarity of surface stimuli predicts the correct response, however, participants need not access conceptual knowledge, and situation effects do not occur (Corollary 3a). When experimental conditions block familiarity, participants access conceptual knowledge that contains situational knowledge, and situation effects ensue (Corollary 3b). Finally, meaningful situations produce stronger situation effects than arbitrary situations.

Origins of Situation Effects

We have reviewed situation effects in various areas of cognition, including episodic memory, conceptual processing, object perception, and language comprehension. As described initially, situation effects also occur in virtually every other area of psychology, and they arise extensively in the other cognitive science disciplines. The widespread existence of situation effects suggests that they are fundamental to cognition. Indeed situation effects are probably present continuously during everyday activity. At any given moment, the current situation activates related concepts, and concepts activate related situations. Furthermore, the concepts active are likely to take situation-specific forms.

Why would this particular property of cognition be so pervasive? Given that situation effects are so ubiquitous in cognition, it is important to understand their origins. We consider two possible explanations next: (1) Situation effects arise because conceptual processes coopted perceptual mechanisms that were evolutionarily convenient. (2) Situation effects arise because they optimize the prediction of entities and events in the environment. Both explanations may well be correct.

An evolutionary convenience. As we suggested earlier, the human conceptual system may be grounded in the brain's modality-specific systems (e.g., Barsalou, 1999b; 2003a; Glenberg, 1997; Goldstone & Barsalou, 1998). If so, one reason for this relation between cognition and perception might be that evolution capitalized on existing brain mechanisms to implement conceptual systems, rather than creating new ones (e.g., Gould, 1991).

If so, the importance of situations in conception could reflect the importance of situations in perception. As described earlier, situations provide the background for perceptual experience. At a given moment, people perceive the immediate space around them, including any entities and events within it. Most importantly, when people focus attention on a particular entity or event, they continue to perceive the background situation—it does not disappear. If perceptual experience takes the form of a situation, and if a conceptual representation simulates perceptual experience, then the form of a conceptual representation should take the form of a perceived situation. When people represent a concept, they should frame it in a relevant perceptual situation. If the conceptual system coopted perceptual mechanisms as an evolutionary convenience, situations should be important for both.

Optimizing prediction of the environment. Another possibility is that situations became important because they improved cognitive performance—not just because they were conveniently available. Because using situations during conceptual processing improved prediction of the environment, they were incorporated into conceptual systems. As Theses 1 and 2 suggest, situations optimize prediction in two ways: Situations increase the breadth of conceptual inferences, and they increase their specificity. We address each in turn.

Incorporating situations into conceptual processing broadens inference by extending it beyond a focal object or event. When representing *chairs*, for example, a conceptual system could simply infer the likely properties of these objects per se. However such isolated inferences omit much situational information that may be useful. For example, if one wishes to find a chair, it is helpful to know locations that contain them. By representing a chair in one or more of its situations, an agent can draw immediate inferences about where to find one (e.g., in a living room). Situational inferences also provide useful information about adjacent objects and likely events. Thus representing a chair in a living room is likely to also represent adjacent tables and lamps, which may be useful in planning events in the situation, such as writing on a table or reading by a lamp. As these examples illustrate, situating an object concept produces a broad range of inferences useful to human activity.

Incorporating situations into conceptual processing also increases the specificity of inferences, doing so at two levels. First, once one has identified a situation, it leads to inferences about objects and events likely to be present. For example, on entering a living room, inferences about its content might specify that chairs, tables, lamps, and people are likely to be present, and that the people are likely to be talking or reading. Second, once one infers a particular object in a situation, the situation-object pairing is likely to produce specific inferences about the object's properties. For example, when one expects to find a chair in a living room, the chair is likely to be large and soft, not small and hard. Thus, once knows a situation, it produces inferences about its content at multiple levels.

By organizing knowledge around situations, the cognitive system greatly simplifies many tasks. Rather than searching everything in memory across all situations, processing focuses on the knowledge and skills relevant in the current situation. As a result, it becomes easier to recognize objects and events; it becomes easier to retrieve relevant information and skills; it becomes easier to understand language; it becomes easier to solve problems and perform reasoning; it becomes easier to predict the actions of other agents.

Future Issues

The conclusion that concepts are situated raises at least as many issues as it resolves. We consider several that have arisen thus far in our review. There are undoubtedly others.

Mechanisms that produce situation effects. So far we have only considered the extensive use of situational knowledge in cognitive processing and the resulting benefits in performance. Although we have not addressed the mechanisms that underlie these benefits, it is obviously essential to do so. As noted earlier, one important issue is establishing the extent to which situation benefits reflect sensitivity, intelligent guessing, or both. More generally, however, it is essential to identify the mechanisms that underlie situational effects, regardless of whether they increase sensitivity, promote sophisticated inferencing, or produce some other aspect of situational phenomena.

The cumulative nature of situations. One important set of mechanisms to be characterized are those that underlie the cumulative perception of situations at multiple grain sizes. As described earlier, a situation is not single holistic background—it is a complex set of hierarchically organized backgrounds present simultaneously. At this time, we do not have accounts of what a hierarchically organized situation contains. What specific backgrounds are present at what grain sizes? We also lack accounts of how the backgrounds in a complex situation originate. Are some always present in perception, presumably because they reflect obligatory processing during the processing of a focal stimulus? Are other backgrounds created in an ad hoc manner as they become relevant?

A related issue concerns how all of the background situations active at a point in time become integrated. How are these various situations integrated to create the illusion of a single coherent situation? It is also necessary to explain how situations at small grain sizes come and go while situations at large grain sizes remain relatively constant.

The nature of situational learning. Once a complete situation becomes assembled, some aspects of it presumably become stored in memory. Thus, another set of critical issues concerns the nature of this learning. A key issue is identifying just what aspects of background situations become stored. One possibility is that the situations stored are a side effect of processing (Barsalou, 1995). If attention and meaningful relations guide the processing of situations, as just described, then this processing may determine the storage of situational information in conceptual knowledge. As attention focuses on some aspect of a situation, that aspect becomes linked to the target stimulus. Noting a chair's relation to a table, for example, stores this relation in memory, thereby situating memory of the chair. As other meaningful relations are processed, they, too, become stored with the chair further situating. As this example illustrates, the particular context for a given stimulus reflects the accumulated collection of cognitive operations performed during its processing.

Thus, one account of situational learning is simply that it follows the processing of situations. Whatever aspects of the situation receive processing become stored in memory with the target concept (cf. Barsalou, 2003a). This account also explains why concepts are not completely abstracted from their background situations. Because attention does not just focus on a target stimulus but also traverses its background situation, situational information becomes stored in the target concept.

One potential exception to this account is that some situational information may be stored obligatorily, regardless of how attention is allocated. For example, Hasher and Zacks (1979) argued that people automatically store information about frequency, space, and time, regardless of how attention is allocated to processing. Subsequent research noted minor exceptions to this conjecture (e.g., Barsalou & Ross, 1986; Greene, 1986; Jonides & Naveh-Benjamin, 1987; Williams & Durso, 1986). Overall, however, these strategic attentional effects on the storage of frequency, space, and time are relatively small. More importantly, large amounts of this information are still stored even when task conditions minimize the strategic processing of target materials.

Space and time are clearly central aspects of situations. To the extent that they are stored obligatorily, they provide exceptions to the hypothesis that situational learning only reflects strategic attentional processing. Interestingly, however, the obligatory storage of such information underlines just how important situational information is to cognition. If the storage of such information became obligatory over the course of evolution, it must have optimized cognitive performance.

Thus, the storage of situational information with conceptual knowledge may reflect two sources. On the one hand, basic information about space and time may be stored obligatorily for the situations that frame a concept's exemplars. On the other, meaningful relations and the focus of attention may store additional situational information relevant to an organism's activities. Important goals for future research are, first, to determine whether situational information is indeed established in these two manners, and if so, to identify the underlying mechanisms responsible.

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Footnotes

[1] Medin and Shaffer's (1978) context model could be construed as storing situational properties of exemplars. In practice, however, context in this model has always been implemented as properties *within* an exemplar that provide context for other exemplar properties. The theory theory of concepts could also be construed as having contextual mechanisms. However, these mechanisms implement background theories, not representations of situational contexts, which we focus on here. It is worth noting, however, that the context model—as well as all other theories—can be readily modified to abstract properties from situational contexts and store them with concepts. Our point is simply that existing theories have not done so, and that future theories should.

[2] Throughout this article, double quotes signify words, whereas italics signify conceptual representations.

[3] We raise the issue of perceptual grounding because it provides an a priori account of why concepts are situated. Our argument for situated concepts, however, does not depend on this assumption. Instead the point is simply that background situations become tightly coupled with concepts during their abstraction from experience, contrary to the assumption that background situations are discarded. Our focal argument is orthogonal to the issue of whether knowledge is perceptual or amodal. In principle, situational information could be associated with concepts that are represented either way.

[4] This definition of *situation* is designed to handle the everyday sorts of situations that most people encounter during daily activity. It is not designed to handle more specialized sorts of situations that occur in technical and formal domains (e.g., mathematics). Although we believe that situations are probably just as in important in these other areas (e.g., Barwise & Perry, 1983; Chi, Feltovich, & Glaser, 1981; Greeno, 1998), we do not pursue them here.

[5] A considerable amount of research on episodic memory and conceptual processing is potentially relevant to this review. Indeed, there is so much literature, that we do not have space to review it all here. Instead, we focus on representative examples that illustrate each important area.

[6] Various factors may explain the absence of situation effects in the isolated-imagery condition. According to Eich, the two learning rooms may not have been as distinctive as the different

environments in Godden and Baddeley (1975), S. Smith et al. (1978), and S. Smith (1979). Relatively drastic changes in physical environments may be necessary to produce situation effects in arbitrary situations. Another possible factor is that Eich's participants were asked to image the words' meanings, whereas participants in the other studies were simply asked to learn words.

[7] Again we remain agnostic on whether one form of a concept becomes active while others are inactive, or whether the active form of a concept is simply weighted more highly than other forms, which also become active. Throughout this discussion, when we discuss a form of a concept being active, we commit to neither of these possibilities. Instead we simply mean that one form is *functionally more important* in cognitive processing than others.

[8] The word superiority effect is an analogous phenomenon, in which a letter is identified faster in the context of a word than in a non-word (Reicher, 1979; Wheeler, 1970).

[9] This result might appear to be at odds with Boyce et al.'s (1989) finding that the associative strength of adjacent objects produced no additional benefits beyond knowing the setting. However, the configurations of objects in the Boyce et al. studies do not appear to have been the same sorts of configurations associated with superordinate categories. Thus, Murphy and Wisniewski's (1989) results suggest that object configurations do produce priming, but only when they are of a certain type, such as those associated with superordinates (e.g., an arrangement of furniture or silverware).

[10] Barsalou (1982) and other studies in this section also report that some properties are salient across all situations, being context-independent. Further research is needed to establish just how context-independent these properties actually are. Regardless, the other results in these studies clearly indicate that not all properties in a concept are salient across situations. Instead, much of the content in a conceptual representation is situation-specific, as the literature throughout this review indicates.

Table 1

Theses and corollaries about the relations between situations and concepts assessed in the literatures relevant to conceptual processing

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Thesis 1. The representation of a concept in memory is associated with situational information about physical settings, events, and subjective perspectives of agents.

Corollary 1a. When a situation is processed, associated concepts become active.

Corollary 1b. When a concept is processed, associated situations become active.

Thesis 2. The information that is functionally important for a concept varies from situation to situation, depending on the information relevant in the current situation.

Corollary 2a. When a concept is processed in a particular situation, properties that are functionally relevant for the situation become salient.

Corollary 2b. When specific properties of a concept are processed, they activate the corresponding situation.

Thesis 3. The situation effects in Theses 1 and 2 occur across a wide variety of tasks, including recall, recognition, categorization, property listing, property verification, etc., as long as task conditions require conceptual processing.

Corollary 3a. When the familiarity of surface stimuli is sufficient for accurate performance, it is not necessary to access conceptual knowledge that contains situational information, thereby bypassing situation effects.

Corollary 3b. When the familiarity of surface stimuli is not diagnostic for correct responding, it is necessary to access conceptual knowledge that contains situational information, thereby producing situation effects.
