The study of creativity typically focuses on the exceptional, including the major accomplishments of inventors, scientists, and artists. Any casual reading of history leaves no doubt that exceptional creativity has influenced human culture. In Western culture, the exceptional accomplishments of unusually talented individuals define who we are to an enormous extent. For this reason alone, understanding exceptional creativity is essential to understanding human nature.

No less remarkable is mundane creativity. Whereas exceptional creativity graces a few individuals, mundane creativity graces everyone. Although exceptional acts of creativity produce dramatic changes in human culture, mundane creativity underlies the general power of natural intelligence. Like exceptional creativity, mundane creativity involves the production of novelty. All humans produce new cognitions and behaviors all the time. Because we observe such novelty day in and day out, it fails to strike us as noteworthy. Nevertheless, mundane creativity is central to what it means to be human, and explaining it is at least as important as explaining exceptional creativity. Although exceptional creativity is “flashier”
culturally, historically, and scientifically, mundane creativity is the workhorse that accounts for the bulk of human accomplishment and that makes exceptional creativity possible. In this chapter, we examine the nature of mundane creativity and demonstrate its central role in the human symbolic system. Our primary goal is to show that a powerful system of perceptual symbols could be responsible for this ability. In a related paper, we explore mundane creativity in perceptual symbol systems further (Prinz & Barsalou, in press).

MUNDANE CREATIVITY

Two types of mundane creativity—productivity and propositional construal—have played central roles in modern cognitive science. A third—variable embodiment—has received relatively little acknowledgment, for reasons that we make clear later.

Productivity

According to Chomsky's (1957) notion of linguistic creativity, all humans share a biologically based ability to produce an indefinitely large number of sentences from a finite set of syntactic rules and lexical elements (see also Kashir, 1991). Indeed, Chomsky noted that people constantly produce new sentences that they have never uttered, nor heard uttered, simply because their linguistic systems possess an inherent creative ability. For the remainder of this chapter, we refer to this type of mundane creativity as productivity, following standard technical usage in linguistics. Although there are many ways to construe productivity, all accounts share the property that a finite set of representations can produce an indefinitely large number of structural and recursive mechanisms.

Propositional Construal

A second form of mundane creativity, propositional construal, has also played a central role in modern cognitive science. Intuitively, a propositional construal describes some aspect of a situation in one possible manner. The process of propositional construal is creative, because the same perceived state of affairs can be construed in an indefinitely large number of ways (Goodman, 1976). Very different construals of a situation result as a function of what perceivers choose to describe and how they choose to describe it.

Propositional construals are propositional for three reasons: First, they are propositional because they capture the gist of an event or event (Anderson & Bower, 1973; Kintsch, 1974). Rather than a linguistic sentence, a propositional construal is a representation of something that can be paraphrased linguistically in many ways (Carnap, 1956; Church, 1951; Frege, 1918/1956; Russell, 1921; Sellars, 1956; Stalnaker, 1984). Second, construals are propositional because they can be either true or false. Perceivers can construe situations correctly or incorrectly, thereby endowing the propositions that represent these construals with truth values. Third, construals are propositional because they are constructed from languages having a combinatorial syntax and semantics. As we show, such languages offer powerful systems for construing situations in many possible ways.

Thus, a propositional construal represents some aspect of an event conceptually, either correctly or incorrectly, using a combinatorial symbolic system. Because an indefinitely large number of propositions could be used to describe a given event, and because the propositions actually used can vary widely between and within individuals, propositional construal is a form of mundane creativity.1

Variable Embodiment

Unlike productivity and propositional construal, variable embodiment is not a form of mundane creativity that has been central to modern cognitive science (but see Goodman's, 1976, discussion of semantic properties in pictorial symbol systems). Indeed, the assumptions that underlie variable embodiment are at odds with prevailing views of the human symbolic system, as we discuss later. Thus, describing variable embodiment is

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1To avoid confusion, it should be noted that there is a sense in which our use of proposition departs from common philosophical usage. Many philosophers regard propositions as Platonic objects that exist neither in the mind nor in the physical world (e.g., Church, 1951; Fodor, 1975; Frege, 1918/1956). We do not endorse this ontologically extravagant conception of propositions but regard them instead as psychological entities. This usage is not without philosophical precedent (e.g., Russell, 1921), and it has gained currency among contemporary philosophers and cognitive scientists (e.g., Pylyshyn, 1975).
difficult at this point, because it requires a perceptual symbol system, which we have yet to define. After presenting perceptual symbol systems later, we provide an account of variable embodiment and the role it plays in mundane creativity. For now, we simply describe variable embodiment as follows: If conceptual symbols reflect their embodiment in particular individuals, then continuous variability in the forms of these symbols may have semantic implications. Variable embodiment is creative, because infinite variability in the form of an embodied symbol can yield an infinite number of conceptualizations. As the same symbol is embodied in different ways, it acquires different meanings, producing another important form of mundane creativity.

MUNDANE CREATIVITY IN AMODAL SYMBOL SYSTEMS

Mundane creativity has played a central role in debates about the human symbolic system. On the one hand, the belief that perceptual representations do not exhibit mundane creativity has fueled the argument that the human symbolic system is not inherently perceptual. On the other hand, the ability of nonperceptual representations to exhibit mundane creativity has supported the argument that the human symbolic system is inherently amodal (i.e., nonperceptual). This criticism of perceptual symbol systems holds only for some accounts of them but by no means for all. Indeed, the perceptual symbol system we present here exhibits both forms of mundane creativity found in amodal symbol systems, as well as another. Before turning to perceptual symbol systems, we first define amodal symbols and illustrate how they produce mundane creativity.

Amodal Symbols

What we call amodal symbols have traditionally been called propositional symbols. We shall see later, however, that perceptual symbols can be propositional just like nonperceptual symbols. To avoid implying that perceptual symbols are not propositional, we use amodal symbols in referring to what most theorists have called propositional symbols. As we shall argue, the most distinguishing feature of traditional propositional systems is their assumption that symbols are amodal. For articulations of this assumption, see Fodor (1975), Harnad (1990), Haugeland (1985), Newell and Simon (1972), and Pylyshyn (1984).

Amodal symbols result from a process that transduces perceptual states into a nonperceptual symbolic language. According to this view, a transduction process takes perceptual states as input and produces amodal symbols as output, with the amodal symbols representing the perceptual states. These symbols are amodal because their form bears no structural resemblance to the perceptual states that produced them. For example, the amodal symbols transduced to represent the perception of a chair bear no structural resemblance to it. This lack of structural relations between amodal symbols and perceptual states is similar to the lack of structural relations between words and perceptual states. Just as the phonological and orthographic representations of the word “chair” bear no structural relations to the visual representation of a chair, neither does the amodal representation of chair at the conceptual level. An additional implication is that the similarity of amodal symbols to one another bears no correspondence to the similarity of perceptual states to one another. To see this, note that words for types of furniture have little in common phonologically (e.g., “chair,” “stool,” “bench”), even though perceptual states of their referents are similar. Conversely, words having similar phonological forms (e.g., “chair,” “hair,” “chain”) have referents that produce very different perceptual states. Amodal symbols are similar to words in these ways, being unrelated structurally to the perceptual states that they represent.

Because the form of amodal symbols is uninformative about their referents, some other mechanism must allow them to establish reference. Theorists typically assume that conventional associations play this role. Through some process, conventional associations become established between amodal symbols and their referents, much like the conventional associations that develop between words and their referents. Although theorists have never specified how these associations develop, we assume that they must arise somehow in the transduction process that maps perceptual states into the amodal symbols that represent them. The relations that
develop are arbitrary. If they were not, the structure of amodal symbols would be informative about their referents, and the similarity of amodal symbols to one another would be informative about the similarity of their referents to one another. As we have shown, however, amodal symbols do not exhibit these properties and are therefore related to their referents arbitrarily.

In modern cognitive science, amodal symbol systems take many forms. In philosophy and logical computation, they take the form of proof-oriented systems (e.g., Fodor, 1975; Hayes, 1985; Mitchell, Keller, & Kedar-Cabelli, 1986; Pylyshyn, 1984). In psychology, artificial intelligence, and linguistics, amodal symbol systems take the form of semantic networks, feature lists, schemata, frames, and many connectionist models. In all of these representational schemes, symbols are assumed to be amodal in form and arbitrary in reference (for reviews, see Barsalou 1992a, 1992b; Barsalou & Hale, 1993). Most important, the symbols in these schemes are not assumed to be constituted of perceptual content.

**Mundane Creativity**

**Productivity**

Amodal symbol systems exhibit a variety of fundamentally important properties, including mundane creativity. As noted earlier, theorists have often argued that productivity is central to human cognition. From Chomsky (1957) to Fodor and Pylyshyn (1988), productive mechanisms continue to be found at the heart of cognitive theory. The properties of amodal symbol systems lend themselves naturally to productive computation. Using the mechanisms of argument binding and recursion from predicate calculus, amodal symbol systems can produce infinite expressions from finite elements. Argument binding involves mapping the arguments of predicates to individuals (or to other predicates). In the predicate, $\text{ABOVE}(X, Y)$, two arguments, one for an upper region $X$ and one for a lower region $Y$, can be bound to a variety of individuals across situations, as in $\text{ABOVE}($lamp, table$)$, $\text{ABOVE}($bird, tree$)$, and so forth. Recursion results from binding arguments to predicates, enabling infinitely deep structure. For example, the lower region of $\text{ABOVE}(X, Y)$ can be instantiated with $\text{INSIDE}(M, N)$, as in $\text{ABOVE}($lamp, $\text{INSIDE}($cup, box$)$). Argument binding and recursion are responsible for the productive quality of many representational systems, from theories of syntax to theories of knowledge. Because a large number of individuals can be bound to arguments combinatorially, and because arguments can be bound recursively, amodal symbol systems are productive. Regardless of whether the system focuses on syntax (Chomsky, 1957) or semantics (Fodor & Pylyshyn, 1988), the same productive mechanisms play central roles. In amodal symbol systems that are less logical, slots in structures such as frames and schemata enable productivity. In all cases, these mechanisms produce an indefinite number of arbitrarily complex structures from finite elements.

**Propositional Construal**

Amodal symbol systems also exhibit propositional construal. Because these systems rely heavily on mechanisms derived from propositional logic and predicate calculus, they readily represent propositions. In predicate calculus, an instantiated expression construes some aspect of a situation truly or falsely. Moreover, different expressions can construe the same situation in different ways, either by describing different aspects of it or by describing the same aspect differently. For example, the propositions $\text{ABOVE}($bird, tree$)$ and $\text{BEFORE}($tree, lake$)$ could describe different aspects of the same visual scene, whereas $\text{ABOVE}($bird, tree$)$ and $\text{BELOW}($tree, bird$)$ could construe the same aspect in different ways. In amodal symbol systems that are less logical, instantiated structures, such as networks, frames, and schemata, similarly represent propositions about the world (e.g., Anderson & Bower, 1973; Barsalou, 1992a, 1992b; van Dijk & Kintsch, 1983).

Over the years, many theorists have provided compelling arguments for the importance of propositions in human cognition (see Barsalou, 1992a, for a review). In arguing against purely analogue views of mental imagery, Pylyshyn (1973, 1981) illustrated the importance of propositional construal. As he showed, a cognitive system must have a multilevel repre-
Advantages and Disadvantages of Amodal Systems

We have reviewed the advantages and disadvantages of amodal symbol systems elsewhere; thus, we do not do so here (Barsalou, 1993; Barsalou, Yeh, Luka, Olseth, Mix, & Wu, 1993). To summarize these arguments, one important advantage is the ability to implement mundane creativity. Amodal symbol systems highlight the importance of productivity and propositional construal, and they have made it clear that any adequate theory of cognition must exhibit these capabilities. Other important properties of amodal symbol systems include their ability to represent gist, to represent abstract concepts, to be expressible in formal languages, and to be implemented on computer hardware. We agree that these are highly desirable qualities, which any theory of cognition should exhibit.

Nevertheless, there are a number of problems for this view: First, we have no direct evidence that conceptual symbols in the cognitive system are amodal in form and arbitrary in reference. Second, we have no account of the transduction process that maps perceptual states into amodal symbols. Third, we have no direct evidence for any such process. Fourth, many theorists have noted problems in the reverse process of establishing reference to amodal symbols (e.g., Harnad, 1990; Searle, 1980). Fifth, this theory is so powerful that it can explain any finding post hoc, often without providing much insight into it or lending itself to an a priori prediction of the finding in the first place. For these reasons, we have come to believe that there are deep and troubling problems with amodal symbol systems that are cause for viewing them with greater skepticism than we have in the past.

PERCEPTUAL SYMBOL SYSTEMS

Perceptual Symbols

Perceptual symbols contrast with amodal symbols in origin. Whereas amodal symbols result from a transduction process that arbitrarily maps perceptual states to nonperceptual symbols, perceptual symbols result from an extraction process that selects some subset of a perceptual state and stores it as a symbol. Thus, the form of a perceptual symbol resembles the perceptual states to which it refers, and the similarity of perceptual symbols to one another is informative about the similarity of their referents. Imagine that the shape of a chair is extracted from the perception of a chair and stored in memory to function later as a symbol. The form of this symbol is related perceptually to the perceptions of subsequently perceived chairs that it might represent. Similarly, the form of this symbol is related to the form of other symbols with perceptually similar referents. For example, perceptual symbols for chair, stool, and bench would be more similar to each other than would be perceptual symbols for chair, hair, and chain. Thus, perceptual symbols bear analogical relations—not arbitrary ones—to perceptions of their referents and provide guidance about the entities and events they represent.

The idea of a perceptually based symbolic system is not new. Until the early 20th century, philosophers generally believed that perceptual representations constitute the core of human knowledge (e.g., Aristotle, 4th century BC/1961; Berkeley, 1710/1982; Locke, 1690/1959; Hume, 1739/1978; Price, 1953; Reid, 1764/1970, 1785/1969; Russell, 1919/1956). During the 20th century, philosophers raised strong objections to this view, followed more recently by cognitive scientists (e.g., Dennett, 1969; Pylyshyn, 1973; Ryle, 1949; for reviews, see Kosslyn, 1980, chap. 11; Tye, 1991). The result, until recently, has been an almost complete unwillingness to view higher cognition as perceptual, thereby allowing the default amodal view to flourish. In the last decade or so, however, cognitive scientists have begun exploring perceptual views with increasing intensity. Most notably, the cognitive linguistics movement has adopted spatial symbols extensively in their treatments of semantics (e.g., Fauconnier, 1985; Jackendoff, 1987;
Researchers in other areas of the cognitive sciences have also incorporated perceptual representations into the core of their theories. In the philosophy of mathematics, researchers have incorporated spatial representations explicitly into proofs, rather than using them implicitly while pretending not to (e.g., Barwise & Etchemendy, 1990, 1991; Stennig & Oberlander, 1994). In the philosophy of science, Thagard (1992) has argued that perceptual analogy has played central roles in scientific insight. In the philosophy of mind, Peacocke (1992) has argued that some thoughts contain ineliminable perceptual representations. In artificial intelligence, researchers are increasingly finding that the use of spatial representations increases computational effectiveness significantly (e.g., Glasgow, 1993). In psychology, much work can be construed as supporting the central importance of perceptual representations in general cognition, not just in mental imagery (e.g., Gernsbacher, Varner, & Faust, 1990; Glaser, 1992; Glenberg & Langston, 1992; Glenberg, Meyer, & Lindem, 1987; Johnson-Laird, 1983; Klatsky, Peligrino, McCloskey, & Doherty, 1989; Miller & Johnson-Laird, 1976; Morrow, Greenspan, & Bower, 1987; Olseth & Barsalou, 1995; Paivio, 1986; Potter & Faulconer, 1975; Potter, Kroll, Yachzel, Carpenter, & Sherman, 1986; Potter, Valian, & Faulconer, 1977; Solomon, 1997; Wu, 1995). As a result of such findings, and also in reaction to problems with amodal symbols, psychologists are beginning to propose that the human conceptual system is inherently perceptual (e.g., Barsalou, 1993; Barsalou et al., 1993; Gibbs, 1994; Glenberg, this volume; Mandler, 1992).

Basic Assumptions

Elsewhere we have begun to develop a theory of perceptual symbol systems (Barsalou, 1993, 1997; Barsalou et al., 1993; Prinz, 1997; Prinz & Barsalou, in press). Here we summarize its basic assumptions briefly. Our goals are not to present the full theory and defend it against important concerns. Instead, we present enough of the theory to motivate an account of mundane creativity. We ask the reader to suspend judgment for the moment and to assume the core assumptions of the theory to see how mundane creativity follows. Our claim is not that this theory provides the correct account of mundane creativity. We cannot defend this claim without much further exposition. Instead, our claim is that it is possible for a theory of perceptual symbols to exhibit mundane creativity. Because it is not widely known or accepted that a perceptually based theory can produce productivity and propositional construal, we believe that it is important to demonstrate that one can. Once we establish this point, the next step will be to demonstrate that the perceptual approach provides the correct account of mundane creativity in human cognition.

Next we present the five assumptions that underlie our theory of perceptual symbols: (a) perceptual symbols are constituted by brain states, (b) perceptual symbols are schematic, (c) perceptual symbols are multimodal, (d) perceptual symbols underlie simulation competence, and (e) simulated events frame abstract concepts. After establishing these five assumptions, we illustrate how a perceptually based system of knowledge produces mundane creativity.

Perceptual Symbols Are Constituted by Brain States

It is tempting and natural to think of perceptual symbols as mental images and conscious experiences that are like physical pictures. However, we do not define them this way. Instead, we define perceptual symbols as being constituted by brain states. We assume that high-level neurons (and sets of neurons) in perceptual systems capture information about perceived entities and events at a relatively qualitative and functional level. In perceiving an object, neurons in the visual system that represent edges, vertices, geons, textures, and spatial relations become active to represent it. Similarly, in perceiving an event, neurons that represent entities, movements, spatial positions, and temporal positions become active. Thus, a perceptual symbol that represents an event or entity is constituted by a configuration of neurons that becomes active during its processing.

Although we ground perceptual symbols in neuronal representations, we assume that they may have conscious counterparts on occasion, although not necessarily. These conscious counterparts, too, have a neuronal basis, but these neuronal representations differ from those that represent the functional information defining the perceptual symbol. This distinc-
tion between conscious and functional brain states follows from both neuropsychological and behavioral evidence. Neurophysiologically, there are different sites in the brain for the functional information in perception and its conscious representation (Damasio, 1994; Kosslyn, 1994). The phenomenon of blind sight, in which a neurologically impaired individual can process a visual stimulus without a conscious experience of it, provides one sort of neuropsychological evidence. Behaviorally, it is well-known that people often process information without being conscious of it. The phenomenon of preconscious processing, in which information is obtained from an unexperienced stimulus, provides one sort of behavioral evidence.

*Perceptual Symbols Are Schematic*

The idea that perceptual symbols are schematic has a long history, beginning with British Empiricists, such as Locke, and continuing to the current time with cognitive linguists (see also Mandler, 1992). On this view, a perceptual symbol does not contain an entire perceptual state but only a very small subset of the perceptual state in which it originated. These symbols become established through a symbol formation process that relies on two basic cognitive mechanisms: selective attention and memory transfer.

In the first step of this process, selective attention focuses on some aspect of a perceptual state, filtering out other aspects to a large extent. In perceiving an array of objects, a perceiver might focus attention on the shape of one object, filter out most of the object’s other properties, and filter out the nonfocal objects as well. It is nearly axiomatic in the cognitive literature that people attend selectively to information in this manner (Shiffrin, 1988). For example, Garner’s (1974, 1978) classic work on separable dimensions indicates that people can focus on some information in perception and filter out other information to a large extent (see also Melara & Marks, 1990).

In the second step of this process, a storage mechanism transfers selected information to long-term memory. It is nearly axiomatic in the cognitive literature that where selective attention goes, long-term storage follows. Nonattended information may be stored to some extent, but clearly the most storage occurs for attended information. Such a conclusion follows from work on encoding specificity (e.g., Tulving & Thomson, 1973), transfer appropriate processing (e.g., Morris, Bransford, & Franks, 1977), and much additional memory research. In all of this work, the information selected during learning determines which retrieval cues will be effective, indicating that selection determined storage.

The result of this symbol formation process is that a large population of perceptual fragments becomes stored in long-term memory, each being a small subset of a perceptual state. Because we define perceptual states as neuronal representations, it follows that the subsets of information extracted by selective attention are neuronal representations as well. As we show shortly, these perceptual fragments function later as symbols, establishing reference to perceived entities and entering into symbol manipulation to produce productivity and propositional construal.

Because perceptual symbols are extracted from perception, their form bears a strong resemblance to the perceptual states that produced them. Furthermore, the similarity between different perceptual symbols corresponds to the similarity between their referents. Thus, perceptual symbols are not at all like the arbitrary amodal symbols that constitute amodal symbol systems.

*Perceptual Symbols Are Multimodal*

The symbol formation process just described can operate on any modality of perception. Not only does it operate on vision, but it operates on any of the other four sensory modalities as well, extracting perceptual fragments that later function symbolically. This symbol formation process also operates on proprioception and introspection, extracting perceived aspects of these experiences that constitute perceptual symbols. Because perceptual symbols can be drawn from all aspects of experience, it should be clear that we are not using *perceptual* in its standard sense. Rather than referring only to perception on the modalities, *perceptual* here refers to information extracted from any perceived aspect of experience. Although consciousness may be necessary to extract these symbols initially, it may fall away as they become familiar.

Perceptual symbols drawn from introspection are especially important to this theory. We assume that the human cognitive system is
biologically endowed to carry out various introspective tasks, such as representing entities in their absence and performing various information-processing operations on them. For example, people retrieve and compare representations, add information to them, delete information, and so forth. Furthermore, the human cognitive system is biologically endowed to represent and process various emotional and affective states, such as joy, anger, and irritation. We assume that the symbol formation process can focus attention on various aspects of these introspective states and store them away for later symbolic function. As we shall see later, such symbols are central to our accounts of abstract concepts.

Perceptual Symbols Underlie Simulation Competence
Perceptual symbols do not function as isolated “snapshots” of perceptual experience. Instead, they become organized into symbol systems that enable the simulation of entities and events in their absence. In perceiving a car, for example, perceptual symbols extracted from the front, sides, and rear, as well as from the passenger area, the engine, and the trunk, become organized spatially with respect to an object-centered reference frame. This enables the cognitive system to simulate perceiving the car in its absence. As the perceiver imagines moving around and inside the car, or as the car is imagined to turn, its physical features come into view in the appropriate spatial order. Similarly, the perceptual symbols extracted from an event are organized temporally to enable later simulations of its subevents correctly. In perceiving someone start a car, for example, the perceptual symbols extracted at each point become organized into a temporal sequence, later enabling a correct simulation.

Thus, the primary purpose of extracting perceptual symbols is to support simulation competence. Symbols are extracted and organized to provide the cognitive system with the ability to simulate, at some adequate level of competence, entities and events in their absence. The construct of simulation competence leads to a somewhat surprising definition of concepts: Having a concept is having the ability to simulate its referents competently in their absence.

We hasten to add several important qualifications to this account. First, we do not assume that simulation competence is ever complete. Instead, it is always partial and sketchy. Because the symbol formation process is schematic, tremendous amounts of information are omitted from the perceptual symbols that underlie simulation competence. Second, we do not assume that simulation competence is always accurate. Instead, it can contain errors, as when a perceptual symbol is stored incorrectly in a spatial or temporal configuration, or retrieved incorrectly from it. Third, inherent biases may underlie the construction of a simulation competence. In idealization, biases toward good form may “clean up” input that is messy or incomplete. For example, a slightly crooked and partially occluded line may be represented as straight and complete. Work on naive physics offers similar examples of such biases (McCloskey, 1983). Fourth, simulation competence is not simply a collection of “sense impressions.” Instead, innate biases select, interpret, and organize perceptual symbols during the construction of simulation competence. In a Kantian sense, innate conceptualizations of space, time, causality, objects, and events guide the extraction, interpretation, and organization of perceptual information.

Simulated Events Frame Abstract Concepts
An important challenge for perceptually based accounts of cognition is to represent abstract concepts such as truth, negation, and disjunction. We do not present our approach to representing them yet, because it relies on propositional construal, which we address later. Here we simply note the basic assumptions that we have found necessary.

Most important, abstract concepts typically cannot be represented with a single snapshot of perception. Instead, the simulation of events typically frames them (Fillmore, 1985; Langacker, 1986). Abstract concepts do not refer to these events themselves but to parts of them. Nevertheless, the entire event is necessary to give the part its meaning. As we show later, the core sense of truth is framed by a basic event sequence that involves comparing an expectation to a perception. However, truth is not the event sequence but is a quality of the expectation in it. We have also found that perceptual symbols for introspective events are central to accounts of abstract concepts. Typically, these concepts include perceived aspects of internal representations, cognitive operations, and emotional states. We return to abstract concepts later in the section on propositional construal.
MUNDANE CREATIVITY IN PERCEPTUAL SYMBOL SYSTEMS

Now that we have established the basic properties of perceptual symbol systems, we demonstrate their ability to produce mundane creativity. Perceptual symbols support productivity and propositional construal in much the same way as do amodal symbol systems. In addition, perceptual symbols exhibit variable embodiment, a consequence of not being amodal.

Productivity

Perceptual symbols lend themselves naturally and elegantly to the productive construction of complex representations. From a finite set of perceptual symbols, an indefinitely large number of more complex representations can be constructed using combinatorial and recursive mechanisms. Corballis (1991) described a similar type of generativity as arising in the left hemisphere of the brain (see also Tippett, 1992). The schematic nature of perceptual symbols contributes to their productive nature: Whereas the formation of a perceptual symbol results from a schematic reduction in the content of a perceptual state, the productive formation of a complex perceptual representation results from adding information back to a perceptual symbol systematically (other forms of productivity are possible as well, as discussed later). Because perceptual symbols are schematic, they have the potential to be embellished. Because embellishment can be combinatorial and recursive, it is productive.

Figure 1 illustrates this process. Figure 1a depicts a small set of perceptual symbols, including five objects (table, chair, lamp, box, cup) and four spatial relations (ABOVE, LEFT, BETWEEN, INSIDE). None of the depictions is a complete account of its respective concept, which we assume is represented instead by a complex system of simulation competence. A given depiction is one projection of the simulation competence for which it stands metonymically. Nor do these depictions imply that conscious picturelike images constitute perceptual symbols, which we assume instead are neuronal representations. Thus, the limited depictions of perceptual symbols in this and later figures simply serve to illustrate their key properties, not to represent their full structure. Also, in the perceptual symbols for spatial relations, the emphasized regions mark the current location of selective attention (e.g., the thicker upper region for ABOVE). Following Talmy (1983) and Langacker (1986), we assume that the operation

Figure 1
Illustration of how perceptual symbols produce productivity. (a) Perceptual symbols for objects and spatial relations. (b) Combinatorial use of perceptual symbols. (c) Recursive use of perceptual symbols.
of selective attention on perceptual symbols carries conceptual information.

Figure 1b illustrates the combinatorial nature of perceptual symbols. As the three instantiated \textit{ABOVE} relations demonstrate, simulating different objects in \textit{ABOVE}'s two schematic regions can potentially produce an indefinitely large number of complex perceptual representations, such as \textit{ABOVE(lamp, table)}, \textit{ABOVE(lamp, chair)}, and \textit{ABOVE(lamp, box)}. Because all pairs of known objects could be simulated in \textit{ABOVE}, not to mention pairs of past, future, and imagined objects, the perceptual symbol for \textit{ABOVE} is productive in a combinatorial sense.

\textit{ABOVE}'s combinatorial potential results from its schematic nature. When the perceptual symbol for \textit{ABOVE} was formed, much irrelevant information was not transferred to memory, including the particular instantiations of its upper and lower regions. Thus, its representation in memory contains no instantiations of these regions, giving them the character of uninstantiated arguments in a predicate. Later, constructive perceptual processes in imagination can add other perceptual symbols to these regions, such as those for \textit{lamp} and \textit{table}, much in the spirit of binding values to a predicate's arguments. Thus, the schematic nature of perceptual symbols underlies and enables their productivity.

Figure 1c illustrates the recursive potential of perceptual symbols. As this complex representation illustrates, the perceptual process that embellishes schematic regions in a perceptual symbol can embed perceptual symbols within perceptual symbols indefinitely. Thus, perceptual symbols for complex configurations like \textit{ABOVE(lamp, LEFT(INSIDE(cup, box), chair))} become possible. Because indefinitely large numbers of embedded relations can instantiate \textit{ABOVE}'s upper region in principle, the perceptual symbol for \textit{ABOVE} is productive in a recursive sense. Again, the schematic nature of perceptual symbols makes this possible. Because regions of perceptual symbols become “blank” through the schematization process, they can later be filled recursively.

Thus, perceptual symbols are highly productive. Because they are schematic, other perceptual symbols can be added to them combinatorially and recursively to produce an indefinitely large number of hierarchal perceptual simulations. Importantly, these embellishments of schematic regions are not limited to those experienced perceptually. Instead, the process is creative in the sense that perceptual representations never perceived can be readily constructed. For example, imagining \textit{ABOVE} relations one has never seen is trivial, including \textit{ABOVE(horse, barn), ABOVE(lamp, horse)}, and so forth.

It is also important to note that these productive processes can apply to any perceptual symbol. Because any perceptual symbol, by definition, results from a reduction in information, the types of information eliminated can later be added back systematically. Thus, perceptual symbols of all types are potentially productive, including those for objects, external events, and introspective events.

Productivity is not limited to filling in schematic regions. Productivity can also result from replacements, transformations, and deletions of existing structure in a perceptual symbol. Imagine that a perceptual symbol for \textit{door} includes a standard round knob. To represent different doors, the perceptual symbol for the standard knob could be replaced with a perceptual symbol for a drawer handle, it could be transformed to a smaller or larger size, or it could be deleted altogether. These sorts of operations appear widely available for processing perceptual symbols, extending their productivity further.

The combination of perceptual symbols is a constructive process that differs in important ways from classical models of symbol combination (see also Prinz & Barsalou, in press). Unlike formal semantics, the combination of two perceptual symbols often produces emergent features not salient for either in isolation. For example, Wu (1995) has shown that combining \textit{half} with \textit{watermelon} produces emergent properties for \textit{watermelon} not typically observed for \textit{watermelon} alone. Because cutting a watermelon in half exposes its inside, individuals describe the inner parts of a \textit{half watermelon} at much higher rates than for \textit{watermelon} alone. This finding, and others in Wu's work, strongly implicates perceptual representations in the noncompositional effects that occur frequently for conceptual combination. Langacker's (1987) notion of accommodation provides another example of how combining perceptual symbols produces emergent features.
Combining the perceptual symbol for *run* with the perceptual symbol for *human*, *deer*, or *robin* produces perceptual features of running not salient for each agent in isolation. As these examples illustrate, the emergence of features during the combination of perceptual symbols violates the strict compositionality associated with classical semantics. Nevertheless, the combination of perceptual symbols exhibits the fundamentally important sense of compositionality: Perceptual symbols can be combined productively to form more complex representations that are coherent and interpretable.

Finally, complex perceptual representations are not holistic, because they contain simpler perceptual symbols as parts. Thus, complex representations are richly structured, containing components, relations between components, and nested substructures of components and relations. A complex perceptual representation never becomes a holistic representation that loses this structure, because the components and relations that constitute it remain linked to the established perceptual symbols in memory that spawned them during productive computation. In other words, the tokens of perceptual symbols in a complex representation retain their individual identities, with the original perceptual symbols providing construals of them. This is one of the many possible forms of propositional construal possible with perceptual symbols, a topic we address next at greater length.

**Propositional Construal**

Perceptual symbols readily support propositional construal. The perceptual symbols that underlie concepts can selectively describe different aspects of a perceived situation, and they can construe a single aspect in multiple manners. The mapping of a perceptual symbol into some aspect of a perceived situation constitutes a construal of the situation that represents its gist and has a truth value. Essential to this ability is the use of multiple perceptual representations that map into each other, similar to Fauconnier’s (1985) treatment of mental spaces.

**Type-Token Construal**

As we just saw for productivity, established perceptual symbols in memory can become bound to aspects of a complex perceptual representation during productive computation. Established perceptual symbols underlie such bindings in many other contexts as well. In construing a perceived situation, for example, established perceptual symbols become mapped to entities, events, and relations in it. Because an established perceptual symbol resides in a simulation competence, it belongs to the representation of a concept. Thus, mapping an established perceptual symbol into a perceived entity construes the entity as an instance of the concept, or in alternative terms, as a token of the type.

These type-token relations constitute propositional construals for two reasons: First, establishing different type-token relations in a situation produces different construals of it. As is illustrated in the upper left portion of Figure 2, the situation might be construed on one occasion as containing a lamp (Figure 2a). On a different occasion, however, it might be construed as containing a table (Figure 2b). The same situation is con-

![Figure 2](image_url)

**Figure 2**

Illustration of how perceptual symbols produce propositional construal. (a) Mapping a perceptual symbol for *lamp* into a perceived lamp grounds the proposition that the situation contains a lamp. (b) Mapping a perceptual symbol for *table* into a perceived table grounds a different proposition that the situation contains a table. (c) Failure to map a perceptual symbol for *chair* into the situation grounds the false proposition that the situation contains a chair.
strued differently on these two occasions, because different aspects of the same situation are bound to different perceptual symbols. As Figure 2c illustrates, these construals exhibit truth values. Because a perceptual symbol for chair cannot be mapped into anything perceived in the situation, it is a false construal. In contrast, the construals in Figures 2a and 2b are true, because perceptual symbols for lamp and table can be mapped into perceived aspects of the situation. In this manner, attempting to map perceptual symbols to aspects of a situation produces propositional construals of it, some true and some false.

Once a successful mapping is established from a perceptual symbol to an aspect of a situation, the simulation competence that underlies the perceptual symbol provides a wealth of inferential information about the aspect. If a perceived entity is construed as a dog, the simulation competence for dog licenses possible inferences about it. If the dog is sitting still, it could be simulated as barking, wagging its tail, leaping, and so forth. Thus, establishing a type-token relation can result in a powerful construal of the token that goes considerably beyond what is perceived literally.

The second sense of propositional construal—a different construal of the same aspect—also emerges naturally from the binding of perceptual symbols to tokens. As Figure 3 illustrates, one construal of the perceived situation on the left is that the lamp is above the table. As Figure 3 further illustrates, however, another construal is that the table is below the lamp. By applying the perceptual symbol for either ABOVE or BELOW to the same aspects of the situation, two different construals result. Again, such construals have truth values, with the ability to establish them successfully determining truth. Both construals in Figure 3 are true, because ABOVE and BELOW can each be bound successfully to the situation. The same perceptual information is represented, but attention is focused on it differently.

Like productivity, the schematization of perceptual symbols underlies propositional construal. Recall that the schematization of a perceptual symbol results from eliminating most aspects of a perceptual state while maintaining a small subset. If the same information is dropped from two different perceptual symbols, it can be added back to both during their subsequent processing. Because the same information is added back to two different perceptual symbols, it is construed differently in each. Thus, the upper regions of both ABOVE and BELOW can become bound to the lamp in Figure 3, because objects in general have been eliminated from the upper region of each during their acquisition.

**Abstract Concepts**

As described earlier, abstract concepts are framed against simulated event sequences that often include propositional construal. Now that we have introduced propositional construal, we can present our approach to representing abstract concepts. Unlike cognitive linguists (e.g., Lakoff & Johnson, 1980), we do not represent abstract concepts indirectly through metaphor but represent them directly with respect to the events that frame them (Barsalou et al., 1993).

We use the abstract concept of **truth** to illustrate our approach. Note that **truth** is a polysemous concept with many meanings and that we only attempt to represent one of these, namely, the psychological (not logical) understanding of what it means for a proposition to be true. We assume
that the following event sequence frames this sense of truth: (a) An agent simulates a nonpresent situation. (b) The agent enters the situation and compares the simulation to it. (c) The agent discovers that the simulation matches the situation. For example, an agent might simulate a situation as containing a lamp above a table (Figure 4a), enter the situation (Figure 4b), and determine that the simulation matches the perceived situation (Figure 4c). On establishing the match, the agent might say, “It’s true that there is a lamp above a table.” We propose that the event sequence in Figure 4 grounds the meaning of “true” in this sentence. “True” does not refer to the sequence in its entirety but to a quality of the simulation that it frames, namely, that the simulation matches the perceived situation. As this example illustrates, an event sequence frames the concept of *truth*; this sequence includes introspective states and operations (e.g., comparison), and it includes propositional construal (i.e., the simulation construes the perceived situation).

The abstract concept of *disjunction* similarly involves these three mechanisms. Consider Figure 5, which represents a core sense of disjunction. Again, an event sequence frames the concept. In the first subevent, an agent perceives a room that contains a chair, lamp, and table (Figure 5a). Subsequently, the agent tries to recall the room (Figure 5b), remembers the chair and table, but cannot remember what was between them. Using reconstructive memory (Figure 5c), the agent alternatively simulates two possible entities that could have instantiated this region, namely, a lamp and a coat rack. While performing this alternating simulation, the agent might say, “There could have been a lamp or a coat rack between

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**Figure 4**

An account of one sense of *truth* using perceptual symbols. (a) Productive construction of a propositional construal. (b) A perceived situation. (c) Successful mapping of the construal into the situation results in attributing the quality of *truth* to the construal.

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**Figure 5**

An account of one sense of *disjunction* using perceptual symbols. (a) A perceived situation. (b) A later attempt to recall the situation, failing to remember the middle entity. (c) Disjunctive simulation of two reconstructed entities in the middle region.
the chair and table." We propose that the meaning of "or" in this sentence is grounded in the event sequence. "Or" does not refer to the sequence in its entirety but to the alternating instantiations of its middle region. Again, an event sequence frames the abstract concept, and it includes introspective states (alternating insertion) and propositional construal (of the remembered situation).

Ad Hoc Categories

In achieving goals, people often construe entities functionally to enable goal achievement (Barsalou, 1983, 1985). According to one account of this process (Barsalou, 1991), an agent first retrieves an event frame for achieving a goal, with the frame containing schematic slots for roles such as agents, objects, instruments, locations, times, and so forth. To implement the frame successfully, these slots must be bound to entities in the environment, while satisfying constraints and optimizing ideals. To perform this instantiation process, the planner searches through a world model for possible specializations of each slot, which together constitute an ad hoc category. For example, the possible instantiations for the location slot of the vacation frame constitute the ad hoc category of places to go on vacation. Other ad hoc categories associated with other slots in the vacation frame include times to vacation, things to pack in a suitcase, transportation to the airport, and so forth.

Through propositional construal, perceptual symbol systems can construe an entity as belonging to multiple ad hoc categories. Figure 6a illustrates a simple room that contains a chair, a door, and a ceiling lamp. Figure 6b represents, in a highly schematic manner, a perceptual simulation of the event sequence, prop a door open with a physical object. Each frame in this series represents one subevent of the sequence. Because the slot, heavy object used to prop a door open, is a schematic region in the subevent, it can be instantiated with the perceptual symbol for an appropriate entity, such as the chair in the room. In Figure 6b, we assume that the perceptual symbol for chair has been inserted into the key schematic region of this simulation, such that a chair is simulated as propping the door open. On other occasions, a table may serve this function, or a floor lamp.

Figure 6c alternatively construes the chair as something to stand on to change a light bulb. Here, the agent simulates changing the light bulb in the ceiling lamp of Figure 6a. Because multiple objects have served this goal in the past, this region of the simulated event sequence is schematic, indicating that it can be instantiated in multiple manners. On previous
occasions, ladders and stools may have instantiated this region. In this particular case, however, the chair instantiates it.

As these examples illustrate, the same entity can be construed in a wide variety of ad hoc manners. By simulating perceptual symbols for the entity in schematic regions of different event sequences, it acquires different construals. Thus, a chair can be construed as *something to prop a door open with* or as *something to stand on to change a light bulb*, depending on the perceptual simulation in which it is embedded. Because most entities can be embedded in many such simulations, they can be construed in many possible ways. Most important, embedding perceptual representations of objects within perceptual simulations of events underlies such construal. This analysis leads to a perceptually based definition of ad hoc categories: An ad hoc category is a set of entities that disjunctively instantiates the same schematic region of a perceptually simulated event sequence.

**Variable Embodiment**

According to the functionalist perspective in modern cognitive science, the symbolic system that underlies human intelligence can be disembodied. Once we characterize the computational properties of this system successfully, we can implement it on computers and a potentially wide variety of other physical systems as well. Furthermore, the same basic symbolic system operates in all humans, independent of their biological idiosyncrasies. In general, functionalism implies that the computational system underlying human intelligence can be understood independently of the human body. Similar to characterizing computer software independently of the particular hardware that implements it, the human symbolic system can be characterized independently of the biological system in which it is embodied (for proposals of this view, see Putnam, 1960; Fodor, 1975; and Pylyshyn, 1984; for critiques, see Churckland, 1986, and Edelman, 1992).

The discrete referential nature of amodal symbols lies at the heart of modern functionalism. To see this, consider the relations in Figure 7a between different forms of the word “chair” and its referent, the picture of a chair at the top of Figure 7b. As Figure 7a illustrates, the word “chair” can be doubled in size, it can be rotated 30° counterclockwise, and it can be cut in half. In each case, however, the transformation implies nothing different about the pictured chair in Figure 7b. Doubling the size of the word “chair” does not mean that the actual chair is twice as large. Rotating “chair” 30° does not imply that the chair is rotated 30°. Cutting “chair” in half does imply that the chair is cut in half. These examples illustrate that words refer discretely. Because words bear no structural relations to their referents, structural changes in them mean nothing for structural properties in their referents. As long as the conventional link between a word and its referent remains intact, the word refers to the referent in exactly the same way, independently of transformations on the symbol.

Because amodal symbols refer in essentially the same manner as words, they refer discretely as well. It is this discrete property of amodal symbols that makes functionalism possible: Regardless of how a particu-

![Figure 7](image)

Illustration of variable embodiment. (a) Examples of how transformations on words and amodal symbols do not imply different meanings. (b) Possible meanings of the symbols in Panels a and c. (c) Examples of how transformations on perceptual symbols imply different meanings (i.e., variable embodiment).
lar amodal symbol is realized physically, it can still serve the same computational function. As long as the symbol plays the same functional role in a computational system, it can be implemented in humans or computers, and it can take idiosyncratic forms in different individuals. Physical variability in the form of the symbol is irrelevant, as long as it maintains the same conventional links to the world, as well as the same syntactic relations to other amodal symbols.

Perceptual symbols behave much differently. In direct contrast to amodal symbols, variability in the form of perceptual symbols has semantic implications (cf. Goodman, 1976). As Figure 7c illustrates, the perceptual symbol for chair can be doubled in size, it can be rotated 30°, and it can be cut in half. In each case, the transformation implies a change in the referent (Figure 7b). Doubling the size of the perceptual symbol for chair implies that the chair doubles in size, holding factors like depth constant. Rotating the perceptual symbol for chair 30° implies that the chair is rotated 30°. Cutting the perceptual symbol for chair in half implies that the chair is cut in half. These examples illustrate that perceptual symbols refer continuously. Because they bear structural relations to their referents, structural changes in the symbols imply structural changes in their referents, at least under many conditions.

It is the continuously referring nature of perceptual symbols that makes their embodiment critical: Differences in how a perceptual symbol is realized physically can change how it functions computationally. Implementing a perceptual symbol in a human body may produce different computational behavior than implementing it in a computer. Indeed, implementing human symbols in computers may be impossible, to the extent that computers do not share crucial physical properties with humans (e.g., Glenberg, this volume; Johnson, 1987; Lakoff, 1987). Similarly, the same perceptual symbol implemented in different human individuals may function differently, because of idiosyncrasies in individuals’ perceptual systems.

Variable Embodiment as Mundane Creativity

We propose that the variable embodiment of perceptual symbols plays important adaptive functions in human cognition, constituting a third type of mundane creativity. We can think of at least two useful functions that variable embodiment might play in natural intelligence: First, variable embodiment allows individuals to adapt the perceptual symbols in their particular symbolic systems to their specific environments. Imagine that different individuals consume the same species of plants and animals as food, but consume somewhat different varieties, because they live in different locales. Through repetitive encounters with their respective foods, these different individuals develop somewhat different perceptual symbols to represent them. Because perceptual symbols naturally exhibit variable embodiment, variations in their referents become represented as variations in embodied symbols. The result is the development of somewhat different symbolic systems, each tuned optimally to its typical referents.

Variable embodiment plays a second useful function as well: Variable embodiment ensures that different individuals can match their perceptual symbols optimally to their perceptions. For example, it is well documented that individuals from the same culture differ in the detailed psychophysical structure of their color categories (Shevell & He, 1995; Smith, Pokorny, & Starr, 1976). As individuals establish perceptual symbols for colors, these symbols exhibit the peculiarities of their respective color systems. Thus, if one individual represents color categories in a somewhat idiosyncratic manner, his or her perceptual symbols will reflect this structure, such that they will be optimally tuned to match subsequent perceptions of color. In using color to perform categorization, for example, optimal accuracy will occur, because the perceived colors of referents will match the stored colors in perceptual symbols.

Because humans vary in all phenotypic traits to some extent, there is good reason to assume that they vary in all the perceptual discriminations that could be extracted into perceptual symbols, not just color. If so, then variable embodiment allows the human symbolic system to adapt itself naturally to variability in perceptual systems. In contrast, such adaptability is not in the spirit of the functionalist view. Because this view rests on amodal symbols that bear no structural relations to their referents, it neither anticipates nor naturally handles individual variability in perceptual systems.
Variable Embodiment and Concept Variability

Variable embodiment provides an explanation of between-individual and within-individual variability in human concepts (Barsalou, 1987, 1989, 1993). When different individuals' concepts of the same category are measured on a given occasion, there are usually substantial differences. Similarly, when one individual's concepts of a category are measured on different occasions, there are again robust differences. Variable embodiment offers one account of conceptual variability: Different individuals represent the same concept differently, because their perceptual symbols developed in somewhat different perceptual systems and have become tuned to somewhat different environments. A given individual represents the same concept differently over time, because his or her perceptual symbols have adapted themselves to the changing environment. In these manners, conceptual variability may reflect the adaptive functions that variable embodiment attempts to optimize.

Symbolic Commonality

We have illustrated how variable embodiment allows for substantial inter- and intra-individual variability. This variability must be complemented by commonality, which raises the question of how different individuals establish common ground in the perceptual symbols they form. There are a number of answers to this question from the perceptual perspective. The first involves the internal commonalities delivered by evolution. For all of the differences among individuals, there are many more similarities. Because human biology endows all people with roughly the same perceptual system, this guarantees a high degree of similarity in the perceptual symbols they construct. Although variable embodiment may tune these systems in important ways, the amount of tuning may be relatively small compared with the amount of shared structure.

A second source of commonality appeals to external factors. Not only do people share similar cognitive mechanisms, they also populate similar physical and social environments. Despite the large variance in climate and terrain, all regions of the planet follow the same physical laws. Moreover, all humans are exposed to similar kinds of things: conspecifics, animals, plants, water, inanimate objects, and so forth. These environmental commonalities result in a common base of perceptual experiences. Similarities in culture also ensure cognitive commonalities. Shared languages, customs, and values are made possible by cognitive commonalities, but they also reinforce and proliferate such commonalities. A culture can direct the attention of its members toward certain objects. Once an individual’s attention has been directed to those objects, it is more than likely that he or she will form perceptual symbols for them. Thus, the commonalities in the symbols people construct are as much a product of culture as they are a prerequisite.

A third source of commonality is a direct consequence of how perceptual symbols are formed. Earlier, we noted that perceptual symbols are schematic. As a result, they may omit the details that distinguish one member of a category from another, and they may produce representations that are qualitative, not metric. This bias has two assets: The first is the frequently cited point that qualitative representations allow an individual to identify objects that differ in detail as members of the same category (e.g., Biederman, 1987). The second asset, much less noted, is that qualitative representations enable uniformity across individuals. If two people live in different parts of the world that have no species of bird in common, they might still form similar bird concepts, because many species of birds can be categorized using the same qualitative perceptual symbols. In this way, the schematic character of variably embodied symbols promotes inter-individual commonality.

CONCLUSION

Our primary agenda in this chapter was to demonstrate that it is possible to construct perceptual symbol systems that exhibit the desirable properties of amodal symbol systems while avoiding their problems. Thus, the perceptual symbol system that we propose exhibits productivity, propositional construal, and the ability to represent abstract concepts. In addition, it accounts naturally for symbol formation and symbol grounding, while suggesting a third type of mundane creativity, variable embodiment.
We are the first to admit that we need a strong empirical case for this view, although we believe that significant evidence already exists. Our goal, however, has not been to defend perceptual symbol systems empirically. Instead, our primary purpose has been to demonstrate that, theoretically, perceptual symbol systems can produce mundane creativity. If we can convince cognitive scientists that perceptual symbol systems are serious contenders theoretically, we have achieved our goal.

Before closing, we return to our earlier distinction between mundane and exceptional creativity. On the one hand, these two types of creativity could reflect fundamentally different cognitive mechanisms. On the other, both could reflect the same mechanisms, with exceptional creativity reflecting a greater use of them. Our deep appreciation of mundane creativity biases us toward the latter alternative, which is the one we explore here. If exceptional creativity involves a greater use of the mechanisms that underlie mundane creativity, how might this greater use be realized? At least three aspects of perceptual symbols may be relevant: higher numbers, greater subtlety, and more generality.

Having higher numbers of perceptual symbols than average may be associated with exceptional creativity. As a person extracts more perceptual symbols from perception, the productive ability to combine them grows exponentially. For example, if each perceptual symbol can be combined with every other, then the number of possible combinations grows with $2^n$. Obviously, not all combinations are possible. Nevertheless the space of possible combinations grows dramatically as new perceptual symbols become available. The more perceptual symbols people know, the more likely they are to create novel combinations that lead to exceptionally creative acts. Of course, many combinations are not useful (Ward, Finke, & Smith, 1995), but if the proportion of creative combinations is a constant, then the number of creative combinations grows with the number of perceptual symbols.

The subtlety of perceptual symbols constitutes a second factor that could enable mundane creativity to produce exceptional products. Imagine that biology, culture, and language induce most humans to extract similar sets of perceptual symbols. As a result, the perceptual symbols that enter into most combinations are familiar, although these combinations may be mundanely creative to the extent that they involve “reshuffling” familiar symbols in novel ways. In contrast, when someone perceives subtle structure in perception and introspection that most people do not, the perceptual symbols extracted to represent it could subsequently produce combinations that contain unusual perceptual symbols. To the extent that a person extracts many nonsalient symbols from experience, the creative acts that reflect them may be viewed as increasingly exceptional.

The context independence of perceptual symbols constitutes a third factor that could enable mundane creativity to produce exceptional products. Imagine that most perceptual symbols are highly domain specific. Once a perceptual symbol has been extracted, its subsequent referents in the world may constitute a relatively narrow class of individuals, namely, those in the domain from which the symbol developed. In contrast, imagine that a person establishes perceptual symbols that can be mapped much more broadly into referents across domains. The ability to extend a perceptual symbol more broadly than average could be construed as a form of exceptional creativity. In a scientific sense, it could also imply a “deeper” understanding of the world. Rather than understanding each domain locally in terms of its own symbols, different domains are understood in terms of common symbols.

The more we explore perceptual symbol systems, the more impressed we are with their powers. Creativity is no exception. From the mundane to the exceptional, there is a story that can be told with perceptual symbols.

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