4 Meaning, Mental Attention, and the Symbolic Function

This chapter introduces signalic and symbolic meaning (semiotics) and analyzes from a dialectical constructivist perspective the functional characteristics of meaning and signs. We examine three dimensions of variation (i.e., signalic vs. symbolic, arbitrary or indexical vs. iconic, figurative or representational vs. operative or procedural) and investigate emergence of these dimensions within organismic schemes, which first occurs at about 12 months of age. Discussions of meaning refer to Peirce, Cassirer, Saussure, Piaget, and von Uexküll. Mental-process task analyses of signs (both signals and symbols) give metatheoretical (epistemological) and evolutionary reasons for these dimensions of variation. We explain ontogenetic development of the semiotic functions (signalic, symbolic) in humans and discuss their presence in problem solving of chimpanzees.

> Meaning is a decisive factor in nature; it appears always, often in novel and surprising ways.
> —J. von Uexküll, 1982, p. 77

> Meaning is *invisible*, but the invisible is not the contradictory of the visible: the visible itself has an invisible inner framework, and the in-visible is the secret counterpart of the visible, it appears only within it.
> —Merleau-Ponty, 1968, p. 215

> [T]he course of human knowledge leads from [intuitive] "representation" to "signification," from the schematism of perception to the symbolic grasp of pure relationships and orders of meaning.
> —Cassirer, 1940/1996, p. 111

In chapter 3 we suggested that infants' transition from perception to higher cognition is made possible by growth of mental attention, of more complex schemes, and emergence of the symbolic function. Because this function is often unexplicated but is essential for high cognition, we will now explain semiotic processes—the organismic generation of signs (i.e., signals and symbols).

Meaning is a decisive experiential factor in animals, whose organisms carry meaning via information-bearing brain processes that are largely learned, context-sensitive, and organized in flexible hierarchies (heterarchies). To help clarify meaning in the organism one should adopt *metasubjective*[1] units applicable at different levels of meaning-defining hierarchies. Organismic schemes/schemas are an example of such units. Schemes satisfy the basic reflective-abstraction properties of G. Miller, Galanter, and Pribram's (1960) TOTE (Test-Operate-Test-Exit) units and can explicate developmental growth in complexity processing with age. Scheme units can dynamically coordinate into more complex systems, which could be seen as organismic analogs of probabilistic computational production systems and related methods.

Classic learning theorists have adopted a meta-empiricist approach (a sophisticated outsider's perspective), failing to propose a workable psychological unit. The exception was Tolman (1959), a great precursor of cognitive learning. Tolman thought of these units as means-end-readinesses ($s_1r_js_2$, i.e., stimulus$_1$ & response$_j$ $\rightarrow$ stimulus$_2$, which can be assimilated to our operative schemes). He contrasted these units to representational units of the form $s_1 - s_2$ (stimulus$_1$ <*connects to*> stimulus$_2$), which, in our terms, are empiricist precursors of figurative schemes. In the TCO we adopt schemes, or schemas, as basic information-carrying psychological system-units (which logically correspond to self-propelling *semantic-pragmatic conditionals*—conditional to situational antecedents).

Piaget (Apostel, Mays, Morf, & Piaget, 1957) defined the *meaning of an object* as constituted by all schemes that can apply to it, plus all schemes that cannot. Related definitions were offered independently by Peirce (founder of modern semiotics—the science of signs) and von Uexküll (precursor of modern ethology). The constructs of sign and symbol often are seen as externally identifiable or interpreted and as incarnate or embodied within the interpreter's organism. A *sign* is something whose presence, in the mind of an interpreter, stands for (intends or announces) something else. A *symbol* is a conceptually explicit or implicit functionally detached sign. Cognition should be grounded on organismic/brain processes intertwining cognition with affect and motivation. However, the "cognitive revolution" of the mid-twentieth century, with its pure (decontextualized and organismically disembodied) cognition, failed to do so. It produced signs/symbols and structures that are purely abstract, decontextualized, and *amodal* (Barsalou, 2008)—amodal in the sense of excluding all modalities and modes of processing that intervene in an actual contextualized communication among subjects/interpreters, or *within* subjects.

Using Morris' (1946) distinction between *semantics* (relations between signs and their referents/objects), *syntactics or syntax* (relations among signs), and *pragmatics* (relation between signs and their use by interpreters), we can clarify a key difference between amodal and modal signs/symbols: whereas amodal ones are focused on syntactics and some semantics, *modal signs/symbols* emphasize pragmatics and semantics (Apostel, 1967) and can be interpreted as schemes. Within a constructivist developmental framework, pragmatics functionally contributes/causes semantics and syntax, because it expresses activity of interpreters. To explain pragmatics, however, one needs a general theory of action/praxis (Apostel, 1967). Our theory of schemes and cognitive operators is one such theory of semantic-pragmatics.

We proceed to review some epistemological (meta-theory of knowledge) reasons for making signs and their science necessary for a deeper understanding of cognitive processes. Readers interested only in signs as products of psychological organizations may wish, on first reading, to skip this section and go to the next section.

Meaning and the Ways of Signs

As discussed in chapter 2, Plato's problem (Pascual-Leone, 1996b) consists of his having recognized two distinct forms of knowing: the world of sensorial/experiential becoming (world of things) versus the world of beings (world of forms or conceptual ideas), although he was unable to explain how the latter emerges from the former. The former refers to "bottom up" (i.e., purely experiential) knowing and the latter to "top down" (i.e., conceptual) knowing. The modern problem is to explain how conceptual knowing emerges from experiential learning via constructively abstracting across situations. This issue remains a problem for cognitive psychology and neuroscience as much as for philosophy. Kant (1929/1965; Jaspers, 1962) gave us a more sophisticated version of the same basic distinction when he talked of three forms of knowing: intuitive sensibility, understanding, and reason. *Sensibility* refers to contact with the concreteness of experience, which is organized by the "pure forms" of space and time (in current neuroscience, the dorsal versus ventral prewired brain networks). Kant's sensibility corresponds to Plato's world of becoming. Kant's second and third ways of knowing, understanding and reason, jointly refer to Plato's world of being or ideas. *Understanding* is Kant's name for intelligent perception and local intellection. *Reason* is his name for truly high cognitive processes, which attempt to fully integrate sensibility and understanding with memory of past experiences and creative imagination (fully rational or intellectual processes). Schelling and Hegel (Beiser, 1993; Lukacs, 1978) criticized Kant for having a problem. They thought that sensibility, understanding, and reason, being radically different modes, could not be integrated unless they shared a common functional substratum (i.e., in the current view, shared organismic/neuronal characteristics). This common substratum would underlie an equivalence or "identity" between the subject (interpreter or agent of understanding/reason) and the object (source of sensibility—the experiential-input processes of the subject). This sort of "identity" (which for Hegel made possible the viable or true knowing of objects) can be explained in a current idiom by referring to Peirce's iconic and indexical functions (Apel, 1995; Buchler, 1955; Johansen, 1993), as discussed below. Advanced semiotics, the science of symbolic signs (pioneered by Peirce, Saussure, Cassirer, Vygotsky, Piaget, and others) is very important to comprehend communication in high cognition and help to clarify Plato's problem.

Let us examine what Hegel meant by "identity" of subject and object. Subject and object of knowledge maintain a dialectical "identity" relation with each other, because they maintain an informational correspondence. In our terms, a subject's initial experience of an actual object is expressed by specific encountered resistances (affordances or encumbrances/obstacles) manifest when the subject interacts with the object. *Informational correspondence* is expressed by either of two functional characteristics that may underlie Hegel's obscure concept of subject-object "identity." (1) The *iconic function* (Peirce's *icon*) is obtained when a subject's sign (a representation token, perhaps an object, sound, or figural unit) has some important aspect like, or resembling[2] in its configuration, the intended object's appearance (the referent). For instance, a photograph or a portrait is an icon sign (iconic representation) whose configuration reflects important aspects of the object as experienced by the subject. This iconic function explains why a referent often can be spontaneously recognized in, for example, a photo or painting. As Peirce claimed, images, diagrams, and metaphors (among others) are icons by the same relational definition. (2) Peirce called *index*, *indices*, or indicators another sort of informational correspondence. According to Peirce,

> indices may be distinguished from other signs, or representations, by three characteristic marks: first, that they have no significant resemblance to their objects; second, that they refer to individuals, single units, single collections of units, or single continua; third, that they direct the attention to their objects by blind compulsion. … Psychologically, the action of indices depends upon association by contiguity and not upon association by resemblance or upon intellectual operations (Buchler, 1955, p. 108).

Two Main Semiotic Functions

Thus, for Peirce, there are two organismic functions: the iconic (association by resemblance or similarity, due to stimulus-response compatibility or *F*-factor pattern matching) and the indexical, which produces indices (due to association by contiguity, associative learning). The two together explicate Hegel's dialectical concept of subject/object "identity." Both iconic (similarity) and indexical (associative) functions stem from a nonlogical but experiential active bias in the subject. Subjects tend to notice (be biased toward) what is relevant for their agency or praxis, and what is pragmatically relevant is highlighted and made salient. The subject's current purposive activity designates what is relevant in "informational correspondence" alignments. Driven by agency/praxis, a common dynamic substratum (shared brain processes) interconnects the cognitive representations (and the indexical function) to the subject's sensorial/perceptual experience of objects (and the iconic function). Hence, emergence of high cognition from low cognition becomes possible (e.g., objects, procedures—progressively more complex at various levels), which eliminates Plato's problem. The brain's organismic-functional characteristics and connectivity that a subject's top-down cognition and bottom-up sensorial perception share account for Hegel's "identity" of subject and object. Subjects automatically construe objects and procedures appropriately for their agency and survive. A signaling system alone, functionally independent from agency/praxis (goal-directed activity addressed to the environment) would not work. As Jorna (1995, p. 236) said, representation not only involves "standing for" but also "interpreting as" or "interpreting within" a given sort of agency or praxis.

Heinz Werner formulated in psychology his *orthogenetic principle* with the same idea. Werner and Kaplan (1984, p. 7) described this principle: "[D]evelopment is a constitutive moment of organismic functioning. We assume that organisms are naturally directed toward a series of transformations—reflecting a tendency to move from a state of relative globality and undifferentiatedness toward states of increasing differentiation and hierarchical integration" (geared toward agency/praxis). This orthogenetic principle serves to "characterize development as distinct from other types of change over time" (Werner & Kaplan, 1984, p. 7). The orthogenetic principle assumes with neuroscience that our organism is very active—endogenously driven to adaptation, development, and growth, via flexible hierarchies (heterarchies) that a symbolic function makes possible. Such adaptive tendency converges with Piaget's optimizing equilibration and his reflective abstraction, concepts discussed in chapter 1.

Major qualitative-functional differences exist between initial levels of processing (perceptual sensibility, low cognition) and more advanced levels of processing (understanding, high cognition, reason). Such differences (in the view of Cassirer, 1940/1996, and others) are largely due to the functional difference between signals (meaning-bearing processes functionally attached to their intended referent) versus symbols (meaning-bearing processes functionally detached from their referent). We discuss these two sorts of signs below.

Why is the symbolic function important? In addition to play, imitation, and dreams there are four major psychological processes that the symbolic function enables: (1) emergence of language; (2) reflective abstraction (i.e., progressive structural integrations that begin from concrete/intuitive cognitions to create symbols progressively referring to more complex and abstract knowledge, with wider scope of applicability); (3) executive processes, which anticipate the future and prospectively organize behavior to serve plans and expected future outcomes; and (4) effective communication, objective, subjective, and intersubjective, even when language is not used (e.g., gestures, drawings).

Signs as Products of the Working Mind

Peirce (Buchler, 1955; Johansen, 1993) thought that objects of knowledge are cognitively grasped and re-presented to the person's own mind by way of signs.[3] For Peirce, a sign (which we designate as **SGN**) is the product of a habit, that is, a durable mental coordination (often a complex scheme or schema—a functional structure) made of four meaning-generating constituents. (**SGN 1**) First is the *token-sign* itself or *sign vehicle*, which Peirce called "representamen" (Saussure called it "signifier"; Nöth, 1990), often manifested in acts of communication as when the French word "homme" is uttered or written as signifying man. (**SGN 2**) Second is the *context* or *ground of meaning* for which the token sign stands; Frege called it "sense" and Saussure called it "signified." An example is the awareness that "homme" is a given word with meaning in the French language. Frege's example is the morning star and the evening star, which express the same referent (the planet Venus) using two different contextual senses or grounds of meaning. (**SGN 3**) Third is the *referent* or actual *object* for which the sign stands; in the case of "homme" a two-legged rational animal, and so forth. (**SGN 4**) Finally, the *semantic operative* or *functor* (the operative process generating the semantic function) coordinates the meaning of the three previous constituents to combine them into a single semantic-pragmatic entity, that is, the meaning of man in the example given.

Peirce's concept of a semantic "ground" seems to refer to the operative process of the semantic/semiotic function or to the sense (or context) of meaning. Indeed, Johansen (1993) pointed out that Peirce often collapsed our constituents **SGN 2** and **SGN 4** into a single term called *interpretant*. This triadic relationship among sign (or symbol), its referent/object, and their interpretant (or interpreted meaning, i.e., semantic operative plus context) often is emphasized in semantic logic. According to Peirce, what enables an *internal-meaning sign* to function as interpretant of another *external sign* is the equivalence of representative functions that relate each of the signs ("homme" and "man" in our example) to the referent/object (Johansen, 1993); this is the subject-object "identity" in Hegel's sense that we have discussed. Thus, *semiotic function* can be seen as triadic, although, its formulation in terms of the four SGN-terms just given is much more revealing in cognitive development.

Cassirer (1944/1966) emphasized that symbol is a sign without unique (fixed or rigid) meaning, the sign remaining semantically detached from both its referent and its context, so that meaning can change with a change in context, and so on. For instance, when a baby begins to use language, one of the first words he or she learns is "mom," which is used in relation to the mother (Pascual-Leone, 1995, 1996a; Pascual-Leone, Escobar, & Johnson, 2012; see figure 4.1). At first, the sign in question is not a symbol but rather a signal, that is, an intuitive sign that is attached to its referent or context. Thus, the uttered "mom" sign has a fixed meaning irrespective of context. For instance, if the baby learned to say "mom" as the mother tried to feed baby, the sign in question may have the fixed meaning of "feed me"; if learned in the context of playing, this sign may have acquired the meaning of "raise me in the air," and so on. At this point the infant may be 8 or 9 months. When the child grows older, after 12 months of age,

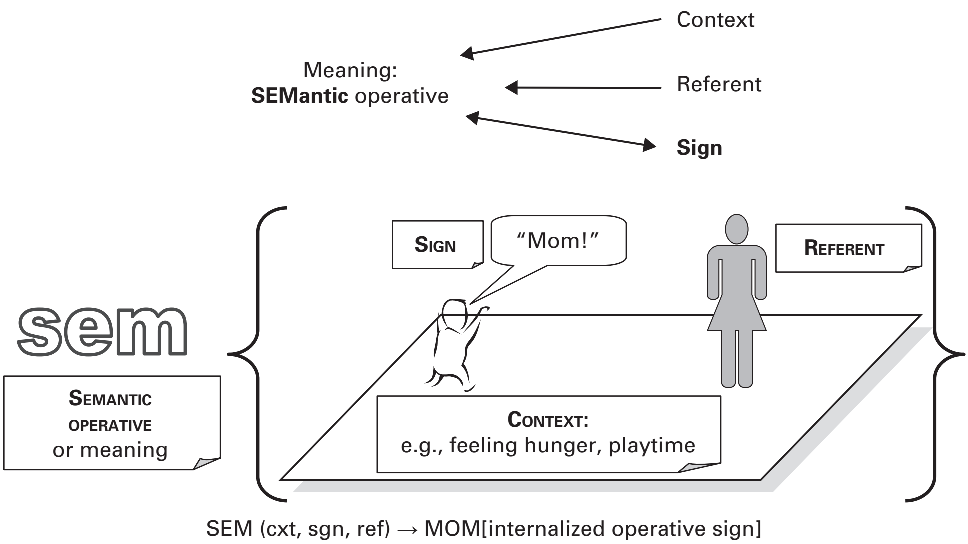

Figure 4.1
Schematic representation of constituents in a sign with illustrative example of baby calling his or her mother. (From Pascual-Leone, J., Escobar, E. M. R., & Johnson, J. [2012]. Logic: Development of logical operations. In W. Hirstein [Ed.], *Encyclopedia of human behavior* [2nd ed., p. 539]. Elsevier. Copyright 2012 by Elsevier.)

the sign "mom" will have changed into a symbol, carrying the meaning of "feed me" in the context of feeding, but the meaning of "raise me in the air" in the context of playing, and so on.

Notice that symbols and signals, if compatible, can replace each other as functional processes. However, as Cassirer (1940/1996) pointed out, signals and symbols often may contradict each other, creating misleading situations. For instance, under emotional stress or with habitual practice, symbols can functionally turn into signals. When an anxious, panic-prone person hears the shout, "Fire!" inside a movie theater, he or she may not take it as a symbol suggesting the possibility of actual fire but rather may take it as a signal and run in panic to the door. Whereas a symbol conveys a possibility (for instance, "perhaps there is a fire in the theater"), a signal conveys the actuality here and now of its referent.

There is a vast literature on signs/semiotics that we need not review, since Nöth (1990) and other excellent books have done so. Instead we attempt to generalize some basic concepts from the literature with a fourfold classification table for the main sorts of signs. Our classification has emerged by taking seriously the idea (in various ways assumed by Peirce, von Uexküll, Cassirer, Saussure, Piaget, and others) that there are different sorts of signs, ontologically and developmentally, that differ in terms of the brain processes they demand. Drawing on Peirce and Cassirer's terminology, we distinguish four fundamental kinds: *iconic function, indexical function, signalic function, and symbolic function*. Before presenting this fourfold table, we shall discuss further the last two.

As illustrated in figure 4.2, we distinguish between two semiotic functions (Pascual-Leone, 1996a; Pascual-Leone & Johnson, 1999). The signalic function (signals) appears early in development, and we share it with lesser animals. The symbolic function first appears in children at about 12 months (Pascual-Leone, 1995, 1996a), and we share it, in simple versions, with other primates (Russon, Bard, & Taylor Parker, 1996; Tomasello & Call, 1997). In terms of cognitive processing, these two semiotic forms are very different. Signals can be produced by just one organismic scheme (a neural circuit, functioning as meaning-bearing processing unit), in which the scheme's *releasing conditions* carry the token-sign (**sgn**), which becomes a cue when it matches a suitable feature(s) or aspect(s) in the input situation. The scheme's *effecting component* carries the set of effects resulting from the scheme's application to or assimilation of the situation. Finally, the scheme's *functional component* embodies the gist of the scheme's functioning, and it often carries a semantic intention (intentionality) toward the signal's referent (**ref**), anticipating the scheme's application outcome. Signs result from application of individual schemes, and signalic meaning is the consequence of initially applying

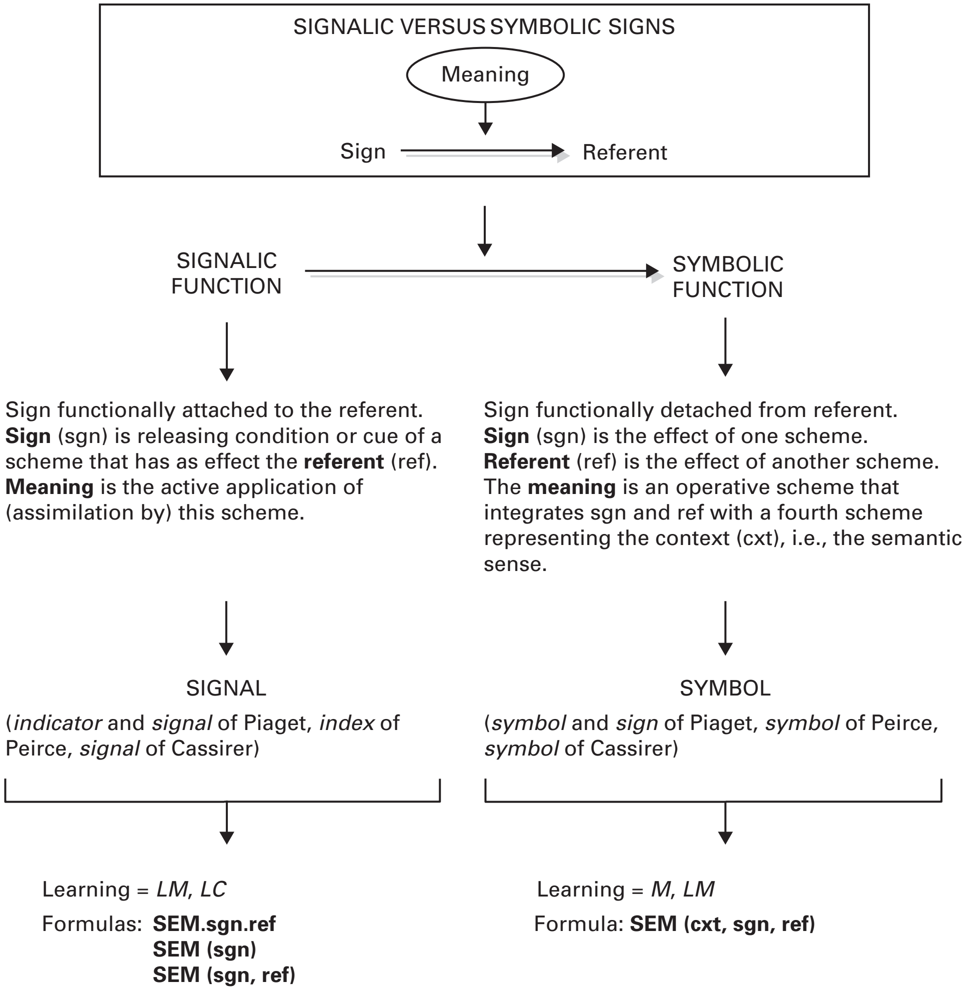

Figure 4.2
Signalic versus symbolic signs.

just one scheme. The learning of signals is largely the product of associative learning, which we call *content* (*C*) *learning* when it is simple and not relational. We call it *LC* learning (*Logical*-schemas resulting from automatizing *C* learning) when it includes more or less complex schemes or schemas (Pascual-Leone & Goodman, 1979; Pascual-Leone & Johnson, 2005, 2011).

When fully automatized, such a signalic scheme is a coordinated logical system or "package." We could represent it as <**SEM.sgn.ref**>, to indicate that the three essential sensorimotor aspects of the sign (i.e., its semantic functor **SEM**, its token sign **sgn**, and its referent **ref**) are all packaged or chunked within the same scheme. This is the case only when the signal is fully automatized, however. When it is not automatized, two or three sensorimotor schemes (plus mental attention and associative learning, to coordinate them) may be necessary to learn the signal. A two-scheme signal could be represented as <**SEM(sgn)**>. A more flexible three-scheme signal could be represented as <**SEM(sgn, ref)**>. Notice that these formulas cannot stand for symbols, because a semantic context (**cxt**) that carries the sense (ground or local/specific meaning) of the sign is not included. Unlike symbols, in signalic schemes the intended specific meaning is fixed and cannot change with the situation.

Although not yet symbols, signals that use three coordinated schemes offer considerable functional complexity. A brief illustration of such complexity was exhibited by our cat, Misty. When I (JPL) would arrive home in the evening, Misty was already waiting for me, having heard my steps. When I entered the house, Misty rushed toward the stairs to the basement, where I fed him customarily on arrival. Usually Misty would stop midway down the stairs, looking behind to see whether I was following. Clearly three distinct schemes are involved here. Misty acted *as if* he would have learned a flexible rule or invariant performance pattern, such as, when I enter through the door (this is the **sgn**), Misty will be fed in the basement (this is the **SEM**) when I reach the basement (I am initially **ref**, but Misty's food becomes **ref** of the complex feeding scheme once Misty and I have reached the basement). Only by flexibly coordinating the three schemes could Misty achieve such a clever performance. This is not yet a symbol, but it is close. We call it a *protosymbol*.

Consider now the symbolic function and its symbol unit. Current use of the concept of symbol (Nöth, 1990) can be demarcated by four functional characteristics, of which the first suffices to have a symbol unit (**SYM**): (**SYM 1**) the symbol/sign is functionally detached from its referent and context; (**SYM 2**) it is conventional; (**SYM 3**) it is generically abstract; and (**SYM 4**) it is motivationally driven by affects. The four together clearly differentiate symbols from signals. For instance, when a symbol-processing 18-month-old baby calls "Mom," the sign's meaning can change with the context (**SYM 1**). A symbol is conventional (**SYM 2**) in that it often is related to its referent by way of more or less arbitrary associative links with contextual schemes (e.g., "connection rules" shared and adopted, tacitly or explicitly by all interpreters, e.g., the flag as a symbol of a nation, the math parameter Pi as symbol of the ratio between circumference and its diameter).

This is not always the case, however: iconic symbols relate first via similarity. Peirce, who emphasized only the cognitive-associative aspect of symbols, insisted on their conventional and rule-governed aspect (e.g., "the signification I attach to it, that of a conventional sign, or one depending upon habit"; Buchler, 1955, p. 113). A symbol is generically abstract (or general, **SYM 3**) in that it usually corresponds to a class (or type) of "objects" and has many distinct particular referents that are equivalent in terms of the symbol's meaning (or semantic dimension—highlighted by the purposive activity that the symbol supports or relates to, e.g., "food," "writing").

Consider again the characteristic **SYM 1** of functional detachment (which Cassirer, 1944/1966, emphasized). In principle, every symbol (symbol etymologically means "thrown together with") is semantically pointing to a set of possible individual referents and not just one of them. Thus, we should define symbol as a semiotic sign in which the token sign (or sign vehicle) is functionally detached from its current referent. We know that a sign is functionally detached from its referent when the meaning attributed to the symbol changes with the context (as already illustrated with the baby-Mom example). Such functional detachment of the symbol's meaning is often called "situated" or with "context sensitive" meaning (e.g., Pribram, 1971). It generates true conceptual thinking (at times called mediation or reflective abstraction), which explains why these symbolic representations give mobility and cross-situational generality to thought (often constituting mental operations).

Simple (not complex—not compound, nor hierarchically organized) schemes are functionally indivisible processing units (embodied in basic meaning-bearing neural circuits—Pascual-Leone & Johnson, 1991, 2005, 2011). For this reason, when a single simple scheme (perhaps a single neural circuit) carries simultaneously the semiotic meaning, the referent, and the context of a token sign, these parameters must remain functionally fixed as constituents; consequently these semiotic units function as signals. It follows that to have symbols (whose meaning or sense changes with the given context-situation) organisms must carry the various semantic constituents in distinct coordinated schemes. Symbols emerge when four distinct schemes can function in coordination, each carrying either a semantic operative (SEM) or one of its semantic parameters (token-sign, context, or referent).

We can represent in a semantic formula the symbol's semantic scheme as follows: <**SEM(cxt: sgn: ref)**>. **SEM**, a semantic operative scheme, coordinates three dimensional parameters: context/sense (one or several sense values), token-sign, and referent (one or many values). Each parameter is detached in a different categorial scheme. This separation ensures that each specific (actual or real) context can elicit the appropriate sense (the context-relative specific meaning) corresponding to the given referent. Together these four distinct semantic components (functionally integrated into a complex—superordinate—semantic scheme) produce the flexible semantic functioning typical of symbols.

To illustrate how this formula for symbols can be used in a concrete task analysis, consider the pretend-play symbolic imitation of "talking by phone," which children may practice after 12 months, and more often between 18 and 24 months. Reinecke and Fogel (1994) describe an example. To paraphrase their account: Hannah's mother had tried for some time, without success, to get her daughter to pretend-play talking by phone. But one day, when Hannah was beyond 12 months of age, she spontaneously picked up the phone and offered it to her mother. Her mother took the phone, put it to her ear, and said, "Hi, Grandma!" Hannah smiled and reached for the phone; she put it to her ear (first time she did that) and said, "Ha-o!" Hannah looked and again offered the phone to her mother for some more pretend talk. This observation illustrates well a symbolic act of deferred imitation. Notice that imitation is largely driven by innate affects—a disposition to imitate well-liked persons in the surround, parents in particular (this may be an innate root of intersubjective communication—see Nadel, Guerini, Peze, & Rivet, 1999; Trevarthen, Kokkinaki, & Flamenghi, 1999).

When we apply to this case our formula for symbols (see figure 4.3), the semantic operative (SEM) appears as an operative scheme induced by positive affect: a TALK-to-people-BY-PHONE scheme. Context or sense (cxt) of this operative is the representational scheme *play-with-mom. As usual, we symbolize operative schemes by writing them in capitals, and figurative/representational schemes by writing them in lower case preceded by *. The token-sign (sgn) is the figurative scheme *visual.object/seen.

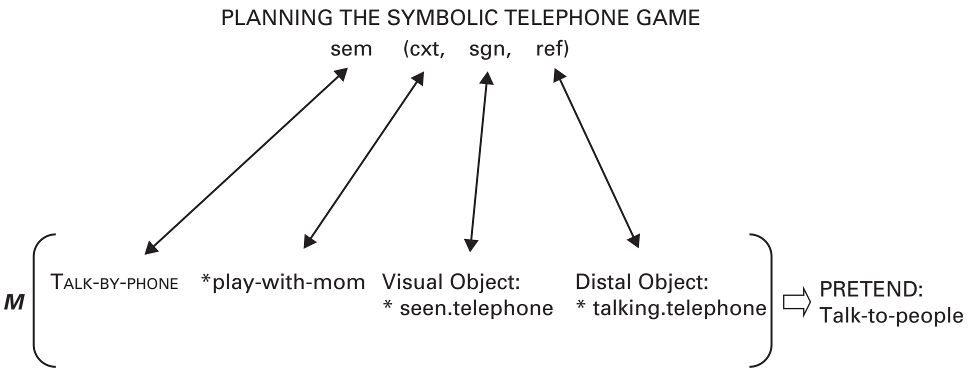

Figure 4.3
The telephone game. Paraphrase of Reinecke and Fogel's (1994) observation:
At about 12 months (*Me* = 4) Hannah picks up the phone and offers it to her mother. Her mother takes the phone, puts it to her ear, and says, "Hi, Grandma!" Hannah smiles and reaches for the phone; she puts it to her ear (first time she does it) and says, "Ha-o!" Hannah looks and again offers the phone to her mother for more pretend talk.

telephone. The referent (ref) is the representational scheme *distal.object/talking.telephone. Notice that one must distinguish between proximal object (here visual) and distal object. An *object* is an entity or "package" of Reality resistances (represented by a complex representational/figurative scheme), which appears in cognition in a given context and is a probabilistic invariant. This object-invariant is a coordination of two sorts of schemes (e.g., actions, perceptions): (1) *positive schemes* that could assimilate or apply to the "package" of possible resistances elicited by the given real object and (2) *negative schemes* that cannot assimilate these resistances. The latter schemes demarcate the distal object in question and make it more clearly distinct. Such definition is a paraphrase of the meaning of an object as formulated by Piaget (Apostel et al., 1957). It is similar to Peirce's (Apel, 1995; Buchler, 1955) and to J. von Uexküll's (1982) object meaning. As discussed in chapters 2 and 3, a proximal object is the object-invariant that emerges in the context of purely perceptual processes (here and now). A distal object is the object-invariant that emerges in the context of intentional activity across situations, where one's own actions encounter invariant resistances, often to be controlled or eliminated while pursuing intended goals.

There is another distinct source of often unconscious meaning that a distal object (or distal act) can elicit: the affective or affectively loaded personal/emotion schemes elicited by (or seeking expression in) the object. Following Jung's terminology in a very liberal manner, we call these strong unconscious schemes *shadow schemes* to highlight their frequent unconscious presence, and perhaps haunting expression, particularly within psychosocial or emotional situations. A shadow scheme relevant to the present talk-by-phone example is the one presented below in formula **f2**. This is a baby's compelling scheme of exploring a small object by taking it to his or her mouth. Such shadow scheme makes it hard for the baby to synthesize the pretend play "talking by phone," unless she or he has enough mental attention (*Me*-capacity). Shadow schemes contribute much to the individual's personal style and the form or content of art and literature. Notice that these shadow schemes often are signals under our definition, although as the subject becomes aware of them, they could evolve into symbols.

Using this terminology, the symbolic formula for the pretend play of "talking by phone" can be stated thus:

TALK-BY-PHONE (*cxt*: *play-with-mom, *sgn*: *seen.phone, *ref*: *talking.phone) **(f1)**

According to this model, the child must be able to coordinate simultaneously four distinct sensorimotor schemes to understand the pretend game and thus have the idea of playing. Mental attention grows with chronological age in children, as described in chapter 3. Simultaneous activation with mental attention of four distinct sensorimotor schemes cannot occur before 12 months of age; three such schemes can be activated at about 8 months, but not before (Alp, 1988, 1994; Benson, 1989; Pascual-Leone & Johnson, 1991, 2005). In this way we explain why flexible signals (<**SEM (sgn, ref)**>) are not often found before 8 months; and the symbolic function begins in most children at 12 months. This developmental timing is well recognized in the literature, but it remains without explanation, which we have now provided.

Having dynamically synthesized in her mind (via some concrete instances) the mentally real equivalent of this symbolic formula, the child can have the idea to pretend-play talking with her grandma. But actual implementation-in-action of this idea (or executive plan) requires other schemes as well. Notice that such implementation is hindered (interfered with, i.e., dialectically contradicted) by a misleading factor: the affect-driven (*A*) habit of exploring physical objects by taking them to the mouth—an overlearned shadow-scheme automatism of children at this age, which is strong at 8 months and earlier. The corresponding formula for this *misleading factor/strategy* is:

EXPLORE.PHYSICALLY^{A}(*sgn*: seen.phone, *ref*: solid.phone) ➔ phone-in-mouth **(f2)**

To shorten the formulas, henceforth we eliminate the * in front of figurative schemes. This formula corresponds to a flexible signal as described earlier, which induces the child to explore the phone physically and take it to her mouth. This signal, which initially demands simultaneous activation of three schemes, becomes automatized and turns into a habit. Notice that in this formula, after the arrow, we represent the performance that results, via overdetermination, from the schemes' application. When the resulting scheme is automatized, it does not use mental capacity. A habit such as mouthing the phone creates a misleading situation for babies who would try to produce the symbolic performance: this habit interferes with implementation of the plan "talking to grandma." Symbolic processing, which ensures that all necessary distinct schemes are separately boosted with mental attention, is then needed to overcome the interference. When this is done, a symbolic performance emerges, which we model as follows (Pascual-Leone, 1996a):

TALK-BY-PHONE^{L,A} ({#GRASP.TAKE-TO}$_{L,A}$ (*where*: ear, *subject*: baby/mother, *distal.object*: talking.phone)) ➔ phone-at-ear-talking **(f3)**

In this formula the baby, following an operative TALK-BY-PHONE partly boosted by affect (superscripted *A*) and already overlearned as a logical-structural procedure (superscripted *L*), moves (GRASP & TAKE TO) the telephone to the ear for talking. This operative scheme (i.e., GRASP.TAKE-TO) functions here as an operative parameter (#) of TALK-BY-PHONE and is already overlearned and chunked with the main operative, indicated by the subscript *L, A* matching the superscript of the logical-structural procedure. Activation of the main operative scheme transfers automatically to its overlearned subordinate operative parameter. Thus, the total number of distinct sensorimotor schemes to be boosted with mental attention (to ensure production of the overt response "place **phone-at-ear** and begin **talking**") is four at most, which makes mental demand of implementing this task the same as the demand (shown before) of planning the gist of the task and its executive. Although there has been much research conducted on play and imitation, there does not seem to be a developmental organismic theory that explains, as our model does, growth of imitation and play induced by maturational growth of the child's mental attention. In this sense the model we have just outlined fills a gap in the literature.

The misleading-factor (shadow scheme) strategy created by the three schemes for taking the phone to the mouth (see formula **f2**) is an interference factor that can be overcome by boosting with mental attention the task-relevant strategy, made up by four other schemes. Because the four *M*-boosted schemes in this symbolic strategy are stronger as a functional totality than the three misleading automatized schemes (which concurrently are being interrupted by attentional inhibition), the relevant symbolic strategy dominates and applies resolving the conflict situation. This conflict resolution illustrates how all organismic schemes apply locally and compete for application when a situation offers suitable releasing features, which is why effortful symbolic processing must be used. Indeed, signalic/intuitive experiential processing tends to bear on salient elements of a situation, whereas symbolic processing tends to deal with more complex aspects that involve coordination of scheme units from both the situation and long-term memory.

Semiotic Relations and Cognitive Processing

We have discussed four semiotic functions: iconic, indexical, signalic, and symbolic that can be crossed to generate types of signs. Table 4.1 presents the resulting fourfold semiotic table. We use *sign* as the general name or generic designation for all types of semiotic relation. This is the generic extension of a term found in Peirce, von Uexküll, and Cassirer, although this denomination is not universal (for instance, Piaget used the term *sign* to denote what our table calls *conventional* or *symbolic indexical* sign). The columns of table 4.1 present two semiotic modes (signalic vs. symbolic) bearing on the degree of a sign's functional detachment from its referent. The rows present two modes (iconic vs. indexical) bearing on degree of configural relation (iconicity versus lexicality) between sign and referent.

Table 4.1
Signs: Fourfold table of semiotic relations

	SIGNALIC FUNCTION: Functionally attached; Cassirer's signal sem (sgn) Mechanism: *C, LC, S, T, F, E*	**SYMBOLIC FUNCTION:** Functionally detached; Cassirer's symbol sem (cxt, sgn, ref) Mechanism: *M, LM, I, F, E*
ICONIC FUNCTION: configural relation; Peirce's icon Mechanism: *SOP, F, E*	**configural signal** (perception) Peirce's icon Saussure and Piaget's motivated sign	**universal symbol** poetic symbol Freudian/Jungian symbol Piaget's "symbol" Saussure's motivated symbol Peirce's iconic symbol
INDEXICAL FUNCTION: arbitrary/non-configural relation Mechanism: *C, LC, LM, I, E*	**arbitrary signal** (Pavlov) Piaget's "indicator" Peirce's "index"	**conventional symbol/sign** much of language, logic, math Piaget's "sign" Peirce's "symbol"

To each of these four semiotic functions corresponds a distinct way of processing information. In the case of signalic processing the main mechanism is associative learning: both content-based learning (*C* learning) and logical-structural (relational) learning caused by automatization (Hebb, 1949/1961; Pascual-Leone & Goodman, 1979; Tolman, 1959), which we call *LC* learning. For instance, consider our cat, Misty, discussed before: he had learned with practice to interpret as cue my entering the house through the main door. This cue (largely via *C* learning) served to anticipate that Misty was about to be fed in the basement, an expectancy acquired via *LC* learning. Other mechanisms may intervene in the emergence of signals, such as executive processes (the *E* organismic factor), the spontaneous spatial and temporal structuring of information (what we call *S*- and *T*-factors—occipito-parietal and occipito-temporal cortical processing), or Gestalt-field saliency (*F*-factor). Iconic examples of signalic processing are, for example, the marks of steps in the snow, a photo, or the standard sign for a ladies' washroom. Examples of arbitrary signals are the sound of rain at the window's glass, or smoke as sign of fire, or the bell of mother calling for dinner (when it evokes thoughtless hunger and desire to go to eat).

In the case of symbols (symbolic function) organismic mechanisms are mostly problem-solving acts via mental-attentional activation (working memory processing), which we call *M*-processing, accompanied by a logical-structural learning that is enabled by this *M*-processing, which we call *LM* learning. However, other mechanisms such as executive processing (*E*-operator), attentional inhibition or interruption (*I*-operator), or Gestalt-field saliency (*F*-operator) may also intervene.

The iconic function of Peirce (which generates icons—i.e., configural or perceptually "motivated" signals or symbols) occurs because of the brain's disposition to express/adjust itself, in cortical processes of representation or action, to the configural/relational characteristics of sensorial/perceptual input processes. By *configural signals or symbols* we mean signs that in their own structural constitution express configurally (i.e., are *in-formed* by, in the sense of "injecting form into") some salient or overriding structural aspects of the referent or input-situation itself (as perceptually represented). For instance, when we refer to a configuration of points in the data graph as a "cloud of points," the term *cloud* is used as an icon configurally expressing actual arrangement of points in the page (as synthesized in perception).

We think that iconic processing, whether in language (e.g., metaphors) or cognitive performance (e.g., mimetic representation, imitation, dancing to music), is made possible by what Gestalt psychologists and others have called internal field effects, which we call *F*-operator/factor (also known as simplicity or "minimum" principle of representation and as "stimulus-response compatibility"; Hochberg, 1964; Pascual-Leone, 1989; Proctor & Reeve, 1990; see chapters 1 and 3). If compatible, schemes may apply together to codetermine the ongoing process or performance. Other organismic factors such as mental attention (*M*-operator) or executives (*E*-operator) possibly intervene in this semiotic function. Iconic symbols (at times called universal symbols, because they can be understood without prior learning) are illustrated by experiences captured in linguistic descriptions such as "the sunset of life," "dawn of civilization," or "cloud of points" mentioned. Every metaphor, verbal or not, has as its kernel an iconic symbol.

Finally, the indexical function, formulated by Peirce in contrast to the iconic, is the product of associative learning (*C* and *LC* learning), although factors already mentioned in chapter 1 (e.g., *M, LM, I, E, SOP*) may also be relevant. There are two distinct products of the indexical function: *indexical signals* (often called arbitrary or conventional signals) and *indexical symbols* (often called conventional signs or arbitrary symbols). Examples of arbitrary indexical signals include, as mentioned, the sound of rain on the window or smoke as sign of fire. Examples of arbitrary indexical symbols are a country's national flag, the number of stars in a hotel's rank, the key to the city that exceptional visitors might receive from the mayor, or the bell of mother calling for dinner (only when it evokes mother's love, the dinner table, or mother's demand not to be late for dinner, and so on).

Because the two semantic dimensions of variation in table 4.1 (degree of functional detachment vs. degree of iconicity between sign and referent) can be crossed, we obtain the four main ways of semiotic processing: *configural* motivated *signals*; *arbitrary* or indexical *signals*; *universal*, configural, motivated *symbols*; and *conventional symbol* or *sign*. The four types result by combining compatible processing mechanisms for each semiotic mode. For instance, universal configural symbols may result from the combined use of *M*, *LM*, *SOP*, and *F*. Signalic processing often is referred to as mental *habits,* useful in facilitating situations, whereas symbolic processing may be described as *mentations* or metacognitions, thinking, mental mediations, or problem solving (particularly in misleading situations).

Complex systems of signs may be combined into *mental models*. These models may stand for complex entities of reality (e.g., universities, airports, cities, transportation organizations—internalized *figurative* or *object models*) or for complex blueprints of action (internalized *operative* or *executive models*). They are also found as mixed models, combining these two aspects (e.g., *causal models*). Symbolic models often are organized in levels of relational representation (levels of reflective abstraction) that become progressively more abstract.

A different important sort of symbol that our fourfold table does not include is the *personal* (i.e., cognitive *and* affective) symbol. When personal symbols are complex and strongly boosted by affects, they may generate spiritual, *numinous symbols* that clinical depth analysts, and in particular Jung (Campbell, 1971), have emphasized. Such numinous symbols could be explained by powerful unconscious "packages" of compatible and complex personal (affect-driven) schemes. They may be universal expressive symbols produced unconsciously by our brain's innate organization, which all humans share, as the brain encounters and reacts to many existential categories of situations that we all encounter. Because the symbolic function is universal in humans, the resulting expressive (perhaps numinous) universal symbols should be similar across humans for different cultures.

Notice, however, that the essential aspect of symbols is that they have their sign-token, referent, and meaning functionally detached and contextualized. It does not matter much for cognition whether the symbols are expressive, universal, or numinous. And because this detachment and contextualization is brought about by mental attentional syntheses, any animal whose brain processes resemble ours, and has enough mental attention, could exhibit symbolic processing. This is the case of the other high primates.

Symbolic Function in Chimpanzees

Preschoolers and older children produce anticipatory symbolic processing, and so do our biological cousins, adult high primates. However, mental processes of nonhuman primates lack mobility, reversibility, and combinability, relative to preschoolers, perhaps because the mental-attentional capacity of apes only compares to that of

26-to-35-month-old humans. The following discussion is adapted from Pascual-Leone (2006).

Consider the chimpanzees' use of multiple tools (hammer-stone, anvil-stone, wedge-stone to stabilize the anvil) for cracking nuts, discovered by Matsuzawa and Yamakoshi (1996; Pascual-Leone, 2006; Yamakoshi, 2004). The logic of action in this behavior includes two nested functional components. First is an operative scheme (PLACE) for positioning the nut (*nut-food) on the anvil stone (*anvil) during nut cracking. Second is another operative (CRACK) that uses the hammer-stone (*hammer) as tool and the nut as target (*nut-target). Although the schemes *nut-food and *nut-target refer to the same actual object (same semiotic *referent*), in our method of task analysis they are distinct schemes. This is because they belong to different *context*s of use and thus have a different sense—distinct functional activities or practical skills (this rule is an application of postulate of schemes **Sch4** given in chapter 5). To crack a nut, chimpanzees must coordinate simultaneously six sensorimotor schemes:

<u>CRACK</u> (*<u>hammer</u>, <u>*PLACE*</u> (*<u>anvil</u>, *<u>nut-food</u>), *<u>nut-target</u>) **(f4)**

First the chimpanzee, with the intent (*operative expectancy*) to crack the nut, places the nut-food on top of, and supported by, the anvil. Then, always maintaining the nut in place, he cracks the nut by using the hammer-stone. This is symbolic processing. The situation is misleading (e.g., prior habit-schemes should lead chimpanzees to take the nut to their mouth and ignore the stones), and so performance requires chimpanzees to boost all relevant schemes with endogenous mental attention (*M*), and inhibit or interrupt (*I*-operator) interfering scheme habits. Specifically, six distinct schemes must be simultaneously boosted in activation using mental attention. This is the most complex symbolic coordination of schemes that great apes seem capable of (six or seven perceptual-motor schemes), which places them on par with the mental attentional capacity of 26-month-old or 3-year-old children (Pascual-Leone & Johnson, 2005; see chapters 3 and 7).

This example of problem-solving performance shows chimpanzees' symbolic anticipatory processing, as well as their limitation. Processing is essentially perceptual-motor, cued by facilitating situations, and somewhat lacks mobility. Once habits are formed, great apes have a hard time in overcoming them within misleading situations. Although it is a sensorimotor symbolic operative coordination, this performance marks the peak ceiling of their symbolic processing. Lack of more mental-attention capacity (which includes both *M* and *I*) prevents them to produce more complex and hierarchically deeper mental symbolic processing. In contrast 2- or 3-year-old children, who achieve equally complex symbolic processing, are just at the start of their symbolic-complexity growth ladder, which in due course brings them to the symbolic-processing ability of human adults.

Conclusions

We have shown how signs can be signalic or symbolic. High primates, and particularly humans, are symbolic because they have enough mental attentional capacity to synthesize symbolic schemes. This symbolic function opens cognition to *intentional mentation*, the capacity of the working mind for analysis and agency in future and possible problems. This working mind creates the psychosocial and sociocultural domains, as well as domains of arts and science. But this is beyond the scope of this book.

Because meaning and signs are unavoidably constituted by schemes, the next chapter examines in more detail organismic schemes, their development via dialectical-constructivist learning, and their expression in performance.

The Working Mind

Meaning and Mental Attention in Human Development

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