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Title
The Neuroscience of Form in Art

Permalink
https://escholarship.org/uc/item/12s3q5k9

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Publication Date
2006

Peer reviewed
The theory of form in art presented here rests on the Cog Hypothesis: There are neural structures in the sensory-motor system that are “secondary” in the sense that they are connected neurally to “primary” neural ensembles that are more directly involved in either perception or movement. An obvious example would be premotor cortical structures that carry out highly structured complex motor actions via connections to the primary motor cortex, which controls simple actions. When the premotor-to-motor connections are inhibited, the secondary premotor circuitry can function as a “cog”—it can still compute complex patterns that permit inferences and can evolve over time. Such patterns can structure what we see as form in art. Many kinds of cogs have been hypothesized and each type corresponds to an aspect of form.

The idea for this chapter came from observations by Rudolf Arnheim (1969) in Visual Thinking. Though Arnheim could not supply the neural underpinnings for a general and explanatory theory, he nonetheless had many of the basic ideas. I first turned to Visual Thinking in 1975, after hearing a lecture at Berkeley by Leonard Talmy on primitives of spatial relations. In English, for example, spatial-relations terms include the prepositions (on, in, through, etc.). Talmy, looking at many languages, had concluded that no two languages convey exactly the same range of spatial relations in their words and morphemes. However, spatial-relations concepts can be decomposed into universal cognitive primitives that recur across languages.
For example, consider *on* in a sentence like “The glass is on the table.” Here the meaning of *on* is a composite of three primitives: *above, contact,* and *support.* That is, the glass is above the table, in contact with it, and supported by it. Not every language has the complex concept that we express by *on,* but every language appears to have those three primitives. We call those primitives *image schemas.* Consider another example: “Harry walked through the kitchen into the dining room.” The meaning of *into* consists of two primitives: a *container—that is, a bounded region in space—and a path,* with a *source* and a *goal.* The complex image schema for *into* consists of a *path schema* and a *container schema,* where the *source* of the path is in the *exterior of the container* and the *goal of the path* is inside it.

The Talmy idea, shared by others such as Ronald Langacker (1990), Susan Lindner (1981), Claudia Brugman (1981), and Eugene Casad (Casad and Langacker 1985), is that these primitives are not concrete images that you can see, but “schemas”—cognitive structures that fit many scenes that you *can* see. Thus, a room fits a *container* schema, and so does a cup, as does a forest. Moreover, the image schema is imposed by a viewer, as when you are thinking of bees swarming in a garden. There is no physical container that the bees are in, but we can impose a mental one. Image schemas, I shall argue, give form to art.

When I began to work on this chapter, I went back to the copy of Arnheim that I had read in 1975 and looked at the dog-eared pages. I was in for a surprise. I date my own understanding of the phenomenon of metaphor to 1978. Yet here, reading Arnheim in 1975, I had marked the following passage: “What makes language so valuable for thinking, then, cannot be thinking in words. It must be the help that words lend to thinking while it operates in a more appropriate medium, such as visual imagery” (pp. 231–32).

In the next section, “Words Point to Percepts,” Arnheim (1969) continues:

The histories of languages show that words which do not seem now to refer to direct perceptual experience did so originally. Many of them are still recognizably figurative. Profundity of mind, for example, is named in English by a word that contains the Latin *fundus,* i.e., bottom. The “depth” of a well and “depth” of thought are described by the same word even today, and S. E. Asch has shown in a study on the metaphor that this sort of “naïve physics” is found in the figurative speech of the most divergent languages. The universal verbal habit reflects, of course, the psychological process by which the concepts describing “nonperceptual” facts derive from perceptual
ones. The notion of the depth of thought is derived from physical depth; what is more, depth is not merely a convenient metaphor to describe the mental phenomenon but the only possible way of even conceiving of that notion. Mental depth is not thinkable without an awareness of physical depth. Hence the figurative quality of all theoretical speech, of which Whorf gives telling examples:

I “grasp” the “thread” of another’s arguments, but if its “level” is “over my head” my attention may “wander” and “lose touch” with the “drift” of it, so that when he “comes” to his “point” we differ “widely,” our “views” being indeed so “far apart” that the “things” he says “appear” “much” too arbitrary, or even “a lot” of nonsense!

Actually, Whorf is much too economical with his quotation marks, because the rest of his words, including the prepositions and conjunctions, derive their meanings from perceptual origins also. . . . [H]uman thinking cannot go beyond the patterns suppletable by the human senses. (pp. 232–33)

Arnheim did not have the whole theory of conceptual metaphor by a long shot. He did not have systematic conceptual mappings that preserve inferential structure, nor did he have image schemas and the neural system that defines them. But he did have a basic understanding of metaphor as conceptual, not merely linguistic, and of the conceptual as based on the perceptual.

What is most remarkable to me in retrospect is that Arnheim did have the idea that structures like image schemas give form to art, and that metaphors apply to image schemas in paintings, to give meaning to paintings. Let’s start with three examples from Arnheim. The first is his analysis of Rembrandt’s Christ at Emmaus (1648, Musée du Louvre; see http://theartful mind.stanford.edu):

In Rembrandt’s Christ at Emmaus, the religious substance symbolized by the Bible story is presented through the interaction of two compositional groupings. One of them is centered in the figure of Christ, which is placed symmetrically between the two disciples. This triangular arrangement is heightened by the equally symmetrical architecture of the background and by the light radiating from the center. It shows the traditional hierarchy of religious pictures, culminating in the divine figure. However, this pattern is not allowed to
occupy the center of the canvas. The group of figures is shifted somewhat to the left, leaving room for a second apex, created by the head of the servant boy. The second triangle is steeper and more dramatic also by its lack of symmetry. The head of Christ is no longer dominant but fitted into the sloping edge. Rembrandt’s thinking strikingly envisages, in the basic form of the painting, the Protestant version of the New Testament. The humility of the Son of God is expressed compositionally not only in the slight deviation of the head from the central axis of the otherwise symmetrical pyramid of the body; Christ appears also as subservient to another hierarchy, which has its high point in the humblest figure of the group, namely, the servant. (p. 269)

Let’s translate Arnheim’s commentary into the language of cognitive linguistics. A grouping is the imposition of a container schema, a bounding of a region of space with figures contained within. Arnheim describes two such schemas, one without the servant boy and one with him. In the inner container schema, Christ is in the center and highest. The metaphors interpreting this arrangement are important is central and divine is up. Not only is Christ, the divine, the highest, but he is looking up, toward the divine God. In the upper grouping, the servant boy appears. He is painted as being in the middle of an action, serving Christ food. This puts him socially below Christ, but Christ is painted as below him, the metaphor being humility is down. The same metaphor interprets the structure of the servant boy’s body: he is bowing, tilting his body down toward Christ, showing his humility. The action of serving Christ food is metaphorical for serving Christ. The light emanating from Christ instantiates one of our culture’s basic metaphors for God: God is the source of what is good, in this case the source of light, which is interpreted via two conventional metaphors: morality is light and knowledge is light. The image schemas structuring the painting are orientational: high-low, two container schemas, two center-periphery schemas, and light-dark. Our conventional cultural metaphors apply to these schemas structuring the painting, to give it a meaning expressing an important aspect of the Protestant religious tradition: The ordinary person serves Christ in all humility, while Christ, the most important figure as the source of goodness and knowledge, sets the example, showing his own humility relative to people, and looking upward to God.

Arnheim’s point is that form is not just form; metaphors apply to forms to give meaning. Form is therefore a vehicle for inference, and the content of the inference depends on the metaphor.
Let us turn now to one more of Arnheim’s examples: Jean-Baptiste-Camille Corot’s *Mother and Child on the Beach* (John G. Johnson Collection, Philadelphia). Arnheim compares this painting with Henry Moore’s 1934 *Two Forms* (The Museum of Modern Art; see http://theartfulmind.stanford.edu for both). Arnheim includes a line drawing (his figure 73a, p. 273) showing the similarities in the forms of the two works. Here is Arnheim’s commentary:

The child, symmetrical and frontal, reposes like a self-contained, independent little monument, whereas the figure of the mother is fitted to a bending and reaching wave shape, expressing protection and concern. Moore’s carving, equally complex and subtle, embodies a very similar theme. The smaller of the two units is compact and self-sufficient like Corot’s infant, although it also strains noticeably towards its partner. The larger seems wholly engaged in its leaning over the smaller, dominating it, holding it down, protecting, encompassing, receiving it. One can find parallels to human or otherwise natural situations in this work: the relation of mother and child, spelled out in the Corot, or that of male and female. Such associations rely on the similarity of the inherent patterns of forces.

One of Talmyn’s (1988) great contributions to cognitive linguistics is his analysis of force dynamics and the way that forces enter into the meaning of language. Talmyn has taught us that the image schemas that characterize meaning in language are not just about vision. They are also about action and the application of force. In short, form is embodied, and Arnheim’s commentary shows an acute awareness of the embodiment of form. The child’s symmetrical form indicates that it is grounded and sitting independently—not exerting force in any direction. The shape of the mother’s body shows that she is attending to the child, bending, reaching, adjusting her balance, adjusting her body to the position of the child. Again the mother is in the middle of an action, and the action is determined by the position, size, weight, and demeanor of the child.

We know this because we, too, have bodies—and mirror neurons, a system of neurons forming a cluster across the premotor and parietal cortices with bidirectional connections. These neurons fire when we perform a coordinated action or see a corresponding action performed. Our understanding of Corot’s painting depends on our systems of mirror and canonical neurons; it depends on our being able to see an image of a body in mid-motion acting on something, feel what it would be to perform that motion and action, and thereby know what is involved in the motion. As Arnheim observes, our ability to do this is not dependent on the details of meaning—a mother,
a child, the beach, short sleeves, a long skirt, and so on. The capacity for such understanding applies to Moore’s abstract sculpture as well. How?

The Cog Hypothesis

An answer to this question requires a discussion of the Cog Hypothesis and the neural theory of metaphor. We will therefore take a bit of a detour, returning to Corot and Moore—and looking at other paintings—after a digression.

Aspect as the Exploitation of Motor Control Schemas

Any complex coordinated action must make use of at least two brain areas—the premotor cortex and the motor cortex—which are separated in the brain and linked by neural connections. The motor cortex controls individual synergies—relatively simple actions like opening and closing the fist, turning the wrist, flexing and extending the elbow, and so on. The job of the premotor cortex is motor control: structuring such simple actions into coordinated complex actions, with the simple synergies performed just at the right time, moving in the right direction, with the right force, for the right duration. That is, the premotor cortex must provide a phase structure to actions and specify just the right activations of effectors, directions, and degrees of force in just the right phases. This information must be conveyed from the premotor to the motor cortex by neural connections activating just the right regions of the motor cortex. And of course, the same premotor circuitry that governs motor control for actions must govern motor control for simulated actions in our imagination—since imagined perceptions and actions use some of the same neural substrate as actual perceptions and actions.

Narayanan (1997b) has constructed dynamic neural computational models of such circuitry, including, of course, the parameters—choice of effector, direction of motion, degree and duration of force, and so on—governing their operation. In doing so, Narayanan made an important discovery: the same relatively simple phase structures for bodily actions recur in case after case—sometimes in sequence, sometimes in parallel, sometimes embedded in one another. That is, complex motor control structures are combinations of the same simple motor-control structures. Here is such a simple structure:

- Initial State
- Starting Phase Transition
- Precentral State
• Central Phase Transition (either instantaneous, prolonged, or ongoing)
• Postcentral State*
• Ending Phase Transition
• Final State

*Postcentral Options:
• A check to see if a goal state has been achieved
• An option to stop
• An option to resume
• An option to iterate or continue the main process

To perform a motor action, you have to be in a state of readiness (e.g., your body correctly oriented, having sufficient energy, and so on). Next, you have to do whatever is involved in starting the process (e.g., to lift a cup, you first have to reach for it and grasp it). Now you are in a position to perform the main process. While the central action is still in process, you check to see if a goal state has been achieved. You may stop, and, having stopped, may resume. You can then repeat or continue the central process. Finally, you can do whatever it takes to complete the process. Then you are in the final state. Of course, some actions are even simpler, leaving out some of these phases.

These are the phases of just about any bodily movement—with more complex movements constructed by branching into parallel, sequential, or embedded structures of this form. The grasping schema, for example, has such a phase structure:

Initial State: Object Location: Within Peri-personal Space
Starting Phase Transition: Reaching, with Direction: Toward Object Location; Opening Effector
Central Phase Transition: Closing Effector, with Force: A Function of Fragility and Mass
Goal Condition: Effector Encloses Object, with Manner (a grip determined by parameter values and situational conditions)
Final State: Agent In-Control-of Object

Narayanan (1997a, 1997b) called the circuitry for controlling phases of motor control the “controller executing schema,” or “controller X-schema” for short. A schema using such a structure—for example, the grasping schema—is called an executing schema, or “X-schema” for short.

Linguists are familiar with phase structures of this kind. They occur in the conceptual structure of every language in the world, and go by the name “aspect.” For example, be + ing marks a central phase transition: “He is
drinking” indicates that he is in the central phase of the act of drinking. *About + to* marks the initial state, as in “He is about to take a drink.” *Have + past participle* picks out a point in time and indicates that the final state of the action occurred prior to the given time and that the consequences of that action still hold at that time. Thus, “I have done the food shopping” indicates that, at present, the final stage of the *food shopping* schema has been reached, with the consequence that we still have food. In short, linguistic aspect markers indicate what portion of a given schema has been carried out to date. The term “state” is relative to the controller X-schema. What we experience as an ongoing state (e.g., being annoyed) would be characterized in the model as a phase transition that is ongoing for the duration of that state.

Motor control is about *actions*, which are performed. Aspect is about *concepts*, which are used in reasoning. Narayanan (1997a, 1997b) showed, in his model, that the same structures that can move a body can also be exploited for reason and language. This is not surprising for action concepts like *grasping*, given that it is a sensory-motor concept. But *all* predicational concepts have aspect. It doesn’t matter what kind—actions, processes, and states, both concrete and abstract. What Narayanan showed through modeling was that the same neural circuitry that is capable of *performing motor control* in the premotor cortex is also capable of *computing the logic of aspect*. The same circuitry that can *control phases* can *compute the logic of phases* for both concrete and abstract concepts.

Here are the elements of Narayanan’s theory:

- The neural system characterizing the controller X-schema structure resides in the premotor cortex, where it performs motor control. Indeed, region F5 of the premotor cortex contains neurons whose firing corresponds to phases of particular actions.
- Since the same structure is used for observing, acting, and simulating, that neural system must contain mirror neurons.
- The controller X-schema can perform its computations even when all of its connections to the motor cortex are inhibited.
- There is neural circuitry from the premotor controller X-schemas to other, nonmotor domains, allowing the premotor structure to be exploited for structuring other conceptual domains.

If there were no such exploitative circuitry, exactly the same X-schema structure would have to be duplicated in many other parts of the brain for all abstract predicational concepts, no matter what the subject matter. The reason is that there are many nonconcrete subject matters with the same aspectual structure: emotions, thinking, sensing, and so on. Narayanan’s theory is
plausible because we recognize, in his account of cognitive operations, the sort of things that brains do: exploit computations in one part of the brain and use them via neural connections in other parts of the brain. The theory explains why exactly the same computational structure needed to run a body will compute the logic of aspect for every kind of concept there is, no matter where in the brain it is characterized.

Narayanan’s theory that motor control is exploited for aspect in this manner leads us to a new concept, what I call a cog.

The Nature of Cogs and the Cog Hypothesis

A cog is a neural circuit with the following properties:

- A cog provides general structuring for sensory-motor observation, action, and simulation: the specific details for this general structure are filled in via neural connections to other regions of the brain; it is in those regions that the “details” that fill in the cog structure are characterized. When functioning in this way, the cog circuit is a natural, normal, seamless part of the sensory-motor system—as when the controller X-schema is used to control the action of taking a drink.
- A cog performs its neural computations even when the connections to the specific details are inhibited.
- A cog can be exploited to characterize the structure of “abstract” concepts.
- A cog’s computations, which evolved to serve sensory-motor purposes, also characterize a “logic” and can be used for reasoning. Since the cog can attach to any specific details, its computations characterize a general form of logic (e.g., the logic of aspect, which applies generally to any action, process, or state).
- A cog can function in language as the meaning (or part of the meaning) of a grammatical construction or grammatical morpheme.

Thus, if Narayanan’s hypothesis is correct, the controller X-schema, which characterizes the semantics of aspect in all of the world’s languages, is a cog.

The Cog Hypothesis generalizes this idea further.

The Cog Hypothesis: any neural structure that characterizes the semantics of a grammatical construction is a cog.

We will give more examples of cogs shortly. But before we do, we should consider why the Cog Hypothesis is initially plausible. Grammatical constructions and morphemes have general meanings. The plural morpheme
pluralizes all relevant concepts. The first-person morpheme indicates a speaker, no matter who the speaker is. Or consider the Forced Motion Construction, which consists of a Force followed by a Patient followed by a Path. It applies in general, with specific details filled in; e.g., “Harry knocked the lamp off the table,” where knock = Force Predicate, lamp = Patient, and off the table = Path. It also applies to metaphorical forced-motion cases, where the Event Structure Metaphor (cf. Lakoff and Johnson 1999, chap. 11) maps forces to causes, motions to changes, and bounded regions of space to states; for example, “The home run threw the crowd into a frenzy” and “The election knocked global warming off the legislative agenda.” Under the Cog Hypothesis, we would expect to find grammatical meanings to be general in this way, able to fit both concrete and nonconcrete instances.

But such generality characterizes only part of what a cog is. It should also function normally, naturally, and seamlessly as part of the sensory-motor system in which it presumably evolved. With this in mind, let us consider other potential cogs.

Other Candidates for Cogs

Image schemas and force-dynamic schemas, as discussed above, are excellent candidates for cogs. These primitives (1) all have primary sensory-motor uses; and (2) are all general, with links to specific details. Some prepositions are primarily spatial (e.g., out, around), while others primarily involve force (e.g., against). Regier (1996) has argued that the visual system of the brain provides the right kinds of structures and operations to characterize the visual components of spatial-relations concepts. He has constructed neural computational models (using structured connectionism) of such spatial primitives. The models make use of computational analogues of topographic maps of the visual field, excitatory and inhibitory connections, within-map and across-map connections, center-surround receptive fields, orientation-sensitive cells, spreading activation, gating of connections—and, in more recent work, vector-sum ensembles. Regier has tested these models on language acquisition tasks, in which a program embodying the model has to learn often complex spatial-relations words on the basis of (1) a visual input with figures in a spatial relation, and (2) a range of positive exemplars (no negative cases). The program has worked to within 99 percent accuracy on examples taken from English, Russian, Arabic, Hindi, and Mixtec. Thus far, Regier has built no models of motor- or force-dynamic primitives.

Regier’s model as it stands is only two-dimensional, and is limited in other ways. It is far too simple to be ultimately correct. But Regier’s insights are important. He has argued convincingly that the visual system of the brain
has the right kinds of neural structures to compute the visual components of primitive image schemas and to link them to each other and to specific details, so as to handle complex cases.

The container schema is a good case in point. The container schema has an interior, a boundary, an exterior, and optional portals; the concepts in and out make use of it. In perception, the container schema fits or imposes an interior-boundary-exterior schema onto entities and regions of space. For example, a cup is a container, and so is a room. The details are very different, but we perceive and conceptualize both using the same general image schema. A tube of toothpaste can be seen as a doorstop, a backscratcher, a weapon—or a container!

In Regier’s model, the container schema is computed in the visual cortex. It is general and can be fitted to objects of all sorts of shapes—shapes which are computed elsewhere in the brain (for example, the temporal and parietal cortices). There is a logic of containers: If something is in the container, it’s not out; if it’s out, it’s not in. If container A is in container B, and object X is in A, then X is in B—and if X is outside B, then X is outside A. This is basically Boolean logic, and presumably where Boolean logic comes from. Since prepositions like in and out are among the grammatical morphemes of English, the container schema is part of the semantics of English grammar.

Many conceptual metaphors apply to the container schema. States, for example, are conceptualized as containers: you can be in or out of a state, on the edge of a state, deeply in a state, far from being in a state, and so on. Categories are commonly conceptualized as containers, with category members in the categories. Occasionally the boundaries of a category can be stretched to accommodate an outlier. There are many, many more cases.

As Talmy (2000) has shown, the actions using force fall into a small number of general types, what he calls force-dynamic schemas. Thus, shoving and throwing involve a propulsion force on an object away from the body, resulting in motion. Bringing and carrying involve a continuous application of force, resulting in motion. Holding force keeps an object with a tendency to move in place. Supporting force keeps an entity subject to gravity from falling. The same general force-dynamic schemas govern the occurrence of force in many different actions.

Neuroscience has studied specific systems for controlling force in the body, but it has not yet found general force-dynamic schemas. It is plausible that they, or something like them, exist in the brain. Conceptual metaphors apply to force-dynamic schemas, the most common of which is the causes are forces metaphor, which maps forces that result in motion onto causes that result in change. We saw examples of this above in cases like “The home run
threw the crowd into a frenzy” and “The election knocked global warming off the legislative agenda.” Another force-dynamic metaphor is HELP IS SUPPORT, as in “I can count on her for support,” “He is supporting five children,” “I’m supporting Goldberg for Senator,” where help of various kinds—emotional, financial, and political—is understood in terms of a support force-dynamic schema.

A Return to Form in Art (at Last!)

The theory of form in art we are about to present rests on the idea of a cog: there are neural structures in the sensory-motor system that are “secondary” or “general” in the sense that they are connected neurally to “primary” neural ensembles that fill in the details and are more directly involved in either perception or movement. An obvious example would be premotor cortical structures that carry out highly structured complex motor actions via connections to the primary motor cortex, which controls simple actions. When the premotor-to-motor connections are inhibited, the secondary premotor circuitry can function as a “cog”—it can still compute complex patterns that permit inferences and can evolve in time. Such secondary patterns—cogs—structure what we perceive as form in art. Many kinds of cogs have been hypothesized—for example, image schemas, force-dynamic schemas, and aspectual schemas—and each type corresponds to an aspect of form.

Let us now return to where we left off in our discussion of Corot and Henry Moore. We had just made use of the existence of mirror neurons and canonical neurons to explain how we know that the mother in Corot’s painting is attending to the child—bending, reaching, adjusting her balance, adjusting her body to the position of the child. We noted, too, that we can understand the larger chunk of Moore’s abstract sculpture as performing similar actions—brooding over the smaller chunk, stretching out to reach it, hovering over it, protecting it. How, we had asked, is this possible?

Cogs provide the answer. Cogs include aspectual schemas with phase structures, image schemas, and force-dynamic schemas. They inhibit connections to the primary neural structures that would fill in specific details—the beach, a long skirt, and so on—while including the secondary neural structures. These cogs are at once embodied, since they are part of the sensory-motor system, and “abstract,” since they do not include details. Cogs give structure to culture, and conceptual metaphors give substantive meaning to the cogs. Cogs allow us to have an embodied understanding of the form of
abstract art, and metaphors apply to cog structures to provide interpretations for abstract art.

Further Examples

After reinterpreting Arnheim in terms of cogs and conceptual metaphors, I decided to test my hypothesis on other cases. I went onto the Web and picked out a handful of paintings at random. Here they are, discussed one by one.

The first is an image, “Wounded Bison Attacking a Man,” c. 15,000–10,000 B.C.E., from Lascaux, France (see http://theartfulmind.stanford.edu). What is particularly interesting in this case is the aspect cog. The various parts of the painting represent different phases of a scenario: the bison is wounded (weapon in bison at left); the bison charges the man (the bison’s head is down, with horns in attack position and h ackles up); the man is dead (he lies on the ground, with penis in rigor mortis). The painting is composed around the phase structure of the action, with the elements of the scenario ordered visually left to right, earliest phase to latest.

The next example is Gustave Caillebotte’s Le pont de l’Europe, 1876 (Petit Palais, Geneva; see http://theartfulmind.stanford.edu). The first thing to notice about this painting is that although it portrays a sunny day, there is no single position that the sun can be in, given the shadows. For example, the shadows of the man and woman walking are behind them, suggesting that the sun is low and in front of them, while the shadow of the dog is to his left, suggesting that the sun is high and to the right. The shadow of the bridge is not consistent with either of those.

The organizing structure of this painting is the parallel-lines schema. There are parallels everywhere, and that explains the shadows—they are set up to form parallels. The man and the woman form parallel lines, and so do their shadows. The dog and his shadow form parallels. The support structure of the bridge is a series of parallels forming X’s. The parallels are repeated in the shadow of the bridge. The top of the bridge is parallel to the top of its shadow and to the top of the railing that the man in blue is leaning against. That railing consists of ovals whose sides are parallels. The man in the cap walking in the background is parallel to the man and woman, and his shadow is parallel to the shadow of the bridge top. The line of the curb is parallel to the lines of the handrail and the bridge top. The buildings on the street going off into the distance are parallel. The buildings in the distance have parallel horizontal lines and their windows have vertical parallel lines.
Another organizing form is the aspect schema for walking: the man and the woman are in the middle phase of walking, with one foot outstretched. That is true of the dog, the man in the cap, and the man way in the distance to the left. The man leaning against the railing is not walking, but he, too, is resting his weight on one foot (his left), while the toe of his right shoe lightly touches the ground.

The next example is Wayne Thiebaud’s 24th Street Intersection (1977, private collection; see http://theartfulmind.stanford.edu). The Thiebaud painting is structured in two ways: by parallels and by a downward slope evoking the pull of gravity. Let’s start by noticing the parallels. First, there are the parallel lines of the streets and the lines in the middle of the streets, then the parallel lines of the sides of the houses, then the parallel lines of the trees and the telephone poles and the shadows of the telephone poles, and finally the parallel lines of the wires. The pull of gravity is sensed in the hill streets, upper left to lower right, and the hill straight ahead. The lone bus in the distance at the top of the hill looks like it’s about to roll backwards, and the car to the right looks like it’s about to roll downwards. The two organizing principles—parallels and downward force—come together where the hill meets the houses. It appears as though the houses are holding up the hill.

The next example is Mark Tansey’s Derrida Queries de Man (1990, collection of Mike and Penny Winton; see http://theartfulmind.stanford.edu). This painting is based on a Sidney Paget illustration from a Sherlock Holmes mystery (The Final Problem, by Arthur Conan Doyle, 1893; see http://theartfulmind.stanford.edu). In the Paget illustration, Holmes and Moriarty are fighting to the death on a cliff.

Tansey has, quite consciously, created a metaphorical painting, in which Derrida (a French Jew) is the Holmes-like analytical hero and de Man (the Belgian ex-Nazi writer of anti-Semitic tracts) is the brilliantly diabolical villain. Derrida is perhaps best known for his metaphor the world is a text—something to be interpreted indefinitely, especially with respect to other texts, with no “correct” interpretations. Tansey’s painting itself, by its reference back to the Holmes-Moriarty drawing, is an example of Derridean intertextuality—the dependence of one text on another for its meaning. The “query” is an intellectual battle, perhaps based on de Man’s questioning of Derrida’s reading of Rousseau. Tansey’s painting is metaphorical in another way: If you look closely at the foreground, you can see that the cliff itself is made up of letters: in the painting, the world is a text. (See http://theartfulmind.stanford.edu for detail.)

The painting makes central use of force dynamics. Derrida and de Man, dressed in suits, are pushing against each other. They are high up, at the edge
of a deep and rocky chasm: de Man is close to the edge, seemingly in a position where Derrida could push him off, but Derrida is in a perilous position as well. There is light peering through the chasm, but a dense fog prevents it from coming through clearly. The metaphor knowing is seeing allows us to understand the light as the light of knowledge, barely able to penetrate the fog of verbiage in the philosophers' writings. Though functioning at a metaphorically high level, de Man and Derrida are skirting the edge of sense, in danger of falling into an intellectual chasm. The "querying" is seen as Derrida exerting force intellectually on de Man, trying to push him into the chasm—a perilous place where there is no solid ground to stand on.

Here again we see how common metaphors, applying to image schemas and force-dynamic schemas, can contribute meaning to a painting.

Conclusion

Beginning with Arnheim's insights, we have arrived at a theory of form in art and its relation to substantive content. The Cog Hypothesis explains how form can be at once embodied (in the sensory-motor system), permitting inference, and subject to metaphorical interpretation, while being "abstract."

Cogs are complex neural structures that are "secondary" and provide structuring to "primary" sensory-motor content elsewhere in the brain via neural connections. When those neural connections are inhibited, cogs still function, subject to neural computation, and may have connections to other, non-sensory-motor parts of the brain. Examples of cogs are aspectral schemas, image schemas, and force-dynamic schemas. Realist art contains rich images structured by cogs. The images can be structured so that the cogs interact in interesting ways with the content of the images and with conventional metaphors applying to the cog structures.

Arnheim was right that form in art is not "mere" form. Form has inferential structure and may express content in the right context. He was also right that form is not in the art per se. Form has to do with us, in particular with the kinds of embodied structures we impose by virtue of our bodies and brains.

REFERENCES


