11. I am always in a bad mood for a long time after I have disagreements with colleagues.
12. It is easy for me to engage in a quarrel with others.
13. I feel that many people are biased against me.
14. Whenever I face pressures in life, I feel that there are always people offering me moral support.
15. I find it easy to make friends and maintain friendships.
16. I am always on the alert against hurts from others.
17. I have more fun when I am alone than when I am with other people.
18. I feel that nobody truly loves me.
19. I spend more time alone than with others.
20. I seldom share with others the frustration and difficulties in my heart.
21. The members of my family are really concerned about each other.
22. When it is necessary, I can rely on my family to overcome difficulties.
23. I feel that as time has passed, people have become distant from each other.
24. I feel that as time has passed, my interactions with other people have become more and more difficult.

The first two questions (1 and 2) required respondents to answer on a scale ranging from *0* to *4 or more*. All other questions were answered on a scale with six choices: *strongly agree* (6), *agree* (5), *agree to some extent* (4), *disagree to some extent* (3), *disagree* (2), or *strongly disagree* (1).

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Nonverbal Metaphor: A Review of Theories and Evidence

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ABSTRACT. Traditional approaches to metaphor—the received view—have viewed metaphor as largely a property of language behavior. As a result, theories of metaphoric processes have been overly parochial, evidencing an inability to explain various phenomena that may share similar underlying processes. In the present article, three accounts of metaphor are reviewed: the language view, the synesthetic view, and the cognitive (symbol systems) view. Various lines of evidence are offered in support of the cognitive approach: prelinguistic evidence (including studies of metaphor-in-action), physiognomic perception, and evolutionary considerations; studies of children's comprehension and use of spatial, gestural, and pictorial metaphor; studies of adults' use of gestural representation; and evidence from studies of injury to the brain. Various theories of nonverbal metaphor are reviewed, with special attention given to visual metaphor, including illustrations from art theorists and historians and arguments from philosophers. Finally, the issue of visual metaphor is framed within a more general theory of visual thinking.

> . . . just because we find a good theory of linguistic metaphor may not mean that we have a good theory of metaphor.
>
> —A. C. Danto (1981)

ALTHOUGH THE STUDY OF METAPHOR has encompassed a wide array of subject matter over the last 20 years or so (e.g., Ortony, 1979), traditional approaches continue to view metaphor as largely a property of language or language behavior (e.g., Ortony, 1987, 1993). According to this view, metaphor is construed as a similarity between two single-place predicates, a topic and a vehicle. For instance, in the poetic metaphor "Love is a red, red rose," red rose is the vehicle, love is the topic, and the ground is the similarity between the two that the reader infers in some manner (Richards, 1936).

Exactly how the reader goes about inferring the similarity remains something of a mystery; when pressed for an explanation, the reader invokes the usual circularity—he or she fits a schema to an input and comes up with a match. Given the range of experience implicated in the production and comprehension of metaphor—perception, cross-modal association, and emotional expression, to name a few—one could argue that the ability to perceive similarity is a more generalized facility not limited to language—it is a supramodular capacity (Gardner, 1983, 1987). That is to say, the brain's capacity to process metaphorical relations may rely on central cognitive mechanisms that relate percepts or concepts across different cognitive domains on interrelationships among brain areas (see Fodor, 1983).

In fact, recent research indicates that some types of metaphoric behaviors may be largely a result of sensorineurally based, graded, perceptual knowledge that becomes available in development to systems of verbal elaboration (Marks & Bornstein, 1987; Marks, Hammeal, & Bornstein, 1987). Nonetheless, I will argue that metaphor is more properly construed as a cognitive process (e.g., Lakoff & Johnson, 1980; Miall, 1979) that is brought to bear on diverse symbolic instantiations: language, music, film, painting, photography, sculpture, architecture, and dance (Goodman, 1976). If this argument proves true, then a "correlated" set of cognitive mechanisms may play a substantive role.

Language has no special status in this regard because it too is a second-order datum used to describe the "novel perception of resemblances" (Verbrugge, 1977). For example, to use language to describe an aspect of visual experience, as in viewing a painting, is not to say that only the language is metaphorical—that is, the graphic or auditory symbols used in writing or speaking and not the visual aspects of painting: color, form, and subject matter, among other things. Rather, metaphor involves the perception of similarity between disjointed domains of experience, and it is the perceived relationship between those domains that is represented in different symbol systems as metaphorical. To be sure, people often communicate the nonliteral aspects of experience through the use of language because it is such common coin in daily life. Yet language as a symbol system never occurs in isolation. Recent studies have either supplemented linguistic data with gestural and facial information (Seitz & Beilin, 1987) or viewed nonliteral communication in a gestural language (Klima & Bellugi, 1980; Marschark, Everhart, Martin, & West, 1987; McNeill, 1985). As I will attempt to show, when metaphor is conceptualized as a cognitive process rather than merely linguistic embellishment or comparison, then ascriptions of metaphor as largely a linguistic event evaporate.

Three general views have been advanced to account for metaphoric behavior. The received or Aristotelian view states that metaphor is largely a property of language—in perceiving similarity, language simply indexes itself. One alternative, the synesthetic view, is that graded perceptual knowledge is correlated across sensory domains and provides the foundation for metaphoric behavior. The third or cognitive view explains metaphor as a general property of symbol systems.

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Approaches to Metaphor

The Language View

When put under the researcher's lens, metaphor has yielded some of its secrets. For example, adults use the same comprehension strategies (Glucksberg, Gildea, & Bookin, 1982) and rely on the same kinds of contextual information (Gildea & Glucksberg, 1983) whether processing literal or nonliteral language, and both are just as easy to recall (Harris, 1979). Nonetheless, given the finding that lexical decision times for associative word pairs are faster than times for either metaphor pairs or randomly paired words, it has been argued that metaphors do not depend on prior associative relations but actually create relations between concepts (Camac & Glucksberg, 1984).

Nonetheless, it has been claimed that young children under 4 years of age do not comprehend or produce metaphorical figures of speech (e.g., Marschark & Nall, 1985; Ortony, 1987; Vosniadou, 1987). The assertion follows naturally from the language view. Metaphors juxtapose concepts from different conventional linguistic categories to communicate new meanings (Black, 1962). As a consequence, what constrains the younger child's ability to process figurative language is lack of conceptual knowledge and linguistic facility. Those who take the language view claim that metaphor is always about concepts and specifically about linguistic concepts.

But the question remains how these concepts evolved in the first place. For instance, it has been acknowledged that metaphor is important in producing linguistic change, but such a claim does not address the underlying reasons why, for example, temperature terms (warm and cold) have come to specifically describe personality characteristics (Asch, 1958; Martindale & Martindale, 1988). Similarly, assertions that metaphor expresses the inexpressible or highlights a similarity between two things do not begin to tell us what the inexpressible is or on what kinds of similarity metaphor is based. If metaphoric similarity is based simply on learned conceptual–linguistic relations, then almost anything can be involved to explain just about any metaphor in an infinite regress (Goodman, 1976). Although it is undoubtedly true that some metaphors cross-classify linguistically based concepts, this aspect is only part of the picture (pun intended).

The Synesthetic View

According to the synesthetic view, metaphor involves the ability to recognize similarities across different sensory domains. This ability seems to have evolved naturally in human primates with the maturation of the cross-modal zones in the parietal cortex (Geschwind, 1964). Adult research participants have reported increased synesthesia in various drug-induced states (Siegel, 1977) and common affective reactions to different sensory stimuli (Osgood, 1960). Moreover, true synesthetes experience a real percept cross-modally. For example, a 38-year-old woman reported seeing splotches of color while listening to music, and a 36-year-old man recounted seeing geometric shapes while eating (Cytowic & Wood, 1982b). Although synesthetic percepts in these individuals are more vivid than in normal controls, synesthetes give a more restricted and asymmetric range of responses (Cytowic & Wood, 1982a, 1982b). These medical case studies give one a rare glimpse into the sensory connections in the human brain, demonstrating the existence of such anomalies as colored gustation, shaped audition— "I see what you say,"—visual pain, textured and colored speech, and audiomotor synesthesia.

Moreover, this ability in its nascent form is present in nonsynesthetes early in life. Young children, $3^1/_2$ to $5^1/_2$ years old, are able to recognize perceptual similarities between hearing (i.e., pitch and loudness) and vision (i.e., brightness; Marks, Hammeal, & Bornstein, 1987). The authors note that pitch–brightness and loudness–brightness similarities are inherent characteristics of perception based on common sensory codes but that pitch–size similarity emerges in early adolescence as a presumably learned association between size and pitch qualities. Perceptual similarities become available to verbal processes when children begin to map sensory codes onto the abstract representations of language. In this regard, children as young as $3^1/_2$ years old readily map polar adjectives (e.g., warm/cold) onto swatches of color, musical tones, objects felt while blindfolded, and line patterns (Gardner, 1974).

Intersensory equivalences have also been found in infants in the 1st year of life. Research indicates that infants can match static visual events (e.g., up arrow) with dynamic auditory events (e.g., ascending tone; Wagner, Winner, Cicchetti, & Gardner, 1981), and they can note temporal synchrony between an auditory stimulus (e.g., bouncing toy kangaroo) and its filmed version (Spelke, 1981). They can perceive numerical correspondences between spatial arrangements of visually perceived household objects (e.g., memo pad, comb) and auditory–temporal sequences (e.g., drum beats; Starkey, Spelke, & Gelman, 1983), and they can detect shape invariants across different modalities (Meltzoff & Borton, 1979). It has been suggested that infants respond amodally to the overall intensity of stimulation (presumably linked to underlying neural activity) rather than to the categorical differences between modalities (Marks et al., 1987; Wagner et al., 1981). It is not until these modalities emerge as independent perceptual categories at approximately 4

years of age that children are truly responding metaphorically, according to the synesthetic view.

The Cognitive (Symbol Systems) View

According to the cognitive view, metaphor involves the transfer of properties across symbol systems (Goodman, 1976). A symbol refers to one thing (e.g., a yellow traffic signal) used to represent or denote another (e.g., "caution"). Symbols, moreover, group into systems. Symbol systems include, but are not limited to, language, music, film, painting, gestural sign languages, photography, sculpture, architecture, and dance. Moreover, a symbol system consists of a symbol scheme having the requirement of correlated reference or denotation. In the case of metaphor, properties or features of objects and events are transferred from one symbol scheme to another. For example, pictures can express feelings or sounds, as in Picasso's "blue period" painting of a guitar player, and therefore one can speak of "nonverbal" or "pictorial" metaphor. Nonetheless, the foregoing is not meant to imply that the label *blue* has historically been used to talk about melancholy or sadness and now has simply been projected onto paintings, sounds, or whatever. To be sure, Gombrich (1963) ascribed such phenomena to biological fact, so-called natural metaphors, as in the use of red in a picture to denote something strident or violent because it literally possesses those qualities.

In this latter regard, Goodman (1976) distinguished between metaphorical exemplification and metaphorical expression. For instance, a picture may express sadness, but it may exemplify only various shapes, colors, and lines. To express a property, a symbol must metaphorically possess it; to exemplify a property, a symbol must metaphorically refer to it. An example of the latter would be a car that exemplifies the properties of being a Ferrari (e.g., high price, flashy color) without literally possessing those properties (namely, superior design, styling, and performance). The actual process of the metaphorical transfer is based on antecedent practice. In the aforementioned example of Picasso's painting of a guitar player, the color blue has historically become synonymous with sadness or melancholy and has been imported from a previous realm, established by some prior precedent, to a new realm where the property has been projected. Although Goodman (1976), given his philosophical nominalism, addressed only the projectibility of predicates or labels, doing so is simply an easier way to refer to categories, schemata, systems of concepts, realms within a schema, and the like (see Goodman, 1976, p. 72, passim).

From this perspective, metaphor is, in essence, a calculated category-mistake. Not only does it enable the generation of new organizations or sortings of experience but, as a consequence, lends itself to a sort of cognitive economy that helps one better manage the conceptual world. Thus, any symbol system involves metaphorical transfer.

The symbol systems approach, moreover, shares a strong affinity with those perspectives that view metaphor as a general mode of cognition (Lakoff & Johnson, 1980; Miall, 1979). Metaphor, according to this view, is not simply a matter of language, but more generally of concepts: events, activities, ideas, and emotions. The phenomenal world is understood, according to this view, through experiential gestalts that organize experience in terms of classes of metaphorically derived concepts. These include structural and orientational metaphors (e.g., the spatial metaphor, "I'm feeling up today") as well as ontological metaphoric relations (e.g., personification: "The tree held her leaves aloft with great pride"). Indeed, in the nonverbal medium, artistic works function by providing the viewer with new experienced gestalts organized through structural, orientational, and ontological metaphors.

Having outlined three general approaches to the understanding of metaphoric behavior, I next examine a number of lines of evidence that argue for adopting the cognitive viewpoint, specifically the symbol systems approach. Evidence of precursors to linguistic metaphor indicates that at least some rudiments of metaphoric production and comprehension arise prior to language ability. There is evidence from studies of primates and synesthetes, as well as evidence from evolutionary and developmental studies. Studies of children suggest that children think nonverbally and metaphorically in mapping body parts, conveying figurative meaning through gesture, and understanding nonliteral pictorial relationships. Studies of adults with brain damage shed light on the cerebral organization of metaphoric understanding, and studies of normal adults reveal the role of gestural representation in metaphoric thought.

Prelinguistic Evidence

Enactive Components of Metaphor

Metaphor may be derived directly from action (Beck, 1978), or it may rest on an amodal, unisensate base (Wagner et al., 1981). In the former case, it is suggested that there exists a precognitive motor and affective experience that accounts for the enactive components of metaphor. In the latter case, it is suggested that similarities across perceptual events are recognized by human infants before the development of language ability. In this latter regard, Dent (1984), adopting a Gibsonian position, argued that (a) invariants are detected in the ambient structured optic array and motion provides crucial information in denoting similarity across events and (b) use of this information increases with age.

To test this hypothesis, Dent (1984) had 5-, 7-, 10-year-olds, and college students view 10 sets of three scenes of common, real-world objects and events. She used filmed triads (e.g., ballerina leaping, ballerina spinning, and top spinning) in which each triad contained a literal pair (ballerina leaping, ballerina spinning), a metaphoric pair (ballerina spinning, top spinning) and a control pair (ballerina leaping, top spinning). All research participants viewed motion pictures of both object triads (e.g., short building, tall building, tall giraffe) and event triads. The participants used a 3-point Likert-type scale to rate the similarity between the scenes and a 6-point scale that captured the extent to which the participants fused their descriptions of the two objects, ostensibly a measure of metaphoric pairings.

The results indicated that metaphoric and literal pairings increased with age, although the latter increased only for ages 5 to 7. Moreover, event triads elicited significantly more nonliteral pairings than did object triads at all ages, and the metaphoric descriptions referred more often to action. Dent (1984) concluded that the perception of nonliteral similarity in events is easier because it involves fewer invariants, and thus the ability develops rapidly in early childhood. Indeed, observation of children early in the 3rd year of life suggests that they use language figuratively to label the action components of their environment. For example, a child 3 years 3 months old said, as she replaced a cover on a crayon, "I am putting on your clothes, crayon" (Winner, McCarthy, & Gardner, 1980).

Physiognomic Perception

Werner (1948) believed that there is a lack of differentiation in early perceptual processes, such that children should display a greater propensity for making physiognomic attributions. Physiognomic perception involves the attribution of affective properties to visually perceived objects (e.g., attributing a smiling face to an automobile). However, a study by Seitz and Beilin (1987) revealed an increase with age in children's attributions of physiognomic properties to inanimate objects presented in photographs, although even children less than 3 years old were capable of making physiognomic attributions. The increase, moreover, interacted with psychometric intelligence: children with high IQs had higher rates of physiognomic responding. Thus, the ability to detect physiognomic properties appears to be present very early in life—before 3 years—and continues to develop throughout childhood (see also Nathan & Hass, 1970).

In fact, claims that children are using strict analogical reasoning abilities when they map parts of faces (e.g., eyes, nose, and mouth) onto depictions of mountains (Gentner, 1977) may be more parsimoniously explained as the attribution of physiognomic qualities to inanimate objects. Indeed, children performed better on this so-called physiognomic attribution task than on a second task in which they were required to map body parts onto depictions of trees in different orientations (clearly an example of analogical reasoning abilities; Gentner, 1977). No doubt, children develop analogical abilities at a very early age. Even adult chimpanzees display some rudimentary analogical skills in solving simple figural and conceptual analogies (e.g., Gillan, Premack, & Woodruff, 1981).

The ability to impart affective properties to inanimate objects has been studied for some time (Werner, 1948; Werner & Kaplan, 1963/1984). The queson, though, is what is metaphoric about attributing an emotional quality to an ıanimate object? One position (Arnheim, 1988; Harrington, 1980) is that the iewer adds a kinesthetic resonance to a visual percept, a view traceable to .orschach (1921/1942) and Lipps (1897). For example, in looking at a columar building, the viewer "feels" the weight of the building bearing on the olumns.

The other view arises from our understanding of the evolution of symbolic apacities in primates (Geschwind, 1964; LeDoux, 1996). There are neural proections from the limbic areas in the brains of primates (involved with emotionl recognition and expression) to the visual, auditory, and somatosensory cortices. 'hose projections allow primates to link a limbic stimulus with a nonlimbic (senory) stimulus, that is, the linking of affect with the different sensory modalities. 'hysiognomic perception is the behavioral correlate of this capacity in humans.

Moreover, in terms of the development of metaphoric understanding, physognomic perception may be a precursor of the later developing ability to link the hysical and psychological domains (Seitz, 1997, in press). Humans come to unerstand their thoughts and feelings, which they are not able to observe directly, y comparing them with known physical states. Physiognomic metaphor relates n internal (emotional) state to a visually perceived object. Psychological–physscal metaphor functions by relating physical aspects of objects to people's psyhological characteristics or mental states. An everyday example of this is in neeting a new person and saying, "He is as cold as ice."

Prior research suggests that there exists something remarkably akin to physognomic perception in the "visual exploratory motive" (Butler, 1953), "maniplation drive" (Harlow, Harlow, & Meyer, 1950), or "curiosity drive" (Geschvind, 1964) found in members of the primate family. For example, rhesus moneys will persist for long periods in learning object discriminations or solving nechanical "puzzles," with the only reward being the pleasure of visual exploation. Apparently, the pleasure derived from a visual stimulus plays an imporant role in these monkeys' engagement with the external environment.

Evolutionary Evidence

During the Aurignacian period—approximately 35,000 years ago—humans began to embellish their bodies with ornaments that evoked qualities of animal species (White, 1989). They sculpted ivory into anthropomorphic figures (e.g., teeth-like pendants) and engraved and painted limestone slabs with both representational (e.g., animal depictions) and nonrepresentational forms (e.g., patterns of Xs). These more abstract designs may actually be depictions of objects and represent the transfer of patterns in nature to a context in which they function aesthetically, that is, as visual metaphors. Moreover, ornaments worn on the body served a social function by defining and communicating social identity: gender,

social roles, group identity, and economic status. This evidence is the first manifestation that early man fashioned material analogues (i.e., physiognomic metaphors) of animals, fish, and designs found in nature.

Studies of Children

Spatial Metaphor

In Gentner's (1977) study of spatial metaphor, preschoolers (4.4 to 5.2 years old), first graders (6.7 to 7.1 years old), and college sophomores mapped body parts (i.e., head, shoulders, arms, stomach, knees, and feet) onto drawings of trees in different orientations and face parts onto depicted mountains. The children performed significantly better on the latter task, and there were no differences among the groups on the former task. Gentner concluded that analogical reasoning skills are well developed in preschoolers and present at least by the time language emerges in the 2nd year. Nevertheless, the study avoided the use of the term *metaphor* ostensibly because it implicitly acknowledges the Aristotelian definition that metaphor serves solely artistic or literary purposes, that is, is merely ornamental (Ortony, 1987). But the findings seem to show a clear instance of the use of spatial metaphor by children.

Gesture

Increasing attention has been paid to the role of gesture in communication (Klima & Bellugi, 1980; McNeill, 1985; Sacks, 1988) and in creative thought (Harrington, 1980). Two recent studies have investigated the role of gesture in communicating nonliteral meaning, in both normal-hearing (McNeill, 1985) and deaf children (Marschark, Everhart, Martin, & West, 1987). The Marschark et al. (1987) study used a storytelling task in which deaf and hearing children, 7 to 15 years old, were required to act out narrative descriptions through gesture and pantomime. The deaf children readily modified extant American Sign Language (ASL) gestures and combined ASL gestures in new and inventive ways to convey figurative meaning.

Similar parallels were found with hearing children using spoken language. Both groups used gesture to add visuospatial detail to convey important information through ritualized movements (e.g., placing index finger to the lips to convey "shhh!"). Moreover, the deaf children, like the hearing children, displayed a "literal stage" in middle childhood, a finding that suggests that gesture and speech develop in parallel.

It has been claimed, however, that children do not develop true metaphoric gestures until 5 to 6 years of age (McNeill, 1985). Iconic gestures emerge first, at approximately $2^1/_2$ years of age, when either postures or gestures are enactments of virtual objects (e.g., hand rises upward to denote an object ascending). Symbolic gestures subsequently evolve from these enacted events when hands and other body parts function more abstractly in representing size, shape, and meaning (e.g., child places fingers together in a circle to outline the shape of an apple). True metaphoric gestures arise when children begin to use iconic depictions to represent abstract concepts of nonlinguistic or linguistic meaning (e.g., closed fist = [grasped] knowledge).

Pictures

Younger children are quite adept at processing at least some kinds of pictorial information (Seitz, 1997, in press). Pictures appear to tap perceptual processes arising prior to language and have evocative qualities that children can easily understand (Kogan & Chadrow, 1986). Research demonstrates that children under age 4 readily impute emotional qualities to depicted inanimate objects that have human characteristics (Seitz & Beilin, 1987), and by age 4 they cross-classify perceptual aspects of color and shape found in pictorial representations (Seitz, 1997). Cross-modal classifications of pictures are also cognitively available if they are clearly depicted (Seitz, 1997). Although for some material there is a pictorial superiority effect in younger children, this advantage wanes with age (Kogan & Chadrow, 1986). These latter investigators gave their match-to-sample metaphoric triads task (target, nonliteral match, and literal match), in both pictures and words, to second ($M = 7.5$ years) and fifth ($M = 10.7$ years) graders. Although there were significant age differences, with older children outperforming their younger counterparts, the medium of presentation had no significant effect on results. In fact, language enhanced nonliteral matches based on perceptual similarity. Kogan and Chadrow proposed, however, that when young children enter school, the encoding of verbal material supersedes at least some kinds of visual processing, including preference for grouping by perceptual similarity.

In a larger study spanning the age range from 7.5 to 28.8 years, Kogan, Connor, Gross, and Fava (1980) found a progressive improvement in scores on the metaphoric triads task with age. Significant correlations between the pictorial and verbal versions of the metaphoric triads task in high school students—the only group given the verbal equivalents—suggested a general metaphoric style. The finding of a general metaphoric style is significant because it suggests that metaphoric abilities may have common origins. Not surprisingly, correlations with standardized intelligence tests (all language-based measures, i.e., Stanford Achievement language subtests, WAIS similarities subtest, and an analogical reasoning task) were inconsistent across samples. However, there were significant correlations with measures of breadth of categorization and physiognomic sensitivity. For instance, broad categorizers did better presumably because they were willing to risk errors of overinclusion in classification of stimulus objects. On the other hand, physiognomic sensitivity may enable individuals to intuit the underlying relationship constituted, at least in part, on affective grounds.

Another study (Newton, 1985) examined school-age children's ability to process nonmimetic information, that is, pictorial "runes" (Kennedy, 1982). These details, added to pictures (e.g., waft lines to connote odor), are readily found in children's comic books and cartoons, and though largely learned, are undoubtedly environmental in origin (Friedman & Stevenson, 1980). In Newton's (1985) study, 9-, 10-, and 12-year-olds matched featureless figures supplemented with nonmimetic information (e.g., a vertical curlicue over a figure to denote confusion) to words that children had easily matched to real figures previously. Moreover, children's comic book preferences were correlated with the actual occurrence of the pictorial runes in the comics.

Results indicated that there was a significant agreement between the effectiveness of nonmimetic figures and their frequency of occurrence. Although Newton (1985) suggested that children may process such nonmimetic information not as pictorial metaphors but as "glyphs" (word-like pictures), the explanation for this is somewhat obscure. Certainly it cannot be because they share graphic characteristics with words. A simple graphic representation of the sun may clearly denote the sun without having any of the properties that constitute a language (Hockett, 1958). In this regard, there is a particular danger in theorizing about nondiscursive symbol systems as if they merely piggybacked on language—a problem that has plagued research on metaphor.

Studies of pictorial metaphor involving children can be categorized according to the types of metaphoric content. Gardner (1974), Kogan and Chadrow (1986), Kogan et al. (1980), Mendelsohn, Robinson, Gardner, and Winner (1984), Newton (1985), and Seitz (1997) have included perceptual aspects in their studies, primarily shape and color. For instance, a cherry lollipop is like a traffic stop sign because they are both red and similarly shaped. Indeed, children at the earliest ages are able to sort across conventional categories according to visual likeness. As Mendelsohn et al. (1984) indicated, "The child who labels the bat as corn is creating a genuine visual metaphor" (p. 188).

With regard to the enactive components of metaphor, Dent's (1984) study is the only one that has investigated it in a filmed (i.e., pictorial) medium. Such research has received support from language studies in which young children's ability to produce figurative language benefited from adult modeling of the action components of metaphor (Winner et al., 1980) and from studies of gestural metaphor that develop in parallel with figurative language (e.g., McNeill, 1985).

Physiognomic aspects of pictorial metaphor, too, have been investigated in a number of studies of children (Gardner, 1974; Kogan & Chadrow, 1986; Kogan et al., 1980; Seitz & Beilin, 1987), as have cross-modal abilities in children 4 years old and older (Seitz, 1997). Pictorial depictions can, of course, convey more abstract conceptual relationships (Kogan & Chadrow, 1986; Kogan et al., 1980; Seitz, 1997a).

For instance, a child might compare a musical instrument to a singing canary or link a physical state with someone's personality. Children as young as 4 years old display an incipient ability to categorize along these dimensions in both pictures and words (Seitz, 1997). The ability to categorize objects shifts with age from more associative (functional) to more taxonomic groupings using basic-level object categories (Mervis & Rosch, 1981). For example, a fork is prototypical of dinnerware, but children also acquire the ability, at about the same time, to sort across categories; a fork is also like a steam shovel. In this regard, Keil (1989) claimed that related concepts structure metaphors from the same domains; that is, metaphor involves two domains that conceptually lie far apart but exhibit close correspondence with respective concepts within the domains (Tourangeau & Sternberg, 1982).

In sum, children are able, at least by age 4, to map body parts onto pictorial depictions, sort according to physiognomic likeness, and note similarity within a modality across changes in color and shape and between sensory modalities in terms of stimulus intensity. Indeed, even infants respond on an innate basis to intermodal equivalences between their mother's vocalic intensity and their own kinesthetic activity (Stern, Hofer, Haft, & Dore, 1985). But children by age 4 are also beginning to appreciate more abstract stimulus categories, as is shown in their nascent ability to cross taxonomic boundaries in comprehending metaphorical relations.

Typically, studies of metaphor have ignored the content of children's and adults' production and understanding of metaphoric relations, assuming that metaphor is the transfer of already established language-based concepts. This trend has led to a parochial insistence that metaphor is largely confined to linguistic symbol systems. It has been assumed that sounds or written language symbols are the only major carriers of transferred meaning in terms of its original Greek derivation (i.e., *metapherein* = to transfer). But meaning is not a property endemic to language. Meaning, including nonliteral meaning, inheres in other symbol systems of culture, including figurative aspects of music (e.g., Meyer, 1956; Sloboda, 1985) and the connotative, nonliteral kinesthetics of dance (e.g., Turner, 1971); and metaphoric meaning is present in painting (e.g., Stella, 1986), photography (e.g., Sekula, 1981), and film (e.g., Harrington, 1973). What is important here is that nonverbal metaphor is doing much of the work of making meaning. The received view of metaphor has almost entirely ignored these areas of importance.

Studies of Adults

Gestural Representation

In an interesting, descriptive study, Harrington (1980) claimed that creativity—operationalized as metaphoric transformations of information—involves the "gestural expression of felt thought" (p. 15). In that study, undergraduates were given a number of self-report questionnaires including an analogical/metaphorical-thinking scale, a use-of-hands scale, and an adjective checklist scored using the IPAR creative architect and composite creative personality scales. There was a moderate positive correlation (average $r = .40$) between the use-of-hands scale and the two creative personality indices for those respondents who scored high on the analogical/metaphorical-thinking scale.

The implication of Harrington's (1980) study is that gestural movement of the hands among high analogical-ability individuals (i.e., more creative individuals) is more likely to involve metaphors of space and motion. The biggest difficulty with the study, however, is that the analogical/metaphorical-thinking scale and use-of-hands scale are limited to two questions per respondent—an overly modest assessment for making claims about metaphorical abilities. Moreover, there is no other convergent validational evidence, except anecdotal reports from respondents, such as architects, who are presumably higher as a group to begin with on spatial cognition.

In a somewhat different vein, Klima and Bellugi (1980) investigated the nonliteral uses of American Sign Language (ASL) by deaf adults. Klima and Bellugi found that, despite previous claims to the contrary, deaf adults used ASL frequently in metaphorical and ironical ways. According to Klima and Bellugi, ASL can express nonliteral meaning through three mechanisms: (a) the overlapping of signs by compressing the message into a single unit, (b) the blending of signs together, and (c) the substitution of one sign for another. Similar mechanisms are also found in spoken and written language (Hockett, 1958). On the other hand, there exists sign poetry ("Art Sign") and deaf theater, which have no correlates in spoken and written language. For instance, there are formal aspects of Art Sign in which the user creates designs in space superimposed on the signing process as part of the aesthetic appeal of the message.

Nonetheless, as in language proper, there is both choice of signs (paradigmatic substitution) and continuity from one sign to another (syntagmatic relationships) in the creation of coherent messages. In fact, Sacks (1988) insisted that ASL satisfies every criterion of a genuine language. As a result of constant exposure to a visual language from birth, people who are congenitally deaf reallocate auditory areas to the function of visual analysis. Consequently, deaf persons are more predisposed to visual (logical–spatial) forms of cognition. The role of the brain, then, bears an important relation to metaphoric understanding.

The Role of the Brain

Winner and Gardner's (1977) study of metaphor comprehension by adults with brain damage is informative regarding the role of nonverbal metaphor in cognition. Hospitalized patients with damage to either the left or right hemisphere were given 18 metaphoric sentences. The metaphoric sentences highlighted either psychological–physical relations (e.g., "A heavy heart can really make a difference") or cross-modal relations (e.g., "It was such colorful music").

The patients were then required to point to a picture from a set of four that went best with the sentence. For example, in the psychological–physical metaphor, the picture choices were (a) a literal depiction of the sentence (e.g., a person carrying a large red heart), (b) a depiction of a physical aspect of the sentence (e.g., a 500-lb. weight), (c) a depiction of an emotional aspect of the sentence (e.g., a red heart), and (d) a metaphoric instantiation (e.g., a crying person). The participants were then asked to explicate the metaphoric sentence verbally.

Patients with damage to the left hemisphere, whose language functions were compromised, could match the sentence to the appropriate metaphoric depiction, but their explanations were overly literal. In contrast, patients with damage to the right hemisphere gave more appropriate explanations, but they were unable to match the proper depiction to the metaphoric sentence. Winner and Gardner (1977) suggested that the right hemisphere is crucial in processing aesthetic meaning, presumably because cognition and affect are dissociated in right-hemisphere-damaged patients.

An alternative explanation, however, is that right-hemisphere-damaged patients evidenced an inability to correlate a genuine likeness between the visual image in the vehicle of the sentence and its actual physical (pictorial) counterpart. It has been suggested that the right hemisphere plays a substantive role in the comprehension of complex patterns and images (Goodglass & Butters, 1988; Heller, 1990), whereas the left hemisphere has been shown to be adept at using visual imagery for comparing details, as in recognition of letters of the alphabet (Farah, Gazzaniga, Holtzman, & Kosslyn, 1985).

Theoretical Issues

Pictorial Tropes

Kennedy (1982) claimed that not only can pictures be metaphoric, but many also correspond to literary tropes. For example, pictures can be allegorical; they can treat subject matter in a frivolous manner (as in persiflage), or can function metonymically by using a part of something to represent the whole (e.g., a man's cane representing the man). Some pictorial devices, however, have no recognizable equivalent in language (pictorial runes). In any case, a pictorial metaphor is defined as one that violates the standard canons of depiction.

There are problems with this approach, however. One presumes that by "standard canons of depiction" (p. 590) Kennedy (1982) has in mind "realistic" drawing and painting. Furthermore, although it may be somewhat easier to specify what standard linguistic canons are, the notion appears somewhat fuzzier in the realm of the plastic arts. What evidence Kennedy does marshal for his position is the classic study by Hochberg and Brooks (1962) in which a 2-year-old who had never been exposed to pictures was able to instantly recognize common objects in two-dimensional depictions. But the researchers assumed that objects in pictures and photographs reproduce, for all practical purposes, their three-dimensional equivalents.

According to an alternative account, the act of viewing a painting, a drawing, or even a photograph relies on learning and the acquisition of visual literacy (e.g., Dondis, 1973). Moreover, many of the stimuli used in the experiment were drawn from cartoons and popular media and did not address the scientific and artistic uses of visual metaphor (Markoff, 1988; see the next section). Nonetheless, Kennedy's (1982) study provides a helpful taxonomy of pictorial equivalents of common linguistic tropes.

Metaphors in Science

In Dreistadt's (1968) terms, a scientific metaphor is a verbal analogy based on sensory imagery, which may or may not include internal proprioceptive feedback. Nonetheless, what Dreistadt referred to as a "personal analogy" (an analogy that includes proprioceptive feedback) is, in essence, a nonverbal visual–kinesthetic metaphor. Moreover, his insistence that metaphor is linguistic is even more puzzling because he cites the claim that Einstein's creative thought derived from visual and kinesthetic experience in which spoken or written language played no substantive role. In fact, many visual analogies in science may be called to witness: the snake image that gave Kekule the idea for the structure of benzene; Darwin's "living tree metaphor" for the evolutionary process (Gruber, 1978); and the structure of DNA, which was likened to a spiral staircase. Dreistadt (1968) misses the point, because the analogy between visual patterns is the metaphor. Although we may use language to denote the relationship, the naming does not constitute the metaphoric act itself.

Homospatial Thinking

Rothenberg (1980) addressed the cognitive mechanisms underlying nonverbal metaphor in a process he called "homospatial thinking." This form of thinking consists of mentally representing, in the same space or spatial relationship, two or more distinct entities, although the thinking can derive from any of the five sensory modalities. Indeed, the approach is a direct descendant of Richards's (1936) and Black's (1962, 1977) views that metaphor involves an interaction or fusion between the tenor and the vehicle, as in the metaphor "The road was a rocket of sunlight." In the case of visual metaphor, there is an integration of visual elements (e.g., shape, form, content, and color) into a whole or unity within the plane of the picture.

Fusion, however, is not limited to the visual modality. One can, according to Rothenberg (1980), experience kinesthetic sensations of moving both vertically and horizontally in the same space, as a gymnast may, or simultaneous tactile sensations of smoothness and granularity, as in running one's hand through unmixed fresh paint.

Filmic Metaphor

A similar account has been invoked to explain filmic metaphor (Harrington, 1973). According to this view, a cinematic metaphor is an analogy linking whole images or individual features of images. For example, in a detective movie, a scene of an English sleuth closing in on a case is abruptly followed by the next day's event, in which foxes are being hunted in the countryside. Metaphor can also arise not only from an analogy between visual images—visual scene juxtaposed against visual scene—but from a montage of sound plus visual and sound plus sound. The juxtaposition of images in this way functions to engage the viewers emotionally and intellectually by enabling them to relate resemblances or remembrances from their own experiences to the events in the film.

Metaphor in Dance

Similarly, in choreography, metaphor involves the juxtaposition of unexpected movements, creating a new kinesthetic and visual–spatial form. This new form may evolve through (a) the use of one movement as an equivalent for another or (b) random variation. For example, in Merce Cunningham's choreography, a relationship among young lovers is conveyed through the juxtaposition of formal choric elements (e.g., an abstract movement pattern communicating rejection). Insecurity is communicated through a spatial analogy to modern physics in which the space of the stage appears to the viewer to lack fixed points of reference (Kisselgoff, 1987).

Models and Analogues

Another consideration is Black's (1962, 1977) use of the term *model*, which he likened to metaphor. The term is used to specify a set of cognitive and affective relations between two conceptual domains. In Black's view, a model or metaphor is a distinct form of cognition that is not reducible to comparison across conceptual domains and that results in an emergent meaning. In particular, Black considered theoretical and analogue models as primarily visual insofar as one domain reproduces the same iconic pattern of relationships in a second domain.

An example of research in this area is Gentner and Grudin's (1985) historical study of 265 mental metaphors used in psychology. They categorized the uses to which metaphors were put, defined in terms of structural or relational analogues. Categories included animate-being, neural, spatial, and system metaphors, the latter including mathematical models. To be sure, neural, spatial, and system metaphors all share a heavy emphasis on iconic (spatial) relations, presumably because neural and system metaphors evolved from theories in physics and electrical engineering, including computer design.

Theories of Visual Metaphor

Philosophers, art historians, and other commentators have theorized about the basis of visual metaphor. Henle (1958) and Ricoeur (1978) claimed that there is an iconic element in metaphor; not all metaphors possess this quality, but visual metaphors possess it by definition. There are two categories of visual metaphor: Some visual metaphors have a direct qualitative similarity (e.g., shades of blue on a map indicate bodies of water), whereas others have a similar structure (e.g., the map denotes a set of spatial relationships in the real world; Henle, 1958). Indeed, Ricoeur (1978) proposed that in the imaginative process of understanding any metaphor, there is (a) a productive mode in which there is an initial synthesis of the two source domains; followed by (b) a pictorial mode in which the metaphor provides mental images (not necessarily visual) that enlarge the sense of the metaphor; and (c) a third stage, marked by suspension of reference, in which a new creative referent emerges.

Similarly, Richards (1936) defined visual metaphor as a process "in which we perceive, think or feel about one thing in terms of another" (p. 116). For example, we may see a building as having a facial expression. Moreover, there is a continuum of visual metaphors, from those that elicit inborn responses (e.g., the color green to denote disease) to those that are learned and based on convention (e.g., height standing for nobility; Gombrich, 1963, 1982). Indeed, research has shown that classes of abstract visual figures convey specific emotional reactions that are universally understood by viewers (Kohler, 1947; Werner, 1948; Werner & Kaplan, 1963/1984).

Other theorists concerned with the role of metaphor in the arts have claimed that visual metaphor juxtaposes two disparate realms as it simultaneously highlights an essential or nontrivial similarity between the two (Heffernan, 1985). For example, a graphic hybrid of Winston Churchill with his head attached to the body of a bulldog makes a metaphorical statement about Churchill's character. Similarly, Alfred Stieglitz's series of cloud photographs suggests a metaphorical resemblance between seemingly nebulous shapes and feelings of alienation (Sekula, 1981).

Philosophical Bases

The previously mentioned illustrations suggest a more general property of visual prehension, a quality referred to in analytical philosophy as "seeing-as" or "metaphorical seeing" (Aldrich, 1968; Wittgenstein, 1958). Aldrich maintained that in seeing one thing, the material (M), as another, the subject matter (A), there exists the expressive sum of M and A, which is "bodied forth" or "expressively portrayed" in the content (B). For example, Pablo Picasso used a wicker basket to represent the rib cage in his painting "The Goat." The wicker basket (M) is seen as a rib cage (A)—not as any ordinary rib cage, but as a found object, presumably representing the interdependency of nature and culture, that is, the content (B). Picasso stated, "I move from the basket back to the rib cage: from the metaphor back to reality. I make you see reality because I used the metaphor . . . My sculptures are plastic metaphors. It's the same principle as in painting" (cited in Aldrich, 1968, p. 75). The same could be said of Picasso's use of a vase to portray a woman's hip. In both cases, according to Aldrich, (B) exists as a visual symbol that expressively portrays the metaphorical relationship between (M) and (A).

In the history of ideas, Nietzsche (1873/1974) maintained that metaphor was primarily nonlinguistic: "He therefore forgets that the original metaphors of perception are metaphors, and takes them for the things themselves" (p. 183). However, whereas Nietzsche saw metaphorical meaning as ubiquitous, Danto (1981) contrasted literal with metaphorical meaning, distinguishing between pictorial cliché and true visual metaphor. Pictorial clichés, for example, have had at one time a metaphorical meaning, but have lost their metaphorical import through overuse.

Pictorial metaphor, however, involves semantic deviance. For instance, stars depicted over a man's head are a visual metaphor for a sustained blow. The depiction is deviant because it is not literally true that stars exist over the man's head; rather, they metaphorically represent mental confusion. A theory of metaphor, according to Danto (1981), must apply, at least, to the main systems of representation, language and pictures, inasmuch as there are semantically deviant instances of each. Moreover, part of the uniqueness of metaphor involves the features of the representational system that embody it. Where equivalence exists, it lies in the fact that each of the rhetorical tropes has its pictorial counterpart (e.g., visual puns).

The Semiotic Perspective

Finally, the semiotic viewpoint offers a perspective on nonverbal metaphor (Worth, 1974). According to this view, metaphor is the juxtaposition of various elements of a symbolic code: visual, verbal, musical, or mathematical, and it provides a structure by which elements of a code may be related. In the case of the pictorial realm, metaphor is best thought of as a "caricature" that communicates a set of symbolic relationships within a pictorial context. For instance, a caricature of Richard Nixon highlights certain facial qualities while retaining some of the literal perceptual features that distinguish Nixon from others. What one notes in a caricature of Nixon is a similarity between certain visual qualities (e.g., exaggerated upturned nose and excessive jowls) and his media personality. According to the semiotic view, metaphor captures the similarity by providing a semantic structure appropriate to the intended characterization.

The Role of Visual Thinking

An ongoing series of empirical studies (Kosslyn, 1980; Shepard, 1978) has marshaled strong support for the view that internal mental representations are imaginal in quality as opposed to claims that they are solely symbolic or linguistic (e.g., Fodor, 1975). Representational objects (e.g., charts, maps, diagrams, paintings, and models) have been conceptualized as the externalization of mental images (Beilin & Futterweit, 1988). Scientific visualization through the use of supercomputer technology has permitted researchers to examine data and detect patterns not previously discernible through analysis of numerical relationships, suggesting that the human brain's capacity to recognize visual patterns is central to scientific reasoning (Markoff, 1988).

Arnheim (1969) argued that thinking may be largely imaginal and that visual, not verbal, thinking is perhaps the most important and central mode of thought. A central tenet of Arnheim's approach is that concepts describing abstract relations have a perceptual origin. For example, the concept of mental depth is derived from physical depth, that is, the perception of depth in the real world. In fact, Silberer (1951) first described spontaneous visual images in hypnagogic states that seem to parallel, in subject matter, thinking with verbal concepts. That is, just upon falling asleep, a fleeting thought is replaced by a visual image that substitutes for the thought in certain respects.

Visual metaphor, according to Arnheim, consists of the pairing of two visual images, resulting in the foregrounding of a quality common to both. For instance, the line "The sea is turning its dark pages" consists of the pairing of two images (the sea and dark pages) and the common quality of waves and pages turning (Levertow, cited in Arnheim, 1969). Similarly, Gruber (1978), in describing Darwin's depiction of evolution as a branching tree, claimed that Darwin used extensive visual imagery in the development of his theory of evolution, ultimately settling on the imagery of a triple-branching structure. Nevertheless, although images may be of a more personal nature (e.g., Freud's graphic representation of the psyche as a tripartite structure), they may eventually come to be shared collectively by the scientific community. Gruber suggested that such "images of wide scope" indicate significant connections between visual imagery, artistic form, and scientific thinking.

Indeed, it has been argued that people who are congenitally deaf use predominantly visual modes in thinking and memory (Sacks, 1988), and it has been suggested that the evolution of visual and spatial imagination stimulated technological progress in the development of weapons and tools (White, 1989). Visual imagery makes possible the reduction in scale essential to creating a three-dimensional model or analogue—such as a tool for extracting objects from narrow spaces—and it serves an important aesthetic function. Even if language did exist before the development of visual imagery, imagery may have fulfilled the important role of communicating shared images. It thus allowed the cultural transition to image-based conventions: the beginnings of representational art and the technology of tool use. Furthermore, imagery, particularly visual images, may play an important role in insight learning. According to Dreistadt (1968), the psychological mechanism of insight serves to "transfer" a visual pattern from a known situation to a new problem context. The parallelism of gesture and speech suggests that two kinds of thinking may be occurring simultaneously: an imagistic type of thought and a syntactic one. Therefore, it has been claimed that gestures and speech share a computational stage in which the "sense" of a word is filled in through imagistic (visual) thought (McNeill, 1985, 1989). To be sure, imagery is not solely visual. Piaget observed his 16-month-old son, Lucienne, appear to invent a solution to a problem of attaining a chain from a matchbox with the almost simultaneous opening and shutting of his mouth (Piaget, 1962). Moreover, this account receives support from developmental studies that indicate that infants possess the capacity to represent information kinesthetically and that this capacity develops rapidly with age (e.g., Seitz, 1992).

Conclusions

Theories of metaphor have been derived from studies of metaphor in language and, as a consequence, have been limited in their generality. Until recently, few researchers have addressed the underlying cognitive mechanisms, and when they have, models have been predicated on linguistic processes. As a result, the models have shown an inability to explain various nonlinguistic phenomena that may share similar underlying processes. The thrust of the present review has been that if metaphor is conceptualized simply as largely a property of language, then progress will be limited in understanding human cognition.

Metaphor is a much more expansive cognitive mechanism. Metaphor appears to consist of several "natural kinds" that cross-categorize experience along a continuum from the more sensory–perceptual (enactive, perceptual, physiognomic, and cross-modal) to the more conceptual (psychological–physical, taxonomic, ontological, and spatial). These processes are "captured," secondarily, in linguistic, graphic, and gestural symbol systems.

Evidence was marshaled to illustrate that metaphor is a mode of cognition that operates in various nonlinguistic media. Metaphor may therefore consist of a correlated set of cognitive mechanisms that are brought to bear on diverse symbol systems. It may be that all metaphor involves recognizing similarities within and between sensory domains (enactive, perceptual, and cross-modal), but some metaphors add a substantial affective component (physiognomic and psychological–physical) or invoke higher order analogical capacities (psychological–physical and taxonomic). In the latter case, there is a re-representation of sensory–perceptual information at higher levels of cortical organization (Hughlings-Jackson, 1884/1932), enabling metaphor to partake of more central cognitive mechanisms involved in human reasoning (Fodor, 1983). To this end, research investigating the content and domains of metaphoric abilities appears to be a promising means of understanding human cognitive capacities.

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