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Relativism in Gibson's Theory of Picture Perception

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J.J. Gibson's ecological approach to depiction is compared with Nelson Goodman's relativist theory of representation. Goodman's commitment to radical relativism and Gibson's to direct realism would make these thinkers unlikely candidates for comparison if Goodman himself had not indicated a substantial body of agreement with Gibson in the area of picture perception. The present study analyzes this agreement through systematic discussion of the following theses: realism in representation is not a function of geometrical optics, physical similarity to what is depicted, or deception; pictures differ in density and articulation from words, so that picturing has no explicit vocabulary; and artists can teach us new ways to see the world. The agreement between Goodman and Gibson has wide-ranging implications for the further development of what might be called a Gibsonian relativism.

James Gibson is known for a psychology of direct perception that is consistent with the philosophy of direct realism (Reed and Jones, 1982). However, some authors have argued that Gibson sometimes endorsed a rather different philosophy—cultural relativism (Costall and Still, 1989; Katz, 1987) or pragmatism (Noble, 1981). Although Katz (1987) argued that classical Protagorean relativism is fully consistent with Gibson's direct perception theory, others have claimed, perhaps more reasonably, that there is an unresolved "tension" in Gibson's theory between its direct realist and cultural relativist elements (Costall and Still, 1989). Surprisingly, those who have discussed the realist–relativist tension in Gibson have ignored a passage by Nelson Goodman (1984, pp. 9–14) that reveals a partial meeting of minds between himself and Gibson. Goodman's stature as a philosopher and his well-known position as a radical relativist should have attracted attention, or at least puz-

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zled interest, from realist Gibsonians. Such neglect is perhaps understandable. For one thing, it is not necessary to refer to Goodman to make the general point that there are relativistic tendencies in Gibson's later writings. And for another, it is now routine for students of direct perception to contrast Goodman's brand of radical relativism with Gibson's direct realism in discussions of these ostensibly opposed philosophical orientations (e.g., Gosselin, 1983). As most readers are aware, a critical comparison of Gibson's direct realist approach to perception with Goodman's relativism can be highly illuminating.

Both the alleged similarities and the obvious contrasts between the approaches of Goodman and Gibson occur in the area of picture perception, specifically in regard to the role of linear perspective in the production of "correct" or "accurate" representations (see, e.g., Gibson, 1971, pp. 29–32; 1986, p. 285; Goodman, 1976, pp. 10–11; 1984, p. 11; Gosselin, 1983; Wartofsky, 1980). Talk of similarities between realists and relativists on the theory of perspective is unusual because the contrasts are, indeed, quite marked. A realist would argue that perspective contributes to the realism of a picture because the rules of perspective allow an artist to structure light so that it conveys to the eye information that is similar to the light delivered from a corresponding scene. In contrast, a relativist would argue that the rightness of perspective is as much a matter of convention as are the theories and facts of science. Perspective informs only relative to the context and systems of Western art. Of course, a realist would object that neither scientific theory and fact nor Western linear perspective is conventional. Accuracy in science and art is often understood to be the result of the correspondence of fact, theory, or picture to an independently existing world—an external world that is somehow set over and against the limits of the human capacity to know and perceive (Bartley, 1987; Gombrich, 1960, pp. 254–257; cf. Goodman, 1960; von Uexkuell, 1957). A realist strives to discover truths in an independent reality despite the supposed inaccuracy of perception and thought, whereas a relativist seeks to recognize truths in the applicability of one or more world-versions (e.g., blueprints, pictures, models, or theories) to a specific set of circumstances. Accordingly, a realist would claim that a picture rendered in "correct" perspective carries truthful information about the world, and a relativist would say that perspective is just one of many ways in which humans can make their worlds through the construction of world-versions that are right by convention.

As a realist, Gibson (1966) argued that pictures convey "knowledge *about* the environment" (p. 91). But Gibson also claimed that pictures involve a more direct response to, or knowledge *of*, their surface properties. The distinction between three-dimensional pictorial reality and two-dimensional picture plane reality is known as the "dual reality of pictures" (Haber, 1980a,

1980b). Indeed, a picture is both a scene and a surface: "We distinguish between the surface *of* the picture and the surfaces *in* the picture" (Gibson, 1986, p. 282). This distinction implies a difference between two kinds of perceptual awareness: knowledge about and knowledge of a pictorial ecology. These two types of awareness are not both present at birth. In fact, children have a difficult time seeing that a picture is itself a flat object despite the fact that they readily perceive depth relations in both pictures and scenes (Haber, 1980b, pp. 15–17). Evidently, learning to perceive the information made available by artists results in a change in awareness such that normal adults can see a picture as a surface as well as a scene. In keeping with his general theory of direct perception, Gibson was content to explain picture perception in terms of a passive process akin to categorical perception (Rosinski and Farber, 1980, p. 158). However, it is possible that in learning to perceive the flat surface of perspective pictures one also learns certain assumptions of picture production and viewing that may be useful in viewing pictures under ordinary conditions of unconstrained observation. Such assumptions would be informed by convention.

Below it is argued that there is more than a hint of relativism in Gibson's theory of picture perception. The information contained in a picture, what the picture is about, is said to be tacit or implicit in the picture (Gibson, 1986, p. 285), and the only information that is directly perceived in a picture is the information that specifies the picture's surface (pp. 280–283). As one learns to perceive the surfaces of a picture and other objects, as opposed to the surfaces within the picture plane, the visual system is modified so that a "mediated" or "indirect" awareness of the surfaces-within-a-surface can be achieved. The space of a picture is a virtual space that is defined relative to an observation point, and geometrically constrained. It is the author's contention that such a space needs no external justification, and that the "correct" stationpoint is just the point from which the artist constructed the spatial layout according to the conventions of making and viewing pictures in standard perspective. As Protagoras was made to say by Plato's Socrates, "nothing remains . . . but that it and I should be or become . . . *for each other*" (Plato, 1934, p. 57). The virtual reality of a perspective picture exists relative to an observer. However, because the markings on a pictorial surface remain unchanged with observer movement, a picture's virtual reality must change (compress, expand, and shear) with observer movement. Yet pictures do look "real" even when one strays from the construction point. No match between a virtual and a physical world seems necessary for realism in art. What the author calls "Gibsonian relativism" is an explicit acknowledgment of the lack of necessity of the Gibsonian realist call to arms. The position put forth in this paper is consistent with Putnam's "internal realism" if the reader prefers that terminology (e.g., Putnam, 1978, pp. 123–140). However, the

main point of the paper is that the essential aspects of Gibson's theory of picture perception can be salvaged without presupposing Western linear perspective as canonical. The system of perspective is conventional, and viewers must adapt their viewing to the peculiarities of that system.

Goodman's own confession of agreement with Gibson provides the basis for the following arguments. The meeting of minds between Gibson and Goodman occurs in the context of an inquiry into the possibility of realism in representation (Goodman, 1984, pp. 9–12). Goodman claims agreement on the following points. First, Gibson rejected the notion that realism derives from an optical identity of the light delivered from a picture and a corresponding scene. Second, Gibson argued that it is impossible to construct a literal copy or replica of objects and events on a flat, two-dimensional surface. Third, the belief that some paintings look so lifelike that they can literally produce an "illusion of reality" is a myth propagated by prejudicial beliefs in the fallibility of the senses and the deceptiveness of art. Fourth, Gibson argued that pictures must be distinguished from words on the basis of the former's complete lack of articulation. And finally, a point unnoticed by Goodman as an instance of the agreement between Gibson and himself (but one that is emphasized in Goodman's own work): Gibson believed that pictures, like words, serve to capture knowledge and act as aids to memory and understanding. All of these ideas are central to both writers' views. In what follows, the way that each idea contributes to the development of Gibsonian relativism will be considered in turn.

Steps Toward a Gibsonian Relativism

Perspective is Not a Correct Equation of Bundles of Light Rays

The rules of linear perspective were originally constructed to provide artists with standards for depiction that could supersede an individual's idiosyncratic way of seeing or depicting the world (Fineman, 1981; Janson, 1962; Kubovy, 1986a; Lynes, 1980). This attempt to provide correction to the artist's eye led to a system of depiction in which pictures could be recognized as surrogates for objects and events in the environment. Perhaps the most intuitive explanation of the so-called "realism" of Western art is the view that representative pictures are the product of a steady hand, a stationary eye, and two precisely matching bundles of light rays: the first delivered from an object's surface to the eye, and the other delivered to the eye from a two-dimensional pictorial surface. A matching of bundles of light rays is measurable in principle, and would justify the correctness of perspective if it could be considered as an adequate criterion of realistic representation. However, following Goodman (1976, pp. 17–19), it is easy to see that matching cannot be such a criterion.

To see why light matching is not an adequate criterion of realistic representation, consider the relation between the artist and the medium. Presumably, the artist's task is to select a cross section of a set of solid visual angles that object surfaces subtend to a single unmoving eye, and transpose that cross section to a two-dimensional picture plane. For a mathematician the transposition is very simple. Artists, too, have shorthand rules that capture, for example, the geometrical fact that a retinal projection decreases in size with increasing distances of its object to the eye. Perspective geometry as applied to a two-dimensional picture plane results in lines that converge toward a point on the horizon, and signify the recession of parallel lines away from a stationary viewpoint. The prototypic example of linear projection is the apparent convergence of railroad tracks as they recede from a static observation point. Because the principles of perspective are mathematically compelling (Sedgwick, 1980, 1986), Gombrich's (1960) remark that one "can not insist enough that the art of perspective aims at a correct equation" (p. 257) is taken for granted by many. It is the nature of what is being equated that is at issue here.

Goodman (1976) has argued at length for the view that a physical matching of bundles of light is not an adequate criterion of realistic depiction (pp. 17–19). To get a feeling for Goodman's argument, imagine looking upward at a tall building. The parallel sides of the imagined building appear to converge inward as the building recedes from the point of observation. This image is analogous to what is seen when looking upward at a tall building. But it is not the view that is ordinarily depicted (though, obviously, it is possible to photograph or paint such a perspective). Now imagine raising the height of the point of observation while also changing the line of vision so that it is parallel to the ground. Continue this process until the parallel sides of the imagined building appear vertical. Now, in order to "see" the entire building at once, the mind's eye stationpoint will have to be moved backwards away from the face of the building. This second image is analogous to the view characteristic of standard perspective. Goodman argued that standard perspective pictures do not require that the artist actually achieve a physical matching of bundles of light. Often, the view that is seen when an artist depicts is not the view that is depicted. As this demonstration has shown, the perspective that is matched may just as well be imagined as physical.

Goodman's argument is not entirely compelling (Kubovy, 1986b, pp. 122–125), but his case does not rest on it. Perspective is not a faithful projection. Arnheim (1974) pointed out that perspective pictures conform to the rule: "no feature of the visual image will be deformed unless the task of representing depth requires it" (p. 286). For example, in simple applications of one-point perspective, the frontal face of an object is rendered in the frontal plane without perspective deformations while its orthogonals converge to a

single vanishing point. In two-point perspective, objects are defined by two families of converging edges but the verticals remain parallel to the picture plane. In three-point perspective, the convergence of the parallels of a tall building seen from a low or high stationpoint can be achieved. But the major problem with all three types of perspective is that outside of a very narrow cone of vision, objects begin to appear stretched, warped, and strangely tilted. Architects generally avoid such "distortion" by means of various techniques because it is distracting in the effort to depict depth. Such distortions are unacceptable in realistic depictions despite the fact that these strange perspective appearances are geometrically correct given the artist's construction point and a flat picture plane. Note, however, that the term "distortion" is applied relative to the purpose of depicting depth not relative to an absolute geometrical criterion.

Such arguments do not rule out the possibility that perspective can approximate the projection of light from an environment. But they do question the validity of the idea that a vision independent match is achieved when perspective is used. Perspective is relative to the relevant aspects of depth representation, and a consideration of what is relevant depends upon what can, or perhaps what will, be seen. The worlds created by means of perspective are not equivalent to the geometrical or physical world. Rather, they are worlds in which the surfaces of objects are depicted so as to display distance to a virtual object from an eye that is stationed at a particular point in space. When one looks into a perspective picture, one looks into a virtual space. Moreover, where one stands to look at a picture determines the shape of that space. If a viewer moves toward the picture plane, virtual space expands. And if a viewer moves laterally, virtual space shears. In this sense, perspective pictures offer a viewer an infinity of virtual worlds that are each the result of occupying one of an infinity of viewpoints that can be assumed relative to a picture plane.

These viewpoints need not be the physical standpoint that the artist assumes in relation to an actual scene. They are just points in space that specify a unique relation between an observer and a virtual reality. If, however, the standpoint of the viewer is identical to (or functionally equivalent to) the geometrical stationpoint employed in the construction of the picture, perspective specifies a place from which the world within the picture can be seen as if a certain ideal relation obtained between the viewer and a represented scene. If the perceiver occupies that precise location, the depth effect can be striking. But there is no guarantee that an observer will actually occupy this location. In fact, viewers ordinarily walk back and forth in front of pictures, changing their distance from the picture plane continually. Despite changing observation points, the perception of a picture's spatial layout remains surprisingly constant (Busey, Brady, and Cutting, 1990; Goldstein,

1987; Rosinski and Farber, 1980). The geometry of virtual space ties the moving perceiver to a multiplicity of virtual worlds, but it does not explain how one comes to perceive a single pictorial world despite multiple viewpoints. The achievement of realism in perspective pictures does not require the strict correspondence of light rays delivered from a virtual reality and a physical world.

Gibson (1986) put these central ideas as follows:

> If it is not true that a picture in perspective represents reality and a picture not in perspective fails to represent reality, what is true? My answer is that if a picture displays the perspective of a scene it puts the viewer into the scene, but that is all. It does not enhance the reality of a scene. The seeing of oneself is not negligible, but it is not the sole aim of depiction. (p. 283)

Perspective geometry puts the viewer into the pictorial scene. It defines where an observer is in virtual space relative to the direction of the gaze. Moreover, a "picture supplies some of the information for what it depicts, but that does not imply that it is in projective correspondence with what it depicts" (p. 279). Gibson argued that perspective "locates the observer in a virtual environment" such that the viewer is "taken out of oneself [and] transported" into the pictorial world by a mediated awareness of "being in the world" (p. 284). But a proper viewing of a perspective picture does not require its correspondence with a physical scene. The relational overtones of these ideas—the specification of a pictorial ecology measured relative to a perceiver—would be considered an advance for a relativist such as Goodman (1976) who argued that "the behavior of light sanctions neither our usual nor any other way of rendering space; and perspective provides no absolute or independent standard of fidelity" (p. 19). Neither Goodman nor, at least, the later Gibson conceived of perspective as a "correct equation" of the light delivered from a virtual and an actual environment (cf. Gibson, 1960, p. 227). However, because we do not see a multitude of worlds when we explore the surfaces in a picture, it is reasonable to ask about the nature and limits of the mechanism(s) responsible for layout constancy in pictures.

Realism is Not Achieved By Tracing the World

In the last section we saw that visual representation cannot be derived from the optical projection of objects. Linear perspective taken as a mutual relationship between subject and object contrasts with the realist notion that accurate pictures necessarily correspond with the world just *as it is*. If correspondence is not the key criterion of realism in art, perhaps a realist can find that criterion in an artist's skill at replicating or copying the world.

The age-old idea that objects can be copied from a single, fixed stationpoint is widely accepted; but it is thoroughly misleading. Imagine looking through a plane of glass at an object in your visual field. Almost anyone could use a grease pencil to trace the edges of the object on the glass plane. Merely tracing the outlines of an object on a piece of glass is not a cultured skill. But Leonardo da Vinci proposed such a method as a means of learning about perspective projections, for the way that light geometrically cuts through such a plane is far from obvious to the untrained eye. Indeed, the freehand coincidence tracing of edges is learned through cultured practice. To understand how the perception of surface information in pictures requires sophistication on the part of the visual system, consider a simple analogy (Niall and Macnamara, 1990, p. 654). If one traces the shape of one's face on a mirrored surface, the shape of the surface reflection will be highlighted and brought to attention. Such a demonstration will make it evident that there is a qualitative difference between the shape of the surface reflection caused by a face and the shape of the face as it is perceived. Moreover, the shape of the face reflection will not necessarily be as recognizable as the shape of a face. One does not ordinarily pay attention to the surface of two-dimensional displays. Priority often goes to the surfaces in a display. Niall and Macnamara (1990) found that people were better at reconstructing the actual shape of an object than they were at simply copying its surface appearances. Such findings reinforce the importance of the need to distinguish between "knowledge about," and the more sophisticated "knowledge of," a pictorial surface. (It should be clear that the phrase "knowledge about," as it is used here, does not refer to the correspondence of a picture's spatial layout with the layout of physical space.) As stated previously, developmental evidence is consistent with the proposition that surface information is perceived later than three-dimensional reality. Interestingly, an expert in the field of perspective drawing techniques (Leach, 1990) advised that learning to draw in perspective requires a special skill to see the world such that "a gable roof becomes an equilateral triangle, a projected bay becomes a cube, a wood turning becomes a series of connected cylinders, and moldings are made up of many shapes combined" (p. 9). Perspective variations are not given, they are constructed (Wartofsky, 1980, p. 147).

Leonardo's prescription for tracing the world seems to be an easy procedure to follow, but there are complications. Much rests, for example, on the selection of one or more stationpoints. Stationpoints can be fixed close to the picture plane or far from it, they can be stretched high off the ground plane or pushed down near to it, and lateral displacements are also possible. Whatever decisions an artist finally makes about the placement of stationpoints, the finished work always depends upon the maintenance of a fixed, monocular viewpoint. As a consequence, the task of copying the world can only be

accomplished by an artist with an inhumanly steady eye. Indeed, Goodman (1976, pp. 11–12) pointed out that if copying demands the adoption of a fixed, monocular point of view, the coincidence tracing of edges is impossible because vision requires movement relative to what is seen.

An important aspect of Gibson's (1986) book is that much of the information for the perceptual systems is said to be generated by the movement of a perceiver. As a perceiver moves, the information in the ambient optic array changes continuously. In order to explain the temporal identity of objects, Gibson found it necessary to argue that there are "invariants" in the flux of the sensory array that can be "picked up" by the environmentally "tuned" perceptual systems of an exploring organism. Pictures, argued Gibson (1973; 1986, p. 271), contain invariants despite the fact that they are temporally frozen and relative to a particular perspective structure. Gibson's world was in flux, and his view of perception was of the continuous activity of information pickup. As Gibson (1986) remarked, "perceiving is a stream" (p. 240). But if so, then replicating, copying, or duplicating the world on a two-dimensional plane must require a literal re-presentation of the perspective and invariants of an earlier optic array. Gibson maintained that an artist can preserve only some of an array's invariants, that scenes "cannot be re-established," and that ambient optic arrays "cannot be reconstituted" (p. 279).

Gibson's claim was not just polemical. As Haber (1980a) pointed out, the ratio of the highest to lowest reflectance from a pictorial surface rarely exceeds 30 to 1. On a flat reflecting surface, such as a picture plane, the 30 to 1 ratio results because the least light absorbing surfaces are asymptotic to 95% reflectance, and the most light absorbing surfaces are asymptotic to 5% reflectance. But in natural scenes, reflections from "water, mirrors, metal, or narrow edges of almost any object may be hundreds, thousands, or even millions of times more intense than the light coming from the same source reflected from other surfaces in the same scene" (p. 374). Haber (1980a) remarked that no artist can ever "hope to duplicate the range of natural reflectances with pigments on a palette" (p. 374). Also, the brightness of hues is muted in pictures, saturation is limited in range, and shadows—which in natural scenes can be thousands of times less intense than illuminated surfaces—cannot be more than 30 times less intense than lit areas. Such considerations lend evidence to Goodman's (1976) assertion that the copy theory of representation "is stopped at the start by inability to specify what is to be copied" (p. 9). Gibson would probably have agreed with Goodman (1976) who said that "nothing is ever represented either shorn of or in the fullness of its properties" (p. 9). Note that the argument also applies to photographs. Though cameras can be held steady to particular points in space, photos are still subject to restrictions of intensity and spectral contrast.

A Gibsonian realist (e.g., 1960, p. 227) would not be discouraged by these facts. It is possible to argue that perspective is part of a *simplification* of ultimate reality. According to Sedgwick (1980, p. 36), for example, there are three major aspects to this simplification: (a) the world with its multiple textured surfaces and imperfect forms is idealized into a set of geometrical forms; (b) light is idealized into a set of rays that travel in straight lines; and (c) the formation of visual images is neglected because the eye is taken as an abstract point in space. The world of the realist is simplified by a reduction of its complexity and richness to a visual pyramid with the eye at its apex and the surfaces of the world at its base. Contrast with this the relativist Gibson (1986) who argued that the ecology of a perspective picture is made up of "*the surfaces of the world viewed now from here*" (p. 286). Clearly, the visual pyramid provides a "scale of space" (Arnheim, 1974, p. 290). But more than this, it is defined by an observer's location in virtual space. Gibson (1986) explained: "I notice the surfaces that face me, and what I face, and thus where I am" (p. 286). In much of Gibson's later writings, subject and object are mutually defined in the manner of objective relativism. But as Gibson insisted, and as remains to be shown, the stance of Gibsonian relativism is neither subjective nor introspective. Rather, it is "actually a reciprocal two-way attitude, not a looking inward" (Gibson, 1986, p. 286).

Deception is Not a Criterion of Realism

If the related notions of matching and copying fail as criteria of realism, perhaps a realist can find refuge in the notion that a picture rendered according to "correct" linear perspective can present an "illusion of reality" (Gombrich, 1960). After all, the spatial layout of a scene is three-dimensional and a picture plane is ordinarily flat. There is no question that this approach is more promising than those considered previously. If an optic array delivered from a picture is identical to a natural array, a perceiver can be fooled into mistaking a picture for what is depicted much as a duck can be fooled by a decoy or Wile E. Coyote by the Roadrunner's fake train tunnels. Gibson, though, had something very different in mind. According to Gibson, representative pictures function to convey information to other people (Reed, 1987a, p. 151). Perspective is not characterized by matching, copying, or deceiving. For the later Gibson, the focus on the identity of light rays that is inherent in these positions was wrong (p. 279). Perhaps it is better to stress the human capacity to see that a picture looks like, but not *just* like, what it depicts. Further, perhaps the selectivity observers employ in looking at perspective pictures is informed by the conventional system of linear perspective. An experiment by Gibson, Purdy, and Lawrence (1955) will help clarify these issues.

Gibson et al. presented a set of experiments that involved a special prop called an "optical pseudotunnel." This tunnel was made out of 19 to 36 thin sheets of plastic. Each of these sheets had a one foot circular hole cut out of the middle, and were hung vertically at equal distances one after another so that all of the holes lined up in the manner of a discrete cylinder. The sheets of plastic were black and white, and were hung in alternating fashion—white, then black, then white, and so on. Because each of the sheets were hung at an equal distance from the preceding sheet, a density gradient of increasing proximity toward the center of the optic array was displayed. Observers were then asked to look into this array structure and report what they saw. When 36 contrasts were shown, all observers reported seeing a solid striped cylindrical tunnel. With fewer (e.g., 19 or 13) or no (all black or all white sheets) contrasts, the visual experience of the inside surface of a cylinder became less and less compelling. Gibson et al. then made the apparent change in the density gradient more and more constant by increasing the spacing of consecutive sheets with increasing overall distances of the sheets from the observation point. Under these conditions, the perception of the continuous surface of a solid tunnel gave way to the perception of an archery target. Evidently, the "surfaceness" of the display depended on the proximity of light–dark discontinuities in the optic array, and their increasing density as a function of distance from the eye.

It must be stressed that this experiment involved the display of information without the ordinary source of that information: the information for the inside surface of a striped cylindrical tunnel without the inside surface of a striped cylindrical tunnel (Gibson, 1986, p. 153). Was Gibson et al.'s optical tunnel an illusion? Gibson vacillated on this issue. As a realist, Gibson admitted to having used the term "optical tunnel" to "suggest that the surface was not material or substantial but was produced by the light to the eye" (p. 153). Sometimes Gibson wished to distinguish the optic array provided by a display from that provided by a genuine world scene. In the realist sense, the optical tunnel was a virtual tunnel—that is, it was not real. So, the experience was illusory. But Gibson also argued that "the illusion was incidental" (p. 153), and that "the observers were fooled, to be sure, but that was irrelevant" (p. 154). Though most subjects were fooled by Gibson's display, that was beside the point. The information in the array specified the surface of a cylinder, it did not specify its own surface (a series of plastic sheets).

Gibson (1986) made it clear that laboratory phenomena such as the effects of the optical tunnel rarely occur in ordinary vision (p. 281). Events that result in the eye being duped by an illusion of reality usually depend on a stationary monocular viewpoint and a constricted field of vision. The eye, in Gibson et al.'s experiment, was considered as if it were a camera—Gibson used the term "aperture vision" to characterize the sort of vision that was

involved. But as Gibson repeatedly stressed, observers normally have two eyes located in a head that can turn, which is on a body that can move around. Goodman (1976) agreed: "Pictures are normally viewed framed against a background by a person free to walk about and to move his eyes" (p. 14). When one views a picture while moving past its surface, retinal patterns expand and contract, and if the viewer looks at more than one area of the picture a shift in maximal clarity will occur. However, because there is no "in front of" or "behind" in the case of a flat picture, the relative change in luminance and spectral discontinuities that occurs as perceivers move past objects in the natural environment is absent from the optic array delivered from the picture plane. In this way, the pattern of light to the eyes resulting from perceiver movement in front of a picture directly specifies the flatness of a picture plane (Haber, 1980b, p. 13). The probability that a binocular perceiver will be deceived by a pictorial world diminishes if the perceiver is free to use his or her perceptual systems to explore the surfaces in and on the picture plane. The staging of perspective can and should be understood in the context in which it is ordinarily viewed.

It should now be evident why deception in art is not the mark of representative realism. In the present context, the term "realism" can only mean that X (an artifact) resembles Y because resemblance does not require matching the geometrical projections of light or replicating the projections from a scene. If X resembles Y, X looks like Y but X is not identical to Y. A picture can resemble Y without the staging that gives rise to the vivid effects of an optical tunnel or an occasional *trompe-l'oeil* painting. Deceptive art, the pinnacle of the identity theory, is not broad enough to characterize "realistic" pictures, or their viewing. As a limiting case, deception in art should not be used as a standard for pictures that stand as visual surrogates. The identity theory misses the important point that resemblance goes hand in hand with the ability to discount negative evidence. Goodman (1976) put these points as follows:

> Deception enlists such mischief as a suggestive setting, or a peephole that occludes frame and background. And deception under such nonstandard conditions is no test of realism; for with enough staging, even the most unrealistic picture can deceive. Deception counts less as a measure of realism than evidence of magicianship, and is a highly atypical mishap. In looking at the most realistic picture I seldom suppose that I can literally reach into the distance, slice the tomato, or beat the drum. (p. 35)

The best attempts to deceive are rarely convincing, and when they are, they often depend upon abnormal viewing conditions. The argument here is not that because one can devise situations in which unrealistic pictures can deceive, deception fails as a criterion of representative fidelity. Instead, the whole basis of the argument from illusion is being questioned. Deceptive pic-

tures are an oddity; they fool because they misinform. The sorts of pictures that are hung on a wall in plain view are more common. If the search is for the criterion of realistic depiction, it must characterize pictures that are recognized as realistic. What ordinary perspective art shares with deceptive pictures is information for surfaces in, not the surfaces of, a standard pictorial space. Perhaps pictures stand as surrogates to the extent that they are informative about the surfaces within their surface, not misinformative with respect to two-dimensional reality. Implied is a mechanism that discounts evidence that a flat display is flat when two-dimensionality is perceived. Moreover, whether a picture is informative is subject to standards. In this sense, there is a normative aspect to Gibson's theory of pictures.

Others have recognized this normative aspect. For example, citing Sedgwick (1980), Costall (1985) restated Sedgwick's point that an artist can misuse an invariant, "but the outcome simply would not count as a 'good picture': it would 'misinform us'" (p. 27). This idea raises interesting possibilities. As Costall (1985) pointed out, "it is not only communication by means of pictures but the very process of their production which must be understood as a social phenomenon" (p. 27). Similarly, Goodman argued that "talk of mental representations turns out in the end to be talk of cognitive activities" (Goodman and Elgin, 1988, p. 90). Images, whether pictorial or mental, are part of an ongoing process of producing, judging, and revising displays and descriptions. Pictures are informative because they are *made* that way. Even a picture drawn according to so-called "correct" linear perspective, or a photo taken with a camera, is not necessarily informative by default. Indeed, the production of an informative piece of work, in art as in science, is a cultured skill subject to external and internal selection pressures. The main point here is that pictures are made with other people in mind so that even perspective must be construed within the context of its production.

The Distinction Between Pictures and Paragraphs

Picture perception is socially mediated, but it is not arbitrary. Costall (1985, p. 27) cited Wittgenstein (1974) to make the point that cooking is socially mediated yet not arbitrary. Just as the rules of cooking show diversity while they also reflect and perpetuate the laws of nutrition, so the rules of artificial perspective can be thought of as reflecting and perpetuating the laws of ecological optics. Perspective may best be conceived as a conventional system that guides the way that ecological laws are used in Western art. But to call perspective a convention is, for many, equivalent to calling it a language. That, however, is as great an error as the common fallacy of conflating the conventional with the arbitrary.

Gibson (1986) argued that the information available in pictures is not explicit in the way verbal information is explicit (p. 285). In spite of Gibson's misreading of Goodman to the contrary (p. 285), Goodman drew a sharp distinction between pictures and paragraphs (1976, pp. 225–232; 1984, p. 10). Though Goodman's argument is much too complex to pursue here, the main idea is that pictures are rendered with continuous variables that blend and merge so that any change in any respect (e.g., brushstrokes, arrangements of lines, coloration) changes the referent of the display, and paragraphs are constructed with discrete variables (e.g., letters, words) that have a prescribed identity. According to Goodman (1976): "nonlinguistic systems differ from languages, depiction from description, the representational from the verbal, paintings from poems, primarily through lack of differentiation—indeed through density (and consequent total absence of articulation)—of the symbol system" (p. 226). The difference between pictures and paragraphs lies in the syntactic density of the former and the discreteness of the latter, and that pictorial information is tacit or not explicit (Gibson's point), is a consequence of that density.

To illustrate, Kolers and Smythe (1979, pp. 330–331) pointed out that Goodman's distinction puts landscape paintings in a different class than architectural landscape plans because landscape plans are instructions for the geometry of object placement. Like a musical score, a one-to-one mapping can be made from a plan to its execution and back. But in a landscape painting, a slight difference in line width, for example, could result in an entirely different tree or daffodil. In this example, it can be seen that musical scores and architectural plans are more like words than pictures in that they have a prescribed identity. In contrast, a landscape painting is dense in the sense that it "provides for infinitely many characters so ordered that between each two there is a third" (Goodman, 1976, p. 136). The information in landscape paintings is not explicit because it is dense and, for that reason, nonverbal.

If perspective is used to depict, then by definition it is made of continuous rather than discrete variables. The term "variable" is taken in its statistical sense: a symbol that stands for a quantity or property. Gibson would obviously object to the characterization of perspective as a symbol (Reed, 1987b, p. 109), but there is no harm in deviating from Gibson when the alternatives seem more fruitful. The point here is to adopt Goodman's characterization of perspective as a symbol, while also making it clear that perspective is not to be considered as a language. In the case of perspective, its converging lines are symbols that delineate distance-now-from-here. Perspective is a continuous variable, meaning that (in theory at least) it is a variable that can take on infinitely many values between any two points. Consider, for example, that height, whether pictured or not, is a continuous variable—there are infinitely many heights between 4 feet 8 inches and 4 feet 9 inches. In con-

trast, words have the characteristic that for every two words K and K' and every word m that is not K and K', determination that m is not K or that m is not K' is theoretically possible (Goodman, 1976, p. 136). To reiterate, words are discrete variables, they are both finitely differentiated and articulate. The continuous variables of pictures are neither of those. If perspective is displayed discretely, it is due to the restrictions of the medium and tools of the artist. Following Gibson (1966, p. 281), information that is provided by the environment is infinitely rich, and lexicons are finite.

Much fruitful research has been done on the geometry of pictures (Sedgwick, 1980, 1986). But that geometry is only part of the story. Geometry alone specifies a unique stationpoint to which observers are not restricted despite the fact that the spatial layout of a scene can be recovered from a number of angles. Pirenne (1970) argued that observers compensate for points of view that deviate from the correct geometrical stationpoint. But compensation is a misnomer if it is allowed that there is no unique place from which to view a perspective picture. The concept of the information delivered from a perspective picture must be broadened to include a range of points, not just one. As Wartofsky (1980) stated, the system of relations among elements of shape and size characterized by perspective art introduces "not only a way of representing scenes, but a way of *viewing* such representations, a way of seeing pictures" (p. 144). Perspective pictures rarely, if ever, correspond (are geometrically isometric) with the physical world; indeed, the notion of correspondence is misleading. Rather, it is the "coherence in the relations among the represented shapes and sizes of depicted objects and scenes" that establishes the constancy of spatial layout despite differences in actual viewing angle (p. 145). The system of picture viewing according to linear perspective incorporates certain standard assumptions including, for example, that the construction point often lies on a line that is perpendicular to the center of, and located at a distance that is twice the height of, the visual display (Rosinski and Farber, 1980, p. 159). It is possible that such conventions of picture production are used together with the direct perception of surface slant and texture to enhance a viewer's ability to see "what the picture *would look like* from the front" (Wartofsky, 1980, p. 145). As Goodman and Wartofsky have conceived the matter, the capacity to view pictures according to a conventional system that enforces coherence in relations is an acquired ability that may be affected by technological and cultural differences. But that a capacity to use guidelines of perspective picture viewing is an acquired skill does not imply that it is difficult to learn (Jones and Hagen, 1980) or necessary (Busey, Brady, and Cutting, 1990; Perkins, 1973). It might be said that pictures are often read rather than registered, but that should not be taken to imply that perspective is arbitrary or analogous to a word (e.g., Davidson and Noble, 1989).

How Perspective Makes the World

As Goodman and Gibson stressed, not all information is explicit. Indeed, most visual information is nonverbal—although the information available in pictures can be made explicit, for example, by someone who writes a book on painting. But the fact that visual information is ordinarily tacit, does not make it second-rate to what has been made verbally explicit. Indeed, Goodman and Gibson wrote that artists can change the way we look at the world through the growth of our understanding. According to Gibson (1986), "pictures give us a rich grasp on the complexities of the natural environment that words can never do. Pictures do not stereotype our experience in the same way and to the same degree" (p. 262). Similarly, Goodman (1984) argued that because our seeing and painting are primarily nonverbal, they "may be more drastically modified by confrontation by an El Greco or a Braque than any string of words" (p. 12). The hold that words have over vision is more remote than the powerful effects of the information that is implicit and densely embedded in art.

It has been part of Goodman's thesis that art, like science, "provides a grasp of new affinities and contrasts, cuts across worn categories to yield new organizations, new visions of the world we live in" (Goodman, 1984, p. 5). Similarly, Gibson (1986) argued that changes in awareness can be induced by pictures, "perhaps even more readily than by words" (p. 262). Because pictures capture some of the richness and complexity of the environment in ways that words cannot, artists as well as scientists have the potential to show us things that we might never have seen, expected, or even imagined. The point, briefly, is that art can make a genuine contribution to understanding. Gibson fumbled for words to describe where his theory was going: a picture "cannot be true in the sense that a proposition is true, but it may or may not be true to life" (p. 262). It is, perhaps, better to say that even if a painting cannot be true, false, or correct, a depiction may be right for a world it makes (Goodman, 1976, pp. 262–265; 1978, pp. 17–19, 130–133, 138–140). It should be clear, given all that has been said, that a goodness of fit between picture and world must involve a two-way adjustment of picture to world and world to picture "with the double aim of comfort and a new look" (Goodman, 1976, p. 264). In sum, Gibson would be wary of the "new look" terminology, but he would agree with Goodman (1984) that the "rightness of what is said is a narrow species of rightness" (p. 39)—a sentiment that is far from the naive and popular notion that science aspires to truth while art aspires to beauty (also see, Kuhn, 1977, p. 340–351).

How, then, does perspective make the world? Arnheim (1974) provided the best answer:

> With central perspective, the relation to the viewer changes. Its principle structural lines are a system of beams that issue from a focus within the picture space and deny the existence of the frontal plane as they rush forward and break through it. Although it takes strong optical devices to give a viewer the actual illusion of being enveloped by this expanding funnel of space, even an ordinary painting done in central perspective will establish a rather direct connection between the events in the picture space and the viewer. Instead of facing the viewer perpendicularly or obliquely, the funnel of central perspective opens like a flower toward the observer, approaching him directly, and when desired symmetrically, by making the picture's central axis coincide with the viewer's line of sight. (p. 294)

Perspective involves the acknowledgment of an audience through a culturally unique window into a virtual reality. It does not determine and prescribe a stationpoint for an actual viewer, though the stationpoint is important in a picture's construction. For most adult viewers, perspective implies a path of observation from which an observer can see what a picture would look like from the front. Still, the existence of the worlds of perspective imply an observer, and reciprocally, an observer implies the existence of a world of surfaces that is positioned relative to a point of view. Though perspective deformations (elongating and squashing) occur on the surface of a picture as we walk past, we do not pay attention to them, we attend only to the familiar or standardized space within the pictorial surface. Vision is intentional, "which is to say we see that which lies before us, and not the properties of retinal images or of processes in the visual system" (Niall and Macnamara, 1990). Here, however, we have also been concerned with the projective deformations that occur *in* pictorial space that are difficult to see, or are discounted relative to the system of making and viewing surfaces rendered according to standard perspective. Exactly when these virtual worlds are seen and not seen, or discounted by compensation are matters for experimentation. Though Arnheim (1974) could conclude that linear perspective is "a manifestation of Renaissance individualism" (p. 294)—a means of constructing a viewer-centered world that reflects and perpetuates a Western hierarchical conception of human existence (p. 295)—it is also important to realize that the worlds in which a viewer is centered would be many if they were not constrained to one by means of some judicious blend of geometry and convention.

Conclusion

We are now in a better position to understand what Gibson (1986) meant when he said that a

> depiction captures an awareness without describing it. The record has not been forced into predications and propositions. There is no way to describe the awareness of being in the environment at a certain place. Novelists attempt it, of course, but they cannot put you in the picture in anything like the way the painter can. (p. 285)

Perspective is not a matter of matching, copying, or deceiving. It does not enhance the reality of a scene, it puts the viewer into the scene. Though the use of linear perspective is normative, perspective is not a language. And it should also be clear that to consider perspective as a symbol—as a continuous variable—is not to consider it as a language. Indeed, Goodman thought it wise to stop short of saying that perspective is analogous to words in a language, or worse, merely arbitrary. Gibson (1986) was mistaken to deride Goodman for holding that depiction was " fundamentally description" (p. 285). Indeed, as was shown above, there is much in Goodman's relativism from which Gibsonian thinking could stand to benefit. At the very least, the adoption of Gibsonian relativism would free Gibsonian psychology from the suspicion that it has made Western perspective canonical, and so, is culturally prejudicial.

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