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Research

Nelson Goodman's Arguments Against Perspective: A Geometrical Analysis

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Abstract. Nelson Goodman's highly influential book *Languages of Art* argued that that all visual experience is merely a cultural construct. In presenting his thesis Goodman relied on a series of geometrical arguments intended to show that the geometrical construction of perspective does not rely on the geometry of light rays. In this article I analyze the geometrical validity of Goodman's arguments.

Introduction

For the past fifty years few books by English-speaking philosophers have exercised a greater influence on art- and architectural history than Nelson Goodman's *Languages of Art* [1968]. This book was an important contribution to the rise of cultural relativism that subsequently came to dominate the English-speaking humanities for decades. Goodman adopted the view (previously advocated by Ernst Gombrich in his book *Art and Illusion* [1960]) that "there is no innocent eye" and that the totality of an individual's perception is predetermined by and a result of that person's conceptual framework.[1] Unlike Gombrich, however, Goodman inferred that, since our conceptual frameworks derive from the cultures we live in, all we can know and perceive is a result of our cultural background; he consequently argued that reality itself was but a cultural construct.[2] According to this view, there are no facts that constitute the world independent of human cognitive apparatus. Reality does not exist independent of our cognition, waiting to be discovered. Rather, reality, including everything we perceive, is itself constituted by one's conceptual framework, and the conceptual framework ultimately results from membership in a culture.[3] In other words, reality is formless; our cultural background slices it, one could say, into units that are comprehensible to us because we belong to a given culture. Since, following Gombrich, there is no innocent eye and we can perceive only what we already know about, Goodman infers that our perception too is fully determined by our membership in a culture.[4] The view has significant implications for architectural theory. If Goodman is right, architectural works cannot be perceived, let alone valued and appreciated on the basis of their shapes and proportions, formal and visual properties, composition of elements and spaces and so on. All that could possibly matter in architecture, according to this view, are concepts, meanings, stories and narratives that can be associated with architectural works. Since its publication, Goodman's book has played an important role in the rejection of formalist aesthetics.

The rejection of both perspective and the view that some visual representations represent *non-conventionally*, by simply showing objects the way they look, was the necessary preliminary step in Goodman's formulation of his argument. The radical cultural-constructivist position that Goodman advocated could not allow the view that a perspectival drawing (or a realist painting) represents an object by simply resembling it – for instance, by delivering a similar bundle of light rays that one would receive when

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looking at the object. Accepting that this is possible would mean that our interaction with reality is sometimes not mediated by our cultural background. It would mean that (in some cases at least) our perception of similarities does not derive from our membership in a culture. For Goodman, the similarity that we perceive between perspectival drawings (or realist paintings) and the things they represent, is only and exclusively a social convention. In his view, this similarity is independent of the geometry of light rays. In other words, resemblance between a cat and a drawing of a cat is nothing less conventional than the use of the word "cat" to refer to a cat. According to Goodman, *every* representation is conventional; the fact that we perceive perspectival images as similar to the objects they represent is a result of cultural inculcation.[5] Like every other mean of communication, perspectival images need to be *read* and this skill is acquired. [1968: 14].

In order to make this argument, however, Goodman had to show that the geometrical rules for the construction of perspectival images are arbitrary and do not depend on the geometry of light rays. The opening section of *Languages of Art* states a number of geometrical arguments that attempt to prove this. Although Goodman's entire argument hinges on the geometrical validity of his analysis and although its validity has been occasionally contested, no systematic analysis of his arguments has been published so far.[6] The absence of a systematic review of Goodman's geometrical arguments is remarkable, considering the wide (and sometimes critical) attention that his book received as well as the wide influence it exercised.[7] My paper is intended to fill this gap, by providing a systematic analysis of Goodman's arguments that pertain to the geometry of perspective. The paper will present a comprehensive analysis of Goodman's errors and define conceptual misunderstandings that generated them.

Light and its geometry

By the time Goodman came to articulate his position, the idea that the ability to comprehend perspectival images is a social, cultural convention was an old one. Its most famous formulation goes back to the early 1920s and Erwin Panofsky's essay "Perspective as a Symbolic Form" [Panofsky 1927]. Panofsky argued that the discovery of the geometrical construction of perspective in the early Renaissance was a result of a new understanding of space; before the Renaissance, Panofsky claimed, space was not conceived of as homogenous. In Panofsky's view, the geometrical construction of perspective as it is normally defined for a flat surface, cannot account for natural human vision. The image that light rays produce on the human retina is formed on a semi-spherical surface and, in Panofsky's view, the very image that we see has to follow the curvature of this surface. He argued, consequently, that our vision corresponds to curvilinear perspective; insofar as the rules of perspective are defined for a flat surface, in Panofsky's view, they are unrelated to how we actually see. The implication is that our ability to read perspectival images must be an acquired skill that the individuals who grow up in Western civilization learn by living in their culture.

The obvious answer to this argument is that we do not see the retinal image, we see things in front of us.[8] The perspectival image endeavors to replicate the bundle of light rays that would reach our eyes if the objects that it represents were in front of our eyes. At the same time, not all light rays are equally important. Those light rays that arrive from the contours of objects define their shapes; a perspectival image that strives to represent a certain disposition of shapes will primarily strive to replicate the light rays that would reach the eye from the lineaments of these shapes. Consequently, Goodman's attack on

perspective needed to defeat the understanding that a perspectival image represents by virtue of producing a bundle of light rays that would reach the eyes from the object represented. Goodman had two available strategies. He could point out that non-conventional representation, based on delivering an equivalent bundle of light rays is simply impossible: that merely perceiving a bundle of light rays is not enough to permit recognition of what a certain bundle of light rays represents. It will always be the case that an infinite number of different dispositions of spatial objects can produce the same bundle of light rays; interpreting a bundle of light rays does not rely on one-to-one relationship. This argument pertains to the *ambiguity* of perspectival representations; I will discuss it in the final section of this paper. Another approach, targeted by all other arguments Goodman formulates is geometrical: Goodman must show that rules for the standard and geometrical construction of perspectival drawings do not correspond to the actual geometry of light.

Before analyzing Goodman's arguments, let us start by considering what actually happens when a perspectival drawing is constructed. Consider a typical situation presented in fig. 1.

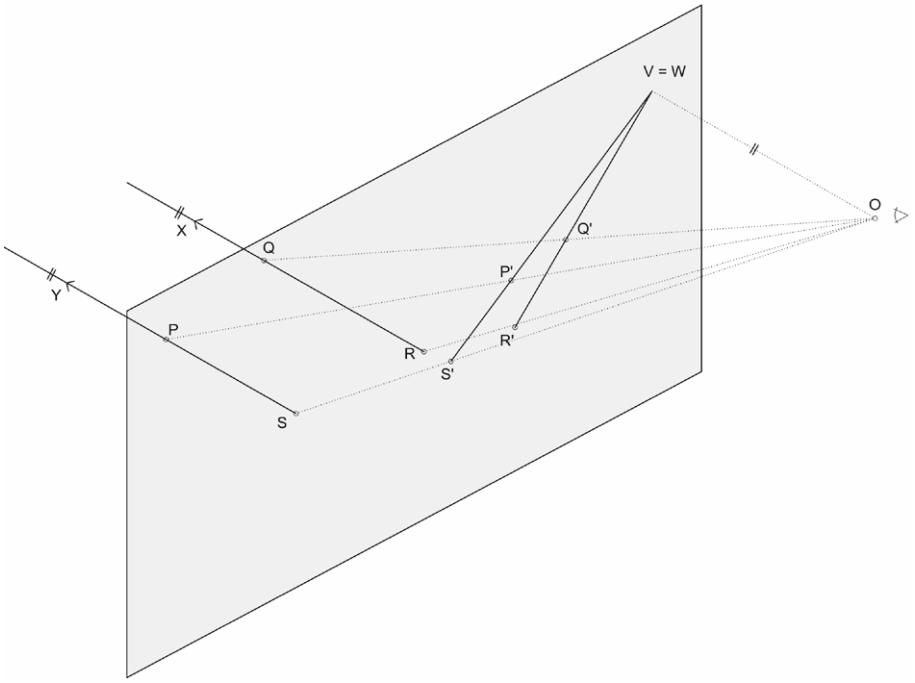

Fig. 1. Perspectival projection
(Technical preparation of the drawing by Arnika Blount, following the author's instructions)

Let O be the position of the eye and let SP be a line seen through a glass panel. S′ and P′ are then the points of the intersection of lines OS and OP with the glass plane. In other words, if one looks at SP through the glass plane and draws on the plane what one sees, one will draw S′P′. Similarly, any point Y on SP has a picture Y′ on the glass plane, which is the intersection of the plane and OY. Now imagine SP extended beyond P and imagine that Y travels along this extension to new positions Y_1, Y_2, Y_3, …etc. The pictures of these points on the glass plane are Y_1', Y_2', Y_3', …etc. The further Y travels

from P, the more parallel OY becomes with the line SP. When Y vanishes in infinity, the line OY will be parallel with SP; at that moment, the picture of Y on the glass plane will be the point of intersection of the plane and the line from O that is parallel with the line SP. Let us name that point 'V'. Consider now another line QR, parallel with SP. Again, the picture of this line on the glass plane will be Q′R′. Let now X be a point that travels along the extension of QR to infinity. As in the case of the point Y, the line OX will gradually become more and more parallel to the line defined by the points R and Q. Ultimately, when X vanishes in infinity, OX will be parallel with the line QR. But since SP and QR are parallel with each other, and since there can be only one line through a given point (the position of the eye) that is parallel with both of them, it follows that when X vanishes in infinity, W, the intersection of OX and the glass plane will be also V. V is the *vanishing point* for all the lines in the glass plane that are the pictures of lines parallel with SP and QR. We thus reach the general principle that in a perspectival drawing *any set of parallel lines appears to vanish in the direction of a line that goes through the eye and is parallel to these given lines.* Various geometrical rules for the construction of perspectival drawings, the use of vanishing points and so on, explain how to construct, on a piece of paper, the drawing that would be created by looking at an object through a glass plane and drawing on the glass plane the contours of the object.

Taking all this into account, it is also important to relativize the idea that the glass plane, or the plane of the picture that replicates the drawing made on glass, has to be a plane surface. A perspectival representation need not be a flat plane, or a plane at all. A perpsectival representation of any object can be any disposition of objects that would deliver to the eye, when seen from at least one point in space, a disposition of light rays that is identical with the object it is representing. (Thus understood, a physical model counts a kind of perspectival representation as well.) Perspectival drawings are just two-dimensional members of a wider family.

Goodman's geometrical arguments

Goodman's main target is thus the idea that a perspectival drawing represents by delivering the same bundle of light rays as the object(s) it represents, that "identity in pattern of light rays must constitute identity of appearance" [1968: 12]

His first argument pertains to the positioning of the eye point in relation to the picture plane. A perspectival picture is indeed constructed in accordance to the position of the eye. Goodman says that "the picture must be viewed through a peephole, face on, from a certain distance, with one eye closed and other motionless" [1968: 12]. Such conditions are abnormal, he says; it is known from physiology that an eye that would be fixed that way would not be able to see. This statement pertains to the fact that the eye is indeed never stationary, that it moves in so-called "saccadic movements".[9] We normally believe that our vision is continuous, but it is not; the eye sees by performing a series of jumps ("saccade fixations"). A saccadic movement of the eye takes between one two-hundredth and one twelfth of a second. The eye then makes a short pause (say, a quarter of a second) and then performs another saccadic movement. During the saccadic movement the eye is blind; what we see, we see in the moments between these movements. However, the important point is that the movement of the eye does not disturb perpectival perception as long as the center of rotation of the eye coincides with the center of perspective [Doesschate 1964: 67]. The point is precisely that a perspectival drawing delivers a bundle of light rays that matches the one that would arrive from the objects the perspectival drawing represents. The eye has its way how it performs its job—

at the same time, operating with the equivalent bundle of light rays can only result in an equivalent perception, whatever the eye does. Perception would be quite different if the head turned, because then the direction of sight changes and the eye receives a different bundle of light rays.

This brings us to another implication of Goodman's complaint that a perspectival drawing requires a stationary eye. Consider, for instance, what happens if a perspectival drawing is viewed from a position different than the one for which it was constructed. A way to answer this question is to draw another perspectival drawing that would provide us with the bundle of light rays equivalent to the one arriving to the eye at the new vantage point (fig. 2)

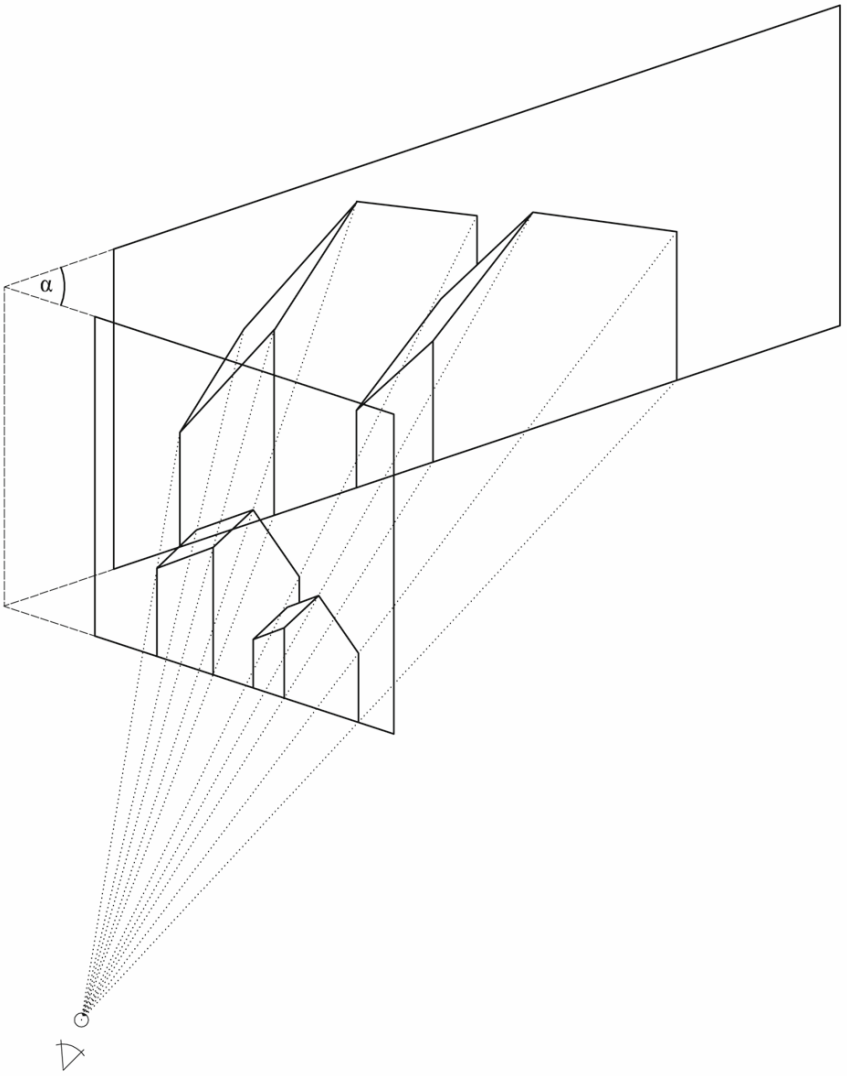

Fig. 2. Perceiving a perspectival drawing outside the designated position
(Technical preparation of the drawing by Arnika Blount, following the author's instructions)

Imagine thus having placed a glass plane between the eye and the original perspectival drawing seen askew. The result would be new perspectival drawing on the glass plane. Let O be the new vantage point and let AB be a line on the original drawing whose vanishing point is V (fig. 3). Then the pictures of A, B and V on the new glass plane will be A′, B′ and V′. While the distance between A′, B′ and V′ will be different from the one in the original drawing (it will depend on the angle between the original drawing and the new glass plane), the three points will still have to be co-linear. And this applies to every line of the original drawing and its vanishing point. In other words, the new drawing on the glass plane will be a perspectival drawing, though, depending on the angle between the original drawing and the glass plane, the proportions and relative sizes of the objects seen as represented will be different.[10] If the angle becomes too big, the original drawing may become unrecognizable, as it is the case with various anamorphic representations.

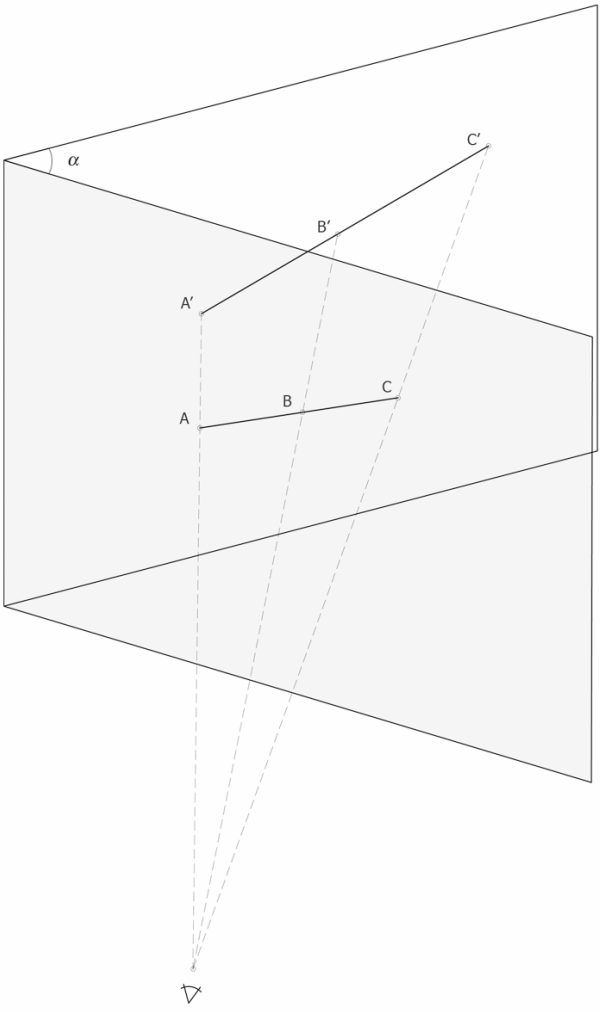

Fig. 3. Perception of a picture plane through a picture plane
(Technical preparation of the drawing by Arnika Blount, following the author's instructions)

Goodman's remaining geometrical arguments directly derive from a failure to understand the fact that a geometrically constructed perspectival drawing is an equivalent of a drawing that one would produce when looking through a glass plane and drawing on it what is seen through it. Goodman thus argues that "a picture is viewed face on at a distance of six feet while the cathedral represented has to be looked at, from, say, and angle of 45° to its facade and at a distance of two hundred feet" [1968: 13]. Obviously, a geometrically constructed drawing has to account for this; very often geometrical drawings do represent buildings seen at an angle. In fact, as mentioned, a drawing itself need not be constructed to be seen orthogonally nor does it have to be on a plane. Similarly, Goodman argues that,

> By the pictorial rules [of the geometrical construction of perspective] railroad tracks running outward from the eye are drawn converging, but telephone poles (or the edges of a facade) running upward from the eye are drawn parallel. By the 'laws of geometry' the poles should be also drawn converging" [1968: 16].

This is obvious nonsense: if poles are parallel with the imaginary glass plane, then they will have to be parallel and not converging in the drawing. The same will actually happen with railway lines if they are seen from above and the imaginary glass plane/picture plane is placed parallel with them.

This same misunderstanding of the relationship between the imaginary glass plane and picture plane motivates Goodman's final, "conclusive" argument. Fig. 4 shows a drawing equivalent to the one he has presented in the book.

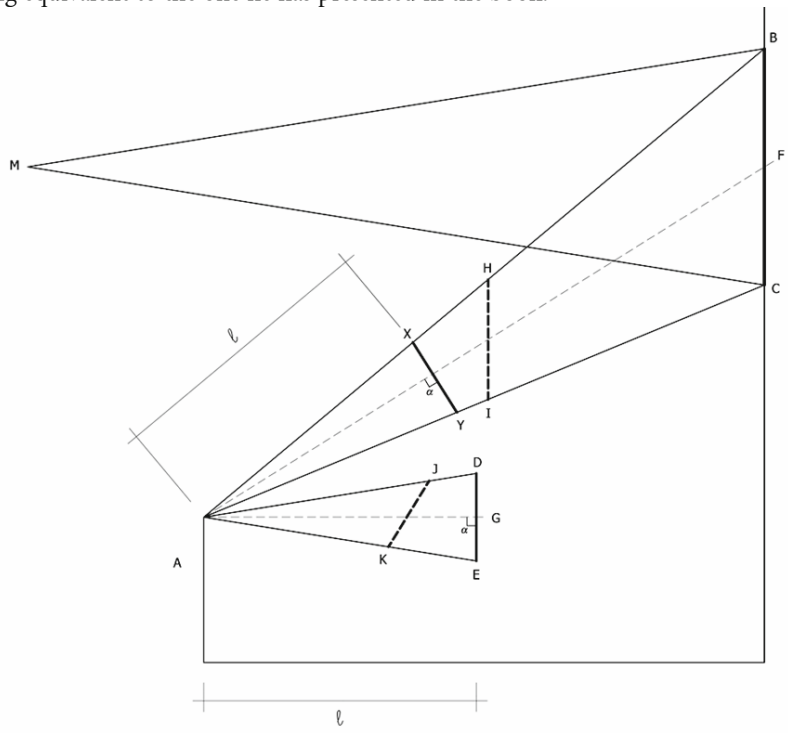

Fig. 4. Goodman's argument about the perception of a building in distance
(Technical preparation of the drawing by Arnika Blount, following the author's instructions)

The observer's eye is at a; b,c is the facade of a high building while d,e is the picture of the facade. He then points out that picture and the facade are parallel but the angles at which they are seen are different. Consequently, he explores whether a picture positioned at hi or jk would provide the same bundle of light rays as the one the eye receives from the facade. This question is the wrong one to ask. The geometrical construction of perspective does not work so that one has a ready drawing and then goes around looking how to position it so that it conveys the same bundle of light rays as the one existing at a given place. Rather, one decides from the beginning about the angle at which the drawing is going to be perceived (normally, but not necessarily, this angle is orthogonal on the line of sight) and the position from which the object represented (in this case the building) would be seen. One then imagines a glass plane between the object and the eye placed at the same angle and at the same distance as the plane of the picture (XY in fig. 4). The geometrical construction of the perspectival drawing should produce the same drawing as the one we would draw on the glass plane, if we drew on it what we see through it. This last example clearly illustrates that Goodman never properly grasped the functioning of perspectival drawings as imaginary replications of drawings that would be drawn on a glass plane placed between the object represented and the eye.

Ambiguity of perspective

It has been mentioned that Goodman has another argument against perspective that is potentially much more damaging. This argument was well-known in the 1960s when *Languages of Art* came out. The important point is that in order to recognize what a certain bundle of light rays represents, mere perceiving that bundle of light rays is not enough. The important problem with perspectival representations is that they are *ambiguous.* A single perspectival image can always be taken to stand for an infinite number of different three-dimensional shapes. Ultimately, every drawing consists of lines; while every line in a perspectival drawing may stand for a single line in three-dimensional space, it can also represent any number of disconnected lines that are merely appear to be a single line when observed from a specific viewpoint (fig. 5).

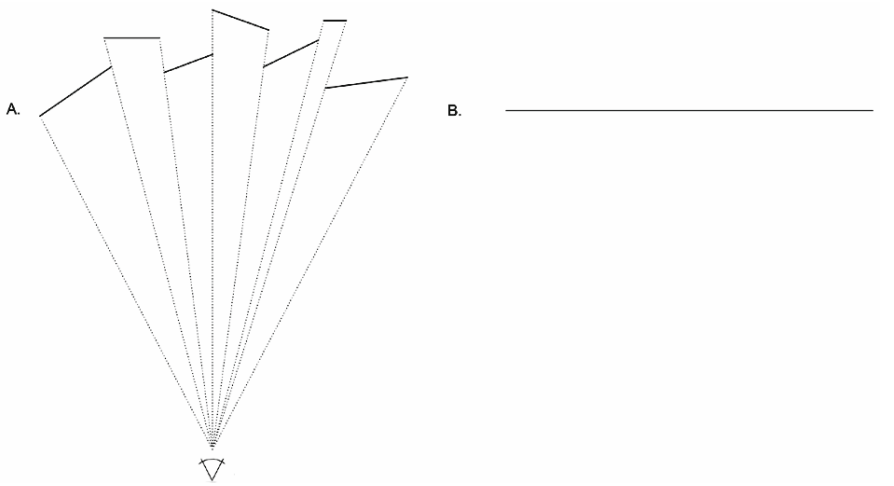

Fig. 5. When perceived from a specific position, a set of separate lines can be seen as a single line (Technical preparation of the drawing by Arnika Blount, following the author's instructions)

In a widely discussed experiment Adelbert Ames constructed a criss-cross of disconnected wires in a room, that, when seen through a peephole, were perceived as a chair.[11] Although the wires were disconnected, hanging in the air and certainly did not form a chair, their endpoints were placed to coincide perspectivally when seen through the peephole. The implication is that when perceiving any perspectival picture, that same image may have been generated by an infinite number of different spatial dispositions of objects. Yet, the human mind chooses one possible interpretation as the right one. Goodman points out that:

> ...the rays yielded by the picture under the specified conditions match not only those yielded by the object in question from a given distance and angle but also those yielded by any multitude of other objects from other distances and angles [1968: 11-12].

While for Goodman this meant that the capacity to interpret perspectival images was culturally inculcated, Ernst Gombrich, who defended the transcultural validity of perspective, regarded the ambiguity of perspectival representations as a confirmation of his thesis that perception is inseparable from conceptualization. From his point of view, when looking through the peephole in Ames' experiment, people saw a chair because their brain organized their perception according to the available concept (chair). It was the availability of the concept that explained the subjects' interpretation of the disposition of wires they perceived [Gombrich 1987].

The modern psychological explanation of this phenomenon, however, does not follow either Goodman's or Gombrich's view. After all, one can form a definite three-dimensional interpretation of a two-dimensional image even when it is impossible to associate a specific concept with what one sees. Subsequent research has provided a different explanation of the way we derive our awareness of three-dimensional dispositions of objects from two-dimensional images. The point is not that the brain relies on available concepts; rather, it relies on specific rules or constraints when interpreting a two-dimensional image three-dimensionally.[12] One such rule, for instance, is that the brain will always interpret an apparent straight line in an image as a three-dimensional straight line (although it may actually consist of a number of disconnected lines that only appear to be in continuation of each other). Similarly, when the ends of two lines coincide in an image, they are interpreted as coinciding three-dimensionally (which explains why subjects perceived Ames's disconnected wires as connected). Further on, elements near each other in an image are interpreted as being nearby three-dimensionally (even though they often may not be). It is these kinds of rules and constraints that determine the interpretation of our retinal image and provide us with knowledge about the spatial disposition of objects around us. A substantial body of modern psychological research indicates that the early stages of human vision are independent of concepts we operate with; the idea that "there is no innocent eye" is by this time considered as "1950s psychology" (see [Pylyshyn 1999, 2006]).

Conclusion

The efforts of a number of twentieth-century scholars, such as Panofsky or Goodman, to reject perspective as a transcultural mode of visual presentation are a remarkable aspect of twentieth-century intellectual history. Their views were accepted and regarded as valid results, although at the time there were plenty of scholars who could have pointed out that they were based on invalid reasoning. In the case of Goodman, the entire argument of his book was built upon the assumption that every

similarity must be conventional, and that, consequently, perspectival images do not operate by delivering an equivalent bundle of light rays as the object represented. In spite of the huge influence of his book, the arguments in favor of this thesis were based on an elementary miscomprehension of how perspectival representation functions.

Notes

1. For a survey of Gombich's views in the context of the relativist and social-constructivist metaphysics that came to dominate the intellectual life of the English speaking world after the 1970s, see [Mitrović 2010].
2. See in particular Goodman's subsequent book, *Ways of Worldmaking*: "Not only motion, derivation, weighting, order, but even reality is relative" [Goodman 1978: 20].
3. He thus expects that his views will be "irritating those fundamentalists who know very well that facts are found not made, that facts constitute the one and only real world, and that knowledge consists of believing the facts" [Goodman 1978: 91].
4. "The catch here, as Ernst Gombrich insists, is that there is no innocent eye. The eye always comes ancient to its work, obsessed by its own past and by old and new insinuations of the ear, no, nose tongue, fingers, heart and brain. ... Not only how but what it seen is regulated by need and prejudice. It selects, rejects, organizes, discriminates, associates, classifies, analyzes, constructs. ... The myths of the innocent eye and of the absolute given are unholy accomplices. Both derive from and foster the idea of knowing as a processing of raw material as being discoverable either through purification rites of by methodological disinterpretation. But reception and interpretation are not separable operations; they are thoroughly interdependent. ... what has been received and what has been done to it cannot be distinguished within the finished product. A picture never merely represents x, but rather represents x as a man or represents x to be a mountain, or represents *the fact that x is* a melon" [Goodman 1968: 6-9].
5. "Just here, I think, lies the touchstone of realism: not in quantity of information but in how easily it issues. And this depends upon how stereotyped the mode of representation is, upon how commonplace the labels and their uses have become. Realism is relative, determined by the system of representation for a given culture or person at a given time. … Realistic representation, in brief, depends not upon imitation or illusion or information but upon inculcation. Almost any picture may represent almost anything; that is, given picture and object there is usually a system of representation, a plan of correlation, under which the picture represents the object. How correct the picture is under that system depends upon how accurate is the information about the object that is obtained by reading the picture according to that system. But how literal or realistic the picture is depends upon how standard the system is. If representation is a matter of choice and correctness a matter of information, realism is a matter of habit" [Goodman 1968: 36-38].
6. For partial discussions see [Carrier 1980] (and the subsequent exchange in *Leonardo* **14** (1981): 86-87); [Topper 1984]; [Kubovy 1986: 122-126].
7. For reviews of Goodman's *Languages of Art see* B. C. O'Neill, "*Languages of Art: An Approach to a Theory of Symbols* by Nelson Goodman," *The Philosophical Quarterly* **21** (1971): 361-372; Wolfgang M. Zucker, "Languages of Art, an Approach to a Theory of Symbols by Nelson Goodman," *The Art Bulletin* **52** (1970): 223-224; Monroe C. Beardsley, "*Languages of Art: An Approach to a Theory of Symbols* by Nelson Goodman," *Philosophy of Science* **37** (1970): 458-463; Daniel Rigney, "*Languages of Art: An Approach to a Theory of Symbols* by Nelson Goodman," *Contemporary Sociology* **8** (1979): 319-320; Annette Barnes, "*Languages of Art: An Approach to a Theory of Symbols* by Nelson Goodman" *Perspectives of New Music* **9** (1971): 330-340; Christiana M. Smith, "Symbolic Systems, Cognitive Efficacy, and Aesthetic Education. *Languages of Art: An Approach to a Theory of Symbols* by Nelson Goodman," *Journal of Aesthetic Education* **3** (1969): 123-136; Nicholas Wolterstorff, "*Languages of Art*," *The Journal of Aesthetics and Art Criticism* **34** (1976): 491-496; Michael Thompson, "*Languages of Art: An Approach to a Theory of Symbols* by Nelson Goodman; *Laws of Form* by C. Spencer Brown," *Leonardo* **7** (1974): 175-176.
8. For this argument, see [Doesschate 1964: 46-56, esp. 49]. See also [Pirenne 1970: 148-149].

9. Good descriptions of the implications of saccadic movements for human vision are found in [McConkie 1979] and [McConkie and Zola 1979].
10. This is a purely geometrical account of the perception of perspectival drawings under an angle. However, in the psychology of perception there exists a substantial literature on the problem. See in particular [Todorović 2005, 2008, 2009].
11. For a description of these experiments see [Ittelson 1952].
12. For a systematic presentation of these rules, see [Hoffman 1998].

Acknowledgments

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