4

Space and Color:
Toward an Ecological Phenomenology

1. Color, adumbration, and space

Current color science accepts as a basic presupposition Newton's thesis that light rays are not colored. Supplementing this presupposition is the corollary that color is a subjective impression resulting from a causal process that begins when colorless rays of light impact the retina eliciting a stimulus. After various information exchanges in the nervous system, this causal process ends somewhere in the brain. According to this interpretation, all color, be it the green of the trees, the red of wine, or the blue of the sky encountered in everyday life is but illusion. Various facts were presented in the textbooks of color science to support various kinds of "argument from illusion," for example, that light rays of different wavelengths cause the same color and that light rays of the same wavelength cause different colors.

In opposition to this "common sense" of current color science, phenomenology presents the theory that colors adumbrate themselves. That the same object appears differently in various situations or that different things viewed from a single vantage point appear the same is not an unusual but is rather a common fact of our everyday perceptual experience. This fact is reinterpreted by Husserlian phenomenology such that the being of a thing is "constituted" by its various adumbrations. This is one of the most important insights of Husserlian phenomenology, and it provides a sort of immunity from the "argument from illusion" in order to "save" the phenomena of the perceptual world. Husserl shows that this concept of adumbration applies not only to spatial form but to sensible phenomena such as sound or color as well, and he thereby erects a kind

of bulwark against the "common sense" of contemporary science.

> Like the perceived thing as a whole, whatever parts, sides, or moments accrue to it necessarily, and always for the same reasons, transcends the perception regardless of whether the particular property be called a primary or secondary quality. The color of the seen physical thing is, of essential necessity, not a really inherent moment of the consciousness of color; it appears, but while it is appearing the appearance can and must, in the case of a legitimating experience, be continuously changing. *The same* color appears "in" continuous multiplicities of color *adumbrations*. Something similar is true of every sensuous quality and also of every spatial shape. (Husserl 1982/1913, p.87/p. 74)

In this way we can establish that a color exists where we see it, namely where a thing is, i.e. within the world.

However, one must not forget that the thesis of color adumbration is not easy to comprehend exactly. One of the most important reasons for this is that, as to the concept of adumbration, the relationship between adumbration and spatiality remains unclear. Husserl writes, for example, that "the adumbrated is of essential necessity possible only as something spatial (it is spatial precisely in its essence)" (Husserl 1982/1913, p. 88/p. 75). Therefore, Husserl apparently holds that the transcendence constituted through adumbrations is essentially connected to spatiality. But how are we to understand that color itself is spatial? Certainly the structure of "identical object/various modes of appearance" is present not only within the mode of adumbration of spatial form, but also with each color. However, color does not have a front or rear side in any literal sense; its mode of appearance does not immediately change as one proceeds around it. In this sense, one cannot speak of one or another "side" of a color, as one can of a thing. In what sense might one then speak of a spatiality of color and mean something more than a mere analogy?

When Husserl speaks of the adumbration of color, he often distinguishes between color as a property of a thing and color understood as various modes of colorful appearance. The former is characterized as a spatial property and the latter as non-spatial sense data. However, it would be a misunderstanding to discuss the modes of adumbration in

terms of two kinds of color, namely "color as objective characteristic" and "color as sense datum," because the adumbrated is joined essentially to the adumbration and one can only speak meaningfully of color in terms of this inseparable structure. If color is characterized as a being that exists essentially independent of appearances, then one can no longer comprehend color as it is normally understood, because it no longer shows itself in a colorful appearance. On the other hand, if color is considered to be a kind of sense datum and a "real" ("*reell*") element of experience that cannot be perceived, then it is also nonsensical to speak of a particular color.

It is more important within our context to confirm that this difficulty exists in a similar fashion in the case of the spatial form itself. When one states that a cube, for example, displays various adumbrations from various standpoints and is thus constituted by adumbrations, this by no means signifies that a spatial cube is constituted by non-spatial factors, nor does it signify that a three dimensional cube is constituted by two dimensional aspects. One cannot "constitute" a spatial being out of non-spatial elements, no matter how many elements one collects. Nor can one "constitute" a three-dimensional being through two-dimensional elements, no matter how many elements one employs. In other words, regardless of whether one is dealing with a "side" or "aspect," it is presupposed that these are spatial and three-dimensional. The concept "adumbration" does not mean that the spatially adumbrated is constituted through non-spatial adumbrations, instead the adumbrations "in" which the adumbrated shows itself with every horizonal reference, from apparent to hidden sides, are thoroughly spatial.

The foregoing makes apparent that we must be careful if we wish to understand properly Husserl's theory of "spatial constitution." Husserl emphasized the well-known essential relationship between spatiality and lived-bodily (*leiblich*) movement. Following Husserl, for the constitution of space the kinaesthetic system plays an important role, in which the mode of appearance of the respective adumbration corresponds to a certain lived-bodily (*leiblich*) movement through which non-visible sides are made visible.

"All spatiality constitutes itself, comes to givenness, in movement, in the movement of the object itself and in the movement of the 'I', which effects given changes of orientation"(Husserl 1973, p. 154). As we read

this quotation, we could perhaps be excused if one were to interpret the preceding passage as stating that Husserl accepts the constitution process of the spatial on the basis of non-spatial factors. However, this conclusion is not compelling, for, as Husserl discusses in the sentences following this quotation, the spatial already appears in each single perception. "In each single 'onefold' ('*einfältig*') perception the spatial appears to us; in addition to the thing in its spatial embodiment appears its relation to other things. […] In subsequent onefold perceptions the object with various sides eventually appears, namely in the combining synthesis of identification, but does not come to a fuller and more identifiable givenness" (Husserl 1973, p. 154).

On the basis of this discussion, we can state that the role of movement in Husserl's theory does not lie primarily in the constitution of the spatial itself but instead in the constitution of the spatial *thing* through various appearances that are made possible through bodily movement. In any case, we can establish that even for Husserl himself each phenomenon of adumbration can from the start be observed as an appearance in which something spatial appears.

Our task now becomes clear: If various modes of appearance of the spatial thing possess spatiality from the outset, and if various modes of color appearance are realized exactly in such a spatial appearance, then every single appearance of color itself must possess certain spatiality. In fact Husserl emphasizes this point when he repeats the well-known thesis of Carl Stumpf, which states that "color and extension are inseparable." Concerning these circumstances, can one speak of a characteristic spatiality relative to color? If one can, what kind of spatiality can one find in color phenomena? This is the major task that I would like to tackle in the following essay.

In order to attend this task, firstly I begin by making the problem of spatial perception in general the main theme. In this context, I find in William James a clue to further this theme, specifically I find in James' conception of the spatiality of sensation a guide representing a break with the traditional interpretation of sensation. Secondly I thematize David Katz' phenomenology of color, which develops the problematic of the spatiality of color in a highly influential manner. Lastly I attempt to show how the ecological optics in the perceptual theory of J. J. Gibson can be viewed as a further scientific development of Katz' phenomenology,

which supports the thesis regarding the spatiality of color.

2. Spatiality of sensation

1) The problematic of spatial perception

a. Living as "being-in-space"

Our lives always unfold in space. Upon awakening in the morning until going to bed at night and even while sleeping our lives are bound to a certain place and in a spatial relationship to other things. Our lives can in this sense be regarded as "being-in-space."

Correspondingly, our experience is always an expression of spatiality in one way or another. Not only our everyday visual perception but also the darkness in which we cannot see brings an extension to expression, no matter how vague. If we close our eyes, we can "see" an extended "color" that E. Hering designates as "eye-gray." To have visual consciousness means nothing more than to have a sensation of some color and some extension, even without any corresponding clear knowledge of some object. This holds not only for visual consciousness but for other types of sense perception as well. The sound of a siren emitted by a speeding ambulance is first scarcely and distantly heard, then "louder" and more near and then finally "softer" and distantly heard. We distinguish clearly between a soft sound heard in close proximity and a loud sound heard off in the distance. Spatiality is not absent even from the phenomenon of sound, the temporal character of which is very clear. The situation is no different with so-called bodily sensation. A toothache is felt in a single tooth, and an ache in the back is localized on one's back. Even a vague feeling of sadness does not lack a spatial character. For example, sadness initially faintly felt, but then "increases" before finally "overflowing" in tears.

In this way we can say that every conscious sense-phenomenon displays spatiality in this or some other manner. However, here immediately presents a problem, namely the problem of what sort of relation obtains between space and sensation. Is space itself a kind of sensation, like color or sound? Or is it not any sensation, but rather a "form" which orders various sensations? Above all, the philosophical problematic of spatial

perception is acutely distinguished through the fact that spatial consciousness itself remains a puzzle. How is an experience like spatial perception possible at all? This is the fundamental question with regard to the spatial perception, just as in the case of the temporal perception.

A traditional dualistic ontology such as Descartes' postulates from the beginning the non-spatiality of sensation, and this non-spatial character is regarded as an essential attribute of the mind in opposition to the spatiality of things. If it is postulated that the mind is non-spatial, we cannot but inherit the insoluble problem of how such a non-spatial consciousness can apprehend the spatial characteristics of things. While various philosophers have dealt with this question, Lotze's theory of "local signs" is especially noteworthy for its clear formulation of this problematic.

b. Lotze's theory of "local signs"

Lotze initially questions how it happens that qualities of color are localized in specific ways, i.e., that one and the same red can appear once at this location and subsequently at another and that colors in a given visual field can appear distributed (Stumpf 1873, 86). Lotze explains the characteristic of this question as follows: Although the stimulus, in which a spatial order of sensations is retained, is received by sense organs and subsequently proceeds to the brain, the transmitted spatial order is fully lost in the subsequent passage from the brain to the mind, because the mind is essentially non-spatial. This difficulty is similar to the case of a library which is dismantled and its contents packed up only to be reassembled in another location. It is important to see that this difficulty remains even if we were to accept the spatiality of the mind, because the fact that a spatial relation within the mind is realized does not mean that the mind perceives this relation.

> When we perceive the points a, b and c next to one another in this order, our consciousness places a to the left of b, and c to the right of b; but the representation of a, through which we represent a as such, does not lie to the left of that of b, and the representation of c is not to the right of that of b; representations give these predicates only to the represented points, and they themselves do not possess these predicates. (Lotze 1912, p. 546.)

This problematic formulated by Lotze is present in current psychology and neurophysiology as well, in which it is no longer the mind but the brain that plays the major role. Take the following example: I now see two red patches at two different locations A and B. Even when the colors are identical, I can distinguish the two patches, i.e., I perceive the two locations in which the red patches lie in a determinate spatial relationship. In order to explain the formation process of this perception of differentiated location, one could offer the following arguments. The two stimuli are received at the two locations (a, b) in the retina, or two excitations are found at different locations (x, y) in the nerve fibers of the brain. In addition to that, it could perhaps be confirmed that a perception of A corresponds to the reactions at the location a and x and a perception of B to the reactions at the location b and y. Can we now reasonably state that the formation of a perception of spatial relation (A-B) has been explained?

I think not. What has manifestly not been explained is precisely how the spatial relation realized either in the retina or brain becomes transformed into a *perceived* spatial relation. That means, if we can establish that two events—one of which corresponds to the perception of A and the other to that of B—are realized in a determinative relation within the brain, then we could explain how the perception A and that of B arise, but this is to have said nothing about the perception of the spatial relation (A-B).

In order to explain this perception of the relation A-B, perhaps an assumption of a determinate nerve cell joining x and y will be made, or else a specific causal pattern will be assumed, in which the agitations in x and y so to speak resonate with one another. This could be interpreted as proof that some kind of relationship exists between the perception of A and that of B, but this still does leave unfulfilled the claim regarding the perception of A-B. Above all, none of these sorts of findings touch upon the key puzzle, that of precisely how and why the spatial relationship within the brain makes possible the spatial perception of A-B, which is realized "there," outside of the brain.

Lotze provides a unique answer to this puzzle. Just as with the dismantling and reconstruction of a library it is helpful when each book is provided with a call number, it is useful with the perception of spatial relations if a sign expressing the original location of the stimulus is joined

to each perception of a location. It is especially important to note that such signs need not remain in their original spatial configuration. Lotze designates these signs "local signs."

As a concrete example of a local sign of visual perception, Lotze considers the sensation of eye movement which moves a given stimulus into the center of the retina. Each of these eye movements, as characterized through its size and direction, corresponds to a certain place of stimulus upon the retina. When different sensations are elicited each time by their corresponding eye movements, these sensations of movement can be regarded as local signs. When a color sensation is accompanied by such a sensation of movement, then the mind can distinguish every color stimulus on various parts of the retina and finally reconstitute a spatial relation from out of these color patches. Although this process appears highly complex, the mind can after long and repetitive practice acquire the capability to detect spatial differences in an unmediated way.

c. Critique of Lotze's theory

Certainly Lotze's attempt to provide a clear statement of the problem and an insightful solution must be acknowledged, but just as certain is the fact that this attempt remains attached to the traditional interpretation of sensations, according to which sensation itself is non-spatial. According to this presupposition, it is impossible to comprehend space within the realm of sensation, so that one cannot avoid positing a super-sensory function rendering this comprehension possible.

Carl Stumpf designates Lotze's theory a theory of "psychic stimulus" (Stumpf 1873, p. 72ff). According to Lotze's theory, the perception of sense-phenomena such as color or sound arises immediately from physical or physiological stimuli. The perception of spatial relations on the other hand arises not directly from physical or physiological stimuli but instead is mediated through the sensation of movement which serves as a secondary stimulus for the formation of spatial perception. In this sense, the sensation of movement can be designated as a "psychic stimulus." Because the function that reconstitutes spatial relation is regarded as a function that belongs only to the "super-sensory" and "intellectual" dimension, Lotze's theory appears to be a kind of "Kantian" theory akin to those of Wundt and Helmholtz (Stumpf 1873, p.99ff). Stumpf demonstrates the fundamental weaknesses of theories such as these, weaknesses that derive from their need for two steps in order to explain the process of the formation of spatial perception.

Does the process of movement sensation unfold consciously or unconsciously? If it is a conscious process, then spatial perception must display a conscious association between spatial location and the sensation of movement, which our experience contradicts. If the process is an unconscious one, then it is incomprehensible why it is regarded not as a physical or physiological but rather psychic process, as Lotze himself seems to assume that there are various unconscious processes even in the case of the sensations of simple qualities. Thus Stumpf concludes that there is no special reason that space cannot be as originally and directly perceived by the mind as other qualities. James takes over Stumpf's critique and discusses it in the following way:

> To Lotze we owe the much-used term "local sign." He insisted that space could not emigrate directly into the mind from without, but must be reconstructed by the soul; and he seemed to think that the first reconstructions of it by the soul must be super-sensational. But why sensations themselves might not be the soul's original spatial reconstructive acts Lotze fails to explain. (James 1950/1890, p. 276.)

Lotze clearly saw a fundamental difficulty that must be accounted for if one attempts to explain the origin of spatial perception presupposing the non-spatiality of sensation. On the other hand because he subscribed wholly to this presupposition, he could only assume a super-sensory function if he were to solve the above problem. This would have been "removed" if he could have accepted the fact that sensation is spatial from the beginning. In this way, James proposes along with Stumpf that the relationship between space and sensation is immediate. James designates this spatiality that every sensation possesses from the outset "spatial quale."

2) "Spatial quale": original spatiality of sense-phenomena

James begins his theoretical undertaking with a critique of the traditional conception of space that results when space is conceived as the order of coexistence. Certainly spatiality can be discovered only in the relation of one place to other places, and a place, isolated and indepen-

dent of other places, cannot be regarded as something to which some spatial quality can be attributed. In this sense, the concept of "quantity of coexistent places" or "order of coexistence" is often regarded as a definition of spatiality. However, this definition cannot avoid a fundamental deficiency.

First, if space consists of relationships between single places, the comprehension of single places must always precede any conception of their spatial distribution. However, in all our various experiences of space, whether everyday visual perception or a vague sensation of extension, such a comprehension is not found out.

Second, the determination of the "relation of coexistent places" can be attributed not only to the concrete spatial relation but also even to the abstract relations. For example, color scientists construct and use various kinds of "color space," in which a relation of similarity or opposition between various colors is to be demonstrated in some spatial relationship. However, this kind of "color space" lacks spatial extension in any literal sense (James 1983/1879, p. 65ff).

Through an examination of James' discussion, we can now find out wherein the fundamental problem of Lotze's theory lies. According to his theory, the mind could *comprehend* an abstract "relation of coexistent places" based upon given local signs, but could not *experience* visual space, because there is no guarantee that a reconstructed space is spatial in an original sense of the word. Exactly here can be found the reason for James' emphasis upon the special quality of spatiality, which is irreducible to a relation of coexistence. James describes this quality in the following manner:

> It seems to me that all our sensations, without exception, have this spatial quale. The squeaking of a slate-pencil is less spatial than the voluminous reverberations of a thunderstorm; the prick of a pin less so than the feeling of a warm bath; a little neuralgic pain, fine as a cobweb, in the face, far less so than the heavy soreness of a boil or the vast discomfort of a colic or lumbago. (James 1983/1879, p. 67.)

In this way, every sensation has "massiveness" or "voluminousness," i.e. spatiality, and this spatiality of sensation can be regarded as the origin of a concept of space.

The scope and significance of James' thesis cannot be overemphasized. As has been previously mentioned, because the traditional conception of space presupposes the non-spatiality of sensation, which is closely connected with the non-spatiality of the mind or consciousness. When the spatiality of sensation has been established, it becomes possible to establish further that the mind or consciousness itself is spatial. If this can be established, we need not to presuppose such process as that of the destruction and reconstruction of a library in order to explain the realization process of space perception. There is no such process at all, which is necessary for the realization of spatial perception. Space is immediately given with any sense perception. In other words, each sensation is spatial from the beginning, and with a sensation we are always already in space and out "there" in the world. To have a color sensation means nothing other than the fact that a color appears with a certain spatiality in the world, or at least within the *Lebenswelt*. This is precisely the core of the Husserlian thesis put forth at the outset, namely the thesis that color adumbrates itself.

I must add something here: If the sensation of quality and spatiality are so closely tied to one another, one cannot simply state that the same space appears in various sensations of quality. Rather, we need to notice that spatiality of visual perception and that of auditory perception must be differentiated at first. It is precisely in this context that we can begin to understand why Husserl took the kinaesthetic system of space constitution to be so important: Because bodily movement and its accompanying kinaesthetic sensation play a decisive role in the constitution of the same spatiality of various qualitative phenomena. When we interpret Husserl's thesis in this manner, it becomes clear that our thesis regarding the spatiality of sense phenomena as prior to that of bodily movement does not contradict Husserl's theory of the constitution of space.

In any case, we can now state that the spatiality of color is not constituted through the kinaesthesia but instead that this intrinsic original spatiality of color, even when initially very vague, guides various kinaesthetic movements which in turn introduce further spatial distinctions in the original spatiality. However, what sort of spatial character can be discovered in original appearances of color? In order to clarify this intrinsic spatiality of the world of colors, I enlist the aid of Katz' phenomenology of the color world in the following section.

3. The spatiality of color

Katz dealt with two themes relative to the phenomenology of color in his major work, *Der Aufbau der Farbenwelt* (1930): The "modes of appearance of color in space" and the "phenomenon of illumination."

1) Surface color and film color

The concept of "modes of color appearance" is well known, first of all, for the distinction between surface and film color. Surface color is characterized by the way of appearance that it is localized at a determinate distance from the viewer and offers also a visual resistance to her. It can also assume any orientation whatever with reference to the direction of vision and manifest a certain bending and a fine grain structure like, for example, a mass of grains. In contrast, the character of film color is indefinite with regard to distance. It displays itself in an essentially frontally parallel orientation and shows a soft and aesthetic character. A typical example of surface color is the mode of appearance of the surface of everyday objects and that of film color is the color of the sky or the mode of appearance of a color of a surface as seen through a small hole.

In order to illustrate the difference between the two types of color, Katz cites a case, investigated by Gelb, of a patient who, due to a brain injury, is unable to perceive surface color. According to Gelb, in the patient's world, the color of all visible objects takes on the character of film color. "Colors appeared to the patient to have a spongy texture; everything appeared 'fuzzy and soft.' The patient had to reach into the color in order to touch the surface of a colored object" (Katz 1935/1930, p. 14).

Perhaps one could raise the following objection: Although there exists a distinction between surface and film color, this distinction does not belong to the essential moment of color as such, but is instead only a concomitant element that accompanies the various experiences of original color phenomenon. Katz himself seeks to counter this objection with his own argument (Katz 1935/1930, p. 15ff).

Certainly in most of the textbooks of color science are only three elements—hue, brightness, and saturation—are introduced as essential

elements which are necessary in order to identify any color; certainly this kind of determination of color has a validity independent of spatiality. However, when it seems that we can deal with the essence of color, which is independent of spatiality, it is rather the case that a certain spatial mode of appearance is presupposed in an unacknowledged way. It is well known that one can, with the aid of a projection wall into which a small hole has been situated, transform various modes of color appearance into film color, and every film color can almost invariably be identified with the three designated elements. In this sense it does not hold that there is initially color independent of all spatiality, to which various spatial characteristics subsequently adhere. Instead, initially there are various spatial modes of color appearance, from which a determinate mode of spatial appearance is selected as the standard mode of appearance and to which all other modes of appearance are reduced.

Another probable ground for objections lies within the fact that the word "surface" or "film" in the expressions "surface color" and "film color" places it in proximity to the view that takes the surface color as the color of the surface of things or the film color as the color of a real film. In other words, a color's modes of appearance is explained as the characteristic of an object. Although this way of explaining the matter seems self evident, it is a manifest misunderstanding because as to the level of "constitution" the "surface" in the term "surface color" is much more basic and original than the concept of the thing's surface. The sense of "surface" in "surface color" becomes definite or constituted originally already within the visible world, and the spatial determination of the surface of a thing in the normal sense is constituted only on the basis of this original spatial determination within the visible world. Put simply, concerning the visual phenomenon, it cannot be said that the surface color is determined by a thing's surface, but instead the reverse: The character of a thing's surface is defined by the surface color.

Of course, this does not mean that the surface appearing in the visible world always corresponds to reality. We make mistakes regarding the perception of surface color. For example, Hering presents the following example: As someone proceeds under a thick leafy canopy, perhaps she notices white colored spots upon the ground due to lime deposits. As soon as she looks more closely, she discovers shimmering light upon the gray-brown earth. However, such perceptual deception does not alter

the above mentioned state of affairs concerning the levels of constitution. This means that it is not the case that the spatiality of color as constituted through the surface color's modes of appearing presupposes the spatiality of a thing's surface, but instead the reverse. The spatiality of color has its origin in its own modes of appearance and not as the characteristic of a thing.

2) Phenomenology of illumination

Another point Katz emphasizes in relation to spatiality is the "phenomenon of illumination." Along with the perception of surface colors basic to our everyday lives, we find simultaneously and invariably the phenomenon of illumination, which itself plays an essential role in the constitution of the space that surrounds every surface color.

The two facts, that "something is illuminated" and that secondly "there is a source of light for something," are physically the same state of affairs, but are phenomenologically distinguishable. A paper lantern held against an entirely dark sky shines in the dark sky, but forms no illumination phenomenon because there are no illuminated objects around (Katz 1935/1930, p. 39). The reverse is true of everyday circumstances when an illumination phenomenon appears and illuminated objects are seen without noticing a source of light. In this sense, the light and color, which are constituted by the luminosity from a light source and those, which are constituted by the illumination phenomenon, are to be seen to be phenomenologically distinct even though physically identical.

Secondly, Katz emphasizes the immediacy of illumination phenomena with regard to the sense of sight. Against the possible objection that the detection of illumination phenomena follows a mediated course based upon the perception of an object, Katz proposes an interesting experiment in which the immediacy and originality of illumination impressions can be proven. The experiment deals with an individual who, when presented with a certain scene initially closes her eyes and then opens them for a short time. Especially in the case of very weak or very strong illumination such as that in the street in the twilight or at the seaside on a hot summer day, this experiment illustrates that it is not isolated colors upon objects but rather the illumination impression as such, about which the subject can give the surest information. One cannot generalize this result, because in most cases we require a sufficient knowledge of the

object in question in order to grasp its illumination, but on the basis of this experiment we can at least establish that there is a non-derivative, non-inferred primary illumination impression. In most cases, there is constituted a close relationship between illumination impressions and the perception of objects. "Our conclusion must be that a convincing impression of illumination can appear only where objects are apprehended, and that wherever objects are apprehended there must be an impression of illumination" (Katz 1935/1930, p. 42).

The third important point relates to Katz' analysis of light and color in an empty space. Color which fills up a certain space, like the color of some liquid in a glass or the color of fog, is designated by Katz, "volume color." Distinct from this volume color is the color phenomenon which fills an entire empty space. Whenever an object appears in some illumination, an empty space appears correspondingly before the object in the same illumination. In other words, the situation that an object appears in a certain illumination means nothing but the situation that there appears an "empty space." Katz describes this situation in an impressive way:

> Empty space appears in general as illuminated in the same way as do the objects which bound and delimit it. It is perhaps preferable to speak of a *lighting* of empty space, and thus to make the lighting of the empty space in the visual field correspond to the illumination of the objects in the visual field. I cannot characterize the relationship between empty space and light more adequately than by saying that empty space is filled with light (strong light, weak light, etc.). The relationship between illumination of objects and lighting of empty space may become more intelligible in the light of some further observations, which have the added merit of taking into account the case in which different parts of the visual field are differently illuminated at the same time. "If we stand before a wall, the illumination of which is essentially uniform (in the physical sense), we have no hesitation in attributing to the empty space in front of it a phenomenal character of brightness or of being filled with light (*Erleuchtung*), which is in keeping with the brightness of the wall, and is in a sense equal to it. If the intensity with which the objects are illuminated is changed uniformly, the lighting of the empty space changes in proportion. If the visual field is variously illuminated, in part

> normally, perhaps, and in part by direct sunlight, the illumination impression created by the whole empty space in front of the wall is determined by that part of the visual field the illumination of which is apprehended as dominant. Thus the space appears in normal illumination when all the objects, with the exception possibly of a few shadow-spots or light-spots, appear as normally illuminated. Immediately before the shadow-spots or light-spots, however, the space seems to assume the corresponding deviating brightness without at the same time presenting any clear-cut dividing line to indicate where one spatial brightness gives place to another. Similar relationship can be observed in a visual field in which the different parts are illuminated in qualitatively different ways. (Katz 1935/1930, p.43ff.)

According to this description, every color in the visual world appears not only with a determinate spatial character as do surface and film colors, but also through a determinate empty space. This means every color in the visual world appears in a determinate "depth," and it is the spatiality of this depth that constitutes the illumination phenomenon.

This depth structure formed by the illumination phenomenon originates neither from the associations with the tactile sensations, as Berkeley had explained, nor from kinaesthetic sensations, as A. Bain or Husserl had claimed. It is also not the spatiality reconstituted by the cause of the aforementioned "local signs." Rather, this depth structure belongs to the color phenomenon as such. Thus we can confirm once again that color is essentially spatial.

3) Ecological optics

The color phenomenon always forms itself in a spatial structure. This result obtained by Katz' analysis has a great scope. If the essence of color possesses a determinate spatiality, then it becomes impossible simply to repeat Newton's thesis that light is colorless and that color is a mere subjective sensation. Rather, we need to say that there is color precisely where one finds light and where one finds things, which contradicts the basic presupposition of current color theory.

Of course, various results of Katz' analysis were accepted into current color science, but the bulk of them were dealt with only in the realm of psychology. No matter how strongly the spatiality of color might have

been emphasized in this context, space as revealed by color has been conceived at most as a "psychological space" having nothing immediately to do with physical space. According to this presupposition, there are apparently two spaces, one a psychological and the other a physical space, and hence the "phenomenological" results of Katz' analysis amount to nothing. Is it not possible to develop a science of color that corresponds to phenomenological results? As a possible candidate for such an undertaking, lastly I would like to point to J. J. Gibson's ecological optics with a view to how it supports the thesis of color's spatiality.

According to Newtonian optics, which comprises the point of departure for current color science, the relation between light and color is established on the basis of spectral analysis in an experimental situation, and the essential character of color is determined according to this model of spectral color. Certainly this investigation established a precise view about the relation between the wavelengths of light and spectral color and provided a basis for modern color science. However, it should be taken into consideration that this viewpoint restricts our interpretation of color in decisive ways. According to the premises of this theory, the perception of color actually signifies the perception of the spectral light abstracted from various environmental factors. According to this presupposition, the distinction emphasized by Katz between light as illumination and light as the source of illumination is regarded as only incidental to the essence of color.

Gibson presents his ecological optics as diametrically opposed to this traditional viewpoint of modern optics. For Gibson, the origin of the color phenomenon is not to be found in the laboratory but instead in the everyday environment. When dealing with light, we must initially distinguish the various levels on which it appears and various meanings it correspondingly has. For example, Gibson distinguishes three types of light: "light as physical energy" (light thematized independent of the perceptual), "light as a stimulus for vision" (light as observed from a physiological standpoint), and "light as information for perception" (light as making possible the perception of the environment). "Ecological optics" mainly takes as its object the third of these types of light. In this optics, the distinction between luminous bodies and illuminated objects or between the phenomenon of luminosity and that of illumination is seen as one of the most fundamental aspects. "But in ecological optics,

the difference between a luminous and an illuminated surface is crucial. Where a reflecting surface in physical optics is treated as if it were a dense set of tiny luminous bodies, in ecological optics a reflecting surface is treated as if it were a true surface having texture" (Gibson 1979, p. 48).

As Katz had previously shown, the luminous and illumination phenomena have a fundamentally different sense for the constitution of space. While in the illumination phenomenon the illuminated object and the surrounding empty space are differentiated and thereby constitute a structured space, something comparable does not result from the phenomenon of luminosity. The dark chamber through which Newton conducted his spectral analyses can be seen as a device that negated these natural distinctions. In other words, Newton's dark chamber is a device in which a light phenomenon that is inseparable from spatiality is made up into a light phenomenon that is independent of spatial constitution. Only on the basis of this result, we come to interpret the light and color phenomena in such a way as if they are independent of all spatiality. In contrast, ecological optics concentrates upon the phenomena of color and light that are neglected in the physical optics, namely the phenomenon of illumination. In this sense, one could designate ecological optics as an *optics of illumination*. "No one sees merely light. One can perceive a rainbow, to be sure, a spectrum, but even so that is not the seeing of light. Halos, highlights on water, and scintillations of various kinds are all manifestations of light, not light as such. The only way we can see illumination, I believe, is by way of that which is illuminated, the surface on which the beam falls, the cloud, or the particles that are lighted" (Gibson 1979, p. 54ff).

The visual field is structured by this illumination phenomenon, and the light that originates through the illumination phenomenon, Gibson designates with the well-known expression "ambient light." "Many-times reflected light in a medium has a number of consequences that, although important for vision, have not been recognized by students of optics. Chief among them is the fact of ambient light, that is, the light that surrounds a point, any point, in the space where an observer could be stationed" (Gibson 1979, p. 50). The concept "ambient light" is not easily understood, but in this context we can interpret it as "structured light that is formed through illumination." That is, it is light which is reflected from various surfaces, structured, and stabilized in a determinate

condition. This condition of structured light is no different from that which Katz impressively described relative to the illumination phenomenon and empty space.

With all of these points, we confirm that Gibson's ecological optics can be made sufficiently compatible with Katz' phenomenology of color. To which extent the two correspond each other cannot be foreseen here and hence must be further investigated. In any case, it can now be said that we need not restrict the phenomenological insight regarding the spatiality of color to the realm of psychology and that this insight can play an important role as a guide for a possible science of color. Concerning the phenomenon of color, we need not to abandon a hope to build a bridge over the yawning gulf separating phenomenology and natural science, which has sometimes appeared unbridgeable. Such a hopeful attempt will be able to show, on the one hand, that the spatiality of color, which constitutes an essential aspect of our worldly lives, does not contradict scientific findings, and, on the other hand, that a science of color is possible that is not opposed to our life but is instead in proximity to it.