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LIGHT AND COLOR FROM A PHILOSOPHICAL POINT OF VIEW

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Abstract. Light and color are familiar basic traits of the visible world. The article discusses the problems which arise if we expect more from the sciences than a variety of information about particular conditions and aspects of light and color, i.e. if we expect an answer to the philosophical question: what are light and color? In trying to answer this question, science turns light and color into an insoluble riddle. This riddle cannot be solved unless scientific realism is subjected to a philosophical critique returning to the reality of the 'Lebenswelt' (E. Husserl) from which the meaning of scientific concepts and theories originates. This critical reflection would help philosophy preserve the primary reality of light and color in its irreducible totality for human experience.

1. What are light and color?

In *Confessions,* Augustine (1991:230) ponders time:

> *What is time? Who could explain this easily and briefly? Who can comprehend this even in thought so as to articulate the answer in words? Yet what do we speak of, in our familiar everyday conversation, more than of time? We surely know what we mean when we speak of it. We also know what is meant when we hear someone else talking about it. What then is time? Provided that no one asks me, I know. If I want to explain it to an inquirer, I do not know.*

Augustine's difficulties with time are similar to the problems we encounter when we discuss light and color. Like time and space, light and color are not specific objects in the world. Rather, they define the qualitative and sensual entirety of the visible world that surrounds us. Everything that we see is somehow lit and colored. For that matter, we must be somehow 'in light' (i.e. in a lit and colored world) in order to see anything at all.

At the same time, we cannot *see* light directly without being blinded by it; to us, pure light means the same as darkness. We can only perceive it indirectly when it lights a space and makes objects visible to us in their coloredness. In his *Farbenlehre* (Color Theory), Goethe recommends that we think of light and color

as “belonging to the whole of Nature: through them, Nature in its entirety wants to reveal itself specifically to our sense of sight” (Goethe 1966a:315).

If light and color are such omnipresent factors in our lives, why is it so difficult to answer the questions: What is light? What is color? We are helpless when faced with these questions because we relate to light and color in an especially familiar way. They are basic traits of our environment to which we pay no attention until their presence is disturbed. In the same way that we first become conscious of our health once we have become sick, we begin paying attention to light and color only after we notice that the lighting is too dim or that colors are too faded to serve their practical purposes as signals and differentiators. The other qualities of objects (their form or material characteristics, for example) are usually more interesting from a practical perspective. For the most part, light and color interest us explicitly in regard to aesthetics and fashion, when designing our environment, or in art.

2. What answer can science offer?

Augustine went to the trouble of trying to understand the essence of time by reflecting on familiar basic traits of temporal experience. We, on the other hand, tend to choose easier methods. We turn to ‘experts’ who we think are qualified to answer our questions, try desperately to remember what the physics teacher told us in grade school, or check the encyclopedia.

The amount of knowledge the sciences have collected about the physical, chemical, and biological aspects of light phenomena and their perception is impressive. This progress of knowledge allows us to research new options for artificial lighting and to manufacture natural and synthetic dyes and paints. We see its effects in architecture, in the textile industry, and in the media. Neuro-physiological and sensory research allows modern medicine to treat people with eye problems that cause them to see light and color abnormally. Psychology examines how light and color phenomena relate to emotions, linguists compare the expressions used to describe them in various languages. The humanities address their symbolic meanings in art and literature. Anthropology does the same for religion and culture.

The variety of information about light and color, which has been incorporated in a variety of color theories, is interesting and useful for many purposes. But it is only confusing if one is looking for a total orientation in this area – in old-fashioned terms, looking for an answer to the questions about the *essence* of light and color.

Since secular western society is no longer guided by religious world-views, many expect the sciences to be the source to all answers. As the philosopher Bernulf Kanitscheider put it, the scientific world-view is supposed to help us “find orientation in a dreadfully complex world which [we] did not create and to which we relate often with astonishment, sometimes with insecurity, and much of the

time with helplessness" (1984:9). Can the sciences fulfill these great expectations?

3. Could holistic science be a solution?

Regarding the splintering of scientific knowledge, C.F. von Weizsäcker argues, "a specialized science can not give us a world-view that would offer foothold in the confusion of our existence" (1979:5). Hence the popular call for a holistic science. But what makes such a holistic account possible? What could it be based on?

There is a trend in the sciences, which runs opposite to the splintering of terminology, methods, theories, and disciplines. This trend is the attempt to unify by reducing the most widely varied phenomena in accordance with a few common principles systematized in a "fundamental science". The language and conceptual-methodic organon of this fundamental science is supposed to be normative for all other sciences. Mathematical physics functioned as such a fundamental science until a short while ago, as can be seen in the *Einheitswissenschaft* (unified science) program propagated by Logical Empiricism. W. Oswald outlined a hierarchical system of science based on mathematics and physics at the beginning of his *Farbkunde* (color science) (1923), in order to determine the role of color theory. Today, biology has taken the place of physics as a fundamental science. Some scientists and philosophers, such as K. Meyer-Abich, see this change as a welcome paradigm switch from an "atomistic," "mechanistic" world-view to a "comprehensive" and "organic" one (1988: chap. III, 78–103).

In his color theory, H. Küppers attempted to establish physiology as the fundamental science for colors. The theory is ambitious and controversial but the basic assumptions are exemplary for similar attempts. For practical and didactic purposes, Küppers outlines a "generally valid and generally understandable theory of color […] that has validity for all disciplines and fields where color is an issue". This would serve as a generally binding basis for color didactics and for the „environmental responsibility of color designers" (Küppers 1978:9, 201).

Küppers bases his theory of color on the physiological laws of seeing, i.e. on the three primary colors violet, green, and orange. These three colors correspond to three types of sensory cells on the human retina (1978: § 8, 26–28). These laws could explain the origins, combinations, and perceptions of color. According to Küppers, even principles of color harmony can be derived from this basis (1978:9).

Küppers' theory may be useful for certain practical purposes. But his claim to holistic orientation and to have answered the ontological question: "what *is* color?" is based on an old philosophical prejudice that remains a source of controversy in the current philosophical debate. It is this prejudice that makes color a seemingly insoluble riddle.

4. How light and color became an insoluble riddle

Basing a theory of color on physiology implies that colors are subjective sensual perceptions. As Küppers (1978:22) wrote:

> *The external world is colorless. It is composed of colorless matter and colorless energy. Color exists only as the sensual perception of the observer. […] The green is not on the lettuce leaf.*

This is a standard thesis. Not only can it be found in most conventional lexicons and introductions to color theory; it has a time-honored tradition that reaches back to antique atomism. In Democrates' writings we read that:

> *It only seems that a thing has color; it only seems that it is sweet or bitter. In reality are only atoms and empty space* (Capelle 1968: 399, fragment 7).

This assertion is based on a conviction of the reality of an imperceptible atomic world. Since Galileo's times, modern physics has held that this assumption can be empirically confirmed. According to this theory (and contrary to all appearances), there are no colors in the external world but only those physically ascertainable qualities and processes, which J. Locke called "primary qualities". Their existence is deduced from experiment results but is in and of itself imperceptible. For Newton, light is a material substance; for modern physics it is a type of electromagnetic radiation, which is concealed from the senses. Physical stimuli are supposed to affect the senses in such a way as to cause physiological changes, which in turn appear to our consciousness as light and color phenomena. For Locke, this process is just as mechanical as the way we perceive pain from a sword stroke. According to this theory, the colored and lighted world that we perceive is a sort of film, which, controlled by an invisible hand, plays on the stage of our consciousness, a dream we see with our inner eye.

This conception of sensual qualities does not fit our normal assumption that the green is on the lettuce leaf, i.e. that the world itself is colored. Contrary to Kanitscheider's opinion, we are not helpless and unsure of ourselves without the help of the sciences; rather, we have a practically reliable basic orientation. We only become unsure when we come into contact with the "scientific world-view." Light and color phenomena may be astonishing and remarkable for normal human intellect. But they become an insoluble riddle only when we expect the sciences to do more than supply us with information about the conditions and patterns observed in the origins and perception of these phenomena. The sciences cannot supply us with answers about the *essence* and *ultimate causes* of light and color. Neither classical nor modern physics, neither biology nor neurophysiology is in a position to do so. All these disciplines are based on a model of the world and of perception that is no less mechanistic than the atomism of antique and classical physics. An answer to questions about the essence of the phenomena is made impossible by this model, as can be seen in the philosophical discussion of perception.

5. The mechanistic world-view: where have all the colors gone?

The mechanistic model of the world and perception is characterized by a basic differentiation between a material external world and a mental internal world. The external world is divided into an objective physical and a subjective physiological level. Thus one can define a total of three levels in this model: the physical, physiological, and psychological. These are interconnected by a stimulus-reaction mechanism. This model is still in use in a slightly modified form as an information processing system, as can be seen in modern biology. As Küppers (1978:24) writes:

> *The organ of sight operates like a computer system. The eye functions as the input device and the brain is the processor. Perception of color is the output.*

Accordingly, colors are often seen as constructions of the brain. The process of seeing colors is understood mechanistically, although the new computer-based conception of the mechanism is much more refined.

The mechanistic model of the world and perception leaves us with the question: where in this model are colors *as such* to be found? The internal world of consciousness, to which they were banned as ideas or as "sensory data" by Democrates, Descartes, Locke, and their disciples, appears on closer inspection to be a purely intellectual construction, as much a fiction as the concept of an external world which is completely and absolutely independent of our perception of it. Plato and Aristotle raised this objection against the atomists, Bishop G. Berkely raised it against Newton and Locke, and Husserl and Wittgenstein raised it in the last century against the cartesian-scientistic world-view in general (cf. Rehbock 1995).

Wittgenstein's criticism of the idea of a mental internal world inspired language philosophers to a *materialistic* designation of colors as physical qualities. According to this designation, green *is* an objective characteristic of the lettuce leaf. But we tend to be mistaken about what it is that we actually see and what it is that the word "green" applies to – what it *means*. The sciences are expected to give the answer to that question.

This expectation is countered by those philosophers who base their arguments on neurophysiological evidence, which indicates that no clear relationship can be established between physical stimuli and sensory perception. The same wavelength combination of light and the same surface characteristics can cause varied perceptions of color. Conversely, perceptions which viewers believe to be the same can be caused by various physical stimuli. This "metamerism" leads to the conclusion that perceptions of color are first produced after the brain has processed the stimuli. Thus, they are neither characteristics of physical objects nor purely psychological entities (sensory data). Rather, they are neural states or processes.[1]

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[1] A fundamentally similar opinion was held already in the 19th century: sensory qualities are states of excitement in the sensory organ that perceives them. This was based on the observations, which Johannes Müller expressed in his law of "specific sensory energies". This law states: The

Other philosophers object to the reduction of sensory qualities to physical or physiological qualities on the grounds that this reduction disregards the *qualitative* dimension of the sensory qualities. This qualitative dimension can only be *experienced* from the inside and is completely dissimilar to the physical and physiological process, which can be objectified from the outside (cf. Rehbock 1998). We know much about the physiological equipment of bats and about the nature of the world which they perceive. Despite that, what they experience and how they perceive it remains unknown to us; we cannot answer Th. Nagel's question: *What is it like to be a bat?* (Nagel 1974).

F. Jackson came to the same conclusion in his depiction of a scientist named Mary, who knows everything there is to know about the physical and neurophysiological processes through which perceptions of color are produced. But she can only see the world in black and white, because she has been locked into a room, which is completely colorless since she was born. Jackson argues that, should Mary acquire the ability to see color, she would learn something fundamentally new, or at least a fully new perspective on something which was previously only accessible to her from the outside. This implies that her former knowledge was „incomplete". The knowledge or the consciousness of the colors which she experienced herself, the *qualia*, cannot be replaced by knowledge of material processes (cf. Jackson 1982, 1986).

The philosophical discussion is obviously running in circles. The internal world of former times returns in a slightly modified form as the so-called "phenomenal consciousness," and in place of "sensory data" we see the "qualia". Most critics of reductionism admit that the origin and mode of existence of qualia are mysterious since they cannot be explained by reduction to material causes. An "explanatory gap" appears between phenomenal and physical characteristics. "Consciousness" has become "a riddle," observes the philosopher P. Bieri, a similar conclusion to that which E. Dubois-Reymonds, the founder of experimental physiology, came to in his famous lecture *Über die Grenzen des Naturerkennens* (On the Boundaries of the Knowledge of Nature) (1872). (See Bieri 1996) But while Dubois-Reymonds, remaining skeptical, holds to the "Ignorabimus", i.e. we don't know and *will never know*, the modern-day qualia-theorists only follow him as far as the "Ignoramus": we don't know, but have still reason to hope for a scientific explanation of consciousness in the future.

In the following, I offer a science-critical perspective to these simultaneously skeptical and scientistic positions. This perspective solves the "riddle" and makes a return to the life-world as a reliable basis of meaning for the concepts and methods of scientific research.

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same stimuli, e.g. mechanical pressure, are converted to completely different sensory qualities depending on which sensory organ processes them. C. L. Hardin currently argues for this theory in a neurophysiologically modified form when he argues that "colored objects are illusions", since "phenomena of the visual field are represented in the visual cortex [...] descriptions of the visual field may be replaced by descriptions of neural processes" (Hardin 1988: 111).

6. Solving the riddle through critique of scientific realism

We have seen that the sciences help us no more – and even perhaps less – than a religious world-view or transcendent metaphysics in our search for an answer to the *essence question* and for comprehensive orientation in the world. The so-called *scientific realism* – belief in the existence of an *objective* world independent of the subject and hidden from the senses – is the modern version of a naive belief in a transcendent world. That is shown clearly in the criticism of scientific reason practiced by philosophers such as Berkeley, Kant, Hegel, Nietzsche, Husserl, Heidegger, and Wittgenstein. But the *skeptical* consequence, which apparently ensues from this criticism – an *instrumentalistic anti-realism* that denies the existence of atoms and sees them simply as a useful fiction – is also misguided. Much more reasonable would be a rather more radical realism that anchors both our everyday concepts as well as our scientific ones in the sensually perceptible reality which is commonly accessible to us all.

The mechanistic model of the world and perception is as such not nearly as problematic as is often asserted. Only when this model is interpreted meta-physically as a representation of a transcendent reality closed to the senses do we run into difficulties. Such an understanding forgets that such models are created through a complex intellectual process within technical-practical contexts of our life-world and can only be understood relative to these contexts. This process is based on *concept formation through idealization*, e.g. mathematical construction, on *operational definition* of concepts using technical methods, on *methodical reduction*, which reduces reality to its relevant aspects and simultaneously ignores other (disruptive) phenomena – in short, on an *adjustment* of reality for the purposes of the experiment. Reduction is validated based on the principle of *analogy* or partial similarity of the phenomena, allowing description of the most varied phenomena in a moment, which gives them a homogenous structure. The mathematical wave model is used in physics to describe such various phenomena as light, sound, and warmth using the mathematical structure of vibration.

Such models gain empirical reality by making assertions within a conceptual and methodical framework that is defined by the model. These assertions can be confirmed or refuted in our life-world through experiments. The model itself is not true or false; it can only be more or less appropriate as a method of representation. We can not suppose that light, sound, and heat are *in reality nothing more than* vibrations, that the human act of seeing is nothing more than a data-processing system, or that colors are nothing more than neural processes. Models of this kind are intellectual constructs, which can describe one of the many aspects of the reality of light and color.

The leftover aspects should not be ignored as *merely subjective*. This is how the above-mentioned riddles and problems come into being. They cannot be *solved:* we must *dissolve* them by recognizing them as the products of meta-physical fictions. The understanding of the relationship between the internal and the external world, between subjectivity and objectivity that is implicit to scientific realism must be reversed: those things which we see as belonging to the

inner realm – the phenomena of light and color as we sensually experience them – have objective reality. That which has been understood as a description of objective reality – scientific concepts and models – are intellectual constructs of a subject. Their relationship to reality can only be proved in a sensually perceptible reality.

7. The objective reality of colors

Many objections to the objective reality of colors have been raised on the grounds that various groups – color-blind people, members of other cultures, or animals like Nagel's bats – perceive colors other than we do, if at all. These objections rest on two assumptions: on the one hand, that a reality exists independent from us that remains the same and that, on the other hand, we have – in our consciousness – varied subjective conceptions of this reality. This train of thought leads to rather curious skeptical conclusions like the argument that we can never know whether others see colors completely different from us. According to this conception, colors are like beetles that we all carry around in the little private matchboxes of our consciousnesses, unable to see into each other's matchboxes to compare our beetles.

Wittgenstein, who conceived this metaphor, allowed nothing to remain in the inner realm of private consciousness, not even pain. He argued that we would be unable to communicate with each other about such purely private objects. Wittgenstein points out that we possess a common human language, which allows us to express and communicate, even the most subjective things like dreams, feelings, and sensations (not to mention colors). This communication itself is only possible insofar as linguistic expressions gain meaning in the contexts of common ways of life. These contexts also include very elementary corporal-sensual experiences and behaviors. This account holds that expressions used for color are no more based on something *within us* than are terms used in physics; rather, they refer to something which we can localize in our human world, a something which we can experience along with others because we can point it out, describe it, and share it:

> *Look at the blue of the sky and say to yourself, 'How blue the sky is!' If you do this spontaneously and not with philosophical intent, it will not occur to you that this impression of color belongs only to you. Further, you will have no reservations about making this observation to someone else. And if you are pointing out something with your words, you are talking about the sky. I mean, you don't have the feeling that you are pointing out something within yourself* […] (Wittgenstein 1971: § 275, 150).

Also those things that are more subject-related, which we cannot point out in this manner, have a reality, which is both intersubjectively accessible and objectively describable. Wittgenstein shows this using the example of pain. Goethe speaks of the "physiological colors" such as colored images. A colored image created by the eyes is *as such* just as real as the relatively permanent

surface color or spatial form of a corporal object. For this reason, Goethe argued strongly against understanding and designating these colors as "apparent colors", "optical illusions", etc.:

> *The term 'optical illusions' […] should be banned. The eye does not delude itself; it functions according to rules, thus making a reality of that which could be called a specter by expression but not by nature* (Goethe 1966b:237f.).[2]

The complementary insight to Goethe's thoughts – an argument used already by Berkeley and Leibniz against the distinction between primary and secondary qualities – can be formulated as follows: Even the most objective physical qualities can only be accessed and experienced under corporal-sensual conditions. The empirical scientist makes her observations *through her own body*; she must read measuring devices, set up experiments to obtain the data which she then analyses using theoretical concepts. These concepts have no corresponding reality *beyond* the phenomena, which is only accessible to her reason. Physical entities like electromagnetic radiation are only real insofar as they, like all real entities, take effect in this world in such a way as to be accessible to our senses, with or without the help of technical equipment. In the case of "neural processes" it is especially obvious that they can have no reality independent of the material mass of the eyes and the brain, which can be handled, sliced, and put under a microscope – in short, have form and color that can be perceived by the senses.

If scientific concepts, theories, and models are to make any sense, it must be possible to relate them to the reality, which is accessible to the senses. The objections based on the differences in animals' or color-blind peoples' modes of perception are only objections to a false conception of objective reality. Reality is neither fully dependent on subjective conditions nor does it independently remain the same: it is contingent upon perspective. That is, it varies and alters itself *partially* dependent on the sensual-corporal perspective of the observer.

Philosophy has contributed to a false conception of objective reality by orienting itself on abstracted mind-games using for instance "Mary," a bodiless and timeless entity. According to F. Jackson, Mary is a brilliant scientist who is forced for some reason to see and study the world from within a black and white room using a black and white television monitor. Mary supposedly learns about colors when someone gives her a color television (cf. Jackson 1982 and 1986).

But if Mary is a real flesh-and-blood person, she must be thought of as color blind; i.e. with a physical disorder in her eyes or brain and with an abnormal modus of perception and physical behavior, which can be observed both by her and by others. The color-blind Mary does not have "incomplete knowledge" (F. Jackson) of the inner nature of experience. Rather, she sees and experiences the world fundamentally differently as someone with normal sight. While she cannot access reality in its coloredness, she does not see the world simply black and

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[2] Cf. also Goethe (1966a: §§ 1–3). Goethe is probably using the word 'specter' as an allusion to the Latin term 'spectrum', which was used in its definition 'deluding appearances' to describe not only the spectrum of colors but also to refer to uncorporeal color phenomena such as after-images or rainbows.

white as on a black and white television. She reacts differently to light and darkness: normal daylight blinds her, making her squint or wear dark glasses; on the other hand she can see some things better than those with normal sight, especially at dusk or in darkness.[3]

It is of course only to a certain extent possible for those with normal sight to see through the eyes of the color-blind, as it were, or vice-versa. It is difficult to communicate such a perspective linguistically. But it is not impossible. There are reliable criteria, which can be used to determine if, and to what extent other people or animals – due either to (color)-blindness or other sensory abnormalities – perceive the world partially different than we do. Not only is it possible for color-blind people to overcome the difficulty of communication and describe their sensory experience to others; we can see the difference in their sensory experience through the difference in their behavior. This behavior may be foreign to us, but it is not totally incomprehensible.

Mary is able to recover her color vision through surgery. To say that her "knowledge" of the world is completed by an *inner, purely subjective* knowledge – one caused by her new access to the sensations and experiences *within* a color-seeing person – would not be a realistic description of the change that takes place. Rather, her whole world and her whole behavior changes fundamentally. This change from black-and-white to color is probably not as difficult and dramatic as the change that takes place in those people who, blind from birth, receive their sight for the first time (cf. Zajonc 1993). But Mary encounters similar difficulties in seeing and distinguishing colors and in orienting herself in the world under the new perceptual circumstances of light and color.

8. *Lebenswelt* and phenomenological grammar

If we want to understand what light and color are without dreaming up a fictitious world behind appearances, we, like Augustine, must take the trouble of returning to the basic realities of life-world experience. According to E. Husserl, these basic realities comprise the "Lebenswelt"**,** which is to be considered as "vergessenes Sinnesfundament der Naturwissenschaft" (the forgotten foundation of meaning for natural science) (1969: 48). Husserl asserts that natural science should remember and reflect this forgotten foundation for two reasons: *firstly* in the interest of the rationality and methodological order of science itself, and *secondly* in the interest of saving the phenomena in their original and irreducible entirety for life-world experience. This applies especially to the phenomena that

[3] In his book "The Island of the Colorblind", Oliver Sacks tells of his own experiences: "That is one of the special strengths of color-blind people: they seem to see the shadowlike movements of fish under the water and the glitter of the moonlight on their fins when they jump as well or even better than others" (1997:76). Sacks describes the whole human situation and the very practical problems that present themselves to the color-blind due to their modus of perception in an impressive way. See also his account of the dramatic story of a painter who became completely color-blind as a result of an accident (cf. also Sacks 1995).

correspond to the so-called "secondary qualities" (J. Locke) such as color, taste, smell etc. As the phenomenological *horizon* both of day-to-day experience and of scientific experience, the "Sinnesfundament" cannot be itself an *object* of experience. It can only become the subject of philosophical thought after a fundamental change has been carried out from the natural attitude (natürliche Einstellung) of daily life and scientific investigation to the phenomenological attitude (phänomenologische Einstellung). What Husserl calls mostly the "(transcendental) horizon" or the "Sinneshorizont" of experience corresponds on the level of language to what Wittgenstein calls the logic or grammar of our concepts.[4] Wittgenstein (1979: I, § 22) emphasizes the methodical precedence of this logic relative to both day-to-day experience as well as to scientific investigations and experiments, which it makes possible:

> *We do not want a theory of colors (neither a physiological nor a psychological one). Rather, we want to discover the logic of color concepts. This logic does that which has often (and falsely) been expected of a theory.*

It is wrong to expect scientific theories to provide answers to questions about the essence of a thing. "The *essence*," says Wittgenstein, "is expressed in the grammar" (1971: § 371), that is, not in empirical or metaphysical statements but in basic concepts of our language.

The expressions "logic" and "grammar" should be understood metaphorically. As with formal logic or the grammar of a language, the conceptual logic or grammar of colors does not contain any empirically verifiable statements about reality with truth-values. Rather, it states the conditions or rules according to which such statements are formulated and defines the conceptual framework where such statements are possible. Since statements about this framework, the so-called "grammatical sentences," appear superficially similar to empirical statements, it can sometimes be difficult to recognize them for what they are. This difficulty can be best understood in light of the following examples (see Wittgenstein 1979: I, § 1):

Table A is lighter in color than Table B.	*White is lighter in color than black.*
	Yellow is lighter in color than blue.
Table A is twice as large as Table B.	*4 is twice as many as 2.*

The statements on the left-hand side are empirical statements, which can be true or false. They can be verified by observations or measurements. The statements on the right-hand side describe the color and number systems, which we presuppose when making empirical statements. They are like statements about a standard of measurement, which we use to measure objects. We do not have to test empirically whether grammatical statements are true or false. That would be like going to Paris and measuring the Urmeter (original meter) with a meter stick in order to confirm that it really is a meter long.

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[4] A more detailed explanation of this conception that unites Husserl's phenomenology with Wittgenstein's analysis of language is to be found in Rehbock (1995: chap. VIII, X; 1998).

Nevertheless, grammatical structures do not exist independently of the perceived world as pure linguistic structures. They determine "the type of statements that we make about phenomena," and in doing so determine "the possibilities of the phenomena" (Wittgenstein 1971: § 90). In this way, our color concepts determine the sensual-qualitative form of the entire visible world. Wittgenstein echoes Husserl's phenomenology in this regard. For this reason, conceptual logic can also be called "phenomenological grammar".

According to Wittgenstein, many of the famous color systems are geometric representations of conceptual or grammatical relationships, including his preferred *Farbenoktaeder* model. This model was suggested by the psychologist A. Höfler (1897:113) and also used by H. Ebbinghaus (1902: 184; cf. Rothaupt 1996: chap. 22). It describes the "three dimensions" of the logic of color space: the Black-Gray-White row, color hue and saturation. According to Wittgenstein, these are the basic grammatical dimensions, which outline the possible description and designation of colors. Further, the model uses the four corner points of a square surface to represent the division of pure colors into the four primary colors: yellow, blue, red, and green. All other colors can be described as mixtures or in-between color relatives to these primary colors.

But Wittgenstein also emphasizes that such models only represent certain aspects of our phenomenological grammar of colors while ignoring a multitude of other relationships. The way color depends on light and darkness or on the presence of other colors is one example of such a relationship. The grammar of color concepts also includes the complex internal relationships of colors to the other basic dimensions of the world such as space and time. For example, there is an internal relationship between color (and light) and the spatial qualities of objects: contrasts between light and dark areas and between different colors are prerequisite to the recognition of the size, shape, and surface qualities. Further, colors can appear as surface colors, free colors, and the colors of space. The phenomenological psychologist D. Katz, the author of these differentiations, has also examined the manifold phenomena of shine, glow, shimmer, flicker, transparency, etc. in their relationships to color (Katz 1911). These phenomena were also of special interest to Wittgenstein (1979).

Another question to this theme is whether there is an internal conceptual relationship between colors and the typical surface characteristics seen on certain types of objects or materials. This would make statements such as: "Gold is yellow," "Snow is white," "The sky is blue," grammatical rather than empirical statements. That was obviously Goethe's opinion. "One doesn't need to travel around the world to understand that the sky is blue everywhere" (Goethe 1973: no. 1379, 547).

9. Philosophy and science

In view of what has been said so far, we can come to the conclusion that we cannot and will not reach an answer to our primary question about the nature of

light and color through scientific theories and definitions. In a certain sense there is no possible answer to this question, at least not the same type of answer as the sciences give us to satisfy our theoretical curiosity. Light and color *are* those light and color phenomena, which we know from day-to-day life. In another sense, however, there are a wide variety of answers to our question. These answers make us conscious of that which we take for granted, allowing us to discover it anew. This is possible through a philosophical analysis of the complex phenomenological grammar of color concepts.

But what is the point of analyzing phenomenological grammar philosophically? How do such analyses relate to the sciences? To answer these questions, it is necessary to differentiate between three purposes of philosophical reflection: 1. Methodical criticism of scientific reason; 2. Holistic orientation, and; 3. Clarification and critique of common sense.

9.1. Methodical criticism of scientific reason

The psychologists Hermann Ebbinghaus, David Katz, Carl Stumpf and Ewald Hering were especially conscious of this purpose for philosophy. Husserl's influence can be seen in this emphasis. They were aware that phenomenological clarifications of relevant aspects and relationships between the phenomena, which are substantiated by the life-world, *must* precede their empirical studies. Katz prefaces his empirical-experimental psychological studies with a lucid survey of the "Erscheinungsweisen der Farben" (appearance modes of colors). He states that the relationships represented in this survey cannot be "proved by experiments"; rather, they must be exemplified through the "many appropriate cases of life experience" known to the reader (Katz 1911:6).

C. Stumpf emphasizes that, when carrying out such pre-empirical studies, one must "under all circumstances avoid perverting them by mixing in physical factors." Further, Stumpf suggests that such studies do not contain a "direct study of psychology or physiology – they are phenomenology." In reference to his psychological investigations though, he does say that the phenomenological studies were carried out "for the sake of psychology and in the hope of finding starting points for research into psychological functions. Others carry them out for the sake of cerebral physiology" (Stumpf 1917:8).

The ambiguity of the differentiation between primary and compound colors is appropriate to elucidate the conceptual confusion that occurs when this methodical order is not followed carefully enough. According to a commonly held prejudice, there *are* three primary colors: red, yellow, and blue. Thus, green is a compound color. But this assessment is not based on what we actually see. We do not *see* green as yellowish blue or bluish yellow in the same way as we see orange as reddish yellow. Green only becomes a compound color through the chemical (subtractive) mixture of yellow and blue pigments. We find it surprising that green can be mixed in this way – it was once an empirical discovery. We forget this all too easily, once we know it.

The element of surprise in this discovery implies that beforehand we have perceived green as a primary color, that its placement in our phenomenological grammar is based on this perception. Further, it implies that in this perceptual sense green will remain a primary color even after this discovery. The expressions "primary color" and "compound color" have different meanings depending on whether we are mixing pigments or dealing with the colors that we see, which can not be actually mixed.

A similar confusion marked the dispute regarding the Young–Helmholtz tricolor theory and the four-color theory of E. Hering at the beginning of the 20th century. The tricolor theory bases the hypothesis that there are three different types of receptors in the retina on the fact that (almost) all colors can be mixed additively from three primary colors (mostly orange, green, and violet). Hering's theory, on the other hand, argues that the color pairs red-green and yellow-blue correspond to two physiological processes, which mutually eliminate each other. C. Stumpf (1917) points out that the tricolor theory is an *empirical* physiological hypothesis, whereas Hering's theory should be treated as *phenomenological*. This is a reference to the fact that, without prior physiological knowledge, we can identify four primary colors (what Hering calls "*Urfarben*", or primeval colors) when we only perceive them. Unlike for example orange or violet, these colors do not appear to be mixed or in-between colors. Further, the primeval color pairs blue-yellow and red-green mutually exclude each other, i.e. they are fundamentally unmixable in the sense that we perceive orange to be reddish yellow or violet to be reddish blue. Thus, we cannot speak of "bluish yellow" or "reddish green". For this reason, Hering also refers to them as "Gegenfarben" (anti-colors).

The physiological hypothesis based on Hering's four-color theory was only confirmed much later by experiments on apes. But even in the absence of any such evidence, the phenomenological basis of his theory would not have been affected in the least. It cannot be proved or disproved by empirical experiments; rather, it can only be shown through philosophical reflection on relationships known to us from the life-world. This is not true for Helmholtz's tricolor theory. Without the empirical knowledge of the laws of additive color mixture from three primary colors and of the receptor types in our eyes, which are sensitive for those colors, we would never have thought of designating three colors as primary colors in this way. It is just the other way around: to assign colors a wavelength or receptor type, we must already be able to describe them as a specific green, orange, violet, etc. – i.e. as compound or primary colors in the perceptual sense. This in turn presupposes the grammatical or phenomenological framework of the four primary colors.

9.2. Holistic orientation

The problem of the specialization of the sciences becomes significantly less threatening for our orientation in the world once we cease to expect assertions about essence and a holistic orientation *from them*, i.e. once we cease to expect an ontological and holistic *science*; in short, when we stop looking in the wrong

direction. To understand and assess the contribution of the sciences to our understanding of the world and to grasp their practical importance, we must use philosophical reflection to return to the basic holistic orientation, which is already familiar to us. This does not mean that philosophy can take the place of physics or biology as a basic science. There is no science of the world as a whole, not even a philosophical one. The world *as a whole* can neither be experienced nor theorized about, as Kant already pointed out in his "Critique of Pure Reason". The world itself is no possible *object* of experience. Rather, it composes the grammatical *whole horizon* of possible experiences *in* the world in which scientific theories and philosophical reflections must have an understandable and experience-related application in order to be comprehensible.

In light of this basis, it should be recognized that the great variety of sciences and scientific disciplines is not only not obstructive to orientation but also that this variety is a necessary condition for successful scientific work. This can be seen when the sciences orient themselves on clearly outlined and precisely formulated questions with reference to a specific matter and with a specific conceptual and methodical instrumentarium. Through these three aspects, the perspectives of the various disciplines on reality are each limited in a special way. Scientific disciplines constitute different *perspectives* on the same reality. They should not be differentiated by designating them to different *areas* of reality as is done in the dual world or three-level models, which we discussed earlier. If we took this designation literally, the unity of our world would be split into a number of worlds – the physical and the psychological, for example. This unity cannot be restored by the invention of, shall we say, cybernetic models, no matter how brilliant and up-to-date they are. It can of course be necessary to outline a comprehensive conceptual and methodical perspective, which is common for various disciplines, like for instance the mechanistic model of the world and of perception. Such models represent *the whole*, but only under a limited point of view.

If we take the demand for *objectivity* of recognition seriously, we must be especially interested in a variety of perspectives and thus in a *plurality* of scientific disciplines. As Nietzsche (1999: III. § 12, 365) notes:

> *The more eyes, different eyes we employ for the same thing, the more complete will be our concept of this thing, our objectivity.*

What Nietzsche has formulated here is an ideal of objectivity, which is shared by Goethe's color theory. This theory opens up a variety of aspects and perspectives that is as differentiated as possible for all color phenomena. It tries to bring these aspects and perspectives into a "leicht übersehbare Ordnung" (Goethe 1966a: 327), i.e. into an order which can be surveyed easily. With this theory, Goethe tried to create a common horizon for orientation and a common basis for communication for all scientific disciplines that have to do with colors. This intention manifests itself on the one hand in an organization of the color theory which comprises (almost) all possible aspects of colors, from the "physiological", "physical," and "chemical" to the technical and practical and the psychological

and artistic aspects. On the other hand, Goethe claims to have made a significant contribution to all sciences as well as to the practical fields in which knowledge is applied (e.g. medicine, color design, painting etc.). According to his holistic conception, the various sciences – according to Goethe's division, these are: physiology, physics, chemistry, psychology, and esthetics – can be assigned various aspects of *one and the same* phenomenon.

However, even Goethe hopes too much for one comprehensive theory of the whole. As he himself recognizes, he thus runs the risk of committing himself dogmatically to one theoretical conception and through that of ignoring a multitude of other possible aspects. It is neither necessary nor possible to make one discipline into the basic science or to come up with some sort of comprehensive theory in order to guarantee that the various perspectives refer to the same thing and to avoid the splintering of scientific disciplines. Rather, it is important to return to the horizon of orientation which we already have available in our daily lives and colloquial language. We use the conceptual means and differentiations of this language quite successfully and comprehensively to orient ourselves in concrete practical situations. This brings us to the third purpose of philosophical reflection.

9.3. Critique and enlightenment of common sense

One thing becomes especially clear through philosophical reflection on the phenomenological grammar of colors: It is wrong to say that we would not have *known* what light and color were, had not the sciences enlightened us on the subject, or that without this enlightenment we would have had to draw on the shaky intuitions and prejudices of common sense. The opposite is true. We are already in possession of a highly differentiated and complex grammar of colors without which it would be impossible to orient ourselves in the visible world and even more impossible to formulate usable scientific questions in this field. We are simply unaware of this basic orientation because we do not possess it in the form of explicit knowledge. Rather, it takes the form of fundamental "certainties" (Wittgenstein). For this reason, philosophical reflection demands a special effort and a peculiar attitude, one, which we do not normally take either in the sciences or in daily life. E. Husserl describes this as the characteristic attitude for the philosophical method: the above-mentioned *phenomenological attitude*.

Thus, the task of philosophical reflection is to enlighten common sense as to the primacy of its own life-world orientation and thus to its freedom and autonomy with regard to the sciences. For light and color, this can be seen in the primacy of their *visible* reality over conceptual and mathematical construction. Without the grammar of color concepts, which is oriented to visual perception, it would be impossible to recognize scientific light and color theories as theories *of light and colors*. These theories do not treat light *as light* or colors *as colors*; rather, they deal with the physical, chemical, and physiological conditions of their perception. That is, they deal with uncolored dimensions of reality, which are in a regular relationship to the perception of color. Colors in the primary sense are

neither radiation of energy, physiological processes or sensations, nor chemical pigment. "Color is not material," as W. Schapp points out. "Color can not be scratched off. One shouldn't confuse it with paint" (Schapp 1985:27). The primary reality of colors is the objective and omnipresent coloredness of the world, which surrounds us, in all possible aspects and modes of appearance. For this reason, Wittgenstein (1981: § 218, 273) calls for a "purely phenomenological color theory" in which "only the perceptible is spoken of and no hypothetical entities – waves, cells, etc. – are mentioned".

Unlike Goethe himself, Wittgenstein recognized that Goethe's color theory does not rival physics nor is it a physiological or psychological theory of colors, as many have argued. Rather, it is an analysis of the logic of color concepts based on perception (cf. Rehbock 1995: chap. VIII). Goethe's main objection to Newton's position is directed against Newton's belief that his optics could explain the *nature* or the *essence* of light and color, as is apparent when Newton says: White light *is composed of* variously colored light rays, or: Colors are *in reality* only variously refractable light rays. This, argued Goethe, is a reduction of light and color to something, which they are not; light is not understood *as light*, nor color *as color*.

Goethe is not arguing primarily against Newton himself, but against the popular Newtonianism of his time that could be found in lexica, textbooks, universities, even in art and poetry. Goethe saw its unchallenged authority as comparable to the authority of the medieval church and its theology. Authors of popular scientific texts, such as the Italian Algarotti in his book *Il Newtonianismo per le dame* (1739), pass on physical theories to the unsuspecting lay public under the cloak of scientific authority – they astonish their readers, who do not entirely understand what they are reading. This can be compared to recent popular science books on the Big Bang, black holes, or the allegedly imminent discovery of the universal formula. Algarotti, says Goethe, explains Newton's theory as follows to a lady "who once read of the seven-fold light in some sonnet or other":

> *He presents the phenomena to her with mere words, he explains them with words. And the dear lady believes on the spot, as hundreds of others have believed. She doesn't need to think any further on the subject; she is forever at peace as far as colors are concerned* (Goethe 1966b:192).

10. So what are light and color?

By way of conclusion it can be said: We can expect an abundance of interesting information, facts, and discoveries in the field of light and color phenomena from the sciences. Scientific progress has widened the range of options for experience, technical activity, and our life-world environment significantly, for example through artificial lighting and synthetic colors. It has widened our conceptions and extended our understanding of the world, has even changed it partially. But what light and color are – we know that already, or, better said, that must be familiar to us from our day-to-day experience. Philosophical criticism of

science counters the stubborn tendency to drive out our basic orientation and understanding of the world with scientific concepts and theories, allowing mere words to hide the primary reality of light and color.

Just as we can only perceive light through its effects – in the phenomena of brightness, luster, or coloredness – Goethe suggests that we can only grasp the *essence* of something by bringing to our minds the variety of its possible sensually perceptible modes of appearance as well as pointing out certain fundamental structures or conditions of the phenomena. According to Goethe, this includes above all the basic polarity of light and dark as well as some dim medium (air, water, glass, smoke, etc.) through which light must pass in order to be perceived in color phenomena (cf. Rehbock 1995: chap. VIII, part 6). These "Urbedingungen" (primary conditions) – as part of the "Urphänomen" of colors – must themselves be present *in the perception*. That is, they cannot consist only of intellectual constructions or geometrical means of representation such as Newton's light rays. Even when light comes through a small opening, maintains Goethe, we do not perceive rays or ray bundles; we perceive "pictures" of light (Rehbock 1995:155–156, 178–179). The light is only visible in a moderated form in contrast to darkness and through contact with a material object. For colors to be visible a dim medium is necessary – Newton's prism is only one example of such a medium.

For this reason, Goethe begins his color theory with paradigmatic primary experiences of light and darkness. Their existential meaning for our orientation in the world can be seen in a section from the story "Bergkristall" (The Rock Crystal) by A. Stifter. Two children lose their way in the mountains when overtaken by a driving snowstorm:

> *There was […] nothing around them but the White, and all around them there was no interrupting darkness to be seen. It seemed to be a great abundance of light, and yet one couldn't see three steps ahead. One might say that everything was covered in a single white darkness, and because there were no shadows, there was no way of judging the size of things, and the children couldn't tell whether they were going upwards or downwards until their feet met a slope and forced them to go upwards* (Stifter 1980:200–201).

Only after the snow lets up and contrasts between light and dark become apparent can the children see objects and color contrasts again, allowing them to orient themselves.

If we want to know what light and color are, we cannot ignore their relationships to ourselves: not to ourselves as organs of sight or brains with certain functions, but to ourselves as corporally seeing and acting subjects in concrete life situations and life stories. To this belongs what Goethe called the "sinnlich-sittliche Wirkung" (sensual and ethical effect) of colors on our emotional and mental mood, as well as the symbolic, religious, and aesthetic meaning of color. Art or literature are thus a far better source for answers about the essence of light and color than the sciences. Philosophy is in this respect closer to art and literature as it is to the sciences. This inspired Wittgenstein to remark that

"Philosophy should actually only be written as poetry." But that is another subject.

Translated by Heiner Mommsen.

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References

Augustine (1991) *Confessions*. Translation by Henry Chadwick. Oxford.
Bieri, Peter (1996) "Was macht Bewußtsein zu einem Rätsel?" In *Bewußtsein. Beiträge aus der Gegenwartsphilosophie*. Thomas Metzinger, ed. 61–77. Paderborn: Ferdinand Schöningh.
Capelle, W. (transl. and ed.) (1968) *Die Vorsokratiker. Die Fragmente und Quellenberichte*. Stuttgart: Alfred Kröner.
Ebbinghaus, Hermann (1902) *Grundzüge der Psychologie*, vol. 1. Leipzig.
Goethe, J. W. (1966a) *Zur Farbenlehre. Didaktischer Teil*. Hamburg: Christian Wegner, 5th ed. (E. Trunz, ed. Goethes Werke. Hamburger Ausgabe, vol. 13: Naturwissenschaftliche Schriften, 314–536).
Goethe, J. W. (1966b) *Materialien zur Geschichte der Farbenlehre*. Hamburg: Christian Wegner, 5th ed. (E. Trunz, ed. Goethes Werke. Hamburger Ausgabe, vol. 14: Naturwissenschaftliche Schriften. Zweiter Teil).
Goethe, J. W. (1973) *Maximen und Reflexionen*. Hamburg: Christian Wegner, 7th ed. (E. Trunz, ed. Goethes Werke. Hamburger Ausgabe, vol. 12, 365–547).
Hardin, C. L (1988) *Color for Philosophers. Unweaving the Rainbow*. Indianapolis: Hackett.
Hering, Ewald (1920) *Grundzüge der Lehre vom Lichtsinn*. Berlin.
Höfler, Alois (1897) *Psychologie*. Wien. 2nd ed. 1930.
Husserl, Edmund (1969) *Die Krisis der europäischen Wissenschaften und die transzendentale Phänomenologie*. (Husserliana, VI.)The Hague.
Jackson, Frank (1982) "Epiphenomenal qualia". *Philosophical Quarterly* 32, 127–136.
Jackson, Frank (1986) "What Mary didn't know". *Journal of Philosophy* 83, 291–295.
Kanitscheider, Bernulf, ed. (1984) *Moderne Naturphilosophie*. Würzburg.
Katz, David (1911) *Die Erscheinungsweisen der Farben und ihre Beeinflussung durch die individuelle Erfahrung*. Leipzig.
Küppers, Harald (1978) *Das Grundgesetz der Farbenlehre*. Köln: DuMont Buchverlag.
Nagel, Thomas (1974) "What is it like to be a bat?" *Philosophical Review* 83, 435–450.
Nietzsche, F. (1999) "Zur Genealogie der Moral. Eine Streitschrift". In *Kritische Studienausgabe*. G. Colli & M. Montinari, eds. vol. 5, 245–412. München: Deutscher Taschenbuch Verlag.
Meyer-Abich, K. M (1988) *Wissenschaft für die Zukunft. Holistisches Denken in ökologischer und gesellschaftlicher Verantwortung*. München: C. H. Beck.
Rehbock, Theda (1995) *Goethe und die 'Rettung der Phänomene'. Kritik des naturwissenschaftlichen Weltbilds am Beispiel der Farbenlehre*. Konstanz: Verlag am Hockgraben.
Rehbock, Theda (1998) "Wo sind die Farben geblieben? Über die Wirklichkeit der Farben als philosophisches Problem". *Deutsche Zeitschrift für Philosophie* 46, 601–622.

Rothaupt, J. G. F. (1996) *Farbthemen in Wittgensteins Gesamtnachlaß. Philologisch-philosophische Untersuchungen im Längsschnitt und in Querschnitten*. Weinheim: Beltz Athenäum.

Sacks, Oliver (1995) "Der farbenblinde Malter" In O.Sacks *Eine Anthropologin auf dem Mars. Sieben paradoxe Geschichten*, 19–71. Reinbek bei Hamburg: Rowohlt (Original ed. *An Anthropologist on Mars: Seven Paradoxical Tales*, New York: Alfred A. Knopf 1995).

Sacks, Oliver (1997) *The Island of the Colorblind and Cycad Island*. New York: Alfred A. Knopf.

Schapp, Wilhem (1985) *In Geschichten verstrickt. Zum Sein von Mensch und Ding*. 3rd ed. Frankfurt am Main: Vittorio Klostermann.

Stifter, Adalbert (1980) *Bergkristall und andere Erzählungen*. Frankfurt am Main: Insel.

Stumpf, Carl (1917) *Die Attribute der Gesichtsempfindungen*. (Abhandlungen der Königlich Preussischen Akademie der Wissenschaften, 8.) Berlin.

von Weizsäcker, C. F (1979) *Die Geschichte der Natur. Zwölf Vorlesungen*. 8th ed. Göttingen: Vandenhoeck & Ruprecht.

Wittgenstein, L. (1971) *Philosophische Untersuchungen*. Frankfurt am Main: Suhrkamp.

Wittgenstein, L. (1979) *Bemerkungen über die Farben*. Frankfurt am Main: Suhrkamp.

Wittgenstein, L. (1981) *Philosophische Bemerkungen*. Frankfurt am Main: Suhrkamp.

Zajonc, Athur (1993) *Catching the Light. The Entwined History of Light and Mind*. New York: Bantam.