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MODELS IN PERCEPTION AND MODELS IN SCIENCE

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0. Introduction

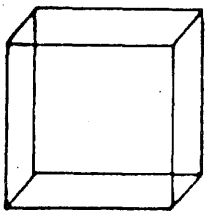
The purpose of this paper is to look into the basic kind of modeling that takes place at the perceptual level as such, and to expose the relations between these models and those used in science. I will begin with the description of some insights of Norwood Russell Hanson, from the first chapter of his book *Patterns of Discovery*, entitled "Observation", where he successfully applies so-called gestalt-switch examples. I will develop some of the central observations and concepts in this compressed text by following up the explicit and implicit connections to Ludwig Wittgenstein's *Philosophical Investigations (PI)*, part II, section xi, and to Wittgenstein's remarks on the philosophy of psychology, from which the reflections that are presented in *PI* have been selected. Wittgenstein's most important contribution in this connection is his pondering over the conceptions and misconceptions of perception and its preconditions. Russell Hanson's central insights will be developed into a more fruitful conceptual framework with the help of some central concepts borrowed from Immanuel Kant. The thoughts I develop about models in ordinary perception and about some of the preconditions for this modeling, will be applied in connection with both the explanation and the correction of some of the concepts of models in mathematics; more specifically, in connection with the distinction between ostensive and symbolic constructions. I will also touch upon the use of models in physics, and their connections to models in perception (and mathematics), using as an example part of the physical explanation of the rainbow.

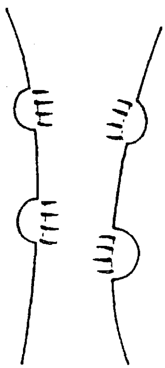
My paper has four parts: 1.) Perception; models in and models for, 2.) The preconditions for modeling in perception of outer objects; 3.)

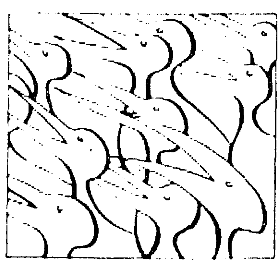
Models in mathematics and in science; 4.) Models of the preconditions for modeling in perception.

1A. Models in Perception

Norwood Russell Hanson remarks on some examples of so-called gestalt-switch figures and on the reflections Ludwig Wittgenstein made concerning similar examples. He introduces two distinctions to account for what is at play in these pictures: “seeing as” and “seeing that”. “Seeing as” is associated with the structure of organization of what is seen in the picture, and “seeing that” is associated with the rules that connect this picture to other possible pictures of the object seen. Russell Hanson was the first who used the term “theory-laden” about similar phenomena in perception and observation. But, in contradistinction to Thomas Kuhn, he explains why the perceptions have to be theory-laden, if experience and science can be possible at all. I will try to deepen this line of thought, by seeking to explain, with the help of Wittgenstein and Kant, that perception would not be meaningful, or possible at all, if observation was not laden with models of the objects observed or perceived.







I turn then to the gestalt-switch figures. In the upper left of figure 1 you see some straight lines drawn in a manner, so that you most probably will see it as a box or as a cube seen from above or from below. If you look relaxed at the figure for some time, you will experience that the appearance switches involuntarily from being seen either in accordance with the first and the second description, or the other way around. Hanson (with Wittgenstein) poses the question: what has changed? As you will figure out for yourself - neither is anything changed in the picture as such; nor has something new been discovered in the lines and points on the paper. But it somehow looks differently. It does not seem sufficient to say that we interpret it differently from time to time, since there does not seem to be any explicit interpretation; and we may all the time *know* that the picture can be seen both as a box seen from above and as a box seen from below. But the picture itself will definitely have only one of the alternative appearances at a time. Hanson finds, partly in accordance with Wittgenstein, that what has changed is the "organization" of the lines and points on the paper; viz. the way they are seen together in some totality or unity. This explanation of what has changed, makes at least some sense. When we see the figure as a box from above, all the lines seem to have some quite definite parts to play in the manner they are integrated (synopsis). They are also seen as organized into some specific spatial gestalt or form, i.e., as a box, which is not seen in the paper, as such.

There are lots of interesting and probing questions that deserve to be asked in connection with this example and other related, but slightly different, ones. I only have time (and space) to discuss some of the most basic ones here: what contributes to the figure being seen this way or that way? Part of the answer is: the context, that is, the cultural and linguistic setting, the figures around the figure (as in figures at the right of the illustration), and, eventually, the supposition that these two-dimensional figures may be seen as depicting three-dimensional bodies. But we may extend our set of examples - as Hanson does with dramatic effect, when he asks if you don't see that the paper you have before you has a backside; or if you first see some black spots on the paper before you, and only then interpret them as letters when you read. We will then find that the kind of organization that is conspicuously present in the gestalt-switch figures is always already there in all ordinary perception and experience. The fact that the organization is always already there, points directly to what Kant meant when he wrote about synthetic unity. The principle of organization in Hanson and Wittgenstein - is identical with the synthetic unity in Kant's philosophy of perception and experience. And the widest context within which our perceptions is organized is the framework of the forms of intuitions, space and time. We may demonstrate this on all the examples that Hanson discusses.

More importantly, Hanson also points to the manner in which the synthetic unity is involved in perception and observation, in general and in the sciences. What we have seen through the gestalt-switch examples, is designated as "seeing as" by Hanson. "Seeing as" points to an element in all seeing. But it is also intimately connected with another element that Hanson calls "seeing that". When we see a young Parisian woman in figure number two, we *see that* if she turned her head towards us, we would probably *see that* she had a medallion attached to the silk ribbon around her neck. We would see the color of her eyes, and she would maybe speak to us (in French), and so on. When we see figure number three as a bear on the backside of a tree, we *see that* if we grabbed its pawn, it probably would growl and climb down the tree and come after us, and so on. This "see-that" element in our perception and observation is directly connected to the synthetic unity of our perception, and we see that it immediately connects the perception to other possible and real perceptions that we have made or may make. In this manner the synthetic unity of our perception makes it possible to unite our perceptions into experience as a whole.

Many interesting remarks and comments could be made at this point, but I will restrict myself to make only a few of them: The synthetic unity is, according to Kant, presented in the concept of the thing seen. Thus, the concept may lead us to see something as something; or the other way around: the perception of an unknown thing may be reflected in a new (or well known) concept. This regressive-progressive joining of concept and perception is vital, if we intend to arrive at knowledge - as in ordinary experience (Erfahrung) or as in science. However, this connection must be realized through the "seeing as" and "seeing that" elements of perception. Only when we «see (the perceived) as ...» is the concept applied on the perception, and only when we «see that----» is the perceived object understood through a judgment. Restated with the help of Kantian terminology: The manifold in perception is organized in a "picture" or "image" (Bild) according to the unity thought in a concept, and the manifold of possible and real perceptions of the thing perceived is synthesized according to the schemata of the concepts in a way that make determinate judgments about the object possible. There are of course some finer points that should have been explained in this connection, but I have to omit such a comment here.

The three elements; the concept of the synthetic unity, the form or gestalt into which the manifold of perception is structured, and the manifold of schemata that establishes the connections of this perception with an unlimited number of other possible perceptions taken together, constitute what I consider to be the basic form of modeling or models in perception.

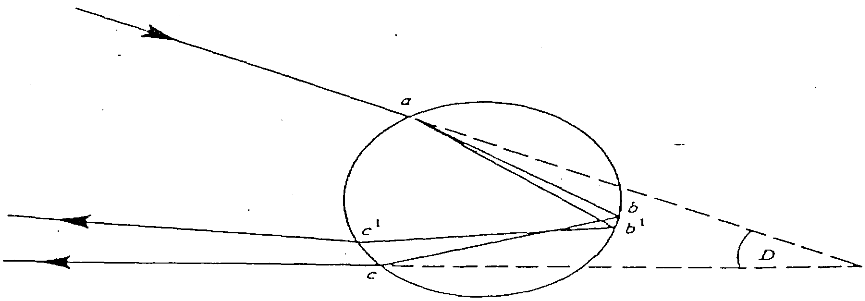
1B. The Development in Science of the Modeling in Perception through the Use of Scientific Models

In science these three aforementioned elements in the modeling of perception are developed systematically and methodically. This is accomplished through the precision and sophistication with which the scientific conceptual apparatus is developed and applied, through the levels in which science systematically develops "images" of structures of the objects, and through the methodical exposition of the rules of scientific laws. But development in science must somehow be transferred back to the level of modeling in perception if scientific knowledge of the objects of perception is considered to be possible. And so they usually are. They are connected in this way mainly through the various forms of models used in science.

The modeling operation differentiates the moments that constitute perception into illusion, aspect perceived, and image of the object perceived.[1] Through the exposition of the manifold in the perception, the contrast between how things are given to us intuitively, and the way they are known in experience, is further developed and explained. But the contrast is, as just mentioned, already presupposed in perception as such. For instance: when we see an oar stuck into water, it has the appearance of being broken. But we know that it is not broken, and if we want to make sure that this is the case, we do so either by lifting it up in the air,

[1] This corresponds to Kant's distinctions between Schein, Erscheinung and Erscheinung der Erscheinung. These concepts, and the relations between them, are developed in Kant's Opus postumum, which gives in outline a Kantian philosophy of science

or by touching it with our hands. When we perceive something as being something, we always presuppose possible corrections of the influence on our perception of our perspective, of our perceptual apparatus, of the medium of perception, and so on. We could not start with sensations or sense data; we always start with the perception of something as something, even if we are not certain *what* we observe, and even if the image is blurred etc. It is always possible that we are mistaken in the way we organize our perceptions, i.e., in the use of the models structuring our observations. On the other hand, we would not even have the possibility to be right if our perceptions were not organized in this way. Natural science has to reflect on this structure of organization if it wants to generate knowledge. The following sketch of a scientific explanation of the rainbow may serve as a humble example.



Looking at a rainbow, we see the colors outlined in concentric circles in the direction away from the sun. When we move, the rainbow moves with us, and when it stops raining, at the location where we see the rainbow, it disappears. From examples like the appearances of a broken oar, we know that light is refracted on the border between air and water. And we know from examples like Newton's prism, that light of different colors are refracted differently, i.e., to different degrees. We may then explain what happens in a single raindrop in the following manner: different light-photons from the sun have different wave lengths (that are associated with different colors), and will therefore be differently refracted and reflected in the raindrop, so that blue-colored light is sent out above the red-colored. Now, the question is; will we see the red-colored circle above or below the blue-colored circle in the rainbow? The answer is ... below! Why? Because the blue-colored rays and the red-colored rays, as seen by us, are stemming from different raindrops! To understand this explanation, we have to put the different pictures associated with the different models used in the explanation back into the comprising context, which consists of the system of space, and ourselves in some definite position and with a specific perspective on the rainbow (seen only there where it is seen, by someone placed exactly in this way). Thus, the explanation relates the models used in the explanation with the models organizing our perceptions; and we see the rainbow *as* so and so and *that* so and so.

1C. Models of Perception

There exist one dominating epistemological model of perception; the model of re-presentation. This model has been used especially successfully and persistently to explain visual perception. The model is itself modeled on the ordinary or most widespread conception or model of the function of pictures: It has been supposed that one sees (that is, senses) projections of objects on a visual field, and that the conceptions of perspective and distance are applied to the objects through some kind of inference on the basis of the characteristics of the pictorial projections on the visual field.[2] This model *for* perception is strangely circular in the sense that it must take our spatial "perception" of the projections on the visual field for granted, in order to explain how we see objects in space. As explained above, however, we perceive with the contrast between on the one hand the appearance of the object and on the other hand the object appearing built into the perception as such. I see a plate as being circular, though it should "appear" as elliptical in the visual field. The conception of a visual field is something of a hoax, anyway, since we would not even be able to see something elliptical, if it were not placed in three-dimensional space - at least imaginatively. We do not sense something visually on a visual field or plane, since the plane itself has to be placed somewhere in three-dimensional space to make visual or

[2] This model of visual perception has recently been severely criticized, though. Cf. D.MM.Lopes, The Philosophical Quarterly 1997, pp. 425-40.

perceptual sense for us. It should therefore be no surprise that blind people are able to draw and recognize perspectival pictures, since perspective is presupposed in all perception, included the auditive and tactile perception (I suppose these are the most decisive kinds of perception for a blind person).

The appearance of something circular *as* circular, when showing only an elliptical aspect, as seen from my point of view and under my specific perspective, is therefore not something that is supplied in *addition* to the perception of the elliptical aspect. I may be mistaken; my perception may be illusory, but the correction must take the «seeing-as» element of the perception as a point of departure to attain the truth. This is the case with the oar stuck in the water, and with the rainbow. Now, the natural sciences should organize the search for knowledge through observation (developing the «seeing-as» element of perception) and experiment (developing the «seeing-that» element of perception), and do so in a methodical and systematic way. In their search for objective knowledge, the sciences explore the relation between how the objects show themselves in perception (*Erscheinung*), and how they are conceived and imagined as being themselves, when understood in connection *with* the perception (*Erscheinung der Erscheinung*). The methodical and systematic way to accomplish this is usually measurement. But to measure something, one must have a measurement apparatus or system. One may, for instance, place clocks at points at certain distances from each other in three-dimensional space, and define the points of the clocks with the help of measuring sticks. One may then use these clocks to measure the speed of an object traveling along some trajectory. This is what is done imaginatively in the setup of special relativity for the presentation of the so-called Clock Paradox. And this Paradox has generally been understood as representing a clash between the commonsense notions of spatial and temporal relations based on ordinary perceptions and the corresponding scientific sound and advanced notions of space and time. To really solve the apparent conflict between perception and science presented in this paradox, one must be able to mediate both philosophically and mathematically between the various models used in science, and the modeling that takes place in perception and observation. A first step on this road is to mediate philosophically between the different mathematical models that are used. But to do that, we must first reflect on the basic preconditions for modeling in perceptions of outer objects.

2. The Preconditions for Modeling in Perception of Outer Objects

The basic precondition for modeling in perception of outer objects is of course space itself. But how is space showing itself in the modeling of perceptions? Essentially as a system of perspectives! And this space must be understood as given with the perception as such, since the perception is essentially perspectival. Recent experiments with blind people show that they have the ability to interpret and make tactile pictures, in a way that depend heavily on the understanding of perspective.[3] Their perceptions of the pictures could not be mediated through a visual field, so the reason why they understand outlines and shapes as pictures of three-dimensional objects, must come from other sources. This points to the neglected fact that all our perceptions are informed by something that transcends what is sensually given. Blind people's pictorial abilities point to the fact that their tactile perceptions likewise present objects only within perspectival limitations. We see the surfaces sides, corners and edges of objects, but their backsides are not visually present. Tactile perception is in the same manner only partially sensuously filled with the object; we can usually only touch parts of the object at a time, and we don't sense the inside. This suggests that our perceptions of objects in general are informed by perspectival models of the objects; i.e., that our perceptions are governed by the way we expect the objects to look or feel or sound, perceived from a certain vantage point, and placed in a certain orientation and at a certain distance. We recognize and re-identify the same objects seen from other vantage points, oriented differently and at other distances, and are able to orient ourselves when we move around and between the objects. These models therefore involve what would be rather advanced and complex structures, for instance when explicated in algebraic group theory.

The kind of space which is presupposed by the modeling that constitutes perception, is a perspectival, directional and oriented space, intuited by a perceiving subject situated within it. This space is also essentially

[3] Cf J.M.Kennedy, Scientific American, 1997, pp. 60-65.

the basis for the ostensive constructions of Euclidean geometry.[4] Euclidean geometry is about quantas, that is, entities that have the character of being wholes that can be quantified, but that are not as such given with a specific number. To illustrate the difference, I will present you with a simple problem; how to divide the figure below into four part figures with the same form and size, i.e., in the same way as a square and an equilateral triangle may be similarly subdivided.

Now, the solution can be said to express one of the most important spatial preconditions for models in perception; homogeneity across size. It also illustrates another important precondition for models in perception; orientation; in this case orientation in the horizontal plane. (All the part-figures are not really congruent, as they are given in the plane; they are incongruent counterparts, and the difference between them can be described as that of orientation (in the plane).) Though, one of the most deep-founded and paradoxical principles governing all our perception is not seen in this example, since it cannot be seen or demonstrated through such a construction. It is the already mentioned perspectivity that places the perceived object in a certain position and orientation in relation to the perceiving subject. (In this connection, Wittgenstein talks about the dimension of depth.) This unseen (unperceived) dimension may be understood as that which really makes possible perception of something at another place in space. When we look at the examples of Russell Hanson, we find that they may all be seen as two-dimensional pictures of some-

[4] That may be the deeper reason why we generally use Euclidean models when we want to explain or prove the consistency of so-called non-Euclidean "geometries". In the strict sense there is only Euclidean geometry as such; the so-called non-Euclidean geometries are in my opinion really algebras, real analysis and arithmetics, i.e., theories about the relationships between numerical quantities and other abstract entities. Cf. Section III.

thing three-dimensional. When used to illustrate the change of aspects, they make us aware of how we construct our perceptions in the dimension of depth, and thus first then are able to perceive something *as* something. We know and see that the gestalt-switch figures are plane figures and thus only picture something as three-dimensional. But even then we must see the paper as three-dimensional; as having a backside and position and direction in space. What we are originally presented with in perception is something spatial as seen in a certain direction from a certain vantage point. The perception must carry the three-dimensionality of the perceived object on its sleeve. Complementarily, it must present the perceived object as perceivable from other vantage points and showing other sides and aspects of itself. (This was realized by Wittgenstein, as may be seen from his reflections on the philosophy of psychology.) This «aspect» of the three-dimensionality of the perceived object is important in connection with the concept of triangulation used by David Gooding (and Davidson, though differently). In his book, *Science and Philosophy. Experiment and the Making of Meaning*, Gooding makes use of the shadow box experiment of Gruber and Sehl.[5] The point he wants to make is that experience and observation are construed in a situation of social interaction. I do not disagree with that. But I want to point to the intra-subjective precondition of this inter-subjectivity, that we have just considered above, i.e., that the individual perception of the individual perceiver is already constructed or constituted according to a spatial three-dimensional model of the perceived object. And I want to insist that this is the basic precondition for the social re-construction of the perceived object. If I do not have the ability to imagine how the object can be seen from other points of view, I will be unable to communicate with those who see the object under other perspectives, and thus finally agree with them on what kind of object we are perceiving. The shadow box experiment shows that sometimes we need to compare the aspects seen from several different perspectives to come to such an agreement.

[5] Cf. D.Gooding, Experiment and The Making of Meaning, Boston 1990, p. 21.

3. Models in Mathematics

The three-dimensional modeling of perception is then determined through the directional ordering starting out from the perceiving subject. We could make this evident through the construction of imaginary coordinate axes pointing out from our body. For instance, I could have the positive x-axis going out from my outstretched right arm; the positive y-axis following the direction of the gaze of my eyes; and the z-axis going through my standing body in the direction from my feet through the top of my head. Having done this, I could choose a measure of length, for instance the breadth of my right hand, and measure out distances in all directions. In principle, every location may then be identified with three numbers representing the x-, y- and z-coordinates of the location. As we all know, on the basis of such coordination, it is possible to give algebraic functional descriptions of straight lines, and different curved lines, surfaces, and bodies. Through these mathematical devices, three-dimensionality may be expressed in algebraic form. There is no problem with the generalization of this system of coordinates to other dimensions than three; and with the generalization of the algebraic functional descriptions to analogues of lines, surfaces, and so on. In this way we have vastly expanded our mathematical knowledge and consequently our capacities to express, explain and measure mathematically the physical relations of objects in space. In the explanation of the rainbow we use only a rather limited amount of these capacities. But even in this case we may profit from the modeling across the mathematical disciplines of geometry, arithmetic, and algebra. When explaining differential refraction, we express the relation between the frequency of the electromagnetic waves (identified with light) in its algebraic functional relation to the velocity of light in the medium, and may thus numerically express the differential refraction. These algebraic, functional relations may then be geometrically modeled, and so on. We usually have no problems with keeping the balance in our handling of all these modeling relations. This depends on our implicit understanding of how all these modeling relations are themselves related to the basic spatial modeling of perception.

Our ability to keep the balance in our philosophical handling of these modeling relations is not that good. This lack of philosophical sophistication has its roots in the ignorance of the distinction between ostensive and symbolic mathematical constructions. The generalization that takes place over the algebraic representation of spatial relations, for instance in more than three-dimensional «spaces», that is, so-called non-Euclidean geometries, is not really a generalization of geometry, but rather arithmetic and algebraic theories, that are not based on the ostensive constructions of the mathematical concepts of "length", "straight line", and so on, but "only" on corresponding symbolic constructions. This is why we may supply two-dimensional non-Euclidean "geometry" with a quasi-geometrical Euclidean model. "Space" is then for instance identified with the surface of a sphere, "point" is understood as a pair of antipodal points on the sphere, and "straight line" is seen as a great circle on the sphere. All these "geometries" are thus really algebraic alterations or generalizations of some algebraic model of geometry in the Euclidean sense. Therefore, they do not challenge the insight that we cannot have more than three mutually perpendicular straight lines, i.e., that space is three-dimensional, directional, and oriented.

The most serious challenge to these insights into the spatial preconditions of modeling in perception does not seem to come from mathematics as such. Rather, it seems to come from mathematical natural science, as the special and general theory of relativity are examples of.

4. Physical Models of the Spatial and Temporal Preconditions of Modeling in Perception

I have then to address the allegedly *physical* models of the spatial (and temporal) preconditions of the modeling that takes place in perception. To meet this apparent challenge to the directional, perspectival, and three-dimensional space, we would have to reflect on how observations and measurements are related to the observed and measured objects through a measuring system of measuring instruments. To measure movement, we require a comprehensive system of measuring instruments for the measurement of distances and periods of time, and these measurements have to be coordinated. The measurements of time thus demand not only a set of distributed clocks, but also a procedure for synchronization that makes us able to coordinate the clocks. But since the clocks, as well as the process used to synchronize them, are themselves physical phenomena, they will also be in physical interaction with each other, with the phenomena to be measured, and with the rest of the physical universe. The measuring system will therefore in some sense “hide” itself as physically measurable, while being used as a measuring system. This creates complex problems for the philosophical mediation between the scientific conceptions and models, and the spatial and temporal preconditions of modeling in perceptions. These problems appear in apparent paradoxes and dilemmas, as for instance in the Clock Paradox. These problems can, however, be solved. And they can and must be given a solution that confirms the spatial and temporal preconditions of modeling in all our ordinary (and extraordinary) observation and perception. To show that, however, I have to wait for another opportunity, within another setting in space and time.

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