Color geometry — or color grammar?

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The present paper is about the epistemology of the theory of color and aims to confront two different approaches. In the first half, I present an overview of some key tenets of Meinong's *Remarks on the Color Solid and the Mixture Law* of 1903. In the second half, I discuss Meinong's approach at length and compare it with another approach which I tend to favor, namely the grammatical and pragmatic approach promoted by Wittgenstein. I highlight some of its difficulties and raise some objections.

The question I will address is whether the theory of color can be categorized as an a priori science, and, if so, in what sense. At first glance, Meinong's position in this respect may seem somewhat schizophrenic. On the one hand, he insists that the psychological approach to colors is highly misleading. As he claims on the opening pages of his 1903 paper, "colors are as little mental as are places or even numbers" (Meinong 1903: 3). He appeals for an a priori theory of color that is completely autonomous from empirical psychology — a theory of color that is more like mathematics and his theory of objects. His claim is that the theory of color must be analogous to Euclidean geometry. On the other hand, however, Meinong maintains that empirical findings must play a central role in the theory of color and that, in some sense, even the geometrical representation of the relations between colors belongs to empirical psychology.

In fact, Meinong's purpose is precisely to clarify the relationship between what is empirical and what is a priori in color theory — and this is what makes his *Remarks on the Color Solid* philosophically interesting and illuminating.

Meinong's most central claim about the theory of color is twofold. First, the theory of color is, at least in part, an a priori science, namely that science which studies a priori relations among colors, for example the relations "orange is between red and yellow" or "no color is composed of two other colors". That the theory of color is an a priori science means, for Meinong, that it

is not about the existence of particular colors or colored things, but about the "nature" of colors (*Natur*, *Beschaffenheit*), namely about internal relations among colors (Meinong 1903: 3; Mulligan 1991: 80). As such, the theory of color has to do with his theory of objects and, more specifically, with his theory of higher-order objects (Meinong 1903: 4).

The second claim is that these internal relations among colors can be schematized using a three-dimensional solid. In other words: each color is completely determined or defined by a triplet of coordinates just as are points in Euclidean geometry.

Let us draw three perpendicular lines. The end points of the first line — say, the x-axis — are pure red and pure green. The end points of the second line — the y-axis — are pure blue and pure yellow. Those of the third line — the z-axis — are white and black. All visible colors, that is, all the colors that are inside the color solid, must be representable as a triplet of coordinates on the three axes. For example: pure green and pure red have only one value in common, namely that on the white-black axis; purple has one value in common with some hue of blue and one value in common with some hue of red, and so on. Since every color is defined by its coordinates, it is a priori impossible for two different colors to be at the same place in the color space. Two different colors that would have all of their coordinates in common would be both different and identical. In Meinong's view, this means that the compositional view of color is false. For example, purple is not a compound of red and blue. However, if we take the word "compound" in a looser sense, then we must say that all colors are compounds insofar as they are analyzable in three coordinates (Seron 2015; Seron 2016).

To sum up: the theory of color is an a priori science and it deals with relations that are analogous to geometrical relations. The immediate consequence of these two claims is that the theory of color should be conceived of as a "color geometry" (*Farbengeometrie*).

The idea that color relations are analogous to geometrical relations and hence representable through geometrical figures was not new at the time Meinong wrote his *Remarks on the Color Solid*. It was already at the basis of color wheels such as those proposed by Goethe and some others already in the eighteenth century. Most color theorists in the nineteenth and twentieth centuries opted, like Meinong, for three-dimensional models. Among them are Helmholtz's color cone, Ostwald's double cone, the color sphere of Runge and Wundt, the octahedron of Höfler, Ebbinghaus, and Wittgenstein.[1] In Höfler's color octahedron, for example, the existence of a line from yellow to red indicates the possibility of orange hues; the absence of any line between red and green indicates the impossibility of reddish green; and so on.

[1] For an overview of those debates, see Kuehni & Schwarz 2008, Crone 1999.

For some reasons Meinong seems to prefer Ebbinghaus's color octahedron (Meinong 1903: 8), but this is of secondary importance. What is important here is the epistemological analogy between geometry and color theory, namely the view that both provide a priori knowledge. More precisely, the question Meinong is primarily concerned with — and the question I will focus on at a first stage — is about the relationship between color theory and empirical psychology. Put quite simply, the question is how we are to reconcile the view that the theory of color provides a priori knowledge with the fact that psychological experiments are obviously relevant to the theory of color.

The color solid has many properties that are known through a priori intuitions (*apriorisch einzusehen*) and can be expressed as a priori laws. For example, it is immediately self-evident that red is more distant from green than from orange, that you do not need to change direction in order to go from red to gray and hence that the line between them must be a straight line, etc. (Meinong 1903: 6). However, it is plausible to say that not all relations represented in the color solid are a priori relations. Meinong considers the bounds of the solid. For example: the most distant colors from neutral gray on the red-green line are pure red and pure green, so the red-green line is geometrically represented as a line segment whose two end points in the color solid are pure red and pure green. In Meinong's view, the fact that pure red, green, blue and yellow are end points is the only sense in which they can be characterized as "basic" colors (Meinong 1903: 34).

The question is, Is the statement that the red-green line is bounded by pure red and pure green an a priori truth? Or to put it otherwise: Is it a priori self-evident that the red-green line is bounded by pure red and pure green? Meinong's answer is no. The colors that are beyond the bounds of the octahedron are not a priori impossible. These colors — which I will from now on call *transcendent colors* (the term is mine) — are possible even though *we* cannot perceive them. On the one hand, our inability to perceive transcendent colors is a contingent fact due to factors such as the structure of our sense organs, which are subject to empirical inquiry. On the other hand, we do have a priori intuitions about colors that are inaccessible to us (Meinong 1903: 8). For example, it is a priori self-evident that gray is between transcendent red and transcendent green, or that all transcendent colors on the green-red line are such that you do not need to change direction in order to go from one to another.

The question is not without a certain poetry. It is whether it makes sense to talk about colors that are outside the color solid and thus inaccessible to us, for example a blue which is bluer than pure blue, a green which is greener than pure green. Meinong's answer is that it does: it

is a priori possible for there to be transcendent colors and these transcendent colors, like the visible ones, fall within the domain of a priori color theory.

By contrast, the bounds and thus the shape of the color solid are empirical. The fact that the maximal values on the red-green line are pure red and pure green is an empirical fact, open to empirical investigation.

The upshot of this is that the theory of color must have an a priori part and an empirical part. The a priori part is that branch of the theory of objects which deals with what colors are — with their "nature" as it can be known through a priori intuitions. The empirical part belongs to psychology and is about colored things as contents of sensory presentations (Meinong 1903: 4). Transcendent colors are studied in the a priori part of color theory, not in its empirical part.

Meinong captures this distinction by saying that the empirical or psychological part of color theory deals with actual existence, while its a priori part deals with a priori possibility. This, of course, applies to the color solid's bounds. It is an empirical fact that your psychological constitution enables you to perceive such-and-such colors and not other possible colors. "The end point, Meinong argues, is a psychological datum. The fundamental delimitation <of the color solid> is about something actual, not something possible" (Meinong 1903: 9). As he argues some pages earlier, "the fact that the intuitions which are at the basis of the color solid and made manifest by the color solid's shape count as a piece of psychology is doubtless to be explained by the relatively limited operational abilities of our intellect in the field of colors" (Meinong 1903: 3).

To sum up: the color solid itself must be somehow grounded in empirical facts. As Meinong claims, "the color solid cannot be viewed as a result of mere a priori knowledge; (…) it must in part be legitimated by empirical evidence (*durch die Empirie legitimiert*)" (Meinong 1903: 10). In this sense, the color solid deserves to be called a "*psychological* color solid" (Meinong 1903: 11).

Given this, the question now are: Why is the color solid not only psychological? What is properly a priori in the color solid? What is the difference between what is empirical and what is a priori in the color solid? Most illuminatingly, Meinong appeals to the analogy with geometrical space. The idea is that the color solid is part of a color space just as, say, your hand is part of the Euclidean space. Your hand exhibits many geometrical properties and relations that are accessible to a priori intuition and subject to geometrical laws. However, its shape is obviously something empirical. Likewise, the color solid, as part of the color space, displays properties and relations that are subject to a priori intuition and knowledge. Thus, the

difference between the empirical and the a priori parts of the theory of color coincides with the difference between the color solid and the three-dimensional color space it is part of (Rollinger 2008: 125). As Meinong summarizes:

> Like every real solid, the color solid, too, is in space and participates in the properties of space; but if I am right, it could help overcome some difficulties to very explicitly characterize the space here in question as a *color space*, and to oppose it, as the proper object of a priori color knowledge, to the color solid taken as the object of the corresponding observations, which are in principle empirical. (Meinong 1903: 12).

The emerging picture can be summarized as follows. The color solid presents all the colors that are accessible to human experience. The corresponding empirical data are materials for a priori intuitions about the nature — or internal relations — of visible colors (Meinong 1903: 4). However, as Meinong emphasizes, "the a priori treatment, here as anywhere else, extends beyond that which experience presents to it" (Meinong 1903: 4-5). The color space can be viewed as a geometrical representation of such an "a priori treatment".[2]

Color geometry vs. color grammar

Let us now attempt a brief comparison between Meinong's color geometry and a grammatical approach in the style of Wittgenstein. I will not delve into the details and will confine myself to a couple of sketchy remarks on some differences that I consider most significant from a philosophical point of view.

Consider the following view, leaving aside the question whether it is the actual view of Wittgenstein or any other: (1) the theory of color includes a priori laws such as "orange is between red and yellow"; (2) all of these laws are purely conceptual in some specific sense:

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[2] Cf. (Rollinger 2008: 127): "When Meinong speaks of a priori knowledge he means only that it is to be obtained strictly from a consideration of the nature of the known object. This obviously does not rule out the possibility that the concept of what is known has its origin in experience".

they are rules for the use of color words. The a priori part of color theory is about our practice with color words.

To some extent, this view is not so very different from Meinong's view. It is well known that Wittgenstein himself accepted the idea of a geometrical representation of the internal relations among colors (Mulligan 1991: 82; Carvalho 2017: 321ff.). In his *Philosophical Remarks*, he hesitates between Höfler's octahedron and Ostwald's double cone (Wittgenstein 1975: 278; Barceló & Saab 2017). The similarity is even more striking if Meinong's idea of analyzing colors in three coordinates is understood, say, in terms of conceptual analysis. In the *Tractatus*, 6.3751, and later in his *Some Remarks on Logical Form*, Wittgenstein endorses the view that each color can be logically analyzed in a sequence of numbers (Wittgenstein 1963: 144-5; Wittgenstein 1929: 166-7). In the *Philosophical Remarks*, he clearly assumes that color solids are *grammatical* representations (Wittgenstein 1975: 51; Park 1998: 136-142; cf. Wittgenstein 1977: 23).

Nevertheless, there are significant differences between the two views. I mention three of them that strike me as more salient:

(1) The first one concerns Meinong's essentialism, namely his idea that the coordinate triplets in the color solid capture the "nature" of colors and that this nature is accessible to a priori intuition. At the most general level, there is an enormous difference between understanding what the word "orange" means and having an a priori intuition of the "nature" of orange color. In order to understand what a word means you need, say, to know in what circumstances it ought to be used. By contrast, the notion of intuition suggests that a priori knowledge is more like seeing something that resides in individual things.

(2) The second difference is that, according to Meinong's analogy with geometry, the color space has a character of continuity which grammatical structures do not have. In the color octahedron, pure red and pure yellow are connected by something analogous to a geometrical line, which indicates that there is a continuum between them. Of course, you can express the same idea by saying that the distances between colors are continuous magnitudes, or that each color is defined by three variables with any real numbers as values. By contrast, the distances between color words or concepts are neither continua nor continuous magnitudes.

(3) The third and final difference concerns the meaning of "a priori" and the demarcation line between empirical and a priori. On Meinong's view, all colors, including transcendent colors and the colors for which we have no words or concepts, stand in a priori relations that can be represented geometrically. By contrast, the a priori relations of color grammar are relations between a limited number of color words or concepts available in a given linguistic

community. The fact that this orange is more similar to this red than to this blue is a mere empirical fact. What is a priori here is rather the fact that the word "orange" is normally used to denote a color that is more similar to a certain property normally called "red" than to a certain property normally called "blue". It may be false that this flower has a color that is more similar to blue than to red. But it is a priori impossible that this flower's orange color is more similar to blue than to red, because the word "orange" is normally used to denote a color that is more similar to red than to blue.

First objection: perceptual contrast vs. conceptual distinction

At this point I would like to turn back to the three differences I just mentioned and, on the basis of them, suggest that the grammatical approach to color has some advantages over the geometrical approach.

The first difference was about Meinong's essentialism. Obviously, the idea that colors have a "nature" which is not merely conceptual and can be grasped through a priori intuition is a problematic idea. What does it mean for a color to have a "nature"? This nature must be something independent of the empirical data. On Meinong's view, the shape of the color solid is empirical, but the quasi-geometrical properties of colors cannot derive from, say, the structure of your visual field as it is described by empirical psychology. In some sense, it is undeniable that a priori relations among colors are independent of experience. For example: a red-blind person will have a completely different color solid than a normal person. This is an empirical fact which is due to her neurophysiological constitution. However, if a red-blind person tells you that red is not different from green, you will reply to her that she is *wrong* and that red is a priori known to be different from green. This is a priori knowledge: she has no experience of the color we call "red", and yet she ought to know that there is such-and-such a priori relations between the color we call "red" and other colors.

Now the question is, Why are you right and why is she wrong? Do you have a priori intuitions that she is not able to have? This view seems unnatural and needlessly convoluted. Why not say more simply that a red-blind person can *talk* about colors that she is not able to *see*, that

is, (incorrectly) use the concept of red? She can certainly talk about the red color, because normal persons have taught her that there is a color that is called "red" and is the color of ripe tomatoes. It is in no sense a matter of seeing. The red-blind person sees everything that needs to be seen. She does have color experiences, she sees ripe tomatoes with a certain color. The real point is that she is not able to say whether the color she sees is red or green. In other words, she is not able to talk correctly about colors, namely to make a correct use of the words "red" and "green".[3] So, if she tells you that red is not different from green, you will not say that she perceives red but does not see its real nature, but rather that she perceives a color which is not red, or that she wrongly uses the word "red" to denote a color that is not the color normally called "red".

In a nutshell: Her inability to perceive the contrast between this red and this green is an empirical fact to be explained by psychologists. Her inability to recognize the a priori difference between red and green is a linguistic matter: she is unable to recognize the a priori difference between red and green because her contingent inability to perceive the contrast between these reds and these greens prevents her from mastering the use of the words "red" and "green".

Suppose a friend comes to you and says this: "I just saw a magnificent flower in the garden. It was of a bright orange color. But that orange was very strange: it was not between red and yellow, but rather between blue and green." Of course, you will think that what she says makes no sense. It is a priori impossible for the orange color of the flower not to be between red and yellow. If the flower's color is not between red and yellow, then it must be another color than orange. But what will you reply to your friend? If you are a robust essentialist, then it seems that you must reply something like this: "Please go back in the garden and take a closer look at the flower so as to have a more accurate intuition of its orange color. Then you will see that the flower's orange color is not between blue and green, but rather between red and yellow." Such a reply sounds absurd. Of course no sensible person will conclude that your friend lacks a priori intuitions. You will more likely think that your friend is joking or that she does not master English language. Maybe you will lend her a dictionary and ask her to get a look not at the orange flower, but at the definition of the word "orange". Once again, your friend's inability to know that orange is between red and yellow is a linguistic matter.

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[3] This view is suggested by (Wittgenstein 1977: 39): "In order to describe the phenomenon of red-green colour-blindness, I need only say what someone who is red-green colourblind cannot learn; but now in order to describe the 'phenomena of normal vision' I would have to enumerate the things we can do."

There is another reason why you will not take seriously what your friend says about the flower's color. It is absurd to say that a given color is between two colors in some cases and not in other cases. Orange is between red and yellow in all possible cases and no empirical observation will ever show the existence of an orange color that is between blue and green. But here again this impossibility is better seen as a linguistic fact. Obviously, orange is in all possible cases between red and yellow just because the word "orange" is normally used to denote a color which is between the color usually called "red" and the color usually called "yellow". Thus, it is perfectly conceivable that in the future orange could be between green and blue, but this will then simply mean that some change in usage of color words has occurred.

All this suggests the Wittgensteinian conclusion that the a priori rules of the theory of color do not tell us anything about the nature of colors. The statement that orange is more similar to red than to blue is not a statement about orange color, it is just a rule according to which the word "orange" should be used only in cases where you experience a color that is more similar to red than to blue.[4]

Second objection: continuity

We come now to the second difference between color geometry and color grammar: the lines of the color solid are continua, while there appear to be no continua between color words or concepts. Meinong's geometrical approach has difficulties in this respect.

The problem is that for example the set of visible colors from red to yellow is not exactly a continuum as are geometrical lines. Two different colors can be too close to each other to be discriminable. The human eye can discriminate, say, up to ten million colors. This is much, and yet not enough to form a continuum. Accordingly, it seems that the geometrical representation misleads us into thinking that visible colors form a continuum.

Note that fine-grainedness raises different issues than the color solid limitation, even though both can somehow be explained by our psychological constitution. The problem, here, is not

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[4] William Brenner has put the point very nicely in his (Brenner 1999: 122): "But it means nothing to speak of the grammar itself as true, or to talk of pointing to what makes it true. So if you say that color grammar is made true by 'the nature of the colors themselves', we respond with a puzzled 'The nature of *what?*' For is it not *grammar* that tells us what kind of object (e.g., color, shape, or sensation) something is?"

that some possible colors are invisible, but that some visible colors are different although indiscriminable.

Consider the case where two different colors on the red-yellow line are not discriminable. Are we to say that they are defined by the same coordinate triplet? On Meinong's view, if they are defined by the same coordinate triplet, then they are not two different colors, but one and the same color with one and the same "nature" — which contradicts our initial supposition. But if they are defined by different coordinate triplets and thus have a different "nature", then the whole theory becomes unintelligible. The part of color theory that deals with color solids studies colors as phenomenal properties — as phenomenal colors as opposed to light waves and the painter's pigments. In the phenomenal realm, a difference between two colors is called a "chromatic contrast". Now, we are asked to conceive of two colors that are different yet indistinguishable, that is, two colors that differ without contrasting. This seems to make no sense.

Maybe some would reply that for a red-blind person red and green are different colors that do not contrast. But this would be a poor argument. The red-blind person does not see two different colors that do not contrast, but only one color. If you say that there really is two different colors and that the red-blind sees neither them nor the contrast between them, then you are talking about colors that are different and contrast in such-and-such optimal conditions, namely in day light, for a subject that is not red-blind, and the like.

A further, closely connected difficulty for Meinong's account relates to the intransitivity of color discrimination. It is obvious that, if every color is defined by a triplet of numerical values, then identity and difference between colors must be transitive relations. For identity and difference between numerical values are obviously transitive. If identity and difference between colors are not transitive, then it is false that necessarily two colors are (phenomenally) identical if, and only if, they correspond to one and the same coordinate triplet. However, it seems that the relations of phenomenal contrast and non-contrast between colors — unlike conceptual identity and difference — are non-transitive. A series of color patches can form a smooth transition from yellow to red such that each patch is indiscriminable in color from the one or two patches adjacent to it. Thus, the relation "looks the same color as" is not transitive. Likewise, the first patch of the series does not contrast in

color with the second one, although both the first and the second patch do contrast with the last patch: the relation "contrasts in color with" is not transitive.[5]

Needless to say, since there is no continuum between color words or concepts, the above objections do not apply to the grammatical view. [6]

Third objection: millions of rules

The third difference mentioned above is that Meinong's color space includes transcendent colors and colors for which we have no words, while the a priori rules of color grammar apply to a limited number of color words or concepts.

An issue often raised about colors is that each color within the octahedron should stand in an enormous number of a priori relations to other colors. For instance, each color is different from each of the ten million or so other colors of the octahedron — let alone those that are outside the octahedron — and each difference can be expressed as a rule. Now, it is extremely implausible to say that color discrimination requires us somehow to know millions of rules. This applies also to conceptual differences between colors. We can ask whether the acquisition of the concept of green requires experiencing all visible green hues, and whether your concept of green is deficient in the converse case (Hardin 1988: 122).

Here again, it seems to me that a Wittgensteinian account is more plausible. Suppose we have only three words to denote all the color hues on the octahedron's line from pure red to pure

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[5] See, among many others, Goodman 1977; Wright 1975; Dummett 1975; Hardin 1988: 170ff.; Rescher 2017: 60. Some authors have defended the view that such relations are transitive. See Jackson & Pinkerton 1973, and Graff 2001. A common response is that adjacent colors may be different even though they are indiscriminable. This suggestion, however, encounters the same difficulty as Meinong's view that two indiscriminable colors may have a different "nature" (see above). As Papineau (2015: 291) correctly points out: "The difficulty facing this line is obvious. In what sense can two samples have different conscious 'looks' if they are visually indiscriminable? Surely their indiscriminability means that they consciously look the same. The idea that these samples produce different conscious responses seems of dubious coherence. If the responses are consciously different, how can the subject be unaware of this?"

[6] The question that arises is to what extent Wittgenstein *took seriously* the geometrical representations of the relations between colors in his *Philosophical Remarks*. Mulligan (1991: 85) observes very rightly that "the central difference between the two Austrian accounts of colour space is that Meinong, unlike Wittgenstein, takes seriously the notion of space that is appealed to in talking of tone space, colour space, etc.". Wittgenstein views the octahedron merely as a "*rough* representation of colour-space" (Wittgenstein 1977: 51).

yellow, namely “red”, “yellow”, and “orange”. Each of the three words captures a third of the line, which means that all color hues within one of the three segments is denoted by one and only one of the three color words. So there are a huge range of color hues on the side of visual experience, while there are only three color words on the side of language.

As I understand it, Wittgenstein’s view is very simple. It is that all the a priori relations dealt with in color theory are on the language side. Such relations hold not between colors merely as they are experienced, but between color words. Consider three different colors within the “orange” segment on the red-yellow line. Since the three colors are located in the “orange” segment, all should be called “orange”. To distinguish them you will have to say “this orange”, “that orange”, “that other orange”, etc. On Wittgenstein’s view, the three experienced colors have no relations that can be called “a priori” in any intelligible sense of the term. This view is intuitive and plausible. The truth that this orange is between that orange and that other orange is not a necessary truth. It is no more than an observational truth: you are presented three colored patches, side by side, and observe that they stand in such-and-such relations to each other. It is certainly possible for this orange not to be between that orange and that other orange. By contrast, the truth that this orange is between red and yellow *is* a necessary truth, whose negation is self-contradictory. A person who denies it should not observe the orange patch more accurately, but consult a dictionary. Thus, it may happen that somebody else, say, a Chinese person, has three different words to denote three orange hues you indiscriminately call “orange”. In this case, the truth that Orange1 is between Orange2 and Orange3 is a necessary truth. But why is the situation different for the Chinese person? Obviously, the situation is different simply because the language is different!

At any rate, a Wittgensteinian treatment of the a priori has the effect of dramatically decreasing the number of a priori relations among colors so as to obtain quite a reasonable amount of rules — not only because the number of available color words is limited, but also because grammatical rules are such that a great number of them can be derived from other grammatical rules. For example, the conjunction of “A is between B and C” and “D is between A and B” entails that D is between B and C; the conjunction of “A is different from B” and “B is different from C” implies that A is different from C; the conjunction of “A is a shade of B” and “B is different from C” implies that “A is different from C”; etc.

Conclusion

Meinong's geometrical approach to the a priori relations between colors faces at least three sets of difficulties related to the following assumptions: colors possess a "nature" that can be grasped through intuition; they are separated from each other by continua in color space; there are an infinite number of a priori relations between colors. These difficulties do not arise for grammatical accounts. Therefore, grammatical accounts are more plausible in these three respects.

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