Reading Aerial Photographs: The Southerner's Advantage

Roberto Casati

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Institut Jean Nicod CNRS/EHESS/ENS/DEC/PLS

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Aerial photographs of the most mountainous areas of the Northern Hemisphere are subject to a concavity/convexity reversal illusion, due to three facts: that sunlight comes from the South, that the visual system is bound to interpret concavities and convexities as if light always came from above, and that North coincides with above in the pictures. This fact is particularly damaging now that aerial photographs are ubiquitous. A remediation is proposed.

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Consider the following image.

Fig. 1. Steep geological features. Retrieved from maps.google.com, November 2011.

In desertic land, mountains suddenly rise, layer of rock upon layer of rock, with sharp crests. It is a strange landscape, thinking of it. An ambitious road has been built on the highest crest; the construction seems incomplete towards the right of the picture. The deep valleys would host rivers, but where do these flow when the valleys meet the plain?

A geographer would say that this is an upside-down world of sorts. And indeed it is, but from the cognitive point of view only. And geographers, of course, know better, as the image depicts one of the most prominent features of Earth. This is actually a right side-up picture of the South Rim of the Grand Canyon, Arizona, west of Grand Canyon Village. The “road” is the Colorado River and what you see as crests are actually the bottoms of valleys. No water flows into the plain from the valleys because the Coconino Plateau is the highest feature in the picture.

Now you know, but can you mentally “reverse” the picture, so as to see elevations in the right order, i.e. mountaintops closest to your eye? Research in vision science has shown that the visual system makes extensive use of an implicit rule in retrieving shape from shading. The rule states that light must be assumed to come “from above” : (Kleffner & Ramachandran, 1992) (Mamassian &

Goutcher, 2001), (Casati & Cavanagh, 2019). The rule is consistent with ecology – in the natural environment, light overwhelmingly comes from above – and thus has a strong evolutionary plausibility. “From above” appears to mean literally “from above” when one looks at a photograph on the screen of a laptop in standard viewing conditions, but it can also mean “from the best approximation to from above”, e.g. when one looks at a picture that lies flat on a table. If unconstrained, the interpretation of shading to retrieve shape is underdetermined. A shaded area could be induced by a protrusion that is situated immediately below it and blocks light from below, or by a protrusion that is situated immediately above it and blocks light from above. If light is assumed to come from above only, the first interpretation is eliminated. The fact that we typically see pictures such as fig. 1 as a pattern of convexities (mountains) rather than a pattern of concavities (a canyon and its tributaries), together with the fact that even if we are told, it is hard to revert to the correct interpretation, is taken as an indication that the rule “light from above” is deeply ingrained in our visual system.

This fact, however, bespeaks difficulties for readers of aerial photographs – actually, for some of them more than for others. Most[1] places inhabited by northerners see the midday Sun in the South. Aerial photographs taken at that time of the day (to minimize the effect of cast shadows) and so oriented that their North coincides with the top of the picture, will display a pattern of “light from below” and, accordingly, will incur the risk of a concavity/convexity inversion. The places inhabited by whose who live in the southern hemisphere will not be subject to this effect as they (mostly) see the midday Sun in the North. The convention of representing North in the top part of the picture thus induces an asymmetry, resulting in the southerner's advantage when it comes to aerial photographs.

Maps typically correct for the asymmetry in representing shadows as cast from a NW light that is impossible in the northern hemisphere. But what remediation can be proposed for aerial photographs? Now, there is a way to put the 3d unfolding of the picture in the right order, so that the highest features are closest, the bottom features farthest from our eye. You should simply turn the picture upside down. You can try this with fig. 1. The effect may not be immediate, but when it is in place, it is robust, in the sense that the concavities and convexities stabilize and it is near impossible to see again the depth of the Inner Canyon and the Colorado as a raised crest with a road.

Thus the remediation consists in learning to use “upside-down” aerial photographs. This is something we can do, as the alignment of North with the top in a map is the result of an unlearnable convention. We cannot, on the other hand, train our brains to unlearn the “light from above” assumption.

However, this remediation may prove difficult if we work with the screen-anchored visual

1 In northern Spring and Summer, some areas within the northern polar circle will see the midday Sun in the south, and in southern Spring and Summer some areas within the southern polar circle will see the midday Sun in the North.

representations – as millions of people do today when using the popular geographic websites. It is not always possible to rotate the screen, and taking a screenshot, pasting it into an image editor and turning it upside down is a few clicks too many. May we suggest that web providers of satellite images insert a simple button “Turn 180°” in the interface? This would also have the indirect advantage of loosening the cultural association between North and top of the picture.

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