SHORT AND SWEET

Blow-up: a free lunch?

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Abstract. We consider operations that change the size of images, either shrinks or blow-ups. Image processing offers numerous possibilities, put at everyone’s disposal with such computer programs as Adobe Photoshop. We consider a different class of operations, aimed at immediate visual awareness, rather than pixel arrays. We demonstrate cases of blow-ups that do not sacrifice apparent resolution. This apparent information gain is due to “amodal occlusion.”

Keywords: occlusion, image structure, visual grouping, visual space, amodal occlusion, visual awareness.

“Blow-up” is best known as the title of a “sixties” cult movie by Michelangelo Antonioni (1966), based on a story by Cortázar and Lickliter (1959). The plot involves a photograph that is repeatedly “blown-up,” apparently revealing progressively more detail. It remains unclear whether the photograph contained (the photograph becomes lost) the record of a murder or whether this is actually the hallucination of the photographer.

We study “blown-up” images in experimental phenomenology (Metzger 1953) rather than physics or information theory. We also consider shrinks, the two (blow-ups and shrinks) being polar aspects of a single process. We consider images as pixel arrays, not (film-based) photographs (Mees 1942).

Figure 1. The original image (a) is a 512 × 512 pixels image. At the center (b) it has been reduced to a 64 × 64 pixels icon. To the right (d) this icon has been blown up again to a 512 × 512 pixels size. In this process, detail becomes lost: c1 shows part of a, and c2 part of d.

The basics of shrinking and blowing up from a physical point of view are illustrated in Figure 1. The upshot is that blow-ups at best conserve structural complexity (Shannon and
Weaver (1949) and thus cannot reveal additional detail. This is unlike real scenes, which can be blown up (using telescopes or microscopes) virtually ad libitum (Ruskin 1843). Shinks actually lose structural complexity and thus contain less detail.

Paradoxically, blow-ups look equally detailed though less sharp than the original, and shrinks equally sharp though less detailed than the original.

Consider Figure 2, in which we have overlaid grids over an image. The grid bars occlude the image; thus, one sees less, and the structural complexity is lowered. This latter fact is not prominent in awareness, though; one feels to see the whole image through the grid.

![Figure 2](image.png)

Figure 2. Image with a grid overlay. Strip width is 0, 1/128, 1/64, and 1/32 of the image size (512 pixels square).

Next, consider the case of Figure 3. Here, we have gathered the tiles between the grid bars (Figure 2) and assembled them as the pieces of a puzzle. When “done,” the puzzles look like complete images. They look like the original, only smaller. We obtain apparent shrinks that are just as detailed as the original on the pixel level. Thus, these shrinks are essentially different from the case considered in Figure 1.

Finally, consider the case of Figure 4. Here, we cut the original image into tiles and spread out the tiles. Thus, these images are like sloppily done puzzles. No structural complexity is lost, and the whole image content is revealed. Notice though that these images look like blow-ups. The cracks left between the tiles appear as the bars of an occluding grid, like those in Figure 2. We have a case of “amodal occlusion.” The image looks complete and is “seen” to continue beneath the bars. These parts are amodally present (Kanizsa 1955, 1979) due to “occlusion.”

Notice that Kanizsa’s “amodal shrinkage effect” (Mitsudo and Nakamizo 2005) is only weak, for these images evidently appear as blow-ups. Yet the level of detail at the pixel level is
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Figure 3. Here the tiles revealed through the occluding grid (Figure 2) are assembled into an image. The image shrinks by 0%, 6.25%, 12.5% and 25%.

the same as in the original image. Thus, the blow-up does not come at a cost, as in Figure 1. Apparently, one can blow-up with impunity!

Consider a generic example of a miracle. Way back, at Tabgha on the northwestern shore of the lake of Galilee, Jesus distributed five loaves and two fishes brought by a boy so as to feed 5,000 people, with 12 basketfuls of broken pieces of bread to spare (Matthew 14:13–21, Mark 6:31–44, Luke 9:10–17, John 6:5–15). Does the demo shown in Figure 4 achieve a similar feat in the image domain?

For the sake of mental sanity: is there something like a free lunch after all? No, the information content of the original (Figure 1 left) and blown-up (Figure 4) images is exactly the same. Only the feeling of a free lunch comes for free. It does not “buy” one additional detail.

In conclusion, we encounter a full dissociation between shrinks and blow-ups in the physical domain, and in visual awareness. Size and resolution are the parameters at stake here. Either of these should be considered from the two ontologically disparate levels. This is well understood in the visual arts (Ruskin 1843) though perhaps not generally recognized in scientific contexts.
Figure 4. The images obtained with tiles progressively spread out. Notice that the images look like occluded by a grid, which of course they are not. The tiles are equally sized in all three images. The gap widths are 0, 1/128, 1/64, and 1/32 of the image size (512 pixels square), corresponding to "magnifications" of 0%, 6.25%, 12.5%, and 25%.

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Jan Koenderink (1943) studied physics, mathematics, and astronomy at Utrecht University, where he graduated in 1972. From the late 1970’s he held a chair "The Physics of Man" at Utrecht University till his retirement in 2008. He presently is Research Fellow at Delft University of Technology and guest professor at the University of Leuven. He is a member of the Dutch Royal Society of Arts and Sciences and received a honorific doctorate in medicine from Leuven University. Current interests include the mathematics and psychophysics of space and form in vision, including applications in art and design.

Whitman Richards is professor at CSAIL (MIT). His main research focus has been visual perception: mechanisms and models. Beginning first with studies of early visual processing, current work is now at a very high cognitive level, with emphasis on perception as a complex system of semi-autonomous modules – roughly akin to Minsky’s "Society of Mind." In the mid-seventies, his research activity was redirected after meeting David Marr. Rather than concentrating on mechanisms of vision, the emphasis changed to understanding the minimal conditions that should be satisfied for a vision system "to work." Computational studies that met Marr’s criteria turned out to be major advances in vision understanding. His contributions appear in a book called "Natural Computation", which covers work in vision, hearing, and motor control.

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