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## Guest editorial

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### Another Babel

In the aftermath of the ECVP'02 in Glasgow I had the pleasure to join in at an evening at the Lighthouse organised on the occasion of an exhibition of paintings that included a fair number by my artist-friend John Jupe. Speakers were artists and vision scientists, the general topic being the relation (if any!) between art and science. I especially enjoyed Nicholas Wade's "pipe dream". When the meeting was over, the discussion was pleasantly carried on over beers till the pub's closing hour (11:30, would you believe it?). The next day, when I met colleagues on their way back at the airport, the discussion continued.

A topic that came up repeatedly turned around the definition of terms. It is evident that working artists and scientists use a number of identical terms in quite different ways. An example is the term 'transparency' that came up in Michael Newberry's talk "*Transparency: A key to spatial depth*" [you're probably interested: fortunately Michael's talk—including figures—can be read on the web (Newberry 2002)]. The general consensus among the scientists was (if I heard right) that the term 'transparency' was used in the 'wrong' way. Wim van de Grind suggested that the notion that was apparently intended might be better covered by the term 'contrast' (but, then, Michael Newberry also uses the term 'contrast' in his talk). This made sense to me in one way, but somehow seemed to miss Michael's point. Sadly enough, for most of the scientists I conversed with, the 'obviously wrong use' of the technical expression had been sufficient to switch them off from the actual contents of the talk.

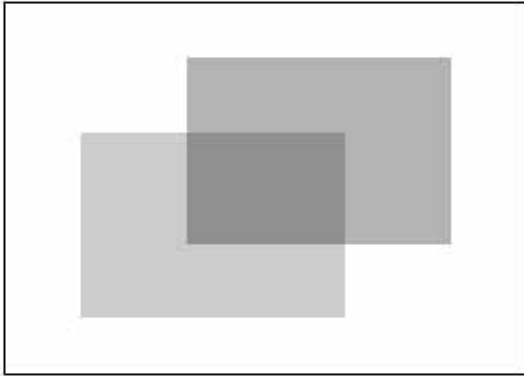
Since my own background is in physics (rather than psychology), it is obvious to me that psychologists themselves use the term 'transparency' in the wrong way. That is to say, from the perspective of optics, their use of 'transparency' is quite inappropriate. Thus the meeting was unfortunately thrown into disarray owing to a confusion of tongues of nearly biblical proportions:

"... He did not resolve to destroy them utterly, since they were not grown wiser by the destruction of the former sinners; but he caused a tumult among them, by producing in them divers languages, and causing that, through the multitude of those languages, they should not be able to understand one another. ..."

(Flavius Josephus *Antiquities of the Jews* Book I, Chapter 4  
*Concerning the Tower of Babylon* English translation available  
at <http://www.ccel.org/j/josephus/JOSEPHUS.HTM>)

comes quite close, doesn't it?

The physicist distinguishes sharply between '*transparency*' and '*translucency*'. In transparent media, radiation propagates without scattering—the only effect of the medium is refraction and absorption. For thin, plan-parallel layers only the latter effect is of any practical interest if we ignore the reflection at the interface. Then 'Beer's law' is all that is needed in a phenomenological description (Kortüm 1969). Such transparent 'filters' look dark (or coloured, the colour being a variety of darkness) against a dark background. In order to see anything, one looks through them against an illuminated scene, or places them upon a white piece of paper. (In the latter case the radiation passes through the filter twice, and therefore the optical effects are quantitatively quite different.) The orientation of the filter is irrelevant, and so is the order in any stack of them. If you can see through, then the scene appears nice and sharp, though perhaps darker or coloured. A stack is necessarily darker than any of its components (see figure 1).

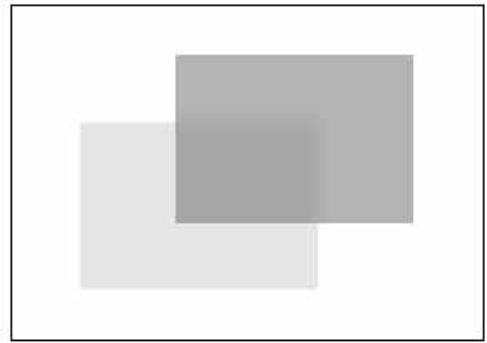


**Figure 1.** Two filters in series against a bright background (no frontal illumination). The contours are sharp, the order is fully ambiguous, the overlap is darkest.

A layer of ‘translucent’ material behaves quite differently. In the bulk, the radiation is multiply scattered, so most radiation that emerges from the surface of the material has suffered a great many scattering events. Since the radiation is thereby thoroughly scrambled, you won’t see the scene in front of you if you place such a ‘turbid layer’ before your eyes. If you put such a layer upon a printed page, you may see the printing ‘shine through’, though it will appear obviously blurred and reduced in contrast (see figure 2). The orientation of a turbid layer or the order in a stack of them typically make a huge difference (just think of a sandwich of a black and a white piece of paper!) when you look *at* the stack, though not if you look *through* it.



(a)



(b)

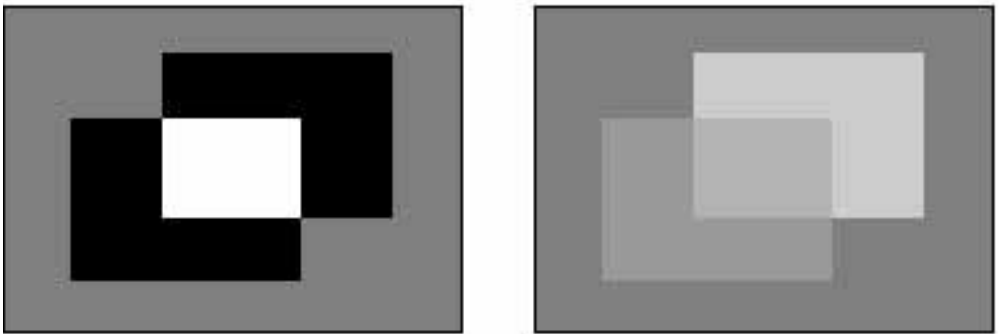
**Figure 2.** (a) Two turbid layers in series on a dark background with frontal illumination. The top right one is nearest as is clear from the blurred contours of the tip of the bottom left one that shines through. In this case the overlap area is lighter than either filter. (b) Two turbid layers in series, frontally illuminated on a light background. The contours immediately reveal the depth order. In this particular case the overlap area is darker than either filter.

Owing to the scattering, a turbid layer is often seen as light even against a black background (of course, only if frontally illuminated)—the layer ‘hides’ the ground. This is the physical principle behind white paint or undies, so I’m talking shop here. Such thin turbid layers are phenomenologically reasonably well described by the Kubelka–Munk theory (Kortüm 1969). This theory, which originated in astronomy in the analysis of the optics of planetary atmospheres (Schuster 1905), describes the optics in terms of two diffuse fluxes of radiation propagating in opposite directions and continually interchanging radiant power. This yields about the simplest, though highly approximate, theory. The theory is generally applied (in the paint and paper industries, for instance) as a tabulated set of highly nonlinear formulas. Although the Kubelka–Munk theory does quite nicely account for the loss of contrast, it completely

fails to capture the effect of blurring of the ground shining through the turbid layer. Of course, more complete theories manage to do this, but these are surprisingly complicated (Chandrasekhar 1960).

The Metelli (1974) theory of ‘phenomenal transparency’ (a well-known instance of a psychological theory of ‘transparency’) has nothing to do with transparency in the optical sense. Surprising as this may sound, there is really no connection. Metelli took his inspiration from a very artificial setup (the episcopister) which allowed him to simulate a linear system that has a remote likeness to turbid layers but is formally quite distinct. (Metelli’s equations are very different from the Kubelka–Munk ones.) Thus most of the stimuli that one routinely encounters in psychology textbooks under the heading of transparency are as ‘non-ecological’ as can be. I have no doubt that Metelli’s treatment is highly interesting as a theory in psychology, but one should be aware of the artificial nature of the stimuli and the parameters used to describe them. More generally, phenomenal transparency (see figure 3) is a highly interesting phenomenon in that it occurs in scenes that may be in violent conflict with physics! For instance, it is possible to have a phenomenal ‘layer in front of a scene’ that boosts contrast or spatial definition (see figure 4), something which, of course, will never happen in nature (Metzger 1975). Perhaps surprisingly, the eye gladly accepts such an impossible scene as ‘realistic’.

‘Transparency’ figures in the arts in manifold ways. For instance, think of the use of folds in drapery to reveal the body underneath (in both painting and sculpture) and so forth. In this case, the issue is rather narrowly focused, though. Michael Newberry’s



**Figure 3.** In the picture on the left one has no impression of phenomenal transparency. On the right is shown a case of evident phenomenal transparency.

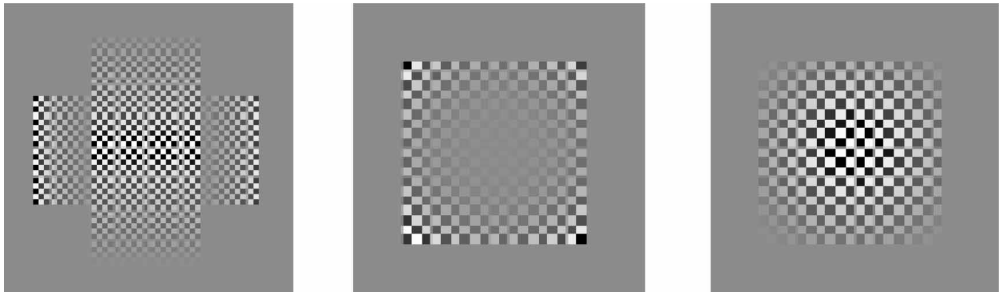


**Figure 4.** ‘Transparency’ in perception is not necessarily something ‘physical’ (ie something you could photograph). In this case, the ‘filter’ improves the clarity, apparently lifting a state of disorder within the area of the ‘filter’. Alas, such filters only exist in the mind—your photo shop at the corner doesn’t carry them. Here the filter reveals one of the treasures of Glasgow; I trust most ECVF attendees will have paid homage to the Macintosh heritage.

rules for the manipulation of pictorial depth order are:

- Given a two-dimensional surface, transparency and contrast are the means to place identities/forms through spatial depth.
- Transparency will place the forms in depth away from us and contrast will raise them towards us.

These are, of course, by no means the only tools available to the artist. But they work remarkably well (see figure 5) and have indeed been applied by artists of various cultures throughout the centuries. These tools are very general (indeed, they work quite well in ‘abstract’ paintings) and quite independent of the generic ‘depth cues’ listed *ad nauseam* in the textbooks of psychology. Contrast (of any type) with a nominal depth layer pulls an object in front of it; more transparency implies less contrast (thus getting nearer to the nominal depth layer) but the *intuition* is that of mixing in of the quality (tone, value) of the ground, hence the aptness of the term ‘transparency’.



**Figure 5.** Some uses of ‘transparency’ as a tool to manipulate pictorial depth. The arms of the cross are clearly ‘separated in depth’; the square at the centre curls up at its edges, whereas the one on the right bulges out in the middle.

In this case, the ‘confusion of tongues’ arises because the same word is used as a technical term in three different ways in art, psychology, and physics. Of course, the problem is only a minor one as long as you keep your bearings right. This may sometimes turn out to be slightly troublesome though, since issues of optics, perception, and art may well pop up in a single conversation, depending upon the company. Hopefully, this will not lead to a parting of ways as it sadly happened in the old days:

“The builders [of the Tower of Babel] departed according to their families, and the tongue they spake, to the countries and places allotted to them. The children of men never did, nor ever will, come all together again, till the great day, ...”

(Mathew Henry’s Commentary on the Whole Bible, Genesis, Chapter 11, Verses 5–9; text available at <http://www.ccel.org/h/henry/mhc2/MHC00000.HTM>)

for the interactions between art and the various sciences are both pleasant and useful.

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