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## Postscript

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This debate has evolved to the point where there is now some agreement that there are significant commonalities between modal and amodal representations and processes. However, disagreements remain about the interpretation of experimental results. Some of these disagreements, along with points of agreement, are discussed below. There has been increasing research activity on the physiological side of this issue, and the next few years may provide much more definitive evidence about the relationship between modal and amodal representations.

## The Stereo Cross

My transparent cross did not evoke the modal–amodal difference seen in Anderson and Julesz's (1995) opaque cross, and my results show that the depth asymmetry remained, falsifying Anderson's claim that the asymmetry was caused by this difference. Anderson and Julesz's theory of interocular contrast differences does not predict my results either because the Michelson contrast differences in my transparent cross are zero. There was no indication in Anderson and Julesz about what measure of contrast they had intended. However, because we are essentially talking about a bipartite local image patch with a single contrast edge, Michelson contrast would clearly be a reasonable choice. Anderson (2007b) said,

How are such phenomena to be understood, and what is their relationship to modal and amodal completion? One set of images involves amodal completion and the other does not, so Albert's (2007) line of argument with our stereo cross (Anderson & Julesz, 1995) suggests that he believes that there are fundamental differences in the computations responsible for the percepts in these different displays. (p. 517)

The whole point of my transparent version is to suggest that the same computation is going on in both versions, which would explain why they both have the same stability asymmetry. Anderson's claim that the asymmetry is caused by the modal–amodal difference would require that there are different computations in the opaque and transparent versions.

Anderson and Julesz (1995) suggested that the stability asymmetry in the opaque stereo cross is due to the relative frequency of occlusion and camouflage in natural scenes and that this asymmetry simply carries over to the transparent case via interocular contrast mechanisms even though the modal–amodal relative frequency argument is not valid in the transparent case. Why should the visual system tune its mechanisms to relative frequency in the opaque case but ignore relative frequency in the transparent case? Anderson provided no answer. In addition to the mitigating factors regarding Anderson's frequency arguments discussed in Albert (2007), I suggest that breaking camouflage can be much more important than amodal completion for object recognition in natural images. For example, if I see the head of a tiger peering from behind a rock, I can recognize the tiger's presence without needing much help from amodal completion. In contrast, an observer is

generally unaware of the presence, much less the identity, of a camouflaged object until modal completion processes segregate it from its background.

### Models

Anderson (2007b) dropped all discussion of the dual-process model of the Petter effect that he proposed in Anderson (2007a), and he apparently now disavows it. Anderson (1997) described glass effects as “vivid stereoscopic illusory ‘glass’ surfaces” (p. 444). In contrast, Anderson and Julesz (1995) described them as weak and unstable. Anderson (2007b) seemed to favor Anderson and Julesz’s view, yet the theory he advocated (interocular contrast differences) offers absolutely no explanation of this instability. In fact, as it stands, it predicts that these contour interpolations should be at least as stable as the ones seen in displays where contrast polarity is preserved because they are simply regarded as being doubly supported by having inducers on both sides. This prediction is contrary to Anderson’s (2007b) view that the percepts in contrast-reversing stimuli are less strong/stable (which I agree with), and it directly contradicts Anderson et al.’s (2002) results with the striped aperture.

Anderson’s (2007b) point about Rubin (2001) showing that modal contours can continue as amodal, but not the reverse, is interesting. In the model I previously suggested, modal completions are represented by stronger V1/V2 signals than amodal completions, which could explain this asymmetry. The model also fits well with the percepts seen in Kellman, Garrigan, Shipley, and Keane’s (2007) Figure 7 and other similar displays and with Bakin, Nakayama, and Gilbert’s (2000) results showing that properties of real contours, such as their depth, border ownership, and salience, can be influenced by amodal interpolation. Anderson (2007b) argued for continuity in the neural processing of transparency stimuli as simulated transmittance goes to zero and the stimulus becomes opaque, which seems reasonable. So, consider a stimulus that evokes amodal completion of a background surface behind an opaque occluder. Let the occluder gradually increase its transmittance. It seems unlikely (in my view and according to Anderson’s continuity view) that whatever neural representation is responsible for the amodal completion of the background contour would suddenly vanish (e.g., via suppression) as soon as the occluded part of its contour became barely visible. If this is correct, then the representation of this contour would be the same as that of the amodal contour plus some additional activity that makes the contour visible and that is carried along with the basic contour representation. Similarly, modal illusory contours would include this additional activity in their representations, making them visible. I propose that relatable contours would need to have at least one active visibility process to propagate visibility along an interpolation. On this account, the sense in which there is an identity between modal and amodal contours is that they share a common core representation (which may constitute most of the amodal representation). This view also would provide another explanation for why modal contours can continue as amodal but not the reverse: Two modal contours could join up underneath an occluder by suppressing the visibility activity along this segment (perhaps triggered by occlusion cues). However, amodal contours do not carry visibility activity, so they could not modally interpolate across an unoccluded segment.

### Other Comments on Anderson (2007b)

On p. 520, Anderson (2007b) said,

If surface properties are not separable from the contour interpolation mechanisms and shifts in surface properties (such as border ownership) can be induced by changing relative depth, then the modal or amodal status of contours can alter the shape of interpolated contours, which contradicts the identity hypothesis.

In the serrated edge, the change in relative disparity causes both the change in border ownership and the change from modal to amodal completion. Anderson claimed that the change from modal to amodal completion causes the change in the shape of the interpolated contours. I claim it is the change in border ownership. In my variant of the serrated edge, the change in relative disparity causes a change from modal to amodal completion without changing the border ownership of the inducing contours or the shape of the interpolated contours, but the display is otherwise very similar to the original serrated edge. This suggests that the cause of the change in the shape of the interpolated contours is not the change in relative disparity per se or the change from modal to amodal completion, but the change in border ownership. On pp. 520–521, Anderson (2007b) said,

Second, Albert’s proposal that there is a bias for the visual system to interpolate smaller figural regions is contradicted by our star demonstration. . . . If there was a general bias for the visual system to interpret smaller regions as figural, both the modal and the amodal variants of the star display should appear as five separate occluding wedges. . . . This is not what observers report.

There are many geometric factors that are well known to influence figure–ground organization (along with fixation and attention). Because of space limitations, I will not go into detail about why Anderson’s argument is wrong. I only suggest that he might want to reconsider whether he has actually disproved the gestalt rule that smaller, surrounded regions tend to be seen as figure, as he has claimed.

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