Binocular Depth Reversals Despite Familiarity Cues: An Artifact?

When pictures are placed in a stereoscope so that an impression of depth is given, such depth is inverted when the two pictures are reversed from left to right. Such inversion, however, does not occur in all cases, especially when photographs of faces are displayed. "Cognitive" factors are then assumed to override the binocular disparity cues of stereopsis. A. van den Enden and H. Spekreijse (*1*) offer a different explanation for the lack of inversion of faces. They note that a stereoscopic picture of a face offers two different sets of cues to depth, namely, binocular disparity and texture perspective—gradients of texture produced by depth. Only the former set of cues is reversed when the two views of the face are interchanged between the eyes. The latter, or texture perspective, signals depth independent of eye of input. The authors therefore reason that depth inversion does not occur in the case of faces in the pseudoscopic situation because of a conflict between texture perspective and stereopsis. Texture perspective wins out. The authors test their hypothesis by altering the texture perspective in such a way as to abolish depth cues from it in the stereogram of a face. They show that a pseudoscopically presented picture of such a face now looks hollow, like a mask viewed from the back.

There is one immediate difficulty with their explanation. Ordinarily, if we view an actual mask of a face from the back, so that it should look hollow, it appears as a normal face instead. Viewing the mask from the back reverses both binocular disparity and texture perspective, and yet the face does not look hollow, even though the authors must predict from their theory that it should. How then do we explain the hollow appearance of the pseudoscopically viewed face in which the authors have altered the texture perspective? We have observed that if spots are scattered randomly on the inside of a hollow mask it too ceases to look like a normal face and assumes the correct hollow appearance. It seems that the addition of extra binocular disparity cues will in the end overcome an interpretation of a visual scene on the basis of other factors. We believe this is the explanation of the authors' results. The authors made their stereogram by using the method of Georgeson (*2*). In this method a matrix of spots is projected (using a slide projector) on a three-dimensional object from a position close to the viewpoint of the observer. Stereophotographs of the object are then made with cameras near the projection point. This method does indeed eliminate texture perspective as the authors state, but it also increases the number of cues of binocular disparity, as each spot, stereophotographed, will match in the two eyes to signal its correct depth. It is this increase in the binocular disparity signals from the dots that confounds the test of the authors' hypothesis and forms the more plausible interpretation of their experimental results. However, our objection to the authors' interpretation of their results does not constitute support for the explanation the authors try to disprove. We, like the authors, do not believe that high-level cognitive factors play a role, since we (*3*) [and others (*4*)] have observed that even complex "nonsense" objects such as lumps of clay or a crumpled newspaper will resist pseudoscopic inversion.

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Van den Enden and Spekreijse (*1*) say that they have demonstrated that cognition is not a relevant factor in the resistance to depth reversal of face stereograms when the left- and right-eye views are interchanged. They postulate that pseudoscopy fails "because the disparity of texture perspective cannot be reversed in the same way as the disparity of edges." Texture perspective (a monocular depth cue) is indeed unaffected by interchanging the views. The disparity of texture perspective (as defined by van den Enden and Spekreijse) is not reversed in the interchanged view, but no evidence is presented that it serves as a depth cue. Therefore, the source of the conflict they allude to is missing. Furthermore, correct texture perspective and nonconflicting disparity of texture perspective are not sufficient to overcome the familiarity effect when one evaluates a hollow face (the inside of a mold of a face) (*2*). Nevertheless, with the additional projected "neutral" texture they generated most observers can obtain detailed reversed shape in depth (*3*).

The texture provided by van den Enden and Spekreijse resulted in a strong, unintentional, binocular cue, the disparity of the projected texture elements. Texture disparity is reversed in the interchanged view just as is the disparity of edges (*4*). This disparity of texture elements is directly correlated with the depth or the reversed depth in stereoscopic or pseudoscopic views, respectively. The abundance of texture disparity cues, rather than the masking of natural texture perspective, may account for the perception of reversed depth in their stereograms.

"Neutral" texture without the disparity artifact could be produced to test their hypothesis by two techniques. (i) Obtain the stereopair of the face without projecting the texture on it. Then remove the model, project the texture on to a screen fronto-parallel to the cameras, and double-expose the two cameras to the texture. The texture in both images will be neutral, will mask the natural texture, and will carry no disparity cues related to the face. (ii) A technique based on the shadow sterograms (*5*) uses only one camera and two illumination lights. Project the texture onto the model, and obtain two photographs from the same camera with the illumination for each coming from one of two different source positions. The resultant shadow stereograms will have neutral perspective texture without the disparity.

If any of the two proposed modified pseudostereograms result in reversed perception of the face, some role for texture perspective in this phenomenon will have been demonstrated. The interpretation of van den Enden and Spekreijse is confounded by the artifactual binocular texture disparity cue.

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3. A result that is in contrast with the report of Georgeson (*4*). He found, with the same method, that monocularly recognizable facial features must be eliminated to enable reversed perception.
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Response: There is no doubt that the disparity of individual texture elements contributes to the perception of the reversed

depth. However, Deutsch and Ramachandran's example of a crumpled newspaper clearly shows that this is not the only factor involved. In this case there is an abundance of high contrast local disparity information provided by the printed letters, yet the pseudoscopic image cannot be reversed in depth. This is also true if the words and letters are completely unintelligible. Likewise, pseudoscopic viewing of the normal face of our original figure 5 (*1*), upside-down or partially covered, does not make the nose reverse. We therefore feel confident that the binocular interpretation of texture perspective (*2*) and not familiarity counteracts binocular depth reversals.

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NOTES

1. Note that the legends of our original figures 5 and 6 were interchanged. Red/green glasses can be obtained from us at no cost.
2. Although texture perspective is known as a monocular depth cue, it is different for the left and right eye and so has a real binocular disparity.

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HIP-70: An Isoform of Phosphoinositol-Specific Phospholipase C–α

We recently reported that estrogen and luteinizing hormone–releasing hormone (LH-RH) induce the same protein, which we referred to as HIP-70 (*1*). Although repeated searches on Genbank before our report was submitted revealed no sequence similarities between the NH_2-terminus of HIP-70 and any other sequence, more recent searches on Genbank revealed an identity (first brought to our attention by M. Christensen) with the NH_2-terminus of a phosphoinositide-specific phospholipase C (PI-PLC) isoenzyme (*2*). This PI-PLC isoenzyme, whose sequence became available in a 15 September 1989 release from Genbank is now referred to as PLC-α (*3*). PLC-α is one of a family of enzymes that generate the phosphoinositide-derived messenger molecules, including the arachidonic acid metabolites, diacylglycerol (which activate protein kinase C) and inositol 1,4,5-triphosphate (which mobilizes intracellular calcium) (*3*). Neither HIP-70 nor PLC-α have any significant sequence similarities with the three other known mammalian PI-PLC isoenzymes (*3*). The rat liver form of this protein migrates on SDS gels with an apparent molecular weight of 68 kD (*4*), consistent with the migration of HIP-70. We suggested that hormonal induction of HIP-70 occurs by modification (probably dephosphorylation) of a more acidic isoform with the same NH_2-terminal sequence (*1*), which is consistent with the hypothesis that phosphorylation may attenuate the activation of PLC-α (*5*). HIP-70 seems to be the most basic of four isoforms from brain that are recognized by an antibody to PLC-α (*6*).

That PLC-α plays a major role in estrogen- and LH-RH–regulated neuronal function is consistent with several additional observations. (i) PLC-α mRNA is especially abundant in the ventromedial hypothalamus and preoptic areas, which are rich in estrogen receptors and mediate effects of estrogen; mRNAs of three other PLC isoforms were undetected in these regions (*7*); (ii) PLC activation leads to activation of protein kinase C; we have shown that phorbol esters, which also activate protein kinase C, facilitate lordosis (*8*); (iii) LH-RH and substance P both facilitate the estrogen-regulated behavior lordosis (*9*), and the phosphoinositol pathway is implicated in mediating effects of these peptides (*10*). We therefore propose that HIP-70 is a specific hormone-induced isoform of the phosphoinositol-specific phospholipase C isoenzyme, PLC-α.

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The report by C. V. Mobbs *et al.* (*1*) on the estrogen induction of the HIP-70 protein in the brain may open more lines of investigation on estrogen regulation of metabolic pathways, as we find that the sequence given exactly matches that of the rat type I phosphoinositide-specific phospholipase C isozyme (*2, 3*), a signal transduction component. This sequence has been in the Protein Identification Resource's Protein Sequence Database (PIR-PSDB) since 31 March 1989.

By searching the PIR-PSDB, Bennett *et al.* (*2*) had earlier found two thioredoxin-like domains in this phospholipase C isozyme, leading them to suggest possible regulatory or catalytic roles for these domains. Another protein containing two domains homologous to thioredoxin is protein disulfide isomerase, a microsomal enzyme catalyzing thiol-disulfide exchange reactions in proteins. While investigating the in vitro degradation of insulin by protein disulfide isomerase and its inhibition by estrogens, we found that a 44-residue segment of this enzyme, which corresponds to exon 3 of the human gene (*4*), has significant similarity with a segment in the estrogen-binding domain of the estrogen receptor (*5*). We proposed that (i) this region of the enzyme interacts with estrogens, causing a change in the enzyme's catalytic site, and that (ii) only a segment in the steroid-binding domain of each receptor determines its steroid specificity. When this phospholipase C isozyme sequence was published (*2, 3*), we compared it with that of protein disulfide isomerase and found that the two proteins are similar along their entire lengths, especially in the thioredoxin domains and in the proposed estrogen-binding region (*5*), and likely derive from a common ancestral gene. The activity of this phospholipase C isozyme might be directly affected by estrogens, especially during human pregnancy, when estrogens reach micromolar concentrations. The work of Mobbs *et al.* (*1*) provides strong evidence for a functional relationship between estrogens and this phospholipase C isozyme.