diagonals which are actually most visible in the display, in contrast to my report (5) that perception of the diagonals tends to be perceptually suppressed. This is probably not a contradiction, as the suppression is only observed under the following controlled conditions: (1) the pattern projects to a homogeneous retinal area, (ii) the contrast magnitudes of the Fourier components are set to control for the contrast sensitivity limitations of the human visual system, and (iii) the oblique effect is controlled. Observation of their checkerboard stimulus shows that the diagonals are suppressed around the point of fixation, but not in peripheral regard where poor optical and retinal resolution will tend to degrade the sharpness of the edges. However, if this low spatial frequency suppression is present in the McCollough checkerboard effect, it might tend to reduce the predominance of oblique orientations. One reason that this suppression may not occur in color perception is the lower spatial resolution of the chromatic system than for chromatic contrast perception, as mentioned in the preceding paragraph.

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Our goal (1) was to compare the explanatory value of two alternative ways of specifying a visual stimulus, rather than to establish the details of possible neural coding mechanisms. As we stated, "The purpose of our experiment is to demonstrate that Fourier analysis can better account for the processing of patterns than an analysis which treats spatial stimuli as collections of visual features."

Smith seems to take it for granted that the visual system must respond to the periodic components of a pattern and that the only trick is to determine their orientations. To this end, he describes a useful informal method of doing so. However, a Fourier analysis is not the only way to describe a scene, since it may also be described as a set of features. The Fourier components of a pattern represent its global attributes, whereas a feature description represents its local attributes. In our study, we had no a priori reason to assume that color aftereffects would be contingent on the inducing checkerboard's global (diagonal) properties rather than on its local (horizontal and vertical) properties.

Tyler shows that it is possible to account for our results if one postulates a neural receptive field structure which "happens to be three or four times larger" than the squares in the checkerboard. This again is an after-the-fact account. Neurophysiological data indicate that visual receptive fields vary widely in size. Prior to experimental testing there is no reason to assume that visual responses produced by checkerboards would be more consistent with the operation of neurons with large, diagonal-sensitive receptive fields than by ones with smaller, edge-sensitive receptive fields.

Tyler suggests that our results can be attributed to the poor spatial resolution of the eye's red-green system. This explanation is unlikely because recent experiments (2) with purely achromatic stimuli have demonstrated that detection thresholds for gratings are significantly raised after exposure to checkerboards whose Fourier components are aligned with the gratings, whereas thresholds are only slightly affected by checkerboards whose edges are aligned with the gratings. By Tyler's account, these results would have to be mediated by "large receptive fields in the achromatic channels," but he offers no independent evidence to specify why large rather than small receptive fields should be involved.

Not all stimulus descriptions are equally useful. One value of the Fourier analysis approach to spatial vision lies in its ability to make precise quantitative predictions, which are difficult to make from a feature analysis point of view. Although Fourier analysis may be a complex way to describe a pattern mathematically, it can yield simpler psychophysical relationships than a more straightforward description. The situation is analogous to choosing a coordinate system with which to describe the motion of a particle. From a straightforward rectilinear point of view, polar coordinates are mathematically complex. But if the particle happens to be rotating, polar coordinates provide a simpler description of its known path and its possible future location than rectangular coordinates do. As visual scientists, we prefer simpler psychophysical relationships to simpler stimulus descriptions. Moreover, to the extent that predictions specified by a Fourier analysis of a pattern are verified, we feel justified in concluding that the visual system as a whole responds as if to the Fourier components of the pattern.

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Both Smith and Tyler address the question of whether or not the visual system actually performs Fourier analysis of spatially complex stimuli. We did not feel that our results constituted direct support for such a notion and consequently were quite tentative in our statements about whether patterned information is processed by Fourier analysis as opposed to feature detection mechanisms. We felt that it would be just as premature to attribute perceptual responses to single cortical units as it would be to state that the brain performs Fourier analysis. Our experiments examined perceptual responses as they relate to one of many heuristic methods of describing visual inputs.

With respect to Smith's nonmathematical explanation of the perceptual response to a checkerboard, it is not at all clear how the output of the moving slit is translated into the perceptual phenomena that we described. Tyler's analysis constitutes a description of possible initial stages of perceptual processing. If the brain does perform something analogous to Fourier analysis of visual inputs—a notion which is more directly supported by other studies (1)—the interaction of outputs from a large number of single units must be involved. It is perfectly plausible to state that a hypothetical cortical unit *could* show maximal activity when stimulated with the diagonals of a checkerboard, but observations indicating that an orientation-specific single unit *does* respond maximally to the fundamental Fourier components of both gratings and checkerboards would be more impressive. So far as we know, data of this kind have not yet been reported.

Tyler's statement concerning poor spatial resolution in the chromatic channels does not seem to add much to our understanding of these effects, especially given his comment that "large receptive fields could also occur in the achromatic channels." He is correct in predicting achromatic aftereffects. As yet unpublished data from several laboratories indicate that results commensurate with our color aftereffects can be obtained with achromatic stimuli. Threshold elevations, obtained under conditions of successive adaptation (*2*), simultaneous contrast (*3*), and interocular suppression (*4*), occur whenever the major Fourier components of checkerboards and gratings have the same orientation. Using achromatic contrast thresholds and checkerboards with Fourier frequencies as low as two cycles per degree, the aftereffect occurs on the diagonals (*2*). Thus, it seems clear that poor spatial resolution occurs with achromatic aftereffects as well as with chromatic aftereffects.

Fourier analysis has made a considerable contribution to the study of pattern perception. Without this powerful conceptualization the argument discussed here would not have occurred. The contribution of electrophysiological data to the understanding of perception has also been great; however, as this argument indicates, the exact relationships between single-unit responses and psychophysical judgments remain to be specified. Fourier components are essentially a feature of the stimulus; our experiment asked what features were salient in this situation rather than directly addressing the question of the type of mechanisms involved.

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Simple Solutions: Concentrations in the Surface Region

In an otherwise excellent article on the colligative properties of simple solutions (*1*), Andrews makes some incorrect statements about concentrations of molecules in the surface region between a liquid solution and its equilibrium vapor phase. He states that in an ideal (Raoult's law) solution "solute molecules occupy the same fraction of the surface as their mole fraction" and that in a Henry's law solution "these fractions are not necessarily the same but they are proportional" (*1*, p. 569). Neither of these statements is true in general, although one can imagine particular binary liquid solutions in which (relative) surface concentrations are the same as bulk concentrations.

Numerous adsorption studies have shown that surface concentrations of solutes (in regions where the solute obeys Henry's law and the solvent follows Raoult's law) are decidedly nonlinear in bulk solute concentration. Typically, the concentration of a surface-active solute in the interfacial region will increase to a saturation value (often corresponding nearly to monolayer coverage) at low bulk concentrations and will change very little at much larger solute concentrations or activities. To be sure, the rate of evaporation of a solvent can be considerably reduced by the presence of a monomolecular layer of a slightly soluble compound (*2*); however, the rate of return of solvent molecules to the bulk solution will be simultaneously reduced by (nearly) the same fraction.

The major point is that, although the kinetics of evaporation and condensation are quite complicated, the arguments developed by Andrews can be made (and in fact are made throughout the rest of Andrews's article) solely in terms of the reduction of solvent chemical potential (μ_1) caused by the presence of a dissolved solute. Stated somewhat differently, the kinetics of evaporation and condensation must be consistent with the thermodynamics, but the actual mechanism of these processes and the changes that occur in the molecular composition of the surface region are of little interest in relation to the thermodynamic treatment of colligative properties.

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I thank Christian and Tucker for calling attention to the molecular model I chose to illustrate ideal vapor pressures in one paragraph of my article. I did not make clear the fact that the model I used was simply an example, chosen because it was easy to understand. Their point is well taken that in many cases more complicated models are required to explain the mechanism of these phenomena, although the overriding thermodynamics is thoroughly understood.

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Checkerboards and Color Aftereffects

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