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Reply to Barris

We are grateful to Dr. Michael C. Barris for pointing out a resemblance between the *subtle color gradients* visible in Wassily Kandinsky's 1916 painting (Fig. 1, below) and the assimilative *watercolor spreading* described by Pinna, 1987.

It is true that there is an apparent similarity regarding the veil of color in both. However, the two effects differ in strength and extent as well as in the way they are produced. Kandinsky uses black contours accompanied by a (yellow, red, blue) chromatic gradient that extends far onto the adjoining area. Typically the gradient is wide and shallow not unlike a sawtooth for eliciting the Craik–O'Brien–Cornsweet illusion (Wachtler & Wehrhahn, 1997). It has no counterpart on the opposite side, but instead includes a fringe of *different* color that is detrimental to watercolor spreading (Pinna, Brelstaff, & Spillmann, 2001).

In comparison, Pinna et al. (2001) use for their watercolor patterns a thin double contour of a dark (e.g. purple) and a lighter (e.g. orange) color. The lighter fringe runs alongside the darker contour over its full length thereby imparting its color to the enclosed surface area. This induced surface color is so striking that most observers take it for real. It also elicits a slight depth effect and a strong figure–ground segregation not present in Kandinsky's painting. The reader is referred to Pinna et al. (2001, Table 2) for a listing of the main features of the *watercolor effect*.

Fig. 2 demonstrates the coloration and figural property of the watercolor effect in a pattern consisting of a large circle, a square, a hexagon, and a small circle, all arranged concentrically. When the figure is rendered only by purple contours (not illustrated here), the outlines of the four shapes are perceived clearly, but surface organization is lacking. When orange fringes are added to one side of the purple contour of each shape that region is perceived as a figure with a uniformly colored surface. The region without the fringe appears as empty space. If now the orange fringes are added to the other side of the purple contours, the coloration and figure–ground segregation are reversed: what was first a figure now appears as empty space and vice versa.

There is no such link between coloration and figural properties in the Kandinsky painting. In fact, from the reproduction in Fig. 1, we would be hesitant to state that there is watercolor. We may safely assume that the weak color gradients in Kandinsky's painting were purposeful, but we have no evidence that he actually intended them as a tool to elicit watercolor-like spreading and figural segregation. The only way to tell what is real and what is illusory is to do spectrophotometry on the original painting. There appear to be parallels, though, to Pinna's discovery in the Renaissance. The mapmakers of that time most probably knew—and applied—the effect to better separate neighboring countries (Bagrow & Skelton, 1985; Wollschläger, 2001). However, in psychophysics, the watercolor effect appears to be novel.

In studying the watercolor effect, our aim was fourfold: First, to demonstrate large-scale assimilative color spreading (coloration) as an example of long-range interaction from sparse information (Pinna et al., 2001). Second, to study the characteristics of the borders leading to the watercolor effect and thereby obtain clues regarding the interaction taking place within the neural network. Third, to emphasize the superior effect of *watercolor* spreading on figure–ground segregation relative to a number of classical *Gestalt* grouping factors (Pinna, Werner, & Spillmann, 2003). Fourth, to elucidate the role of border ownership (belongingness) for the perception of surfaces.

Although visual artists and scientists have the same starting point in phenomenology, meetings at which both are present quickly reveal that their languages, interpretations, and perspectives have little common ground. Unfortunately, even *Leonardo*, a journal dedicated to the exchange of ideas on art and the natural sciences is rarely read by members of the vision community. Thus, although it is true that artists who exploit the potential of the visual brain in their creations provide a rich resource to visual scientists, their potential contribution to the vision science remains to be fully exploited.

The watercolor effect and related phenomena such as the neon color effect, not only present scientific challenges, they also have an aesthetic quality of their own. Bressan, Mingolla, Spillmann, and Watanabe (1997) described neon color as *ethereal*. Such phenomena appeal to the artful *experience* of vision as much as to the scientific analysis of the neural mechanisms underlying perception. After all, the same brain that is used for painting is also used for perceiving light, color, shape, motion, and depth.

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Fig. 1. Wassily Kandinsky's painting ''Untitled'' (Ohne Titel) 1916 (Private Collection, London).

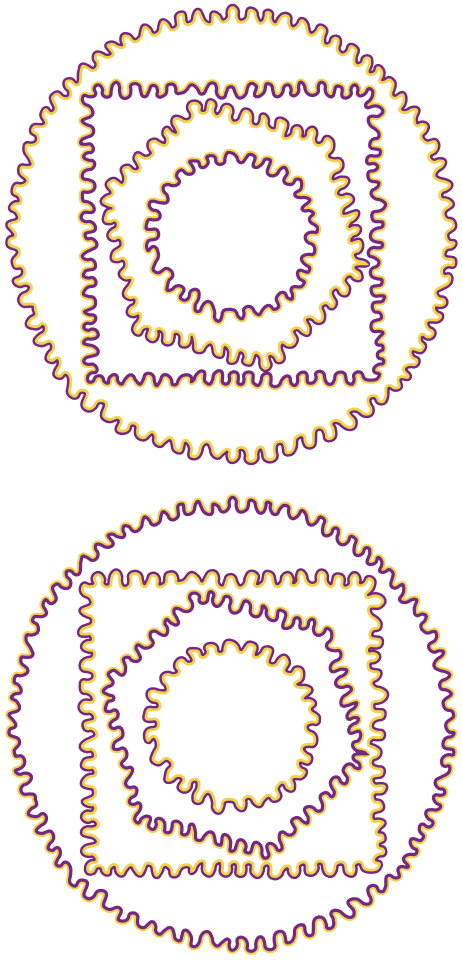

Fig. 2. Assimilative color spreading determines figure–ground segregation in the watercolor effect.

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Lothar Spillmann [*]
Baingio Pinna [1]
AG Hirnforschung
Universität Freiburg, Hansastrasse 9
D-79104 Freiburg, Germany

[*] *E-mail address:* lothar.spillmann@zfn-brain.unifreiburg.de

[1] On leave of absence from Facoltà di Lingue e Letterature Straniere, Università di Sassari, Sassari via Roma 151, I-07100, Italy.