

Dining with Julesz

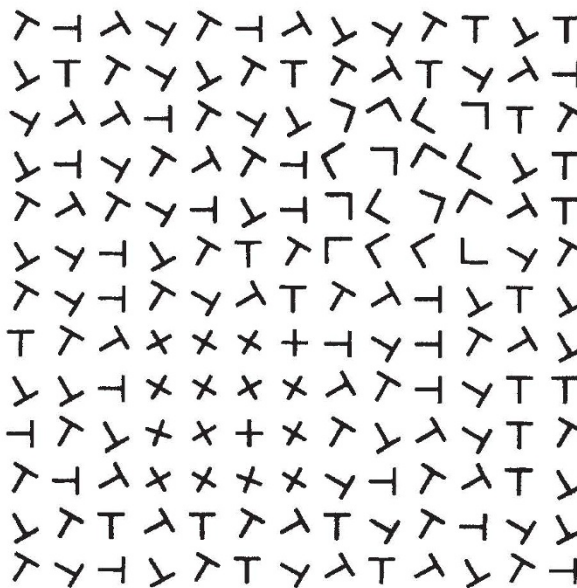
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Dialogues on Perception. By Bela Julesz. MIT Press: 1994. Pp. 276. \$49.95, \$33.50.

Dialogues on Perception is an invitation to get to know Bela Julesz. At present, you cannot escape his influence, even if you do not know his name. Every shopping mall and gift shop bears witness to what is probably his greatest contribution to vision research, the random dot stereogram. The version in the shops is known as an autostereogram. These are the pictures of textured patterns that invite you to cross or uncross your eyes in order to see a ghostly, three-dimensional image emerge from the flat pattern on the wall. They often feature rarefied prose about getting in touch with other planes of consciousness. In fact, when you see the three-dimensional forms, you are getting in touch with binocular stereopsis, the ability to extract depth information from small differences between the images in the two eyes. To see these differences, hold your finger in front of this page, look with the right eye alone and position the finger so it appears just to the left of any word. Now, without moving your finger, look with the left eye alone. The finger now appears to the right of the word. The difference between the two monocular views is binocular disparity.

Our ability to use binocular disparity as a cue to depth was uncovered by C. Wheatstone in 1838, who reported his findings in *Philosophical Transactions of the Royal Society*. For the next 120 years, it was generally assumed that stereopsis added depth to monocularly visible items such as fingers. Then, in the early 1960s, Julesz invented the random dot stereogram and proved that the monocular items were not needed. Purely stereoscopic or 'cyclopean' forms could be seen. Julesz fled Hungary when the 1956 rebellion failed (The Hungarian name is pronounced 'you-less'). He landed at Bell Labs in Murray Hill, New Jersey. From his work as a radar engineer, Julesz knew about camouflage and he knew that stereopsis was one way to defeat it. For example, if the enemy covered its tanks with hay and stuck them in the middle of a hay field, they were hard to spot from the air. But if you took two pictures of the hay field from two different positions as you flew over, you could show one picture to one eye and the other to the other eye. In this stereoscopic view, the tanks would be seen as bumps standing above the field, their camouflage ruined by binocular vision. In the lab,

Julesz used one of the early high-speed computers to show that stereopsis could defeat perfect camouflage. He filled the image in one eye with a random pattern of dots. The other eye saw the same pattern but with a region of dots shifted to the right or the left. Each image alone looked like a formless mass of dots. Seen stereoscopically, however, a sharply defined region of shifted dots appeared to lie in front of or behind the plane of the image.



Find the regions made of 'L's and of '+'.s.

Autostereograms work in a similar way. The random background pattern is repeated like a pattern of vertical bars. One eye fixates one 'bar' while the other eye fixates the neighbouring bar. Slight differences in the pattern in adjacent bars give rise to the depth effect (C. W. Tyler and M. B. Clarke, *Proceedings of the Society of Photographic and Illuminating Engineers* 1256, 182-197; 1990).

Julesz's contributions to the study of stereopsis are discussed in *Dialogues on Perception*, but it may come as a surprise that he does not consider the random dot stereogram and its associated science to be his most important contribution. That position he reserves for his work on "textons", his proposed building blocks of texture perception. The figure shows one example of stimuli that Julesz and others have used. In this texture, regions of 'L's and '+'.s are embedded in a larger field of 'T's. All of these elements are made of two lines of equal length at right angles to each other. But although all the items are similar, the '+'.s segregate into a separate

region whereas the 'L's must be found individually with attentional scrutiny. Apparently, the intersections in the '+'.s make them 'preattentively' visible on a background of 'T's. Julesz is one of the founders of the modern study of preattentive processing and remains one of its most active investigators.

In *Dialogues on Perception*, Julesz explains why stereopsis and preattentive processing are worthwhile intellectual pursuits. The book's structure is unusual. Both parties to the dialogues mentioned in the title are Julesz — the 'A' voice is the public Julesz while the 'B' voice is a critical Julesz who tries to deflate A's "unnecessary trappings of human vanity" (p. xviii) and to keep the conversation moving. The result is very much like a series of dinner

conversations with Bela. As you can't talk back to the book, you have to imagine one of those situations where you feed an opening line to an interesting person and then sit back to listen, tossing in a comment every so often to keep the dialogue going. "So, Bela, what is new?" you might ask. The result might be Dialogue Twelve, "Recent findings with my co-workers". You wouldn't expect tables of data over dinner and you don't get them here. If you are interested, your companion will tell you where to look. Julesz provides an interesting annotated bibliography covering all of his work to date. There are 14 dialogues in the book. You can imagine that if you were to eat with one person every night for two weeks, you might hear the same story more than once. So, for example, the core of texton theory makes several appearances (the most comprehensive in Dialogue Nine).

You would hope for a steady flow of stimulating ideas and the occasional *bon mot*. These the dialogues provide. I particularly liked Julesz's one-line epigraph for behaviourist psychology: "Psychology without consciousness is like math without infinity" (p. 146) — possible, but not very interesting. Take this book in dialogue-sized bites. Endeavour to hear it in a rich Hungarian accent. It is the next best thing to dinner with Bela. □

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■ MIT Press also recently published *Cognition and the Visual Arts* by Robert L. Solso, an accessible and abundantly illustrated account that relates data on how humans perceive, process and store visual information to the viewing and interpretation of art. Price is \$39.95, £35.95.