3-D goes 4-D

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Zirahuén Lake
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Dear Stephen J. Gould,

For quite a few months I had been trying to write to you about my thoughts after reading your and Rhonda Roland Shearer's essay "Boats & Deckchairs". I have greatly enjoyed your column since the early 90's but this essay was especially meaningful for two reasons. First because on this occasion I thought of something you apparently did not. I was initially reluctant to accept that I might have realized something you (or Duchamp!) had not, but the more I thought about it the less reluctant I became. Now I dare to share it with you and ask for your opinion. The second reason is because on announcing your retirement from the column, I realized with a mix of joy and sadness that I would barely catch the immense pleasure and honor of sharing an issue of the magazine [*Natural History*] with you. As my article, "Touchy Harvestmen," will be featured next October. I will begin with my reflections on your 4-D essay, and this will bring me back to my harvestmen's [daddy-long-legs] 4-D perspective.

I haven't read Abbott's *Flatland* (I certainly will) but from your digested excerpts I can conclude that A Square didn't have to fly too high above Flatland to see the shocking and never before imagined perspective being offered from a 3-D world. Of course the higher the better, but just standing a bit above the plane and stretching the neck and peeping would be enough to see Mr. Circle all at once, though somewhat

deformed as an ellipse. (Similarly to when we are lost in the woods and need to climb a tree or a hill to have a map view of where the heck we are and where we are trying to go.) The perfect view of Mr. Circle is at a right angle from above, but any angle larger than zero allows for seeing him all at once, even though the shape distortion increases as the angle diminishes. I would put my money down and say that A Squares' big "WOW!" was just after taking-off and long before reaching a straight angle above Mr. Circle. An experience much like the very first time we fly as children and realize that we can see a whole block or field all at once just after taking-off, long before reaching a complete view.

If I got that right and I properly understood that the analogy should work when going from 3-D to 4-D as well, then I think we (especially us primates) do have a chance to have that 4-D perspective of a 3-D land. In fact, the great majority of us have it all the time, literally in front of our noses. The genesis of my argument goes back to my childhood when staying late in bed. Laying on my side, I would amuse myself by switching between the two different perspectives of the landscape of blankets in front of my face, shifting as I closed each eye. Then, I would force both eyes to focus and converge on something just a few inches from my nose, and close one, and then the other (you see where I'm going?). Then I remembered a zoology teacher of mine in college saying what a "convenient idea" it was in primate evolution to have two frontal eyes, enabling us to judge distances when jumping from branch to branch. And the last relevant revelation along this line, before your essay, came when I took the instructions leaflet of my binoculars and read it (one wanders who on earth would read the directions for a pair of binoculars!). This only occurred as I was trying to kill time while waiting in the rain forest for the end of a butterfly copula that had lasted several hours already. It said that when you see through your binoculars (if they are the kind that includes mirrors), the objects not only look closer, but the 3-D view

is “deeper.” This was because the two sources of the image coming from the objects to each tube are wider apart than your eyes; I thought that was pretty cool too and kept on peeping at “deeper” butterfly sex.

So when I read your article, I first thought it would be possible to do something like using two periscopes (the kind people use to see parades above the crowd) oriented sideways (and maybe slightly forward) to look at an object in front with one eye on each periscope. I wondered if the brain could still handle and integrate that (as it can when the two sources of image are slightly separated when looking at binoculars), and this would look even “deeper”, more in 4-D! However, that would be like A Square trying to see Mr. Circle from almost directly above, closer to a straight angle, with less shape distortion. But we are always looking at things from two different points anyway: from each eye. This difference is negligible with a distant object, but less and less when the object gets closer to the point where we could see it from opposite ends: between our eyes. We know since we were kids we can only focus so close, even crossing our eyes, but I think that is enough to stretch our necks out of 3-D land. A practical object to do this with is for instance is a 3.5″ floppy disk (which in fact is a solid “square” case with a real floppy disk inside, but that doesn’t matter now). It is an object with true volume, although conveniently flattened for our purposes to a couple of mm, a flattened “cube”. If you place it vertical and perpendicular to your face, just between your eyes at the minimum distance at which you can focus and converge your eyes on a single image of the edge facing you (10-20 cm), you are looking at the two full sides of the disk at once. If you close one eye, you only see the opposite side and nothing of the other.

In other words, my argument is that if we only had one eye, or if we had them on opposite sides of our head as many birds and mammals, we would be true prisoners of the 3-D prison. In that

case, we would be unable to see objects from two points at the same time. As long as we have two (eyes) views of the same object (depth vision), and if I understood your essay correctly, we are having a 4-D view of the world, or at least somewhere between 3-D and 4-D. This is as if A Square stood on a chair, on its toes, stretched its neck and could see a deformed Mr. Circle. Leaving primates and owls aside, I was trying to think of animals that had shape-perception with eyes that could really look at an object from different sides at straight angles, maybe some mollusk? But even if there is such we would still need to ask it what that's like. We would be back to where A Square was trying to explain to their friends what it's like up there, so let's better try it ourselves (September 16 is independence day in Mexico and they sell those periscopes in the street to see the parade, I'm getting myself two of them!).

However, visual animals are probably not the most interesting to consider for the cum-hyperhypho-embraced perspective, but those whose main perception of the world come through tactile stimuli, and which can wrap objects to perceive them. It is true that us primates, especially as kids, handle a lot of objects and get the "4-D perception" of them through our hands or mouth. This reminds me of a TV program showing how they allowed this blind-since-birth sculptor to climb on a specially made structure around Michelangelo's David to touch and embrace ("observe") it… he was delighted.

But the true masters of cum-hyperhypho-embracing must be something like flatworms, snakes, octopuses (in spite their good view), and one of my favorite creatures: harvestmen, or daddy longlegs. Many species, including the one I have studied, see nothing but changes in light intensity above them, and their hearing and smelling are hopeless. But they sure have legs, and they do much more than walking with them. As they progress, they are constantly assessing their very complex 3-D environment through their 8 "channels", with an

accuracy that must exceed our poor tactile perception, and that depends clearly on touching objects on several sides at the time. In short, they might not have the resolution primates or owls have, but their depth perception is clearly better, and it’s the only one they got!

During the the many field hours I was working with harvestmen for my dissertation, on top of the great fun they provided me, I frequently read your column lying in my field hammock. It was then that I shared that View of Life, never imaging that I would someday have an excuse to share details of mine with you, which is to a great extent yours anyway. Regardless of your thoughts on my 4-D speculations, I deeply thank you for all this time.

Truly yours,

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