

Living On Earth, Online Notes

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Chapter 6. Consciousness

157 *There's something it feels like to be us*: This well-known formulation of the problem comes from Thomas Nagel, "What Is It Like to Be a Bat?," *Philosophical Review*, 1974.

158 *I won't give arguments*: For more detailed discussions, and some defenses, see *Metazoa*; "Gradualism and the Evolution of Experience," *Philosophical Topics*, 2020; and "Evolving Across the Explanatory Gap," *Philosophy, Theory, and Practice in Biology*, 2019.

158 *Nervous systems may have first arisen*: Fred Keijzer's work has influenced me here, and Fred Keijzer, Marc van Duijn, and Pamela Lyon, "What Nervous Systems Do: Early Evolution, Input–Output, and the Skin Brain Thesis," *Adaptive Behavior*, 2013. See also Gáspár Jékely, Fred Keijzer, and Peter Godfrey-Smith, "An Option Space for Early Neural Evolution," *Philosophical Transactions of the Royal Society B*, 2015.

159 *More of what goes on in our brains matters than that, most likely*: Here I have been influenced by Rosa Cao. See her "Multiple Realizability and the Spirit of Functionalism," *Synthese*, 2022. The views of Anil Seth and Ned Block are also related; see Seth's *Being You* (2021), and Block, "Comparing the Major Theories of Consciousness," in Michael Gazzaniga (ed.), *The Cognitive Neurosciences* (2009).

160 *An example is the oscillation in electrical activity*: There's more about this in *Metazoa*. Also see Wolf Singer, "Neuronal Oscillations: Unavoidable and Useful?," *European Journal of Neuroscience*, 2018.

160 *Some decades ago, Francis Crick (of DNA fame), Christof Koch, and others*: See Francis Crick and Christof Koch, "Towards a Neurobiological Theory of Consciousness," *Seminars in the Neurosciences*, 1990; and Lucia Melloni et al., "Synchronization of Neural Activity across Cortical Areas Correlates with Conscious Perception," *The Journal of Neuroscience*, 2007.

160 *The large-scale rhythmic patterns that Crick and Koch wrote about*: See, for example, Bruno van Swinderen, “The Remote Roots of Consciousness in Fruit-Fly Selective Attention?,” *BioEssays*, 2005.

160 *Back in the 1960s, the neurobiologist L. M. “Mac” Passano*: See his “Primitive Nervous Systems,” *PNAS*, 1963.

162 *This oscillatory activity in the brain*: See Singer’s “Neuronal Oscillations: Unavoidable and Useful?”

164 *The situation is different with another technology that is developing very quickly*: One example of this work: Ranmal Samarasinghe et al., “Identification of Neural Oscillations and Epileptiform Changes in Human Brain Organoids,” *Nature Neuroscience*, 2021.

165 *Rats make use of map-like representations*: See John O’Keefe and Lynn Nadel, *The Hippocampus as a Cognitive Map* (1978), and (among much recent work) H. Freyja Ólafsdóttir et al., “Hippocampal Place Cells Construct Reward Related Sequences Through Unexplored Space,” *eLife*, 2015. For a philosophical discussion, see Nicholas Shea, *Representation in Cognitive Science* (2018).

166 *A 2022 paper found that crows could learn to generate “recursive” patterns*: See Diana Liao et al., “Recursive Sequence Generation in Crows,” *Science Advances*, 2022.

166 *Stanislas Dehaene, a French neuroscientist*: The paper is Dehaene et al., “Symbols and Mental Programs: A Hypothesis About Human Singularity,” *Trends in Cognitive Sciences*, 2022. The paper is about “human singularity”—“We suggest that humans owe their singularity to [internal] symbols.” The crow paper in the note above may push back a little on this.

166 *Language, especially speech, is lateralized in our brains*: Through here I make use of work by Michael Gazzaniga, Lesley Rogers, and Giorgio Vallortigara. Here are a couple of papers: Michael Gazzaniga, “Shifting Gears: Seeking New Approaches for Mind/Brain Mechanisms,” *Annual Review of Psychology*, 2013; Lesley Rogers, “A Matter of Degree: Strength of Brain Asymmetry and Behaviour,” *Symmetry*, 2017; Giorgio Vallortigara, Lesley Rogers, and Angelo Bisazza, “Possible Evolutionary Origins of Cognitive Brain Lateralization,” *Brain Research Reviews*, 1999.

There's also a book by Rogers, Vallortigara, and Andrew, *Divided Brains: The Biology and Behaviour of Brain Asymmetries* (2003).

See also Michael Corballis, et al. "Right hand, left brain: genetic and evolutionary bases of cerebral asymmetries for language and manual action," *WIREs Cognitive Science* 3 (2012): 1-17. doi.org/10.1002/wcs.158.

166 *I have used these remarkable cases to work through some puzzles:* In both *Other Minds*, chapter 5, and *Metazoa*, chapter 6.

167 *Some simple but striking work has been done:* See Victoria Bourne, "How Are Emotions Lateralised in the Brain? Contrasting Existing Hypotheses Using the Chimeric Faces Test," *Cognition and Emotion*, 2010. This paper has a good series of photos showing the effect, as well as a review of hypotheses.

169 *The presence of this highway seems to allow specialization:* See Michael Gazzaniga, "Cerebral Specialization and Interhemispheric Communication: Does the Corpus Callosum Enable the Human Condition?," *Brain*, 2000.

169 *In one experiment, a patient had the word "bell" shown:* This case is in Gazzaniga's "Cerebral Specialization and Interhemispheric Communication."

There's also a more famous example outlined in that paper. (I wanted to use something other than the usual one).

Several years ago we observed how the left, dominant-speaking hemisphere dealt with behaviours we had elicited from the disconnected right hemisphere. We came upon the phenomenon by using a simultaneous concept test. The patient was shown two pictures, one exclusively to the left hemisphere and one exclusively to the right, and was asked to choose from an array of pictures placed in full view in front of him those that were associated with the pictures lateralized to the left and right brain. In one example of this kind of test, a picture of a chicken claw was flashed to the left hemisphere and a picture of a snow scene to the right hemisphere. Of the array of pictures placed in front of the subject, the obviously correct association is a chicken for the chicken claw and a shovel for the snow scene. Patient P.S. responded by choosing the shovel with the left hand and the chicken with the right. When asked why he chose these items, his left hemisphere replied 'Oh, that's simple. The chicken claw goes with the chicken, and you need a shovel to clean out the chicken shed'.

169 *In some further experiments, split-brain patients were shown:* See Elizabeth Phelps and Michael Gazzaniga, “Hemispheric Differences in Mnemonic Processing: The Effects of Left Hemisphere Interpretation,” *Neuropsychologia*, 1992.

170 *People have come up with a number of evolutionary sequences:* As well as the Gazzaniga, Rogers, and Vallortigara work, see Iain McGilchrist, *The Master and His Emissary* (2009).

171 *An intriguing difference that bears on conscious experience:* See Rogers, “A Matter of Degree: Strength of Brain Asymmetry and Behaviour,” *Symmetry*, 2017.

171 *In the memory experiments I mentioned a moment ago:* See Michael Miller and Michael Gazzaniga, “Creating False Memories for Visual Scenes,” *Neuropsychologia*, 1998.

172 *What I have in mind is conscious thought:* Here we reach the territory of “dual system” views of cognition. See Daniel Kahneman, *Thinking, Fast and Slow* (2011).

173 *the French cognitive scientists Hugo Mercier and Dan Sperber:* See Mercier and Sperber, *The Enigma of Reason* (2017). I commented on an earlier version of their view in a note with Kritika Yegnashankaran. See our “Reasoning as Deliberative in Function but Dialogic in Structure and Origin,” *Behavioral and Brain Sciences*, 2011.

173 *An example of an error we all tend to make is confirmation bias:* Mercier and Sperber argue that the phenomenon is a bit misdescribed with this term—it would be better called “myside bias” (“myside” as in *my side*).

174 *A related way in which language and culture:* See Daniel Dennett, “The Self as a Center of Narrative Gravity,” in *Self and Consciousness* (edited by Frank Kessel et al., 1992), and Anil Seth, *Being You* (2021).

175 *Over thirty years ago, Jyotsna Vaid and Maharaj Singh wondered:* See their “Asymmetries in the Perception of Facial Affect: Is There an Influence of Reading Habits?,” *Neuropsychologia*, 1989.

176 *On the other hand, a leftward bias in looking at faces:* See Kun Guo et al., “Left Gaze Bias in Humans, Rhesus Monkeys and Domestic Dogs,” *Animal Cognition*, 2009. See also Lesley Rogers, Giorgio Vallortigara, and Richard Andrew, *Divided Brains: The Biology and Behaviour of Brain Asymmetries* (2012).

176 *Giorgio Vallortigara, writing about animals: “Comparative Neuropsychology of the Dual Brain.”*

177 *This has gone from being semi-implicit lore: See Matthew Egizii et al., “Which Way Did He Go? Film Lateral Movement and Spectator Interpretation,” *Visual Communication*, 2018; Roger Ebert, “How to Read a Movie,” *RogerEbert.com*, 2008.*

178 *In a study of how soccer goals were interpreted: See Anne Maass, Damiano Pagan, and Emanuela Berta, “How Beautiful Is the Goal and How Violent Is the Fistfight? Spatial Bias in the Interpretation of Human Behavior,” *Social Cognition*, 2007. As the authors say, this tells against the idea that a general, species-wide hemisphere asymmetry is behind the left/right distinctions people make in the interpretation of action. But, they add, it does not mean that there can’t be a role for a different style of processing across the two hemispheres. Perhaps the way our brain hemispheres develop during socialization is affected by the way language is handled in one’s culture? Other left-right differences, affecting how we perceive things other than language, might stem from that.*

Here is another study that complicates things: Anne Maass, Caterina Suter, and Faris Nadhmi, “What Drives the Spatial Agency Bias? An Italian–Malagasy–Arabic Comparison Study,” *Journal of Experimental Psychology: General*, 2014: “A comparison of 3 language communities (Italian, Malagasy, Arabic) differing in script direction (left–right for Italian and Malagasy and right–left for Arabic) and in subject–object order (subject–verb–object in Italian and Arabic and verb–object–subject in Malagasy) provides evidence for the assumption that both mechanisms contribute” to differences in how actions are perceived.

179 *You can, as the philosopher John Dewey said a century ago: This is in his *Experience and Nature* (1925).*

180 *A 2002 paper set a lot of work in motion: P. Read Montague et al., “Hyperscanning: Simultaneous fMRI During Linked Social Interactions,” *NeuroImage*, 2002.*

180 *In fact, there was an earlier experiment, published in 1965: T. D. Duane and Thomas Behrendt, “Extrasensory Electroencephalographic Induction Between Identical Twins,” *Science*, 1965.*

181 *The EEG method itself was introduced: I discuss this episode in *Metazoa*, chapter 7.*

181 *This study was done very informally, with no statistics:* Duane and Behrendt looked at fifteen pairs of twins. In the test, one twin would close their eyes in a lit room. Closing the eyes tends to initiate alpha rhythms in the brain. Would the other twin, in a separate room, enter the same brain wave pattern also? The other twin was about six meters away. The researchers said that two pairs of twins out of their fifteen could do it, and the others could not. One brain would start alpha rhythms, and the other would also. The pairs who could do this did so repeatedly. Unrelated pairs of individuals never did. The paper has no statistics or even detailed numbers. The authors just looked at the readouts to see if alpha patterns were visible and when they started. This experiment would have to be done carefully. The fact that most pairs of twins do not show the effect does not kill the result; if a few special pairs could do it over and over, that would be a big deal. In a response to critics, the authors gave a bit more detail: the channel between twins worked in both directions, and “in the successful twins transmission seemed to occur always.” See Charles Tart, George Robertson, Thomas Duane, and Thomas Behrendt, “More on Extrasensory Induction of Brain Waves,” *Science*, 1966.

181 *This 1992 experiment, using EEG scans:* See Jacobo Grinberg-Zylberbaum et al., “Human Communication and the Electrophysiological Activity of the Brain,” *Subtle Energies and Energy Medicine*, 1992. The most detailed account of Grinberg-Zylberbaum’s work and his disappearance I have found is a recent one: Ilan Stavans, “The Grinberg Affair: One of Mexico’s Most Curious Missing-Persons Cases Involves a Scientist Who Dabbled in the Mystical Arts,” *The American Scholar*, 2023.

182 *Several different kinds of scanning are used:* As well as EEG and fMRI, which are described in the text, there is MEG (magnetoencephalography) and fNIRS (functional near-infrared spectroscopy). MEG, like EEG, picks up electrical patterns but does so using magnetic influences. fNIRS, like fMRI, looks at changes in oxygen use, but does so with light. Though the original “hyper-scan” experiment used fMRI, this method can’t pick up fine-grained synchronization in temporal patterns.

182 *The picture emerging is a surprising one:* See Yan Mu, Cindy Cerritos, and Fatima Khan, “Neural Mechanisms Underlying Interpersonal Coordination: A Review of Hyper-scanning Research,” *Social and Personal Psychology Compass*, 2018; Edda Bilek et al., “Information Flow Between Interacting Human Brains: Identification, Validation, and Relationship to Social Expertise,” *PNAS*, 2015; Adrian Burgess, “On the Interpretation of

Synchronization in EEG Hyperscanning Studies: A Cautionary Note,” *Frontiers in Human Neuroscience*, 2013.

I'll add some more references here soon.

182 *Two people playing a guitar duet do synchronize*: For teamwork, see Caroline Szymanski et al., “Teams on the Same Wavelength Perform Better: Inter-Brain Phase Synchronization Constitutes a Neural Substrate for Social Facilitation,” *NeuroImage*, 2017. For the cocktail party effect, see Bohan Dai et al., “Neural Mechanisms for Selectively Tuning In to the Target Speaker in a Naturalistic Noisy Situation,” *Nature Communications*, 2018.

184 *The most radical option*: See Ana Lucía Valencia and Tom Froese, “What Binds Us? Inter-Brain Neural Synchronization and Its Implications for Theories of Human Consciousness,” *Neuroscience of Consciousness*, 2020.

185 *Valencia and Froese also discuss an argument that was given*: See Andy Clark, “Spreading the Joy? Why the Machinery of Consciousness Is (Probably) Still in the Head,” *Mind*, 2009.

186 *In an old experiment done first by chance in the seventeenth century*: See Burgess, “On the Interpretation of Synchronization in EEG Hyperscanning Studies.”

187 *All this is very much on the edge*: See Antonia Hamilton, “Hyperscanning: Beyond the Hype,” *Neuron*, 2021, and Clay Holroyd, “Interbrain Synchrony: On Wavy Ground,” *Trends in Neurosciences*, 2022.

Holroyd says: "Gamma-band interbrain synchrony is probably impossible."

188 *a distinctive part of human life is the formation of shared intentions*: See Michael Tomasello, *Becoming Human* (2021).

189 *That evolutionary thicket has proved hard to fully resolve*: See James Tarver et al., “The Interrelationships of Placental Mammals and the Limits of Phylogenetic Inference,” *Genome Biology and Evolution*, 2016.

190 *we see giraffes walking, as Karen Blixen said*: This is in her *Out of Africa* (1937). She wrote this book as “Isak Dinesen.”