

## **Introduction**

p.1

“Mike, just ten years my elder” – Gazzaniga (1970)

p.2

“That transpired after a fellow student” – Gazzaniga (1972)

p.4

“Our conversation” – Gazzaniga and LeDoux (1978)

“Ever since my studies” – LeDoux (1996, 2002, 2015); LeDoux and Hirst (1986); LeDoux, et al (2003)

“But the book you are reading” – LeDoux (2019)

## **Part I – Our Realms of Existence**

### **Chapter 1 – What Is a Human Being?**

p. 10

“Many psychologists eagerly” – Boring (1950)

p. 11

“In the meantime” – Hall et (1958)

“But by mid-century” – Taschereau-Dumouchel, et al (2022)

“Attempts to deliver treatments” – Miller (2010); Hyman (2012); Penn and Tracy (2012)

“I believe it is because” – LeDoux (2012, 2014, 2015, 2017, 2019); LeDoux and Pine (2016); LeDoux and Hofmann (2018); LeDoux, et al (2018); Taschereau-Dumouchel, et al (2022)

“The problem is less about technological limitations” – The NIMH RDoC is a recent effort to relate mental and behavioral symptoms to quantifiable biological and brain factors (Insel, et al

(2010). It is a start in the right direction but has been criticized (Peterson 2015; Weinberger et al, 2015). My criticism is that the approach falls short by treating the individual as a collection of factors rather than an integrated biological individual with four realms of existence.

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“The digital revolution” – Manyika (2022)

“In *Artificial You*” – Schneider (2019)

“While human nature” – Bjorklund and Pellegrini (2002); Kronfeldner (2018); Roughley (2021); Sapolsky (2017); Schaffner (2016); Diamond (1997); Harari (2015)

## **Chapter 2 –“Self” Doubt**

p. 14

“But according to Christopher Gill” – Gill (2017)

“‘Self’ began to appear” – <https://www.etymonline.com/word/self> retrieved Apr. 15, 21

“By the 14<sup>th</sup> century” – This discussion of the self borrows from Danziger (1997a) and Danziger (1997b). In addition, I received helpful comments from Kathryn Tabb and Kenneth Schaffner via personal emails in August 2020.

p. 15

“Today the word ‘self’” – Gill (2017)

“This way of thinking” – Slowik (2017)

“John Locke, who followed Descartes” – Slowik (2017)

“This was achieved” – Gordon-Roth (2020); Danziger (1997a)

“Locke also introduced the idea” – Locke (1990)

p. 16

“He also took the self” – Danziger (1997b)

“Later, Alexander Bain” – Bain (1859)

“By the eighteenth century” – Danziger (1997b) p. 142

“Armed with an emerging lexicon” – Danziger (1997b) p. 142

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“And his *self*” – Danziger (1997b) p. 142

“It was then, in Germany” – Boring (1950); Michel (2020)

“James made many important and lasting contributions” – James (1890)

p. 18

“Of note is that James’s spiritual self” – James (1902)

p. 19

“The emergence of cognitive science” – James (1902)

“It is also why the self” – Damasio (2010); Feinberg (2011); Northoff, et al (2011); Sui and Humphreys (2015)

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“Shortly after Locke’s time” – Blackburn (2005)

“With the rise of scientific psychology” – Calkins (1915)

“More recently, but in a similar vein” – Dennett (1992); Hood (2012)

“Some have noted that discussions about the self” – Olson (1999)

“I think Thomas Metzinger” – Metzinger (2003)

“A similar perspective” – Dienes (2021)

“Cultural traditions that treat the self” – Mead (1934); Markus and Kitayama (1991); Shweder and Bourne (1984); Fiske (2020); Jackson, et al (2019)

“The philosopher Shaun Gallagher” – Gallagher (2013)

“Similarly, the psychologist Ulric Neisser” – Neisser (1988); Neisser (1991)

“And the philosopher Paul Thagard” – Thagard and Wood (2015)

p. 21

“As explained in a 2017 Technology Report” – Ito and Howe (2017)

“Two versions of emergence” – O’Connor (2020); Chalmers (2006); Mitchell (2022)

“In strong emergence, which is quite controversial” – Bedau (1997); Kim (2005); Searle (2008)

“Many self-models adopt strong emergence” – Thagard and Wood (2015); Nowak, et al (2000); Gallagher (2013); Gallagher and Daly (2018); LaRock, et al (2020)

“Eric LaRock and his colleagues” – LaRock, et al (2020)

p. 22

“James succinctly characterized” – James (1892)

“In *Being You*” – Seth (2021)

“The philosopher Owen Flanagan” – Flanagan (2011)

### **Chapter 3 – The Personality Contest**

p. 23

“But it was not until the late nineteenth century” – Collins (1985) cited in Danziger (1997a) p. 124.

“French physicians” – Danziger (1997a)

“An 1885 book” – Ribot (1885)

p. 24

“The corporeal body thereby” – Teichman (1985)

“But as we will see” – This discussion of various theories of personality is based in large part on Hall et al (1998)

“His encounters with patients” – Kim (2015)

“When referring to the mind” – McIntosh (1986)

p. 25

“For Jung, one’s self differentiates” – Individuation <https://en.wikipedia.org/wiki/Individuation> (retrieved Aug 20, 2020)

p. 26

“B. F. Skinner, a leading figure” – Skinner (1938)

“Toward the end of his career” – Skinner (1948); Skinner et al (1954); Labrador (2004)

p. 27

“The Maslow-Rogers tradition” – Seligman (2002)

“As Theodore Millon put it” – Millon (2016), p. 291

“The Greek philosopher Hippocrates” – Kagan (1994)

p. 28

“He used questionnaires” – Galton (1884)

“Greatly influenced by Darwin” – Galton (1883)

“Early in his career Allport visited Freud” – This text is a paraphrase of a quote from Allport (1967) in Hall, et al (1998) p. 272

“Raymond Cattell also applied” – Summarized by Plomin et al (2012)

“Currently, the so-called big five model” – Goldberg (1990)

“For example, Henry Murray” – Murray (1938); Kluckhohn and Murray (1948); Carlson (1971) (summarized in Hall, et al (1998))

“Jerome Kagan, for example” – Kagan (1994)

p. 29

“Robert Cloninger’s three-temperament domain theory” – Cloninger (2002)

“In the 1970s, the behaviorist Albert Bandura” – Bandura (1977)

“A colleague of Bandura’s, Walter Mischel” – Mischel (1968); Mischel (1969); Mischel and Shoda (1995)

“It posits that one’s personality” – Mead (1934); Harre (1984); Hampson (1988); Markus and Kitayama (1991); Shweder and Bourne (1984); Jackson, et al (2019); Fiske (2020)

“Philosophers interested in personality” – Teichman (1985)

“Peter Strawson, for example” – Strawson (1999)

p. 30

“There is, in fact, a growing movement” – Johnson (2017); Wilson and Foglia (2017); Noe (2004); Varela, et al (1991); Clark (2008); Seth (2013); Harrison, et al (2010); Gibson (1979); Ciaunica and Levin (2022)

“Personality was embodied from the get-go” – Gallagher (2013); Newen(2018)

For example, the philosopher Mark Johnson” – Johnson (2008)

“Thomas Metzinger proposed” – Metzinger (2014)

“and Shaun Gallagher introduced” – Gallagher (2000)

“The neuroscientist Antonio Damasio” – Damasio (2010); Panksepp (1998)

“In my 2001 book *Synaptic Self*” – LeDoux (2002)

“Family and community contribute” – Markus and Kitayama (1991); Allik and McCrae (2004); Terracciano and McCrae (2006); Ebert, et al (2021)

“Indeed, biology is no longer considered” – Cameron and Kulick (2003); Inoue (2007); McIllyenny (2002)

“The question of who, or what, is a person” – Kurki (2019); Kingston (2019)

“Peter Singer and some other philosophers” – Singer (2017); Stucki (2020); Holub (2016)

“Singer argues that there can be humans” – Stucki (2020); Holub (2016); Alcaraz (2019)

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“In the age of artificial intelligence” – Alcaraz (2019)

“Personality theorist Henry Murray” – Murray (1938); Kluckhohn and Murray (1948) (summarized in Hall, et al (1998).

“But conceptions of self and personality” – Examples of issues about identity and culture are discussed in Corfield (2021), Walters (2018), and Alcoff (2006).

## **Chapter 4 – It’s Only Words**

p. 33

“This shortcoming was expressed well” – Block (1995)

p. 34

“This is especially a problem” – Barrett (2017); Fiske (2020); Jackson, et al (2019)

“For example, in their 1959 book *The Language of Psychology*” – Mandler and Kessen (1959)

“In other words, the function or circuit” – Mandler and Kessen (1959); Kelley (1992); Fletcher (1995); Marx (1951)

“Kurt Danziger, in his insightful book *Naming the Mind*” – Danziger (1997a)

p. 35

“To reiterate an earlier point” – LeDoux (2012, 2017); Krakauer, et al (2017); Cisek (2019); Pessoa, et al (2022)

“In 1620, Francis Bacon wrote” – Bacon (1620)

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“As Cameron Brick and colleagues put it” – Brick, et al (2021)

“But as thoughtful psychologists” – Brick, et al (2021)

“He proposes that we treat disorders” – Schaffner (2016, 2020a, 2020b, submitted)

“In the late nineteenth century” – Galton (1883); Eysenck and Kamin (1981); Bouchard (1982)

“Tests were designed” – Binet and Simon (1905); Terman (1916); Terman and Merrill (1960)

“Intelligence came to be thought of” – Galton (1909); Hernstein and Murray (1994)

“Some have suggested that intelligence” – Gould (1981)

p. 37

“Recent studies have shown” – Cao, et al (2021); Soreq, et al (2021)

p. 38

“None involves an entity” – Mitchell (2018)

“The self, in short” – Fleming (2021)

p. 39

“The pioneering cognitive psychologist Jerome Bruner” – Bruner (1994)

“This *you-ness*” – Conway and Pleydell-Pearce (2000)

## **Chapter 5 – A Path Forward**

p. 42

“On this score, members of the animal kingdom” – The number of Kingdoms is a moving target, varying between six and eight, depending on whose counting.

“Our realms are hierarchically related” – A popular way of discussing complex relations between levels is the notion of a nested hierarchy. This term comes from set and graph theory, but is also used in mathematics, organizational charts, evolutionary biology, linguistics, psychology, music. For a general discussion, see Lane (2006). In relation to mind, brain and body see Solms and Panksepp (2012); Feinberg (2011); Bolt, et al (2017); Damasio (1999); Ginsburg and Jablonka (2019).

p. 44

“The evolutionary points” – Novikoff (1945); Maynard Smith and Szathmary (1995)

“Volk referred to the resulting state changes” – Volk’s dynamic realms (Volk (2010) clearly influenced my use of term ‘realms’. But it seems to have been a subliminal influenced since I only realized later when talking with him.

p. 45

“Every such event is preceded” – LeDoux (2020); LeDoux and Lau (2020)

p. 46

“A case could be made” – Margolis (2017)

“Realms of existence are analogous” – Bottani and Davies (2006) provide an overview of philosophical ontological modes.

“There have been many such proposals” – Partitioning nature into ontological categories goes back to the Ancients. Aristotle, for example, distinguished between vegetative, animative, and rational partitions of the human existence. Recent philosophical proposals about ontological modes or realms include: Dennett (2017); Metzinger (2014), Ginsburg and Jablonka (2019), and Margolis (2017). Biologists who have proposed ontologies include Bichat (1800, translated 1977), Bernard (1865, translated 1961), Tinbergen (1955); and neuroscientists include Joseph Altman (1966), Alfred Romer (1972), Antonio Damasio (1999), Jaak Panksepp (1998), Krakauer, et al (2017), and others.

“Perhaps the closest to mine” – Metzinger includes a reactive, bodily system that behaves intelligently, a higher level that represents itself unconsciously, and a conscious mental model of one’s self. I particularly like Metzinger’s description of the relation between his three levels: A normal, conscious human being walking down the street in an ordinary, non-pathological state of consciousness simultaneously is a member of all three classes at the same time.” (Metzinger, 2003). We diverge, though, when it comes to his view of his partitions as level of the self. His lower parts of the self are subsumed within my realms, but without the baggage of ‘the self’. In my model, I only use ‘the self’ to refer to the ‘self-aware self’ that we construct using mental models to non-consciously narrate our conscious understanding of what and who we are.

“Other positions related to mine” – Dennett (1995) and I seem aligned with regards to cognition as the use of mental simulations to make choices based on predictions. But we part when it comes to consciousness. He views consciousness as an illusion resulting from high level cognition fooling itself. For me, consciousness rises above cognitive realm activities the same way that cognition rises above neurobiological realm activities, and in so doing, it adds value to thought, feeling, decision-making, choice, and action.

“Simona Ginsburg and Eva Jablonka” – Ginsburg and Jablonka’s (2019) three modes of being (non-sentient, sentient, and rational) are modeled on Aristotle’s (vegetative, animative, rational souls). These include processes similar to processes in my neurobiological, cognitive, and conscious realms. And we agree that our modes/realms hierarchically nested and interdependent biological processes. But we disagree significantly on how we define the processes involved, especially cognition and consciousness.

p. 47

“It is simply a description” – It might be possible to measure some neural correlate of the integrated activity and try to manipulate it. But any effect would likely be achieved by altering activity related to one of the realms rather than an effect on the coalition, since it is not a thing.

“Clearly, neuroscientists could find” – The idea of dynamic temporary coalitions is quite common in contemporary biology and neuroscience. It is used to account for how interactions between genes, cells, tissues, organs, and neural networks result in measurable states. But there are debates as to whether these emergent states do things (O’Connor, 2020). The strong emergence view says they do. Claims that the emergent states like self and personality have agency are examples of strong emergence. Strong emergence is more controversial than weak emergence, which simply make the uncontroversial claim that nature is filled with complex things that emerged from combinations of simpler things. My ensemble of being is a weak emergence claim.

## **Part II – The Biological Realm**

### **Chapter 6 – The Secret of Life**

p. 51

“The world we live in” – Cohen (2004); Shields (2020)

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“Humans not only possess vegetative and animative souls” – Wendy Lynne Lee (2007) points out that for Aristotle, just as humans were above other animals, men were above women, as the latter had some intellect capacities like locution but not full reason and deliberation capacities. Well, at least we've progressed some in at least some cultures.

“According to Galen” – This discussion of vitalism is based on Haigh (1975), Bechtel and Richardson (1998), and Garrett (2006).

p. 53

“Vitalists believed that” – Vitalism <https://en.wikipedia.org/wiki/Vitalism> retrieved 12 27 20

p. 54

“He used the methods of this field” – This discussion of Bichat is based on Blessing and Gibbins (2008), Haigh (1975), and Bechtel and Richardson (1998);

“His proposal that each of the twenty-one body tissues” – Haigh (1975)

“This shift was a major blow” – Roth (2013)

“From his research” – Bernard (1865 (translated 1961), 1878 (translated 1974)); Summary of Bernard based on Hoenig and Zeidel (2014) and Goldstein (2009)

p. 55

“A consummate experimentalist” – LaFollette and Shanks (1994)

“too unsupported by data” – Elliot (1987), p. 73, Quoted in LaFollette and Shanks (1994).

“Because of Bernard’s stature” – Federspil and Siculo (1994)

“Bernard’s anti-Darwinian perspective” – LaFollette and Shanks (1994)

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“They consider life a mysterious and supernatural force” – Bernard quoted in Federspil and Siculo (1994)

“And Darwin’s proposal that all life” – Haldane (1929)

“With the discover of the replication capacities” – Watson and Crick (1953); for a discussion of origin of life theories, see LeDoux (2019).

“Regardless of which model is correct” – For a scientific discussion of metabolism see Billman (2020).

p. 57

“While Bernard had shown that the body” – Cannon (1929)

“Although Cannon, and many” – Selye (1975); McEwen (1994, 2017); Schulkin, et al (1994); Sapolsky (1998)

“They are about how the body” – Davies (2016)

p. 58

“It refers to the body’s ability” – Sterling (2012)

“The health and vitality of the organism” – Billman (2020)

“Without energy . . .” – Picard, et al (2018)

p. 59

“Some terms come right out” – Thanks to Dennis Tirch for suggesting terms from Eastern spiritualism.

“These are perfectly legitimate philosophical areas” – Garrett (2006); Du Toit (2016); Baron (2020); Matloff (2016); Tweedale (2017)

p. 60

“For example, a position called *integrated information theory*” – See Tononi, et al (2016)

“Considerable pushback has been directed” – A long list of scientists signed a document stating that integrated information theory is not “scientifically established or testable at the moment.”  
See <https://inconsciousnesswetrust.blogspot.com/2020/05/open-letter-to-nih-on-neuroethics.html>

“Some have said that integrated information theory” – Michel and Lau (2020)

“while others have called it pseudoscience” – Jarrett (2020), with regards to integrated information theory, quotes consciousness theorist Michael Graziano as saying, “There is no chance of scientific success or understanding. It’s like assuming that ghosts exist and then going to search for them ‘scientifically’. It is, in a word, pseudoscience.”

“Like most biological scientists” – LeDoux 2019

## Chapter 7 – Bodies

p. 61

“Plato is said” – Kemerling (2011), based on Phaedo (67d)

“Hence the word ‘organism’” – Haeckel (1904)

p. 62

“Two genetic properties are especially important” – Folse and Roughgarden (2010); Michod and Roze (2001); Santelices (1999); Wilson and Barker (2019); Pradeu (2010)

“As a result, organisms are able” – Folse and Roughgarden (2010); Michod and Roze (2001)

“Three key features of organisms” – These points by Maturana and Varela (1987) were summarized by Roth (2013).

“Like organisms, machines are complex entities” – Altman (1966)

“We humans exist and function” – LeDoux (2019)

p. 63

“These have some features that are closer” – Funke, et al (2020); Turing (2009); Newell and Simon (1972); Minsky (1961); Schneider (2019); Kurzweil (2012)

“It has even been proposed that so-called cyborgs” – Alcaraz (2019)

“As articulated by Richard Lewontin” – Lewontin (1970, 1983)

p. 64

“Over time, if the organism” – Which organisms are included within a species, and when a new species comes to be, is, of course, a judgement-call by scientists whose job is to lump and split things in nature.

“Leo Buss expanded” – This discussion of Buss (1987) is based on a summary by McConwell (2017)

“‘Mesoforms’ (i.e. intermediate forms)” – Novikoff (1945). the phrase 'intermediate forms' was added by me to explain what a 'mesoform' refer to. Quote taken from Altman (1966).

p. 65

“Building on such ideas” – This discussion of Maynard Smith and Szathmary (1995) is based on a summary by McConwell (2017)

“Paraphrasing the evolutionary biologist Richard Michod” – Michod (2005)

“This is a crucial point for understanding” – LeDoux 2019

“The views considered so far” – Lewontin (1970, 1983)

p. 66

“For example, the philosopher of biology David Hull” – Hull (1992)

“He notes that although organisms” – paraphrase from Buss (1987)

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“The resulting combined biological individual” – Gilbert, et al (2012)

“It has even been proposed that cancer occurs” – Pennisi (2018)

“Hull’s challenge” – Wilson and Barker (2019)

“The philosopher Peter Godfrey-Smith” – My summary of Godfrey Smith’s views is based on Wilson and Barker (2019). Key citations are Godfrey-Smith (2009, 2013).

p. 68

“This model differs from Richard Dawkins’s well-known theory” – Dawkins (1976)

“The survival of replicators” – Wilson and Barker (2019)

“This position, by contrast with the notion” – Pradeu (2010, 2016)

p. 69

“The immune system plays a key role” – Pradeu (2012)

“Pradeu’s view goes against” – Burnet and Fenner (1949); Langman and Cohn (2000)

“He says this can’t be correct” – Pradeu (2019)

“An influential article by Robert Wilson and Matthew Barker” – Wilson and Barker (2019)

p. 70

“Some basic principles of cell-to-cell interaction” – see LeDoux (2019)

“In fact, true multicellular organisms” – Summarized in LeDoux (2019)

p. 71

“A multicellular organism is a functional unit” – Niklas and Newman (eds.) (2016)

p. 72

“Derek Skillings has referred” – Skillings (2017)

“Identity, on the other hand” – for additional discussion of individuation see  
<https://en.wikipedia.org/wiki/Individuation>

“Yet neither individuality nor identity” – Cameron and Kulick (2003); Inoue (2007); McIllyenny (2002)

## **Chapter 8 – The Duality of Biological Existence**

p. 74

“Early on in writing this book” – Romer (1958, 1972)

“then republished in the 1970s” – Dobzhansky et al, (1972)

“His 1955 textbook, *The Vertebrate Body*” – Romer (1955)

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“In particular, in some vertebrates” – Subbotin (2016)

“But in other respects there seems to be” – Romer (1958, 1972)

## **Part III – The Neurobiological Realm**

### **Chapter 9 – It Took Nerve**

p. 81

“Animals were the last” – The discussion of the evolution of animals and their nervous systems in this chapter is based on my book *The Deep History of Ourselves* (LeDoux, 2019). Some sources from that book are repeated here to make specific new points.

p. 83

“Cells that have these features” – Neurons are not the only cells of the nervous system. Also important are glial cells. For example, see Badimon, et al (2020) and Jakel and Dimou (2017).

“They existed for other purposes” – Brunet and Arendt (2016)

“But for sheer physical reasons” – van Duijn (2017)

p. 84

“These hold individual protozoa together” – Niklas (2014); Grosberg and Strathmann (2007)

“They, unlike sponges” – Shubin, et al (2009)

“All of this suggests” – Conaco, et al (2012)

“Of the Cnidaria” – Greenspan (2007)

p. 85

“Specially, jellyfish have two concentrated collections” – Arendt, et al (2016)

p. 86

“These collections of peripheral neurons” – Arendt, et al (2016); Bertucci and Arendt (2013); Nomaksteinsky, et al (2009, 2013)

“Cnidaria also contributed” – Kanaya, et al (2020)

“The first beneficiaries” – An alternative hypothesis is that centralization evolved several times in early bilaterals. Whether this happened is not crucial here. For a discussion of these issues see: Northcutt (2012); Erwin (2007)

“The reason why most animals” – Northcutt (2012), and in Erwin (2007)

p. 87

“But directional control” – Cisek (2019)

“Early bilateral animals” – Lorenz (1965)

“But they involve much more complex patterns” – Camhi (1984); Grillner, et al (1998)

“Although fixed reactions” – Lehrman (1953); Elman, et al (1997); Samuels (2004); Stich (1975)

p. 88

“The period between about 540 to 480 million years ago” – Erwin and Valentine (2013)

“Armed with powerful species-typical reactions” – Dawkins and Krebs (1979)

“Predation and defense” – A leading idea about the cause is a sharp increase in oxygen due to the proliferation of terrestrial vegetation. See Parfrey, et al (2011)

“According to Thomas Hills” – Hills (2006); Hills, et al (2015)

“It is called *area-restricted search*” – Laing (1937); Knell and Codling (2012)

“This foraging pattern” – Bennett (2021)

“Arms races” – Hills, et al (2015)

p. 89

“As Simona Ginsburg and Eva Jablonka argue” – Ginsburg and Jablonka (2010). One issue with this hypothesis is that studies have found that associative learning may occur Cnidaria, which lack a true central nervous system. Also, some authors suggest that associative learning goes back at least to protozoa (Giurfa, 2013); van Duijn, 2017); Moore, 2004), which lack a nervous system altogether. But most agree associative learning 'exploded' in animals during the Cambrian. Even if Cnidaria and protozoa possess some primitive or associative ability, it surely pales in complexity to what bilateral animals with central nervous systems achieved. And it seems incontrovertible that expanded capacities for associative learning coincided with the increasing sophisticated central nervous systems that were emerging in bilateral animals during the Cambrian.

“Although the evolutionary emergence” – Ginsburg and Jablonka (2010)

“As a result” – Schultz (2013)

p. 90

“Supporting their hypothesis” – Kandel (2001)

“That is, when a behavior succeeds” – Thorndike (1898)

## **Chapter 10 – Vertebrates and Their Nervous Systems**

p. 92

“Most invertebrates” – Much more about the relation of deuterostomes and protostomes to each other, and to their common bilateral ancestor can be found in LeDoux (2019)

“The remaining invertebrates” – There are some other deuterostome invertebrates, such as star fish, which we don't need to consider as they are not in the direct evolutionary chain that led to vertebrates.

p. 94

“The brain of invertebrate chordates” – Holland (2015)

“Reflecting their chordate history” – Of the chordate invertebrates, urochrodates are a bit closer evolutionarily to vertebrates than cephalochordates are. However, because urochrodates have diversified more over that past 500 million years, present day cephalochordates, like lancelets, provide a clearer picture of what the invertebrate chordate ancestor of vertebrates and their nervous systems was like early on (Holland, 2015). Lancelets have only a primitive small neural swelling in the head, and are often said to be brainless. But the key to unlocking an animal's evolutionary history is often in the immature, larval forms of the animal. Indeed, recent studies of larval lancelets have found cellular features and genes that are characteristic of the primitive parts of the vertebrate brain.

“For example, their bodies” – Glanzman (2010)

“An important example” – Thiery (2003); Sanes, et al (2012)

“Later, they contribute” – Martin and Kandel (1996); Sytnyk, et al (2017); Lin, et al (2003); Glanzman (2010)

“Indeed, genetic evidence” – Grant (2016)

p. 95

“The first vertebrates” – This section on the diversification of vertebrates and the evolution of reptiles and mammals is based research I did for *The Deep History of Ourselves* (LeDoux, 2019), and some additional sources cited below.

“This happened when *fishapods*” – Shubin (2008)

p. 96

“Because of this arrangement” – Striedter (2005) p 259

“The resulting higher metabolic rates” – Rudebeck and Izquierdo (2022)

p. 97

“Most mammals remained nocturnal” – This paragraph is based on Hall et al (2012); Kaas et al (2022); Cisek (2022); Striedter and Northcutt (2021)

p. 98

“And differences in the degree” – Preuss and Wise (2022)

p. 100

“This reflects the pre-Darwinian idea” – Hodos and Campbell (1969); Rigato and Minelli (2013)

“For example, around the turn” – Edinger (1908); The philosophical historian Paul Patton has defended Edinger against his contemporary critics, say that he retracted some of his linear views late in life. However, even Patton admits that Edinger retained a lineare view of forebrain evolution. Patton (2015)

p. 101

“Edinger’s line of thought” – Ariëns Kappers, et al (1936)

“But it reached a crescent” – MacLean (1949, 1952)

“MacLean originally used” – It is important to note that the term ‘limbic’ long-predated MacLean (see LeDoux, 1991). It was introduced to in the 16th century to describe a rim of cortex in the medial wall of the cerebral hemispheres (limbic is from the Latin word *limbus*, which means rim). Then in the 19th century this rim was designated the ‘limbic lobe,’ which was meant to be a compliment to the four lobes of the so-called laterally located neocortex (i.e. occipital, parietal, temporal, and frontal lobes). It is therefore scientifically acceptable to use the psychologically neutral term, ‘limbic forebrain’. or ‘limbic areas’ as an anatomical designation. Unfortunately, the limbic system meme sometimes contaminates these more legitimate meanings.

p. 102

“The oldest of his brains” – The quote is from MacLean (1964). He developed the idea further in Maclean (1970) and MacLean (1990).

p. 103

“Through natural selection” – Butler and Hodos (2005)

“But the changes” – Cisek (2019)

“The limbic system/triune brain theory” – Brodal (1982); Swanson (1983); Kotter and Meyer (1992); Damasio (1994); Reiner (1990, 2009); Cesario, et al (2020); LeDoux (1991, 1996, 2002, 2012, 2019)

“These days functions are much less likely” – Meunier, et al (2009); Sherman and Usrey (2012); Cruz et al (2022); Barack and Krakauer (2021); Cisek (2019); Cisek (2022); Pessoa et al (2022)

“Contrary to the idea” – Suryanarayana, et al (2017, 2021, 2022); Puelles, et al (2019); Butler and Hodos (2005); Striedter (2005) ; Striedter and Northcutt (2020, 2021); Nauta and Karten (1970); Cisek (2019); Reiner, et al (1998); Reiner (2009); Swanson (2002)

p. 104

“In fact, a recent textual analysis” – Rigato and Minelli (2013)

“Edinger and MacLean” – Patton (2015)

## **Chapter 11 – Romer’s Rendition**

p. 105

“Receall that in Chapter 8” – Romer (1958, 1972); Blessing and Gibbins (2008); Blessing (1997); Butler and Hodos (2005); Bertucci and Arendt (2013)

p. 107

“My telling of Romer’s tale” – The narrative I construct will build on various points I discussed earlier in the book, but also some new ones. For background, see Arendt, et al (2016); Bertucci and Arendt (2013); Arendt (2008); Nomaksteinsky, et al (2009, 2013); Nakanishi, et al (2010); Greenspan (2007); Holland (2003); Holland (2015); Holland, et al (2013); Jekely (2011, 2021).

“When centralized nervous systems” – Paolo Bertucci and Detlev Arendt (2013) note that in the marine world of early bilateral animals, the visceral stimuli were from the external environment. For example, internal osmolarity pH, pO<sub>2</sub> and pCO<sub>2</sub> are dictated by the aquatic surroundings, water and thus inform the organism about the environment, but also taste, which is a visceral sense related to external food. External sensory inputs are therefore best sorted by circuits related to locomotion (olfaction, vision, and touch) and circuits that process chemical signals related to feeding (external taste and internal osmolarity, pH, pO<sub>2</sub> osmolarity).

p. 109

“To consider these two realms” – A recent article by Anna Ciaunica and Mike Levin make a similar point—that functions of the nervous system and body are highly interactive(Ciaunica and Levin,2022).

## **Chapter 12 – Viscerology**

p. 110

“Bichat proposed that” – Bichat (1977)

“Until recently” – This discussion of Langley is based on Blessing (1997); Blessing and Gibbins (2008); Gibbins (2013); Nozdrachev (2002); Ackerknecht (1974)

p. 111

“The *sympathetic nervous system*” – Blessing and Gibbins (2008)

“While Langley’s terminology” – Blessing (1997); Blessing and Gibbins (2008); Gibbins (2013); Porges (2001).

p. 112

“The neurobiologist William Blessing” – Blessing (1997)

“While the sympathetic and parasympathetic components” – Gershon (1999, 2010); Furness (2006, 2007)

“As early as 1884” – James (1884)

p. 113

“German researchers reported” – Karplus and Kreidl (1910); Hess (1928); Ranson and Magoun (1933)

“Around the same time” – Cannon (1929)

“But in assuming that” – Goldstein (2009)

“With improved techniques” – Hess and Akert (1955); Hunsperger (1956); Hilton and Zbrozyna (1963); Adams, et al (1971); Wasman and Flynn (1962); Egger and Flynn (1963); Cohen and Obrist (1975)

p. 114

“More recent work” – Saper (2002); Damasio and Carvalho (2013); Cechetto (2014)

“The brain not only acts” – Damasio and Carvalho (2013)

p. 117

“Modern understanding emphasizes” – Saper (1987)

“And the transition” – Riganello, et al (2019); Falup-Pecurariu, et al (2021); Oesch and Adamantidis (2021); de Lecea (2021)

p. 118

“Since ancient times” – Plato (1875)

“There was a period” – Miller, et al (1970)

p. 119

“A review of this research” – Blanchard and Young (1973)

## **Chapter 13 – The Behavioral Thoroughfare**

p. 120

“Sir Charles Scott Sherrington” – Sherrington (1906)

“He received the 1932 Nobel Prize” – The Nobel Prize in Physiology or Medicine 1932.  
<https://www.nobelprize.org/prizes/medicine/1932/summary/>

“Sherrington once mused” – Sherrington (1933)

“The external nature” – Key figures involved in sensory and motor studies of the forebrain, especially the cerebral cortex, in the second half of the 19th century included Hermann von Helmholtz, Eduard Hitzig, Gustav Fritsch, David Ferrier, Herman Munk, and Victor Horsley, and Sir Charles Sherrington. In addition, clinical neurologists made important contributions, including Paul Broca, John Hughlings Jackson, and Carl Wernicke. Major milestones in neuroscience are listed on this site <https://faculty.washington.edu/chudler/hist.html>.

p. 121

“As Sara Shettleworth” – Shettleworth (2001)

“In his 1934 book” – von Uexküll (1934)

p. 122

“His point was that” – This summary of von Uexküll is based on Gould (1982); Schroer (2021); Brentari (2009)

“While an animal is still in the womb” – Albert, et al (2008)

“For example, studies conducted” – Hubel and Wiesel (2005)

p. 123

“You know the color red” – LeDoux and Lau (2020); Clark (2000)

“Repeated experiences” – Makino, et al (2016); Merzenich and Jenkins (1995)

“One way that sensory systems” – LeCun, et al (2015)

“This is a form of deep learning” – Clark (2000); Dodds (2018); Karklin and Lewicki (2005)

“and it occurs in both” – Seth and Friston (2016); Barrett and Finlay (2018)

p. 124

“When such expectations are violated” – Dayan (2002); Barto, et al (1990)

“This enhanced ‘tuning’” – Weinberger (1995)

p. 125

“There are, of course, differences” – Nauta and Karten (1970); Striedter and Northcutt (2020); Butler and Hodos (2005); Reiner, et al (1998); Reiner (2009); Swanson (2002)

“These motor programs” – Suryanarayana et al (2021)

“Once learned” – Llinas and Sotelo (1992)

“We know this in part” – Manto et al, (2012); Llinas (2011)

p. 126

“For example, limb withdrawal” – Kimble (1967)

“The sound and shock sensory pathways” – Thompson (2005); Timmann, et al (2000)

“In general, species-typical sights” – Cardinal, et al (2002)

“while stimuli related to predators” – Fanselow and Lester (1988)

p. 127

“Humans rely more on learning” – Ohman and Mineka (2001); Marks (1987); Cashin-Garbutt (2018); Rentschler, et al (1999)

“Because they were particularly dangerous” – Marks (1987); Ohman and Mineka (2001)

“Survival behaviors depend” – LeDoux (2012, 2019); Sternson (2013)

“Much is known about” – LeDoux (2012); Mobbs and LeDoux (2018); Pfaff (1999); Gross and Canteras (2012)

“When a particular survival circuit” – LeDoux (2012)

p. 128

“In future encounters” – Blanchard and Blanchard (1969); Bolles and Fanselow (1980); Davis (1990); LeDoux (1990); Phelps and LeDoux (2005); Dolan and Vuilleumier (2003)

“Major components” – Martinez-Garcia and Lanuza (2018); Amaral (2003); Izquierdo, et al (2005); Kalin, et al (2004); Phelps and LeDoux (2005); Dolan and Vuilleumier (2003); Ohman (2002)

“are depicted in Figure 13.1” – LeDoux (1996, 2002, 2015); Lang and Davis (2006); Fanselow and Poulos (2005); Gross and Canteras (2012); Blanchard and Blanchard (1972)

“If the animal is wounded” – Bolles and Fanselow (1980)

“According to recent findings” – Benito-Gutierrez, et al (2021); Suryanarayana, et al (2022)

“Although protostome invertebrates” – Gibson, et al (2015)

p. 130

“In the late nineteenth century” – Thorndike (1898)

“Like Pavlovian associative conditioning” – Robbins and Costa (2017); Dickinson (2011); Balleine and Dickinson (1998)

“The stamping-in” – Knowlton and Diedrichsen (2018); Graybiel (2008); Balleine and O’Doherty (2010); Poldrack (2021)

“In all vertebrates” – Balleine (2019); Dezfouli and Balleine (2012); Graybiel (2008); Smith and Graybiel (2016); Robbins and Costa (2017); Bennett (2021)

“When the animal tastes” – Schultz (1998); Daw, et al (2011); O’Doherty, et al (2017)

p. 132

“Although MacLean” – O’Keefe and Nadel (1978); Moser, et al (2015)

“In particular, the hippocampus” – Bennett (2021); Murray, et al (2017); Cisek (2019)

“Habits may seem simple” – Balleine (2019); Dezfouli and Balleine (2012); Graybiel (2008); Robbins and Costa (2017); Graybiel and Grafton (2015)

“The chunked action sequences” – Graybiel and Grafton (2015)

p. 133

“Habits, additionally, have a dark side” – Poldrack (2021)

## **Part IV – The Cognitive Realm**

### **Chapter 14 – Internalizing the External World**

p. 137

“That, in effect, narrows things down” – There are fringe cases amongst early animals, with sponges being a prime example, that may have had, but lost, nervous systems. The fact that present day sponges have some molecular building blocks of nervous systems might seem like supporting evidence for their inclusion as neurobiological beings. But we should not jump to a conclusion based on this since some of same molecules are also present in plants and protozoa, neither of which ever had members with nervous systems. Sponges, then, are amongst a very small number of animals that might not qualify as neurobiological beings.

p. 138

“Cognition in the form of thinking” – My summary of the history of psychology in this chapter is based on: Boring (1950); Keller (1973); Nevin (1973); Gardner (1987)

“In searching for animal intelligence” – Thorndike (1889)

p. 140

“Ethology, in fact, emerged” – Griffiths (2008); Gould (1982)

“In psychology the word *schema*” – Piaget (1923); Beck (1967); Pretzer (2014); Bundgaard (2007); Clore and Ortony (2013)

“We each have many kinds” – Hailova, et al (2020)

p. 141

“Although some British animal researchers” – Mackintosh (1963); Gray (1964); Dickinson (1985)

“If the organism carries” – Craik (1943, 1966)

“According to this ‘stimulus-response’ school” – Tolman (1948) p. 189

p. 142

“Tolman proposed, instead” – Tolman (1932)

“In later experiments” – Tolman (1948, 1949a, 1949b)

“And it is this tentative map” – Tolman (1948)

“Karl Lashley” – Lashley (1950)

p. 143

“Lashley additional noted” I am proud to say that my scientific family tree connects me to both Tolman and Lashley. <https://neurotree.org/neurotree/tree.php?pid=588>

“Meanwhile in Canada” – Hebb (1949)

“One of Hebb’s students” – Milner (1954)

“After completing her PhD” – Scoville and Milner (1957)

“Milner’s findings” – Corkin (1968); Cohen and Squire (1980); Squire (1987)

p. 144

“Lashley’s comment” – Skinner (1957); Chomsky (1959)

“He argued that concept formation” – Bruner, et al (1956)

“This transpired in a famous paper” – Miller (1956)

“Miller was also the lead author” – Miller, et al (1960)

p. 145

“And with the publication” – Neisser (1967)

“Although behaviorism persisted” – Dickinson (2012); Holland (2008); Rescorla (1988)

“But George Mandler” – Mandler (2002)

## **Chapter 15 – What Is Cognition?**

p. 146

“A typical contemporary definition” – Lexico <https://www.lexico.com/en/definition/cognition>

“Other animals were not part” – Dickinson (2008)

p. 147

“Descartes’s view” – van Gulick (2014); Michel (2020); Danziger (1997a)

“And when psychology emerged” – Boring (1950)

“Nevertheless, both animal and human psychologists” – Keller (1973)

“In line with Lashley” – This paragraph is based on Nisbett and Wilson (1977)

“For example, the pioneering cognitive psychologist” – Mandler (1975)

p. 148

“Similarly, George Miller” – Miller (1962)

“In the 1980s” – Kihlstrom (1987)

“The acknowledgment by contemporary psychologists” – Some might say that I have omitted an important category – ‘Not Cognitive but Conscious’. For example, the notion of sentience could be such an instance. But this issue is best saved for Part 5, which explores the conscious realm in depth.

p. 149

“In psychology, working memory” – Miller, et al (1960); Atkinson and Shiffrin (1968); Adams, et al (2018)

“In the 1970s” – Baddeley and Hitch (1974)

“The term working memory” – Baddeley (1992)

p. 150

“While working memory and attention” – Oberauer (2019)

“Because rehearsal mainly works” – Camos, et al (2011)

“Although temporary storage of information” – Postle (2006)

“It may consist of the representation” – Fuster (2008)

“An ongoing debate” – Adams, et al (2018)

p. 151

“Research shows that individuals” – Evans and Stanovich (2013)

“But it is now known” – Trubutschek, et al (2017, 2019); Bergstrom and Eriksson (2018); Pan, et al (2014)

“A wide variety of information” – Lundqvist, et al (2021)

“This ability to cognitively apprehend” – Flavell (1979); Nelson and Narens (1990); Metcalfe and Shimamura (1994); Proust (2014); Fleming and Lau (2014); Shea and Frith (2019); Shea et al (2014)

“We also use our understanding” – Premack and Woodruff (1978); Flavell (1999); Tomasello and Call (1997); Tomasello (2018); Carruthers (2009); Frith (2012); Frith and Frith (2005); Heyes and Frith (2014)

p. 152

“The contribution of long-term memory” – Kosslyn and Koenig (1992)

“This body of stored knowledge” – Tulving (1972, 1985)

“Semantic memories also underlie” – Duff, et al (2019)

“Science, art, music” – Binder and Desai (2011)

“Intuitions are fast” – Atkinson and Shiffrin (1968); Norman and Shallice (1986)

“This distinction between” – Kahneman (2011)

p. 153

“Dual-system views have” – Wason and Evans (1974); Evans (2008); Evans and Stanovich (2013)

p. 154

“Evans has, in fact, said” – Evans (2009)

p. 155

“System 2 includes instances” – Fleming (2021); Seth (2019); LeDoux and Daw (2018); LeDoux (2019); Melloni (2015); Reber, et al (2012); Tucker and Luu (2021); Dijksterhuis and Nordgren (2006); Strick, et al (2011); Koriat (2007); Kelley and Jacoby (1996)

“Each of these qualifies as components” – Trubutschek, et al (2017, 2019); Bergstrom and Eriksson (2018); Pan, et al (2014)

“More generally, System 2 processes” – Craik (1943, 1966); Tolman (1948) Fodor (1975)

“System 3, by contrast” – One reason to go in this direction is to escape the traditional presumption from the early days of cognitive science that cognitive processes involve rational, rule-based beliefs underlying reasoning, thinking, deduction, and conscious manipulation of knowledge. Francis Heylighen, for example, has suggested that although cognition was originally cast this way, intuition, emotion, and motivation are viewed by some as cognitive

processes (see Heylighn, 1992). Similarly, Tamar Gendler has contrasted rational, belief-based cognition with non-rational cognitions that she refers to as ‘aliefs’ (see Gendler, 2008).

p. 156

“In the late 1970s” – O’Keefe and Nadel (1978)

“It built on O’Keefe’s observation” – O’Keefe and Dostrovsky (1971)

“The challenge, then, was” – Rescorla (1974); Colwill and Rescorla (1985); Holland and Rescorla (1975); Dickinson (1980, 1985); Dickinson and Balleine (1994); Balleine and Dickinson (1998)

“One of these tests” – Dickinson (1980, 1985); Dickinson and Balleine (1994); Balleine and Dickinson (1998); Balleine (2019)

p. 157

“Rats that later” – Other approaches involve variations of reinforcer magnitude or frequency, or manipulations of the contingency between the reinforcer and response. See Murray, et al (2017); Papini (2008)

## **Chapter 16 – Mental Models**

p. 159

“These processes, grounded in working memory” – Gentner (2002); Behrens, et al (2018); McNamee and Wolpert (2019); Daw, et al (2005)

p. 160

“In 1943, in his book” – Craik (1943)

“Then some three decades later” – Baddeley and Hitch (1974)

“Starting in 1983” – Johnson-Laird (1983)

“Johnson-Laird credited Craik” – Johnson-Laird (2013), while crediting Craik also noted that Craik overlooked an important function of mental models: “Oddly... Craik believed that reasoning depends on verbal rules rather than on mental models.”

p. 161

“The holder of this model” – Johnson-Laird (2013)

“Johnson-Laird placed his theory” – Johnson Laird (2010)

p. 162

“Given the dominance of dual-system approaches” – Daw, et al (2005)

“Researchers there sought to understand” – Sutton and Barto (1998); Mitchell (1997); Dolan and Dayan (2013)

“Early machine-learning researchers” – Bishop (2013); Gregory (1983)

p. 163

“In using these models” – Bornstein and Daw (2013); LeDoux and Daw (2018)

“Why does a brain” – Daw, et al (2005); Murray, et al (2017)

“When they are scarce” – Murray, et al (2017)

“For example, model-free associations” – Dickinson (2012)

“For example, across mammals” – Balleine (2019); Gold and Shadlen (2007); Daw, et al (2005); Dolan (2007); O’Doherty, et al (2007); Rushworth and Behrens (2008); Wallis (2019)

“Further, individuals with greater working memory capacity” – Otto, et al (2013)

“and people suffering from schizophrenia” – Culbreth, et al (2016)

p. 164

“Finally, immaturity of model-based working memory systems” – Decker, et al (2016)

p. 165

“The model-based versus model-free distinction” – Glascher, et al (2010); Wunderlich, et al (2012); Decker, et al (2016); Balleine and O’Doherty (2010); Lockwood, et al (2020); Daw, et al (2011); Behrens, et al (2018)

“Some of my colleagues” – Cisek (2022); Pessoa et al (2022); Buzsaki (2022)

## **Chapter 17 – Model-Based Cognition in Evolution**

p. 166

“Over the past several decades” – Bitterman (1975, 2000); Leal and Powell (2012); Burghardt (2013); Salena, et al (2021); Roth, et al (2019); Gutnick, et al (2020); Clayton and Dickinson (1999); Heisenberg (2015); Moore (2004); Perry, et al (2013); Giurfa (2012, 2015); Giurfa and Sandoz (2012); Chittka (2022); Godfrey-Smith(2016, 2022)

“Some scientists have claimed” – Heisenberg (2015); Moore (2004); Perry, et al (2013); Giurfa (2012, 2015); Giurfa and Sandoz (2012); Mizunami (2021); Godfrey-Smith(2016, 2022); Perry, et al (2013); Giurfa (2012)

“and even single-celled organisms” – Ginsburg and Jablonka (2021); Lyon (2015); Reber (2018)

p. 167

“Charles Abramson” – Abramson and Wells (2018)

p. 168

“Bees, for example” – Chittka (2022)

“Amphibians and fish” – Bitterman (1975, 2000); Leal and Powell (2012); Burghardt (2013); Salena, et al (2021); Roth, et al (2019); Gutnick, et al (2020)

“Under ideal conditions” – Roth, et al (2019); Salena, et al (2021); Muzio, et al (2011); Suboski (1992); Vasconcelos, et al (2012); Papini (2014)

“So far, there is a paucity of research” – These so-called 'reinforcement schedule effects tasks' change the value of reinforcers by manipulating the magnitude or frequency of the reinforcer received (see Papini,2014)

“Overall, the evidence supports” – Muzio, et al (2011); Papini (2006); Murray, et al (2017)

p. 169

“Spatial mapping has been studies” – Roth, et al (2019); Salena, et al (2021); Stone et al (2017)

“It does not, however, involve” – Bennett (2021)

“From the evidence he reviewed” – As mentioned above, I have not pursued cognition in protostomes in detail here since they are not in the evolutionary past of mammals. But, as in

lower vertebrates, their capacities seem to be model-free rather than model-based (i.e. based on present stimuli rather than on future oriented internal representations.

p. 170

“It has long been known” – Pepperberg (2009)

“but also from experiments” – Clayton and Dickinson (1998, 1999)

“Much research, including devaluation studies” – Gunturkun and Bugnyar (2016)

“In sum, mammals and birds” – Salena, et al (2021)

p. 171

“Rather than trying to find” – Barton R (2023) What is it like to be an Octopus? Anthropocentrism, embodiment and the limits of cognitive convergence. European Human Behavior and Evolution Association. Conference abstract.

“Much empirical and conceptual work” – Birch et al (2020a); Birch et al 2020b); Crump and Birch (2021); Browning and Birch (2022); Chittka (2022); Godfrey-Smith(2016, 2022)

“As a result, they could breathe” – Jacobs (2022)

“The heat underlying” – Rudebeck and Izquierdo (2022)

p. 172

“In an adult human” – Clarke and Sokoloff (1999)

“Indeed, Elizabeth Murray” – Murray, et al (2017)

## **Chapter 18 – Foraging in the Mind**

p. 174

“Mental modeling is a widespread feature” – New animals do not emerge fully formed. Speciation is a gradual process. The innovations of mammals, like mental modeling, slowly came to be part of the Class of mammals over their history and as their bodies changed in response to their environments. Some of these variations led to a path from which primates slowly evolved by benefiting from and modifying traits of their mammalian ancestors. But non-primate mammals also continued to evolve along their own paths. That said, I will discuss

mental modeling in early mammals, non-human primates and humans as if each group possesses a single capacity for mental modeling that differs from the single capacity of the other groups. This narrative simplification is justified by the fact that cognition is sufficiently similar within non-primate mammals and sufficient different between them primates.

“Considerable evidence points” – This discussing of foraging in mammals is based on: Hills (2006, 2011); Cisek (2019); Murray, et al (2017); Rudebeck and Izquierdo (2022); Timberlake, et al (1987); Preuss (2007); Rosati (2017)

p. 175

“This allowed them to evaluate” – Rudebeck and Izquierdo (2022)

“About 55 million years ago” – This discussion of primate evo history is based on: Murray, et al (2017); Kaas (2013, 2017); Passingham (2021); Preuss (1995, 2007); Roth (2013); Rudebeck and Izquierdo (2022)

“Because of their exquisite hand control” – Preuss (2007)

“Monkeys diverged from prosimians” – For this this discussion we ignore the difference between new and old-world monkeys.

p. 176

“Specifically, the food required” – From Tree Shrews to Primates: <https://www.climate-policy-watcher.org/population-growth/from-tree-shrews-to-primates.html>; The First Primates. [https://www2.palomar.edu/anthro/earlyprimates/early\\_2.htm](https://www2.palomar.edu/anthro/earlyprimates/early_2.htm)

“Slowly, their vision improved” – Kaas (1995, 2013, 2017); Kaas, et al (2022)

p. 177

“For example, Elizabeth Murray” – Murray, et al (2017)

“Recent studies in fact suggest” – Beran and Hopkins (2018)

“Humans began to diverge” – This para is based on: Roth (2013) Ch 15 Are Humans Unique?

p. 178

“In emphasizing the role of foraging” – This para is based on: Rosati (2017)

“As Amanda Seed” – Seed and Tomasello (2010)

p. 179

“The philosopher Peter Godfrey-Smith” – Godfrey-Smith, (2016, 2020)

“Daniel Dennett nailed it” – Dennett (1996), p. 17

p. 180

“In particular, only humans form” – Penn, et al (2008)

“According to Michael Corballis” – Corballis (2007)

“A prisoner serving a life sentence” – Redshaw and Suddendorf (2020)

“Michael Tomasello’s research” – Tomasello and Rakoczy (2003)

“Dwight Read” – Read (2008)

p. 181

“A capacity that decidedly differs” – Tulving (2001); Buckner and Carroll (2007); Schacter and Addis (2007); Suddendorf, et al (2018); Suddendorf et al (2022)

“Suddendorf and colleagues” – Schultz (2017); Holland and Schiffino (2016); see Suddendorf et al (2018)

“The ability to mentally time travel” – Clayton and Dickinson (1998, 2010); Shettleworth (2009, 2010); Suddendorf and Corballis (2007, 2010)

“and as we will see” – Tulving (2001)

“Thomas Hills” – Hills, et al (2008, 2012); Todd and Hills (2020)

“But in another sense” – Miller and Cohen (2001)

“As when foraging for food” – Mansouri, et al (2017)

p. 182

“But we have supercharged” – Penn, et al (2008); Sherwood, et al (2008); Passingham (2021); Suddendorf (2013); Tomasello and Rakoczy (2003); MacLean (2016)

## **Chapter 19 – The Cognitive Brain**

p. 184

“As mammals were emerging” – The discussion of mammalian cortex evo is based on: Kaas (2013, 2017); Northcutt and Kaas (1995)

“Although the most impressive changes” – Reiner (2009); Martinez-Garcia, et al (2002); Striedter and Northcutt (2020); Butler and Hodos (2005); Striedter (2005)

p. 185

“As Tolman observed” – Tolman (1949a, 1949b); Packard and McGaugh (1996)

“But the goal-directed circuitry” – Balleine (2018, 2019); Mannella, et al (2016); Balleine and O’Doherty (2010); Schoenbaum, et al (2011); Bennett (2021); Keiflin and Janak (2015); Rudebeck and Izquierdo (2022); Sharpe, et al (2019); Cardinal, et al (2002); Everitt and Robbins (2016); Simmler and Ozawa (2019); Wallis (2012); Rudebeck and Murray (2014); Costa, et al (2022)

p. 187

“It is interesting that the hippocampus” – Balleine (2018, 2019); Mannella, et al (2016); Turner and Parkes (2020)

“First, as we saw earlier” – Bennett (2021)

“Both strategies use spatial maps” – Chai, et al (2021)

“Neurons in the hippocampal formation” – O’Keefe and Nadel (1978); Muller and Kubie (1987); Moser, et al (2015)

“Using neural signals” – Mehta (2015); Pfeiffer and Foster (2013)

“Foraging is model-based” – Bennett (2021)

“Second, spatial maps are made” – Burgess, et al (2001); Burgess (2008)

“and both of these with hippocampal spatial memory circuits” – Morris, et al (1982); Rudy and Sutherland (1989); Wang and Morris (2010); Buzsaki and Moser (2013); Moser, et al (2017); Hartley, et al (2014)

“Long ago, Brenda Milner” – Milner, et al (1968)

p. 188

“Object memory—which depends” – Eichenbaum (2000); Murray, et al (2017); Cowell, et al (2010); Eichenbaum, et al (2007); Duff, et al (2019)

“Together these make it possible” – Balleine (2019); Lara, et al (2009); Rushworth, et al (2011); Wallis (2019); Enel, et al (2020); Burton, et al (2015)

“For one thing, areas of the neocortex” – Kaas (2013, 2017)

p. 189

“Because of a distinctive cellular feature” – Brodmann (1909)

“Brodmann concluded” – Brodmann (1909); Preuss (1995); Wise (2008); Passingham (2021); Preuss and Wise (2022)

“I will refer to the latter medial areas” – I use the term sub-granular as a contrast with granular to reflect the fact that meso-cortical areas have degrees of granulation that vary from none to some. See Barbas and Garcia -Cabezas (2016); Garcia-Cabezas, et al (2019); Garcia-Cabezas, et al (2022)

p. 191

“But the function of granular PFC” – Fuster (2008)

“The key breakthrough” – Jacobsen (1936)

“Particularly important studies” – Mishkin and Pribram (1955); Mishkin (1957)

“Joaquin Fuster” – Fuster (2008); Goldman-Rakic (1987); Romanski, et al (1999)

p. 192

“It is now known that both of these areas” – Romanski, et al (1999); Romanski and Goldman-Rakic (2002); Romanski (2004);

“A third component of the lateral PFC” – Ross et al (2013); Kennerley and Wallis (2009)

“One connects the visual cortex” – Ungerleider and Mishkin (1982); Milner and Goodale (2006)

“It is therefore referred to” – Jones and Powell (1970); Mesulam (1998); Damasio (1989); Xu, et al (2022)

“But the lateral PFC also receives” – Murray, et al (2017); Ritchey, et al (2015); Eichenbaum (2017)

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“Because of its input” – Mesulam (1998)

“With the emergence of Baddeley’s model” – Fuster (2008); Goldman-Rakic (1987)

“But it later became apparent” – Petrides (2000); Postle (2006); Curtis and D’Esposito (2003); Passingham and Sakai (2004)

p. 194

“This led Bradley Postle” – Postle (2006)

“Postle summarized several specific kinds” – Postle (2006)

“Earl Miller and colleagues” – Miller, et al (2018)

“Some researchers argue” – Tsutsui, et al (2016)

“Part of their argument” – Balleine (2019)

“Also of note is that rats” – Tsutsui, et al (2016); Posner and Petersen (1990); Kastner and Pinsk (2004); Scolari, et al (2015); Gisquet-Verrier and Delatour (2006)

“The difference is that, in primates” – Yeterian, et al (2012)

p. 195

“It sits at the top” – Badre and D’Esposito, (2009); Koechlin and Hyafil (2007); Burgess, et al (2007); Christoff and Gabrieli (2000); Ramnani and Owen (2004)

p. 196

“This ability for cognitive control” – Miller and Cohen (2001)

“The basic goal-directed circuitry” – Rudebeck and Izquierdo (2022); Wallis (2019); Rolls (2019); Rhodes and Murray (2013); Izquierdo, et al (2004); Grabenhorst, et al (2008); Rolls (1996, 2005); Knudsen and Wallis (2021)

p. 197

“For example, the basic mesocortical PFC areas” – Knudsen and Wallis (2021)

“It’s not that rats” – DeVito, et al (2010); Clayton and Dickinson (2006); Tramacere and Allen (2022)

“Farshad Mansouri” – Mansouri, et al (2017)

p. 198

“More recently, though, homologs” – Preuss and Wise (2022); Murray, et al (2017); Ardesch, et al (2019); Sherwood, et al (2003); Gannon, et al (2005)

“Given that there is no convincing evidence” – Long ago I proposed an idea about how this came about. LeDoux (1982)

“Starting in the late 1990s” – Barton and Montgomery (2019); Semendeferi, et al (1997)

“Other scholars, like Todd Preuss” – Preuss and Wise (2022); Donahue, et al (2018, 2019); Passingham, et al (2017); Smaers, et al (2017)

p. 199

“But evidence suggests” – Neubert, et al (2014); Sallet, et al (2013); Semendeferi et al, (2011)

“Indeed, research by Karin Roelofs” – Koch et al (2018)

“Using structural and functional connectivity fingerprinting method” – Bramson et al (2020a)

“and the amygdala” – Bramson et al (2020b); Volman et al (2011)

“Another idea about the human frontal pole” – Burgess, et al (2007); Henseler, et al (2011)

p. 200

“Baddeley suggested a solution” – Baddeley (2000)

“Later studies found” – Baddeley, et al (2011)

“But research by Daniel Schacter” – Schacter and Addis (2007)

p. 201

“The search for macroscopic unique areas” – Van den Heuvel, et al (2019)

“Clearly, our brain specializations” – Daw, et al (2005); Bornstein and Daw (2013); Balleine and O’Doherty (2010); Dolan and Dayan (2013); Decker, et al (2016); O’Doherty, et al (2001, 2017); van Ede, et al (2020); Haber and Knutson (2010); Glimcher and Fehr (2013); Delgado, et al (2008)

“give us unparalleled capacities” – Todd and Hills (2020); Hills, et al (2010, 2012, 2015); Hills and Dukas (2012)

“It tinkers” – Jacob (1977)

“and adapts blindly” – Dawkins (1996)

“Preuss has pointed out” – Preuss (2011)

p. 202

“1. Connections between the sensory cortex and the granular PFC” – Lau (2019); Dijkstra, et al (2022)

“2. Connections between the sensory cortex and the temporal lobe” – Murray, et al (2017); Ritchey, et al (2015)

“where schema construction begins” – Gilboa and Marlatte (2017); Wang and Morris (2010)

“3. The ventromedial PFC” – Gilboa and Marlatte (2017); Gilboa and Moscovitch (2017)

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“6. Connections between the lateral PFC and the frontal pole” – Burgess, et al (2007); Henseler, et al (2011)

“7. Connections between the lateral PFC and downstream areas” – Bramson et al (2000a); Bramson et al (2020b)

“9. Connections between the lateral PFC, frontal pole” – Mansouri, et al (2017)

“The result is the ability” – Fleming, et al (2018)

## **Part V – The Conscious Realm**

### **Chapter 20 – Is Consciousness Mysterious?**

p. 207

“In fact, it is often said” – Hatfield (2018)

p. 208

“William James” – James (1890)

“He describes this quality” – Nagel (1974)

“But why do conscious mental states” – Chalmers (1996)

“Owen Flanagan” – Flanagan (1991)

“As Anil Seth notes” – Seth (2021)

p. 209

“As the physicalist philosopher J. J. C. Smart” – Smart (1959)

“Describing his inner conflict” – James (1890), p. 350; Quoted in Cooper (1992)

“As the philosopher J. J. Merleau-Ponty said” – Merleau-Ponty (1964) in the chapter called “The Metaphysical in Man”, on page 97. Thanks to Dani Bassett for the quote.

p. 210

“Channeling James” – Place (1956)

“Daniel Kahneman” – Kahneman (2011)

“If we aren’t careful” – Brick, et al (2021)

“The physicalist philosopher Daniel Dennett” – Dennett (1997); Garrett (2006)

p. 211

“For example, integrated information theory” – Tononi (2012); Tononi and Koch (2015); Tsuchiya, et al (2016); Koch (2019); Koch (2020)

“Such ideas are enjoying” – <https://www.psychologytoday.com/us/blog/how-do-life/202007/secular-spirituality>

“But IIT is also” – Bayne (2018)

“Some say it requires” – leap of faith: Michel and Lau (2020); psuedo-science: Michael Graziano is quoted in Jarrett (2020), saying, “There is no chance of scientific success or understanding. It’s like assuming that ghosts exist and then going to search for them ‘scientifically’. It is, in a word, pseudoscience.”

“Whereas theories of consciousness” – Michel, et al (2019)

“Hakwan Lau” – Lau and Michel (2019)

p. 212

“Or if Watson, Crick, and Franklin” – Rosiland Franklin made important contributions to the discovery of DNA, but was less celebrated, at the time, than Watson and Crick.

p. 213

“The initiator of this *unity of science* idea” – Carnap (1934)

“Theories of consciousness” – Atmanspacher (2020); Hameroff (1998); Penrose (1989); Stapp (1993)

“William Bechtel” – See Bechtel (2022)

p. 214

“This exorcism of consciousness” – Ryle (1949)

“But that same year” – Mangan (1993)

“Three decades later” – Fanselow and Pennington (2018)

p. 215

“Having survived behaviorist reduction” – Hebb (1958)

“In the 1980s” – Churchland (1984, 1988)

“Consistent with Churchland’s perspective” – Rose (2005)

“As the esteemed psychologist Jerome Bruner” – Bruner (1987)

“In short, people’s commonsense beliefs” – Kelley (1992)

p. 216

“As the psychologist Melvin Marx” – Marx (1951)

“The solution is to use” – LeDoux 2017

p. 217

“Psychology existed without” – Krakauer, et al (2017)

## **Chapter 21 – Kinds of Consciousness**

p. 219

“The word consciousness is often used” – Rosenthal (2005)

“Creature consciousness is maintained” – Moruzzi and Magoun (1949); Plum and Posner (1966); Zeman (2001); Blumenfeld (2021); Laureys et al (2015); Laureys (2005); Merker (2007)

p. 220

“This can lead to confusion” – See my discussion of this in LeDoux (2022)

“A variety of mental state theories of consciousness” – Some examples include Gazzaniga (1985, 2015, 2018); Graziano (2020); Damasio (1994, 1999); Panksepp (1998); Panksepp and Biven (2012); Vandekerckhove and Panksepp (2011); Crick and Koch (1990, 1992, 1995); Koch (2004, 2019); Edelman (1989); Shallice (1988); Frith, et al (1999); Tononi and Koch (2015)

“I emphasize these because” – Brown, et al (2019)

“Theorists from this school” – Block (1995, 2002, 2007); Lamme (2006, 2015); Malach (2021)

p. 221

“*Higher-order theory (HOT)*” – Rosenthal (2005); Rosenthal (2008); Rosenthal and Weisberg (2008); Metzinger (2003); Brown (2015); Brown et al (2019)

“This additional processing” – Rosenthal (2005); Cleeremans et al (2020); Lau (2019)

“*Global workspace theory*” – Baars (1988, 2005); Naccache (2018); Dehaene and Naccache (2001); Dehaene and Changeux (2004); Sergent and Dehaene (2005); Sergent (2018)

p. 222

“In sum, traditional FOT” – Block (1995, 2007); Lamme (2006, 2015); Malach (2021)

“but mainly for amplifying lower-order states” – Dehaene and Naccache (2001); Panagiotaropoulos, et al (2020); Dehaene and Changeux (2011); Sergent and Dehaene ( 2005)

“and the higher-order theory claims” – Lau and Rosenthal (2011); LeDoux and Brown (2017), Cleeremans, et al (2020); LeDoux (2019); LeDoux (2020a, 2020b, 2021); LeDoux and Lau (2020); Brown, et al (2019); Lau (2019)

“Richard Brown, Hakwan Lau” – Brown, et al (2019)

“Further, HOT more easily accounts” – LeDoux and Brown (2017), LeDoux (2019), LeDoux (2020a, 2020b, 2021); LeDoux and Lau (2020); Lau (2019); Cleeremans, et al (2020)

p. 223

“HOT also offers a way” – LeDoux and Pine (2016); LeDoux and Brown (2017); LeDoux, et al (2018); LeDoux and Hofmann (2018); Taschereau- Dumouchel, et al (2022); Ivanov and Schwartz (2018, 2021)

“Another criticism of first-order theory” – Michel and Doerig (submitted)

“Studies have shown” – Herzog, et al (2020); Michel and Doerig (submitted)

“They propose that a broad network” – Sergent et al (2021)

“For example, Hawkwan Lau” – Dehaene, et al (2017)

p. 224

“Because not all information” – Brown, et al (2019)

“Michael Graziano’s attention schema theory” – Graziano (2020, 2021)

“But Richard Brown and I” – Brown and LeDoux (2020)

“Higher-order theory has its critics” – Summarized in Brown, et al (2019)

“Local first-order theorists” – Block (1995, 2007); Lamme (2006, 2015); Malach (2021)

“Research on HOT does often” – Rosenthal (2019); Lau and Passingham (2006); Lau (2019); Odegaard, et al (2018); Fleming and Lau (2014); Fleming and Daw (2017); Gershman (2019); Morales, et al (2019); Seth, et al (2008)

“But HOT theorists do not” – Brown, et al (2019); Shaver et al (2008); Fleming (2020); Maniscalco and Lau (2012); Fleming and Lau (2014)

“For example, they tend to subscribe” – Rosenthal (2005); Lau and Rosenthal (2011a); LeDoux (2019)

p. 225

“That said, because meta-cognition” – Rounis (2012); Fleming et al (2012); Odegaard et al (2017); Vaccaro and Fleming ((2018); Suzuki (2022); Morales et al (2018); Shekhar and Rahnev (2018); Bor et al (2018; Ruby et al, (2008); Dijkstra et al (2022); Lau (2019); Lau et al (2022); Lau and Rosenthal (2011b)

“In this regard, Nick Shea” – Shea and Frith (2019)

“Instead, what is usually meant” – Metcalfe and Son (2012); Rosenthal (2005); LeDoux and Brown (2017); Brown, et al (2019)

“The importance of this tacit feeling” – Klein (2015)

p. 226

“Lau’s theory” – Lau (2019); Lau (2022); Lau, et al (2022)

“A related sparse PFC coding view” – Fleming (2020); Dijkstra, et al (2022)

“These two sparse theories” – Schroder et al (2013); Blouw et al (2016)

“Cleeremans suggests” – Cleeremans (2008); Cleeremans, et al (2020)

“Richard Brown’s *higher-order representation of a representation (HOROR) theory*” Brown (2015)

p. 227

“Brown and I” – LeDoux and Brown (2017)

“This became the foundation” – LeDoux (2019, 2020a, 2020b, 2021, 2022); LeDoux and Lau (2020, 2022)

“This question came to the fore” – Crick and Koch (1992, 1995, 1998)

“The fact is, since the late nineteenth century” – LeDoux, et al (2020)

p. 228

“In the years following” – Michel and Morales (2020); Odegaard, et al (2017); Brown, et al (2019); Lau and Rosenthal (2011); Dehaene, et al (2001, 2014); Fleming, et al (2010); Levinson et al (2021); He et al (2018)

“Proponents of first-order theories” – Block (1995, 2007); Lamme (2006, 2015); Malach (2021)

“But other studies” – Rounis, et al (2010); Ruby, et al (2018); Bor, et al (2017); Shekhar and Rahnev (2018); Vernet, et al (2019); Watanabe (2021); Weilnhammer, et al (2021)

“show that the participant’s ability” – Rounis, et al (2010); Shekhar and Rahnev (2018); Ruby et al (2018)

## **Chapter 22 – Making Consciousness Meaningful**

p. 230

“And those objects are often embedded” – Epstein and Baker (2019); Zeidman and Maguire(2016)

“The psychologist Jerome Bruner” – Bruner and Postman (1949)

p. 231

“Meaning comes from memory” – My discussion of memory and consciousness in this chapter is based on previous writings, including LeDoux (2019, 2020a, 2020b, 2021); LeDoux and Lau (2020).

“Along these lines” – Friston and Frith (2015); Seth (2021); Frith (2007); Clark (2013); Barrett and Simmons (2015)

p. 232

“This sentiment was also expressed” – Edelman (1989)

“Richard Thompson” – Thompson and Madigan (2005) Cleeremans, et al (2020)

“Memory connects innumerable single phenomena” – Hering (1870)

“Long neglected” – Murray, et al (2017); Pine, et al (2021); Budson, et al (in press)

“To be clear, brain areas” – Sherman and Usrey (2021); Cruz et al (2022); Barack and Krakauer (2021); Cisek (2019, 2022); Pessoa, et al (2022)

p. 233

“The ventromedial PFC is crucial” – Gilboa and Marlatte (2017); Zeithamova et al (2019)

“Outputs of these two areas” – McKenzie, et al (2013); Farovik, et al (2015); Takeuchi, et al (2022); van Kesteren, et al (2010)

p. 234

“My *multi-state hierarchical model of consciousness*” – Brown, et al (2019); LeDoux (2019, 2020a, 2021); LeDoux and Lau (2020); LeDoux (2022)

p. 236

“Recurrency is hardly a model idea” – Lamme (2020); Malach (2021); Dehaene, et al (2011); Pereira, et al (2022); Cleeremans, et al (2020)

p. 238

“Findings showing that” – Nagel et al (2011); Rieckmann et al (2012); Wallace et al (2011)

“I mentioned this earlier” – Brown (2015); Lau and Brown (2019); LeDoux and Brown (2017)

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“Earlier I mentioned that stimuli” – Herzog, et al (2020); Michel and Doerig (submitted)

“I will borrow from summaries” – this para is based on Zamani, et al (2022) and Bramson et al 2020b; Zeithamova et al (2019)

“By constraining what enters” – Cowan (1995)

p. 240

“Supporting the idea of the involvement” – Rounis (2012); Fleming et al (2012); Odegaard et al (2017); Vaccaro and Fleming ((2018); Suzuki (2022); Morales et al (2018); Shekhar and Rahnev

(2018); Bor et al (2018; Ruby et al, (2008); Dijkstra et al (2022); Lau (2019); Lau et al (2022); Lau and Rosenthal (2011)

“For example, people with PFC damage” – Odegaard et al (2017); Fleming et al (2014); Lau and Rosenthal (2011)

“The PFC processes information” – For additional discussion of PFC and consciousness, see Odegaard et al (2017); Michel and Morales (2020); LeDoux (2020a); Brown et al (2019); Lau and Rosenthal (2011); Lau et al (2022)

“Because there are many sub-regions” – Odegaard et al (2017)

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“For example, patients with damage” – Lau and Brown (2019); Brown (2015)

“This is consistent with the idea” – Friston and Frith (2015); Frith (2007); Seth (2021)

“Hence, when granular PFC” – LeDoux (2021, 2022)

p. 242

“In addition, the hippocampus” – Behrendt (2013); Postle (2016); O’Keefe 1985

“It is important in this context” – Merker (2007)

“Even so, many who have cited” – Solms (2020)

p. 243

“Using meta-cognition paradigms” – Bang and Fleming (2018); Fleming et al (2018); Mazor et al (2019); Bang et al (2020)

## **Chapter 23 – Fact-Knowing and Self-Knowing Consciousness**

p. 244

“Long-term memory is typically divided” – Cohen and Squire (1980); Tulving (1985); Squire (1987); Graf and Schacter (1985)

p. 245

“Where, when, and what” – Tulving (2002); Clayton, et al (2001)

“When Endel Tulving” – Tulving (1983)

“Current understanding holds” – Renoult, et al (2019); Conway (2009)

“But there is a unique element” – Lenormand and Piolino (2022)

“Martin Conway” – Conway (2009)

“Although traditionally thought of” – Schacter (2001); Loftus (1991)

“Instead of retrieving exquisite details” – Schacter and Addis (2020); Robin and Moscovitch (2017); de Brigard (2014); Milliere and Newen (2022); Cheng, et al (2016)

p. 246

“A decade or so” – Tulving (2005)

“Paraphrasing the neuroscientist György Buzsáki” – Buzsáki (2022)

p. 247

“In the process of writing my 205 book” – LeDoux (2015); LeDoux, (2017); LeDoux, (2019); LeDoux and Brown (2017); LeDoux (2020a); LeDoux (2020b); LeDoux and Lau (2020); LeDoux (2022) Schacter and Addis (2020); Bulley, et al (2017)

“Janet Metcalfe” – Metcalfe and Son (2012)

p. 248

“To the extent that a self is involved” – Fleming (2021) ; Metcalfe and Son (2012); Rosenthal (2005); LeDoux and Brown (2017); Brown, et al (2019)

“As you can see, semantic and episodic memory” – Ritchey, et al (2015); Duff et al (2020); Ding et al (2020); Binder and Desai (2011); Murray et al (2017); Moscovitch et al (2006); Blumenfeld and Ranganath (2019); Stuss and Benson (1986); Shimamura (1995); Moscovitch (1992); Wheeler (1997); Rolls (2022); Burgess et al (2022); Nadel and Peterson (2013)

“The neural basis of autonoësis” – Wheeler (1997)

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“It takes an interactive collation” – Dafni-Merom and Arzy (2020)

p. 250

“Conceptions closely related” – Buckner and Carroll (2007); Schacter and Addis (2007, 2020); Schacter, et al (2008, 2015); Bulley, et al (2017); Suddendorf et al (20220)

“Indeed, these processes each depend” – Raichle (2015); Buckner and Carroll (2007); Fox, et al (2015)

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“These states also depend” – Blumenfeld and Ranganath (2019); Stuss and Benson (1986); Shimamura (1995); Moscovitch (1992)

“In addition, the frontal pole” – Okuda, et al (2003); Soon, et al (2008); Burgess, et al (2007); Schacter and Addis (2007); Buckner and Carroll (2007); Koechlin (2011)

“The frontal pole is also important” – Lau (2019); Dijkstra, et al (2022). de Brigard et al (2017)

“While global workspace” – Panagiotaropoulos, et al (2020); Graziano (2021)

“Another example is the ability” – Fleming, et al (2018)

“They have also shown that” – Bang et al (2020)

“Other research has found that” – Min, et al (2022)

“Still other research shows” – Miyamoto, et al (2021)

p. 252

“*Theory of mind*–the ability” – Premack and Woodruff (1978); Baron-Cohen, et al (1985); Frith and Frith (2005)

“The topic of self” – Damasio, et al (1994); Damasio (1994, 1999); Panksepp (1998); Panksepp and Biven (2012); Feinberg (2001); Northoff and Bermpohl (2004)

“Much contemporary research” – Buckner and Carroll (2007)

“Despite being located medially” – Northoff and Bermpohl (2004); D’Argembeau and Salmon (2012); Koban, et al (2021); Northoff, et al (2011); Irish, et al (2012)

“Lumping together primate-unique granular areas” – D’Argembeau and Salmon (2012); Northoff and Bermpohl (2004)

p. 253

“For example, antagonistic interactions” – Fox, et al (2005); Sonuga-Barke and Castellanos (2007)

“But recent studies emphasize” – Hearne, et al (2015); Cocchi, et al (2013)

## **Chapter 24 – Non-Knowing Consciousness**

p. 254

“And just as he associated” – Anoësis is from the ancient Greek, and translates to ‘lack of knowledge or understanding.’

p. 255

“These vague, tacit states” – James (1890)

“James’s ‘fringe’” – Kriegel (2004); Reber, et al (2004); Mangan (1993, 2003)

“Bruce Mangan” – Mangan (2003) p. 756

“He extended fringe feelings” – Mangan (1993, 1999)

“To Mangan’s list” – Festinger (1957); Oppenheimer (2008)

“But long before Mangan” – Reber (1967, 1989)

p. 256

“Typically, an entire complex of information” – Broniak (1996)

“Zoltán Dienes” – Dienes (2008)

“These, he said, depend on” – Koriat (2007)

“This unconscious monitoring” – Proust (2013); Fleming (2021); Koriat (2007)

“Steven Fleming” – Fleming also suggested that reports based on higher-order inferences reflect awareness (including awareness of presences and absences), but global workspace reports reflect tacit present-absent judgements based on unconscious inferences, and therefore are not

awareness reports, explain why HOT is about explicit conscious experience and GWT is not (see Fleming, 2020).

“Mangan explains this situation” – Mangan (2003)

p. 257

“Metcalfe and Son proposed” – Metcalfe and Son (2012)

p. 259

“Phenomenologists such as Edmund Husserl” – Summarized by Gallagher and Zahavi (2021)

“Building on Husserl and Sartre” – Gallagher and Zahavi (2021)

“The term affect is often used” – Russell (2003); Barrett (2017); Panksepp (1998); Berridge and Kringlebach (2015)

“Timothy Lane” – Lane (2012)

“Similarly, Stanley Klein” – Klein (2015)

“As William James and others” – James (1890) p 243; Fleming, 2020; Dienes (2008); Koriat (2007)

“For example, Kalina Christoff” – Girn and Christoff (2019)

“Importantly, the effects on ownership” – Zamani et al (2022)

p. 261

“Deep learning may be a key part” – Saxe, et al (2021); Mei, et al (2022)

“These processes continuously” – LeCun, et al (2015); Clark (2000); Dodds (2018); Karklin and Lewicki (2005)

“Uncertainty, he says, prevails” – Based on comments in

<https://www.frontiersofknowledgeawards-fbbva.es/noticias/the-frontiers-of-knowledge-award-goes-to-judea-pearl-for-laying-the-foundations-of-modern-artificial-intelligence-so-computer-systems-can-process-uncertainty-and-associate-causes-and-effects/>

p. 262

“Piotr Winkielman” – Winkielman, et al (2015)

“Hakwan Lau and I” – LeDoux and Lau (2020)

“More recently, Lau and I” – Lau, et al (2022)

“Put in the context” – Fleming (2020)

p. 263

“First-order theorists such as Rafi Malach” – Malach (2021)

“Alex Cleeremans’s radical plasticity higher-order consciousness hypothesis” – Cleeremans (2008)

p. 264

“I will explain how emotions emerge” – LeDoux (2008, 2012, 2021, 2022), Other cognitive theories include Schachter and Singer (1962); Scherer (1984); Ortony, et al (1988); Barrett and Russell (2015); Barrett (2017); Frijda (1986); Mesquita, et al (2016); Flanagan (2021)

“Circuits involving the amygdala” – Fanselow and Pennington (2017); Panksepp (1998); Vandekerckhove and Panksepp (2011).

“The defensive survival circuit” – Satpute and Lindquist (2019)

“But the defensive survival circuit is not itself” – LeDoux (2012;2014, 2015, 2019, 2022); LeDoux and Brown (2017)

“The feeling of fear” – LeDoux (2020b; 2021; 2022)

“Emotion words categorize” – This para is based on LeDoux 2020; Barrett and Russell, 2015; Barrett, 2017; Clore and Ortony 2013.

p. 265

“The main difference in our views” – Vandekerckhove and Panksepp (2014, 2011)

“But it is important to note” – Lang (1969); Hugdahl (1981); Taschereau-Dumouchel, et al (2022)

p. 266

“Underlying this may be” – Damasio (1994)

“I do not subscribe to the distinction” – Ekman, 1992; Izard (1992); Damasio (1994); Panksepp (1998)

“Similarly, Lisa Barrett” – Barrett (2017); Lindquist and Barrett 2008; Lindquist et al (2013); Lindquist et al (2015); Clore and Ortony (2013)

“But cognition and emotion” – Heylighen (1992) and Gendler (2008)

“A critic from the rational camp” – I am grateful to Frederique de Vignemont for these very useful criticisms.

“Nathanial Daw and I” – LeDoux and Daw (2018)

“But just because conscious fear” – Frith (2008); Frith and Frith (2007); Heyes et al (2020); Shea et al (2014); Happé F, Frith (2020); Frith and Frith (2022)

p. 267

“For example, the philosopher Michael Tye” – Tye (2021) summarized in Papineau (2022)

## **Chapter 25 – What Consciousness Might Be Like in Other Animals**

p. 268

“Our brains also differ” – Preuss (2011); Semendeferi, et al (2011); Kaas and Herculano-Houzel (2017); Kaas (2013, 2017); Passingham (2021); Preuss (1995, 2007); Roth (2013) Ch 15 Are Humans Unique?

“and those primates’ brains” – Kaas (2013, 2017); Murray, et al (2017); Striedter and Northcutt (2020); Butler and Hodos (2005)

“The problem is not necessarily” – This section draws from previous writings, especially LeDoux (2015, 2019, 2022).

“According to Descartes” – Descartes (1637); Shugg (1968)

“The philosopher Daniel Dennett” – Dennett (1991)

p. 269

“He points out that” – Lewis (2014)

“This is why verbal reports” – Frith, et al (1999); Naccache and Dehaene (2007); Weiskrantz (1997); Dehaene, et al (2003, 2017); Rosenthal (2005); Dehaene and Changeux (2004); Sergent and Rees (2007); Koch and Tsuchiya (2007); Fleming (2020); Nahmias (2002); Wilson (1994); Ericsson and Simon (1980)

p. 270

“A shortcoming is that the veracity” – Wilson (1994); Ericsson and Simon (1980)

“A particularly popular one” – Heyes (2008); Povinelli, et al (2000)

“This approach has been criticized” – Heyes (2008); Povinelli, et al (2000)

“The extensive reliance on analogy” – LeDoux (2015, 2019); Penn, et al (2008)

“Christoph Marty” – Marty (2009)

p. 271

“Finally, he took the step” – Darwin (1871) Chapter IV, quoted in Keller (1973) p. 48

“But rather than cataloguing” – Knoll (1997)

“Elizabeth Knoll” – Knoll (1997)

“In it, Darwin applied” – Darwin (1871)

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“The psychologist Fred Keller” – Keller (1973) p.48.

“Georges Romanes” – Keller (1973)

“Rats were no longer” – Olds (1956); Mowrer (1960)

“Anthropomorphism is, in fact” – de Waal (1999); Panksepp (1998); Watt (2000); Burghardt (1991); Bekoff (2000); Griffin (2001)

“Scientists like me” – de Waal (1999)

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“But as others have pointed out” – Keller (1973); Penn, et al (2008)

“It is dinned into us” – Kennedy (1992)

“The philosopher Bertrand Russell” – Russell (1927)

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“The kinds of behaviors” – Heyes (2008); Povinelli, et al (2000); Shettleworth (2010); Suddendorf and Corballis (2010); Suddendorf (2013)

“The philosopher Brian Key” – Key (2015)

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“Mike Gazzaniga has described” – Gazzaniga (2018)

“The philosopher Mattias Michel” – Michel in Birch, et al (2022)

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“Jonathan Birch” – Crump and Birch (2021); Browning and Birch (2022); Birch et al (2020)

“I start by considering” – LeDoux (2021); LeDoux (2022)

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“The virtue of this approach” – Some may complain that this approach would ignore the question of consciousness in non-mammalian vertebrates and in protostome invertebrates. But if, in fact, it actually took the history of consciousness back to early mammals living some two-hundred million years ago, that would be an important achievement that would provide a foundation for considering these other groups.

“For example, if the human-unique component” – Heyes (1995); Povinelli and Prince (1998); Suddendorf (2013); Murray, et al (2017)

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“My view of mental-state consciousness” – A few non-mammalian vertebrates, and even a few protostome invertebrates, are endothermic in a situational sense, but do not have the full-body metabolic endothermy that mammals and birds have.

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“In mammals we can at least use” – In a recent publication (LeDoux, 2022) I proposed that the mammalian reverse-engineering strategy might be extendable to early vertebrates as well since

their brains are the direct precursors of mammalian brains. But I doubt this same approach could be useful for protostome invertebrates since they and deutostome invertebrates (the precursors of vertebrates) diverged more than six hundred million years ago.

“And I have no problem with others” – Crump and Birch (2021); Browning and Birch (2022); Birch et al (2020); Chitak (2022); Godfrey-Smith (2016, 2020); Reber (2019)

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“As I noted earlier” – Merker (2007)

“Others point to the ability” – Chikta (2022); Birch et a (2020)

“But there is also the possibility” – Vandekerckhove and Panksepp (2014)

“Such states may exist” – Vandekerckhove (2021). Also, personal communication by email from Marie Vandekerckhove, Jan 2023.

This discussion of content-free sentience is in part based on a discussion with Jonathan Birch on March 29, 2023, at the London School of Economics.

“If you’re certain” – Birch (2023)

## **Chapter 26 – The Stories We Tell Ourselves, and Others**

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“Back then, as I recounted” – Gazzaniga and LeDoux (1978)

“Over the subsequent decades” – Gazzaniga (1985)

“I closely followed developments” – LeDoux (1987, 1994, 1995, 1996, 2000, 2002, 2008, 2012, 2015, 2019)

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“Novelists, apparently inspired by William James’s description” – Apparently, James borrowed this idea from Alexander Bain. Waterhouse (2007). Examples of stream of consciousness literature include writings from James Joyce in Ulysses, Virginia Woofe in Mrs. Dalloway, Marcel Proust’ In Search of Lost Time, William Falkner’s The Sound and the Fury, Samuel Beckett’s Molloy, and Malcolm Lowry’s Under the Volcano.

“James’s novelist brother” – Cited in Bruner (1994), p 48

“But because they often diverge” – Fireman, et al (2003)

“Mark Freeman” – Freeman (2003)

“That may well be true” – Nader (2015); Alberini and LeDoux (2013)

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“For example, Daniel Dennett” – Dennett (1991)

“Owen Flanagan” – Einstein and Flanagan (2003)

“And Alasdair MacIntyre” – MacIntyre (1984)

“If you ever doubted Oscar Wilde’s claim” – Bruner (1994)

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“The stratagems employed” – Bruner (1994)

“Linda Örulv” – Orulv and Hyden (2006)

“Asaf Gilboa” – Gilboa, et al (2006)

“Others have studied confabulation” – Spitzer, et al (2017)

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“and schizophrenia” – Lysaker and Lysaker (2002)

“The sleep researcher Allan Hobson” – Hobson (1999); Pace-Schott (2013)

“According to Lisa Bortolotti” – Bortolotti (2018)

“Healthy people use episodic memory” – Ferretti, et al (2017)

“This is dramatically illustrated” – Morin (2009)

“A case with a more enduring condition” – Wearing (2005); Suddendorf, et al (2009)

“Absent inner narrations” – Hutto(2007)

“As Bruner noted” – Bruner (1987)

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“In his article ‘Death of the Author’” – Barthes (1986)

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“For example, the psychologist Julian Jaynes” – Jaynes (1976)

“Perhaps the voice in your head” – Fernyhough (2013)

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“This idea was challenged” – Vygotsky (1934/1987)

“Consistent with Vygotsky’s point of view” – Alderson-Day and Fernyhough (2015)

“Private speech has also been related” – Winsler, et al (2009); Fernyhough and Meins (2009); Baars (1997)

“Perhaps it is not surprising” – Alderson-Day and Fernyhough (2015)

“Actually, humans are believed” – Arbib (2012); Corballis (2014); Tomasello (2008)

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“These schema are then integrated” – Johnson (1992); Cowan (1995); Camos (2017)

“The output of the pre-conscious model” – Baddeley (2000); Baddeley, et al (2011)

“As originally proposed by the philosopher Jerry Fodor” – Fodor (1975) Fodor and Pylyshyn (1988)

“mentalese is a version of what” – Rescorla (2019)

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“We should not say that” – Rescorla (2019)

“Jake Quilty-Dunn” – Quilty-Dunn et al (in press)

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“In it he writes” – Fodor (1991)

“It is quite similar to a mentalese theory” – Rolls (2008)

“Her version of mentalese” – Schneider (2011)

“Steven Frankland” – Frankland and Greene (2020)

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“Key to their hypothesis” – Hafting et al (2005)

“What Frankland and Greene specifically argue” – Constantinescu et al (2018); Doeller et al (2010); Behrens et al (2018); Bellmund et al (2016); Bellmund (2018)

“Their hypothesis, which treats” – Quilty-Dunn et al (in press)

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“These are bundled together” – Herzog, et al (2020); Michel and Doerig (submitted)

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“What I have described is a mental model account” – Rosenthal, 1985; Lau and Rosenthal (2011)

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“This may also explain why verbal reports” – Dang, et al (2020); Block (2011); Sperling (1960)

“As such, this is a HO HO HOROR version” – Brown, Lau and Brown (2019), LeDoux and Brown (2017)

“The question of whether we actually make” – Gazzaniga (2012); Rose (2005); Dennett and Caruso (2021)

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“In a classic article in 1978” – Nisbett and Wilson (1978)

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“The default condition for consciousness” – Lau (2019); Fleming (2020)

“Consistent with this idea” – Haggard (2017); Crivelli and Balconi (2017); Sperduti et al (2011)

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“It might also help explain” – Libet et al (1983; Klein (2002); Lau et al (2006); Rose (2005); Kovác (2008); Braun et al (2012); Gazzaniga (2012); Dominik et al (2017; Charles and Haggard (2020); Dennett and Caruso (2021); Caruso (2012); Mitchell (2018, 2023)

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“Indeed, these types of analyses” – Joan Ongchoco articulated her suggestion in an email dated November 17, 2022

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“Proposed in 1950 by Alan Turing” – Turing (1950)

“As the philosopher John Searle pointed out” – Searle (1980). For discussion of Searle’s biological naturalism and the Turing Test see Cole (2020)

“More recently, the philosopher Tim Bayne” – Bayne (2018)

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“Writing about such systems” – Campbell (1974) cited in Kovác (2008)

“Alfred Lotka” – Lotka (1925) cited in Kovác (2008)

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“Similarly, Julia Hailova” – Hailova et al (2020)