

Prehistory of Cognitive Science: An Introduction¹

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For the purposes of this chapter, the prehistory of cognitive science is the period up to about 1900. There then followed an interregnum during which cognition was not much studied, and the period of cognitive science proper followed that starting in the 1950s and 1960s. The period up to about 1900 is called ‘prehistory’ because while philosophers and psychologists certainly studied the mind in this period, few envisaged a *science* of the mind. David Hume was one of the few exceptions and even he was only a partial exception because, while he hoped to build a scientific *model* of the mind, he did not do any scientific *investigation* of the mind. The prehistory came to an end when a group, a remarkably diverse group, of theorists began to do just that, Wundt, James, and Freud in particular. With the exception of Aristotle, all the figures that I will introduce in this short chapter came in or after the period often called the early modern period, which is usually dated from about 1600.

The interregnum was the period in which behaviourism reigned supreme in psychology and logical empiricism in philosophy. Then begins the period of the cognitive revolution (the

¹ This chapter is derived from the introductory essay in Brook 2007. The volume contains new essays on each of the ten authors that I discuss here. The contributors are: Stellan Ohlsson, Noam Chomsky, Marcelo Dascal, Anne Jaap Jacobson, Andrew Brook (who also wrote the Introduction), Don Ross, Arthur Blumenthal, Peter Simon, Tracy Henley, and Patricia Kitcher. The authors were asked to identify what was of permanent value in the figure on whom they wrote. The contributors are all active cognitive scientists. The result was a volume closer in topics and style to contemporary cognitive science than one usually finds in histories.

second cognitive revolution, some say, Descartes and colleagues having launched the first). The first glimmerings of the revolution can be variously dated: The development of programmable computers in the Bletchley code-breaking establishment in England of which Alan Turing was a member during the WWII (Turing wrote the seminal papers on computational theory that underpin the computational model of the mind before, during, and shortly after this period),² the famous Hixon Fund Conference, *Cerebral Mechanisms in Behavior*, at Caltech in 1948, the publication of Chomsky's *Aspects of Syntax* in 1956 (a work that revolutionized the way not only language but the whole of human cognition was conceived), and perhaps other dates. The year 1956 was also the year in which the idea of a unified, multidisciplinary research programme into human and artificial cognition was first officially articulated, at the now-famous *Symposium on Information Processing* at MIT, Sept. 10-12, 1956. Whatever, by the mid-1970s, the cognitive revolution had prevailed and cognitive science was well-established. The Cognitive Science Society was formed in 1977 and *Cognitive Science*, the Journal of the Cognitive Science Society, was started in 1979.

Like many other scientists, cognitive scientists tend to know relatively little about the history of their own subject. Such lack of knowledge would be a pity anywhere but it is perhaps particularly unfortunate in a discipline such as cognitive science, where the history is so long and where so much in the conception of the mind of at least classical cognitive science was handed down to us from long-past predecessors and still governs our thinking without much critical assessment.

This chapter does not aim to be a complete account of work in the prehistorical period. Indeed, I will fall far short of discussing all the important contributors in this period. I will introduce what I take to be the ten most important figures but that involves leaving many other significant contributors out. Some of the significant people not discussed include: Antoine Arnauld, logician extraordinaire and Descartes' great interlocutor, John Locke, the source of what came to be called 'British empiricism', Thomas Reid, Scottish contemporary of Kant's and advocate of common sense as a source of genuine knowledge, John Stuart Mill and Jeremy Bentham, worthy empiricist successors to Hume, Hermann von Helmholtz, successor to both Hume and Kant and teacher of Freud's teachers, and John Babbage, inventor of the first mechanical calculating machine. What I am interested in is figures who have had an enduring influence, who continued to be important well beyond their immediate period. To work!

² For many years, Americans in particular claimed ENIAC (**E**lectronic **N**umerical **I**ntegrator **A**nd **C**omputer), built at the University of Pennsylvania in 1946, as the first programmable computer. We now know that it was not. The group at Bletchley had created Colossus and other computers a few years earlier in the course of developing tools to break Enigma and Ultimate, Germany's ultra-high-secret military codes. Some versions of Colossus were programmable. Being under a thirty- to fifty-year gag order, the Bletchley group could do nothing about this misinformation until recently. Indeed, few people knew much if anything about Colossus until recently.

The Context

In the history of cognitive research, 1879 is often taken as a watershed year. Wundt is credited with creating the first-ever psychology laboratory in the Department of Philosophy of the University of Leipzig in that year. In fact, he had been doing psychological experiments for almost twenty years by 1879 but 1879 has stuck as the year in which experimental psychology began. Even though the research that Wundt did was not much like behavioural experimental work today, focussing on introspection as it did, he is credited with launching the experimental side of cognitive science, work that has dominated the discipline ever since.

Likewise, in 1879 Frege published *Begriffsschrift* [Conceptual Notation], the seminal work that presaged his epoch-making *Foundations of Arithmetic* (1884). Though badly received at the time, this work launched the formal apparatus of logic and semantics in the contemporary era, apparatus that continues to constitute the formal foundations of cognitive science, and also of logic and analytical philosophy of language, to this day. Prior to Frege, logic had hardly made any progress since the time of Aristotle and was most often done as a sideline when it was done at all. Kant is a good example: He simply took Aristotelian logic over lock, stock and barrel, and proceeded from there. To be sure, there were exceptions. Medieval writers such as St. Anselm, William of Occam and Nicholas à Cusa did important work, though broadly within the Aristotelian tradition. Descartes, Arnauld, and the Port Royal logicians also did work of enduring value at the intersection of logic and language, though it was lost again soon after. Leibniz formulated a grand research programme for logic, one, indeed, that Frege sometimes saw himself as carrying out. One might also mention Boole (of Boolean algebra fame), though he worked only a couple of decades before Frege. Nevertheless, in general it is true to say that there were few major developments in logic from Aristotle to Frege.

The last decades of the 19th century were a period of considerable ferment in cognitive research. In these years, psychology, linguistics, and logic and semantic theory developed into distinct intellectual enterprises. Prior to then, such work as had been done in these areas had been done mainly by researchers who identified themselves as philosophers or philosopher/psychologists. Even the separation of psychology from philosophy occurred only in the 19th century; Wundt for example was a member of a Department of Philosophy, not Psychology. Prior to this time, cognitive theorists of all stripes called themselves philosophers. (Of course, so did a lot of other researchers. Sir Isaac Newton's Chair at Cambridge, for example, is called the Chair in Natural Philosophy to this day and the term 'PhD' is short for 'Doctor of *Philosophy*' in Latin.) By shortly after 1900, psychology had decisively separated from philosophy, linguistics had come into its own as a separate discipline (though work on language did not have much influence on general cognitive research until Chomsky and the 1950s; Whorf's work in Harvard's famous five-cultures study of the 1950s³ was one of rare exceptions), and the

³. In what is widely considered to be the first major empirical project in anthropology, a group of Harvard anthropologists and linguistics studied five linguistic/cultural groups in the four-

logical/semantic tradition that Frege's work made possible had established itself via Russell, the early Wittgenstein and the logical positivists of the Vienna School as a dominant influence within English-speaking philosophy.

Ten Major Contributors in the Prehistory of Cognitive Science

In this chapter, I will, as I said, introduce ten major figures from the prehistory. They are: Aristotle, Descartes, Hobbes, Hume, Kant, Darwin, Wundt, Frege, James, and Freud. These ten researchers discuss an enormously diverse range of topics in an enormously diverse range of ways. In my view, this diversity is significant; indeed, it is still a feature of cognitive science. If cognitive science is unified as a conception, it is much less unified as an activity. A great many voices and a great many topics contend with one another, voices ranging from hard empirical and computational modelling at one end to broad speculations about situated cognition and chaotic systems at the other, topics ranging from 'classical' ones such as syntax, lexical processing, perception, and reasoning systems to such things as connectionism, dynamic systems, and cognitive neuroscience.⁴ We find much the same diversity in the major figures of the prehistory.

Aristotle

The story of serious, systematic thinking about cognition goes back as far as Aristotle, indeed perhaps even to Plato (see Table 1 for dates). Aristotle, for example, articulated a distinction between practical and theoretical reason that is still accepted and continues to be influential. Theoretical reasoning is reasoning about what to believe, what is the case, etc., while practical reasoning is reasoning about what do, what ought to be the case, etc. Aristotle saw so far into the distinction that he even connected it to the distinction between teleological and mechanistic explanations. Practical reasoning concerns what he called final causes, that is to say, goals and purposes. Theoretical reasoning, though concerned with final causes, also concerns itself with what he called efficient causes or what we now would call mechanisms and causes, period. Aristotle

corners area where Arizona, Utah, New Mexico, and Colorado meet. The groups were Hopi, Apache, Navaho, English-speaking ranchers, and Hispanics.

⁴ Sometimes one finds both sides in one person. William Clancey is a good example. Compare his book *Situated Cognition* (1996) with his earlier AI work developing expert systems such as MYCIN.

articulated a system of sentential logic that survived unscathed until the time of Frege. And his account of what we would now call human cognition in *De Anima* is the first attempt ever to give something like a systematic description of human cognition.

[Table 1 about here]

Nevertheless, in important respects the story of *cognitive* research begins later. Aristotle described something recognizable as cognitive functions, indeed saw them as functions of the body and arguably as biological functions, but he had no conception of representation as we now understand it, nor of consciousness, nor of memory, nor of perception as the processing of information in the brain, nor ... nor ... nor That he did not have a concept of a mental representation, a concept, that is to say, of something that functions by standing for or referring to something else, is arguably the thing that most centrally separates his work from all work on cognition in the modern era, which begins about 1600.⁵ Aristotle held that perception, for example, consists roughly in taking the essential structure of the perceived object into the mind. Thus perception is ‘built out of’ aspects of the thing perceived, not out of states and processes that *represent or stand for* the thing perceived. Aristotle’s view of perception was the view adopted (or assumed) by most theorists, both Platonists and Aristotelians, until the modern era. St. Thomas Aquinas is a good example.

Though there are anticipations of our current conception of a representation in some late medieval thinkers (Pasnau 1997), it achieved its current form at about the time of Descartes and Hobbes (see Table 1 for dates). It is with this conception that the study of cognition as we now understand it really begins (though the idea of a *science* of cognition was still centuries away even at that point). It is not that nothing happened in the roughly two thousand years between Aristotle and Descartes. In fact, a great deal happened, more than is usually realized. In late Roman times, for example, St. Augustine had already articulated the inference for which Descartes is famous, the inference *cogito ergo sum* (I think therefore I am). But Augustine had no precise conception of *what* the ‘I’ is, indeed probably did not get much further than Aristotle on that score. (I am painting with a very broad brush here.) Descartes did, and so did Hobbes.

Descartes

⁵ There is an interesting and complicated story to be told about the history of the notion of a representation. While there is not much evidence of any clear notion of a *mental* representation prior to the time of Descartes and Hobbes, something like our current notion of a *linguistic* representation, a sign, goes all the way back to the Stoics (Dascal and Dutz 1997). Why one notion of something presenting or standing for something else should have developed so much sooner than the other is an interesting question.

Descartes held that the mind is ‘a thing that thinks’. What he meant by ‘thinks’ was something very different from what Aristotle would have had in mind. Descartes conceived of the materials of thinking as representations in the contemporary sense. And Hobbes was the first to clearly articulate the idea that thinking is operations performed on representations. Here we have two of the dominating ideas underlying all subsequent cognitive thought: the mind contains – and is a system for manipulating – representations.

Descartes’ contribution to our conception of human cognition was massive. The central aspects of it endured with no serious competitors until about fifty years ago. These aspects include:

- the notion of a representation, i.e., something cognitive that stands for something else,
- the idea that representations are in the head (in the mind), and,
- the idea of the mind as a unified system of representations, a unified being to whom representations represent

Dennett (1991) calls the last notion, the idea of the mind as a being to whom representations represent in a kind of quasi-spatial arena inside the head, the Cartesian Theatre. All these ideas endure to this day. They all figure, for example, in Fodor’s representational theory of mind. Many of the most persistent problems about cognition also stem from them, e.g., the problem of knowledge of the external world and of other minds. Many recent developments in cognitive thinking are direct reactions to them, e.g. Gibson’s ecological cognition (Gibson, 1979) and externalism about the content of representations (the claim that ‘meanings just ain’t in the head’ in Putnam’s memorable 1975 phrase). In addition to Gibson, other serious alternatives to the Cartesian picture as a whole since World War II have included behaviourism (Skinner 1974, Ryle 1949), Dennett’s multiple-drafts alternative to the Cartesian Theatre (1991, for commentary see Brook and Ross 2002), and connectionism and neurophilosophy (P. M. Churchland, 1984, 1994; P. S. Churchland 1986). However, the Cartesian picture remains overwhelmingly the dominant picture in cognitive science.

Descartes model of the mind has been extensively discussed in recent decades, by Ryle (1949) with his critique of the ‘ghost in the machine’ and Dennett (1991) with his critique of the Cartesian theatre, so I won’t say anything further about it. In addition to articulating a representational model of the mind, Descartes is generally credited with being the father of rationalism, the view that knowledge or at least some forms of knowledge can be achieved independently of experience. His view remains alive to this date, for example in the Chomskian claim that much of our knowledge of grammar is innate.

Against the empiricist-sounding dictum of Aristotle that “nothing is in the

mind that is not first in the senses”, Descartes argued that what the mind achieves by *reflection* on things is closer to knowledge of their nature than what it *observes* about them.⁶ Descartes was thus the first to pay serious attention to the balance between the role played by the mind and the role played by sensible experience in the acquisition of knowledge. In the form of the battle between empiricism and rationalism, this problem achieved its first resolution only with Kant and continues to be a live issue today, for example in the controversies over the size of the mind’s ‘top-down’ contribution to abstracting patterns from sensible stimulations.

Nor was Descartes’ originality limited to the mind. With Galileo and others, he was also one of the originators of the mechanistic conception of the universe, for example, and he did extensive experimental neurophysiology. Indeed, he laid down a neurophysiological conception of vision and of cognition more generally.⁷ Descartes made language a central indicator of the presence of a mind (though, as Dascal shows, he also *separated* language from cognitive activity more radically than most would now). He had a major influence on the work on logic and language of his contemporaries at Port Royal. (Many important ideas of the latter group were lost again.) All of the ideas introduced in the preceding paragraphs are of enduring value.

To be sure, not everything that Descartes believed about the mind has lived on. For modern tastes, he placed the balance between the contribution of the mind and the world too far on the mind side, being the good rationalist that he was. Rationalism as exemplified by theorists such as Spinoza and Leibniz is the view that the representations to be trusted are the ones arrived at entirely inside the head by processes of reasoning alone. (The crucial kind of reasoning here is the exploring of the semantic implications of one’s concepts and propositions.) When cast less austere and therefore more plausibly, a modest form of rationalism lives on, as we said, in Chomsky’s conception of universal, innate grammar and also in Fodor’s language of thought hypothesis (the latter is the view that the materials out of which our concepts are constructed are also universal and innate). However, few theorists now would push the idea as far as Descartes seems to have done.

More importantly, strongly impressed by the complexity of language and the

⁶ Aristotle’s dictum might appear to be ultra-empiricist but we should be cautious about jumping to this conclusion. His picture of perception was utterly different from ours; he thought that essential features of the structure of objects literally move from the objects into us. His picture being so different, nothing but confusion is likely to result from giving the two conceptions of the source of knowledge the same name.

⁷ In connection with this, Descartes and his tradition achieved the first clear articulation of the problem of unifying knowledge formulated at different levels and in different vocabularies, goal-directed language vs. mechanistic language, for example. Aristotle had anticipated some aspects of the issue but Descartes confronted it head-on. It is a major issue today.

free creativity that it made possible, Descartes held that minds able to use language are things entirely ‘separate and apart’ from the body, nonspatial, nonmaterial entities made up of who knows what and, together with this, that nonhuman animals do not have minds. (He held, for example, that nonhuman animals cannot feel pain and dissected them without anaesthetic.) Few contemporary cognitive scientists follow him in any of this. That said, his explanatory dualism persists. Many cognitive scientists think that we are permanently stuck with a duality of explanations – explanations of neurological processes in the language of the neurosciences and explanations of cognitive function in the language of folk psychology or some other teleological language. (This is one way in which Aristotle’s distinction between theoretical and practical reasoning lives on.) Some cognitive scientists even think that we must retain a dualism of properties, e.g., between neurological composition and cognitive functioning, or between cognitive functioning and qualitative feel, ‘qualia’ in philosophers’ jargon (Chalmers, 1996). But few now accept Descartes’ ontological dualism, however obvious it seemed to him; few now think of a person as a “union” of two utterly different kinds of thing. Indeed, the reverse seems obvious to most people.

Hobbes

In this Hobbes has had the more enduring influence. Hobbes was a near-contemporary of Descartes’, indeed wrote the best-known of the six series of objections to Descartes’ *Meditations* of 1645. On the fundamental nature of the mind, Hobbes and Descartes utterly disagreed. Hobbes urged that the mind simply is the brain or certain aspects of it. This is connected to his single greatest contribution to our conception of cognition, the idea, as he put it, that “all reasoning is but reckoning” (1651 I, 5, pp. 1-2) – all thinking is computation. Put Hobbes’ mechanistic materialism together with Descartes’ notion of representation and you have the fundamentals of the contemporary picture of cognition: cognition consists of computations over representations.

If Hobbes was a materialist, there is a good deal more to his view of knowledge than simple empiricism. Hobbes’ claims about the tight relationship between language and thought are closer to the spirit of rationalism, to Spinoza and Leibniz, than to empiricists such as Locke and Hume. Indeed, Hobbes inspired a research programme on thinking that was at the centre of both rationalism and empiricism in the 17th and 18th centuries, a programme that continued at least as far as Stewart in the 19th century. On the other hand, though Descartes is supposed to be the father of rationalism, his separation of language and thought was much more in the spirit of empiricism than of rationalism. Indeed, both Hobbes and Descartes cross-cut the time-worn division of early modern cognitive thinking into empiricism and rationalism.

Hume

As we have indicated, rationalism of one kind or another was one of the great stances on knowledge acquisition and validation of the early modern period. The other was empiricism, as in the Aristotelean dictum that “nothing is in the mind that is not first in the senses” interpreted as we would now interpret it (see note 6). The British philosopher John Locke is generally viewed as the originating figure of what came to be called British empiricism. However, there is at least some ambiguity about the extent of Locke’s empiricism. By contrast, the Scottish philosopher David Hume was unambiguously and radically an empiricist. He carried out the empiricist programme more comprehensively and rigorously than anyone before him (and maybe since). Hume held that there is no source of knowledge except sense experience. He also held that an empiricism rigorously followed out will end up denying that sensible experience has anything like the structure of a language – sensible representations are like pictures, not propositional structures, and associations govern their relationships, not propositional relations. This is enough by itself to make Hume the grandfather of behaviourism and of connectionism. Hume also saw a set of sceptical problems as lying at the heart of empiricism. According to him, we can never justify our beliefs about: the world external to us; the future; or even the past! However, how one views this sceptical streak in Hume’s work depends very much on how one views his project as a whole. If one views him as holding to a picture of representations as like objects of some kind, then one must see him as mired in deep sceptical problems indeed. If one sees him as holding, in the spirit of later thinkers, that representations are cognitive acts of some kind, the issue about scepticism may take on quite a different cast.

Hume not only took empiricism about the contents of knowledge more seriously than anyone before him and maybe since, he also insisted that theories of mind stay within empiricist bounds. In particular, he insisted on what we would now call a naturalized epistemology. Not just the mechanisms by which we acquire knowledge but also the *standards by which we assess knowledge claims* have to be derived entirely from what nature provides. Likewise, by insisting even more rigidly than Descartes that everything about the content of representation is ‘in the head’, he formulated a picture of the content of representations that is still orthodoxy.

Now called *individualism*, it remains the view of most cognitive theorists even in the face of a recent challenge, *externalism*. Externalism is the view that the content of representations, what representations are about, consists of a relationship of some kind between what is going on in the head and what is found in the world (Putnam, 1975). Some (e.g., Clark and Chalmers 1998) even urge that some aspects of cognition lie outside the head. Externalism is largely confined to some philosophers of mind and has never had much influence in the rest of the cognitive community. (Some philosophers view J. J. Gibson and the more recent situated cognition movement as varieties of externalism but this view is disputable (Brook 2005).)

Kant

Kant brought empiricism and rationalism together. Gaps, as Kant saw it, in Hume's empiricism and the sceptical problems about the nature of the self and the knowledge that it seemed to Kant to entail aroused him from what he called his "dogmatic slumbers" – an uncritical submersion in the rationalism of his time. Spurred by the example of the trouble that radical empiricism had caused Hume, Kant argued that the element in knowledge advocated by rationalism and the element advocated by empiricism are both necessary – to acquire knowledge, we need both sensible input and *a priori* activities of the mind. As he put it in a famous aphorism, "thoughts without content are empty, intuitions without concepts are blind" (1781, p. A51=B75). That is to say, we cannot confirm or disconfirm conceptualizations without experiential evidence, no matter how carefully we think about the conceptualizations – but we cannot organize experience without applying concepts to it. The first cuts against full-blown rationalism, the second cuts against extreme forms of empiricism. Kant's resolution of the empiricist/rationalist tension is now widely accepted in cognitive science, some connectionists being among the few exceptions.

Other views of Kant's about the mind have also been incorporated into cognitive science, Kant's view about the mind as a system of functions and his views about the right method to study the mind in particular. For these reasons, Kant can even be viewed as the grandfather of cognitive science.

If some of Kant's central ideas about the mind live on, it is interesting that a number of the ideas that he held most dear have played hardly any role in contemporary cognitive science at all. This is true of Kant's claims about the mind's synthesizing powers, about its various mental unities (in particular, the unity of consciousness), and about consciousness of self. Not only have these views not been superseded by cognitive science, they have never even been assimilated by it—and they deserve to be. Or so I have urged (Brook 1994).

Nineteenth Century

If Wundt, Frege, and 1879 are the divide between the prehistory of cognitive science and the next period, Kant's *Critique of Pure Reason* of 1781 is the divide between the 18th and 19th centuries. Empiricism as Hume had laid it out in the *Treatise of Human Nature* (1739) continued to influence thought about cognition in the 19th century but the dominant influence, certainly in the German-speaking world, was Kant. Except for a few stubborn empiricists, work in German on cognition in the 19th century and even a lot of work in English consisted of spelling out and beginning to test ideas that Kant had articulated. Indeed, that is true of a lot of work on cognition up to the present. (The

influential Cartesian ideas that we listed earlier live on in Kant's picture so Kant's picture continuing to have influence is also Descartes' picture continuing to have influence.) There have been movements that rejected the Kantian picture of cognition, of course. We have already mentioned connectionism and could add behaviourism (a form of extreme empiricism), though it was never part of cognitive science. But classical cognitive science and the great majority of cognitive researchers up to the present hold to a model of the mind that is Kantian in many essentials. Though, as we said, contemporary theorists have neglected some topics dear to Kant's heart, they conceive of the mind largely as Kant conceived of it.

The 19th century saw a blossoming of theorizing about cognition. A great deal of it did not add much that was really original to the two models that we were left with at the end of the 18th century, empiricism and the Kantianism synthesis. J. S. Mill, Herbart, and Helmholtz might be considered examples. Among 19th century figures who did add major new ideas, one thinks immediately of Darwin.

Darwin

Anticipations of Darwin's theory of evolution can be found earlier but as a well-articulated theory based on imposing and powerful evidence, Darwin's work had no antecedents. Evolutionary theory is coming to play a central role in cognitive science, and that for a variety of reasons.

First, evolutionary theory is an excellent way to approach the important task of reuniting cognitive theory and neuroscience. Cognitive theorizing and biology were deeply interanimating in Darwin's time but by the time of the great cognitive revolution of the 1970s, the two had come apart. Entranced by the computer metaphor, cognitive scientists of the classical period urged that, like computer system designers, we can understand the functioning, the 'software', of the mind/brain without needing to know much about how those functions are implemented in the brain. (Indeed, it was common to refer to the brain as the 'wetware'.)

Second, evolutionary theory is an excellent way to approach the task (and also, some think, the limitations) of building a purely naturalistic epistemology – an account of knowledge acquisition within the limits of what nature has provided (including acquisition of knowledge about the mind itself). It took a long time for evolutionary theory to come to play any important role in cognitive science but it is now the case that cognitive scientists who ignore Darwin do so at their peril.

Wundt

Alongside the idea that cognition has evolved, Wundt introduced a second element that was largely new: The idea that claims about cognition should be submitted to empirical test. Of course, the experimental method did not originate with Wundt. What he did was to find a way to apply it to claims about cognition. Few would disagree with Wundt about the importance of experimental verification today.

For Wundt, the experimental method was not an end in itself. Wundt thought that it revealed deep aspects of the mind that other methods do not reveal. Interestingly enough, for Wundt, the mind thus revealed fits Kant's picture better than the empiricist picture. However, Wundt's picture was not Kantian in every respect. His rejection of the idea of discrete, persisting representations resonates more with anti-representational views such as situated cognition than it does with Kant, for example.

Frege

A third new development in the 19th century from an entirely different direction was Frege's invention late in the century of the concepts and tools of modern symbolic logic and semantic theory. Indeed, most of the formal foundations of contemporary cognitive science were articulated by him. His work is the basis not just of logic and semantic theory but also of computational theory, which was the basis in turn of the computer revolution and artificial intelligence. Given that Frege himself fought ferociously to separate logic and semantic theory from psychology, there is a certain irony in the fact that his work laid the foundations for the whole formal side of cognitive science.

Frege's many contributions defy brief summary (for details, see Peter Simon's excellent paper in Brook 2007). However, the formal analysis of language that he pioneered, his concept of a formal system with a rigorous syntax, his proof theory and semantics, and his approach via exact analysis to meaning, reference and thought in many of their forms are now indispensable to more formally-oriented cognitive science. Quite an accomplishment for a single thinker!

James

James' place in the prehistory of cognitive science is a bit different from Darwin's, Wundt's, or Frege's. With James there are no stunning new ideas that changed the shape of cognitive research forever. His body of work as a whole had a major influence but because of its accessibility and the breadth of issues that James took on, not because of major innovations. His best-known contributions are to a topic that slid from the view of most cognitive researchers not long after his time and surfaced again,

at least as an empirical enterprise (it had never disappeared in philosophy), as late as the 1980s – consciousness. Probably the single best-known concept in James is his notion of the stream of consciousness. James also made significant contributions to our understanding of association, memory, imagery, imagination, and reasoning.

Perhaps his most important contribution was his distinction between explanation by reference to biological foundations and explanation by reference to social/behavioural factors – a new version of the explanatory dualism that, as we saw earlier, goes all the way back to Aristotle. Finally, and reason enough by itself for including James as a central figure in the prehistory of cognitive science, his articulation of the idea of the mind as a system of functions is fuller than any in his time, indeed any prior to about thirty years ago.

James did not originate the functionalist conception of the mind. The basic idea goes back to Plato and Aristotle and we find a full statement of what a mental function is and how the mind as system of functions works in Kant (Meerbote 1990, Brook 1994, Chapter 1). James carried an already-existing idea further. However, he carried it a great deal further. (There is a nice irony to James unwittingly following Kant in this way: James ridiculed Kant as few others have ever done (see Brook 1994, p. 1 for a leading example) .)

Freud

Freud fits into the prehistory of cognitive science in yet another different way. He was a great innovator, of course: his theories of unconscious anxiety, defence transference and so on, his view that neurotic and often psychotic emotion and cognition are meaningful, the patients have reasons for feeling and thinking as they do, his theory that dreams contain crucial information about the dreamer, his claims that young children have a far richer, complicated, and structured sensuous life than anyone had realized, and the like changed the way we conceive of the mind. But Freud's ideas have not directly influenced cognitive science in the way that Darwin's, Frege's, and Wundt's have. Indeed, far from being influenced by psychoanalytic theory, many cognitive scientists are deeply suspicious of it. His importance lies in a different direction.

What makes Freud important to cognitive science is that he was the first to build a comprehensive interdisciplinary model of the mind. Where he succeeded and especially where he failed still have a great deal to teach us. Freud's fullest statement of his model (1895) was not published in his lifetime but the ideas in it shaped his thinking for the rest of his life. Perhaps the greatest problem facing such models is that they are hostage to the state of knowledge in the relevant disciplines at the time. Freud attempted to draw together in a single model everything significant known (or

believed) about the mind by neurobiology, psychology, anthropology/archaeology, and evolutionary theory in his time. Unfortunately, this effort entails that if any of them were seriously wrong, his model was going to be seriously wrong, too. And the neurobiology of his day, built on a kind of hydraulic, reflex model of the forces of the mind/brain, was seriously wrong (to speak only of it). Interdisciplinary models of the mind in cognitive science continue to be hostage to surrounding science in exactly the same way.

Indeed, Freud may well have had more faith in the neurobiology of his time than did researchers in the field – something we still find today sometimes when cognitive scientists attempt to import chaos theory, or dynamic systems theory, or neural network architectures, or quantum mechanics into their work.

Conclusion

We will close where we began. No single discussion could come remotely close to doing justice to the range of ideas about cognition articulated prior to 1900. Nor was that my aim. Rather, I have tried to introduce ten researchers prior to 1900 whose ideas continue to shape how we conceive human cognition.

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Plato (438BC-347BC)	
Aristotle (384BC-322BC)	
Descartes (1596-1650)	
Hobbes (1588-1679)	
Empiricism	Rationalism
Locke (1632-1704)	Spinoza (1632-1677)
Hume (1711-1776)	Leibniz (1646-1716)
Kant (1724-1804)	
Darwin (1809-1882)	
Wundt (1832-1920)	
Frege (1848-1925)	
James (1842-1910)	
Freud (1856-1939)	

Table 1. Fourteen main figures in the prehistory of cognitive science