INFORMATION AND COGNITIVE SCIENCE: Preliminary outline, Margaret A. Boden

Information theory was important in the origin of cognitive science, but played almost no part in it thereafter. The most pervasive effect of information theory, as of cybernetics in general, was that it allowed scientists—engineers, biologists, neurophysiologists, psychologists, anthropologists, and even sociologists —to focus on abstract concepts rather than matter and energy.

Psychologists who had doubts about behaviourism could therefore feel free to theorize about things other than observable behaviour. Candidate "things" included mental structures and processes—which were already being discussed, since well before mid-century, by (e.g) Gestaltists and Piagetians.

The licence to speak about mental processes was strengthened by the Ambiguity of the term "information". As Shannon defined it, this had nothing to do with meaning. But as normally understood, it's an intentional concept. Throwing it into the theoretical arena was bound to lead psychologists to think about information and communication (another non-intentional term, when used by Shannon) in their everyday, mentalistic, senses. Shannon himself suggested that statistical measures could be used to predict/analyse language. Some linguists (e.g. Bar-Hillel) were excited by Shannon's theory in the early-1950s. But Chomsky reacted strongly against it.

The concept of information was often used (loosely) by psychologists as a way of thinking about perception and thought, rather than as a way of **measuring** it. The information-psychologists, however, did try to measure it. E.g. George Miller and the Magic Number Seven (1956)—the most-cited paper in psychology.

Donald Broadbent, in the 1950s, focussed not only on channel-capacities (and selective attention) but on information **flow**. This was naturally linked by many people to the idea of detailing psychological **processes**. But when computational psychology (theorizing and/or modelling) arrived, Broadbent didn't switch to it. Even so, he was broadly sympathetic to it as an example of "empirical" psychology. He thought it not so much inappropriate as premature.

Jerome Bruner did a hugely influential study of concept - learning (1956). He distinguished between positive and negative information, and studied degradation of performance with information overload.

Perceptual/conceptual hypotheses were a crucial concept for early work in computational psychology (e.g. Bruner, Richard Gregory). They were also influential in symbolic AI. E.g. the scene-analysis approach to computer vision.

Today's cognitive science retains an interest in the success/failure of communication (E.g. Sperber and Wilson on symbolism and relevance). But the notion of computational overload is more common than that of informational overload. This is no accident: Shannon was interested in whether or not a signal would reach a receiver, not in what might happen inside the receiver afterwards.

The anthropologist Gregory Bateson was enthused by cybernetics in general. And early cognitive scientists assumed that anthropology would be one of the key disciplines in cognitive science In the event, it dropped out of sight in about the mid-1970s. One reason was that mainstream anthropologists now rejected **any** scientific approach to the discipline. Cybernetics and/or information theory were no longer favoured. Whereas Shannon insisted that "information" doesn't imply "meaning," most cognitive scientists were interested in "semantic" computation. So information theory **as such** was soon left behind.

Symbolic computation, capable (so it was assumed) of representing words, concepts, and propositions, was at the fore of cognitive science for a quarter-century. Then, it was joined by a revivified connectionism. But it was still assumed by computational psychologists that AI-

based (symbolic and/or connectionist) theories could represent meanings, and meaningful processes—in a word, "information" in its everyday sense.

Philosophers of cognitive science pointed out that this assumption was problematic. Some argued that it was false (Searle 1980). Others argued that intentionality in general is evolutionarily based (Millikan 1984)--from which it would follow that A-Life evolutionary robots might possess 'proper' meanings, even though designed/programmed systems cannot. However, disputes about the naturalization of intentionality are irrelevant to Shannon's (technical) information theory.

In sum, information theory—often, misinterpreted—was a powerful catalyst in the early days of cognitive science. But it wasn't, and couldn't have been, use to help in postulating specific mental structures and processes. That is, it couldn't be a core aspect of a mature cognitive science.