

5. Bower, 1972 p.56. Although Bower seems to have been a pictorialist when this paper was first written and presented he later espoused a descriptionist position [Anderson & Bower, 1973 pp.449-461]. (Anderson by contrast has since moved some way towards pictorialism [Anderson, 1978, 1983]).

6. See Matthews [1969 §IV] for other objections to the theory.

7. 1974.

8. 1977.

9. In any case, there is independent physiological evidence for the point [Gazzaniga & LeDoux, 1978 p.122].

10. Kosslyn & Pomerantz, 1977 p.57.

11. C.f. Anderson, 1978.

12. Kosslyn & Pomerantz, 1977 p.59. This is also intended to help answer Pylyshyn's [1973] point that storing unprocessed images in memory would quickly overburden the storage capacity of the brain.

13. Inner 'language of thought' models seem to require innate concepts in any case [Fodor, 1981a chap.10; 1975]. If we can swallow that why not swallow innate image parts along with them? It is hard to see how else they could arise.

Notes to §II.C.1.

1. Shorter, 1952 p.538f.

2. See §II.B.4 above. Shorter's claim that the analogies between "visualising" and both "describing" and "depicting" are closer and less misleading than those between "visualising" and "seeing" is surely very much open to question [see Flew, 1956; Hannay, 1971 chap.III].

3. 1969 pp.135f. A very similar argument is set out in rather greater detail by Runzo [1977], but this discussion is too late to in any way anticipate much more concrete formulations of 'descriptionism' in the literature of Cognitive Science.

4. Dennett is manifestly highly uncomfortable with the theory, and elsewhere in the same work [1969 pp.86f] and later [1978 chaps. 3 & 6] he is highly critical of the "brain writing" idea. Nevertheless, he would seem to be even less comfortable with pictorial theories.

5. Philebus 39a - Hamilton & Cairns, 1961 pp.1118-1119. Plato is not advancing a descriptionist theory of imagery however. He goes on to suggest an 'inner artist' painting pictures in our souls on the basis of these assertions [Philebus 39b].

6. Ballard & Brown, 1982 p.xiii.

7. 1986 p.3.

8. Pentland, 1986.

9. The parallel with Plato may be no accident either. Dreyfus [1979 pp.67f] sees the roots of the tradition from which AI springs in the fundamental Socratic/Platonic requirement that all real knowledge can and should be made fully explicit.

10. Haugeland, 1985 p.2. For more satisfactory characterisation read on in Haugeland, or see Boden [1977]. Rather recently the name has also come to be used to cover attempts to apply ideas and programing techniques developed within this project to limited practical problems (in particular, production of so called 'expert systems'), thus defining AI by its methods rather than its aims. But this 'applied AI' is of no special philosophical interest.

11. Boden, 1977 pp.15-17. This insight is probably most associated with the AI pioneer Alan Newell (last spotted riding on an elephant) [McCorduck, 1979 p.129], who has recently discussed it in some detail [Newell, 1981].

12. See Haugeland, 1985 p.4.

13. Boden, 1977 p.15.

14. See Goodman, 1976 chap.I §1.

15. Boden [1977 p.16] also cites historical and practical reasons.

16. Simon, 1972; Baylor, 1972; Newell, 1972; Moran, 1973.

17. C.f. Armstrong [1961; 1968 chap.10] who came this far without the AI influence.

18. Sutherland, 1968 p.315. I think this may be the earliest application of these ideas from computer vision to real problems of biological vision.

19. Pylyshyn, 1973; Anderson & Bower, 1973.

20. E.g. Schank, 1979; Waltz, 1979.

21. Baylor, 1972; see §II.C.2 below.

22. See Pylyshyn, 1973 pp.20f; Simon, 1972 p.195n;

Anderson & Bower, 1973 p.44.

23. Baylor & Gascon, 1981.

24. Kosslyn, 1980 p.471; 1981. Pylyshyn, 1981; Moran, 1979.

25. Propositions, in the Fregean sense familiar to philosophers, are not (if they exist at all) things which can be "in" the memory, or any other part of the mind.

Frege made a careful distinction between (1) the sentence which is uttered or written, (2) the mental idea(s) accompanying it, and (3) the *Gedanke* (usually translated as 'proposition' or 'thought') which the sentence expresses. Ideas are subjective and private, but the proposition or thought is not, having no bearer or owner. It is an abstract entity (...) and enjoys the same sort of reality as a Platonic Idea. Frege thought of it as belonging to a 'third realm' - a timeless order of nonphysical and nonmental objects. [Gale, 1967 p.501]

Clearly the contents of STM are not propositions like this. However, neither would it be appropriate to call them "ideas" since this term carries a strong connotation of the Empiricist theory of self-intimating mental pictures, which is precisely what is here being rejected. Cognitive Scientists have borrowed, and misconstrued, the philosophical term of art "proposition" to express the notion of mental representations which are more like sentences, having both an internal syntax and a truth value, than like pictures [see e.g. Anderson & Bower, 1973 p.3]. Philosophers who have discussed this sort of theory [e.g. Fodor, 1975, 1981a; P.M. Churchland, 1979; P.S. Churchland, 1980] have generally preferred to talk of "sentential" rather than "propositional" representations. However, the usage of psychologists and AI researchers is not without point, for the idea of 'mental sentences' would also be misleading. 'Propositional representations' are supposed to resemble the 'deep structures' of Chomskyan linguistics. They do not consist of sentences in the thinker's natural language (English, Chinese etc.), but rather are expressed in the 'physical symbol system' [Newell, 1981] of the brain or computer. Furthermore, 'propositions' are generally supposed not to be embodied in linear strings of symbols, like a natural language sentence, but in more complex data structures such as networks or 'trees'. This enables them to have considerably less syntactic structure than ordinary sentences (e.g. such representations may be neutral as to active or passive voice). In this last regard they do indeed start to tend toward Fregean propositions, which are purely semantic 'objects'. Sober [1976 p.108] proposes a possible continuum between Fregean propositions (with no syntax) at one end, and natural language sentences (with

lots) at the other. The 'propositional representations' found in computers and perhaps in brains would fall somewhere in between, and it is not entirely obvious which term should best apply to them. There may, however, be one importantly misleading effect of the "proposition" usage. The meaningfulness of Fregean propositions cannot be a problem; if they exist at all they are meanings. The meaningfulness of 'sentential'/'propositional' mental representations, by contrast, is highly problematic (as we shall see in §II.C.5.). The terminological confusion between such representations and Fregean propositions may help to explain the scandalous lack of attention paid by cognitive psychologists to this problem.

26. 1973 p.18.

27. See Kosslyn, 1980 p.471.

28. Fodor, for one, seems to have been misled here [1975 p.188].

Notes to §II.C.2.

1. Feigenbaum & Feldman, 1963; Minsky, 1968. The name "Artificial Intelligence" was originally applied specifically to the former sort of approach, but today it is commonly applied indiscriminately to any work on trying to get computers to think. See Gunderson [1985 pp.167-179] for a similar, but finer, sub-classification of possible aims within contemporary AI research.

In the earlier days of their collaboration Newell was at the Rand Corporation, but he later moved to join Simon at Carnegie-Mellon.

2. Simon, 1972; Newell, 1972.

3. Baylor, 1972; Moran, 1973; Farley, 1974. For briefer, published, accounts of this work see Baylor, 1973; Baylor & Racine, 1977; Farley, 1976.

4. There has been considerable work on representations for visual information, but this has not been specifically directed at problems of imagery or imagination, and is of questionable relevance to them. Some of this work will nevertheless be looked at below.

5. This latter strategy has recently been recommended by Dennett [1978b, 1986]. The "cybernetic" approach to the mind, as represented for example by the simple exploratory and conditionable robots of Grey Walter [1963 chap.5, p.122f; see McCorduck, 1979], did make some attempts along these lines. However, it has been very much eclipsed by AI in recent years.

6. Newell & Simon, 1972.