

quasi-pictorial imagery as the basis of memory see Pylyshyn [1973].

14. e.g. Kosslyn, 1973; Kosslyn, Ball & Reiser, 1978; Finke & Pinker, 1982

15. e.g. Shepard & Metzler, 1971; Shepard & Cooper, 1982; Robertson & Palmer, 1983.

#### Notes to §II.B.4.

1. See §II.B.2 above.

2. Pylyshyn [1978]. The point of this expression is that Pylyshyn holds a view of psychology as explanation in terms of computational manipulation of mental representations. To explain a psychological process is to detail the computations and representations involved in it, but the nature of the representations themselves is only to be explained by a 'lower level' science (physiology, or, if we are dealing with Artificial Intelligences, electronics). Pylyshyn's principal objection to imagery seems to be that if images can be "cognitively penetrated" (i.e. internally modified at the psychological level, by beliefs - or other propositional attitudes - in virtue of their content) then imagery cannot be a fundamental form of mental representation. Fundamental representations should only be "penetrable" by physiological causes, and imagery, rather than being an explanatory concept, would itself stand in need of explanation in terms of computations on the truly fundamental representations [see Pylyshyn, 1980, 1981, 1984]. (Block [1983b] has run this argument in reverse: If imagery, as is quite arguable, is not very "penetrable" then it probably cannot be reduced to lower level representations. In that case computational/psychological explanations may not take us very far, and the true key to the mind is probably physiology.)

If one is not committed to the basic picture of psychology as computation (as I am not) then this argument will have little force. But even if one does accept this paradigm (as Kosslyn does) it is far from clear that it might not be useful to be able to talk about different levels of cognitive representation within a computational system. Imagery might be claimed to relate to the fundamental mental representations somewhat as high level computer languages relate to the machine code in which they are written ('high level' statements reduce to machine code routines, but machine code reduces directly to electronic states). "Cognitive penetration" effects might then be likened to the workings of hybrid high level/machine code programs. To counter such a position "cognitive penetration" would have to be shown to be thoroughly ubiquitous (all the real work of the program done in the machine code sections) and it is not at all clear that this

has been done. Nevertheless, such "cognitive penetration" as does seem to occur may still raise problems for quasi-pictorial accounts of imagination.

In his paper of 1973 Pylyshyn also raises two other problems for quasi-pictorialism. He contends that the storage capacity of the brain would not be sufficient to accommodate a memory based on imagery, and he claims that if representations are imaginal or verbal (as Paivio [1971] claims) then a third, amodal representational system would be needed to mediate between them. These points seem to me to have been satisfactorily answered by Kosslyn & Pomerantz [1977], and I shall not pursue them any further.

3. There are distortions which systematically occur in certain drawings etc. made from memory [see Pylyshyn, 1978 p.26] (a well known example is the strong tendency of children [Piaget & Inhelder, 1956] and, indeed, many adults to draw a tilted test tube of water with the water surface parallel to the bottom of the tube rather than horizontal). But these are at least as plausibly explained by the influence of wrong beliefs or inadequate skills on the reproduction of a somewhat vague image as by the accurate reproduction of a distorted image [Block, 1983a §1].

4. Pylyshyn, 1973 p.10.

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6. Shorter, 1952 p.538.

7. Dennett, 1969 p.135.

8. Dennett, 1969 p.136; c.f. Chisholm, 1942.

9. Berkeley, 1734 Introduction §§ 10,13.

10. Lyons [1984] argues (seemingly on an implicit proto-'perceptual activity' theory like that of Hebb [1968], Hochberg [1968, 1970, 1978] or Farley [1974, 1976] - see chapter II.D below) that tiger stripes might not be countable in practice even on pictorial images. However, Simpson [1984] replies (on rather questionable empirical grounds) that at least certain specially skilled individuals should be able to manage it.

11. Shorter [1952 p.538] claims that we have "no established use for expressions like 'notice a feature of my mental image'", and that therefore this reply will not do. But this, like several other of Shorter's claims about ordinary usage seems highly questionable (see Flew [1956]). Several of Kosslyn's experiments [e.g. 1975, 1976a,b, 1978b] have involved him in asking his subjects, some of whom were small children, to examine their mental imagery for particular features, and they seem to have had no difficulty in understanding such a request. I can confirm from my own (limited) experimental experience that subjects indeed seem to find such a request quite natural. Shorter's

further claim that terms like "notice" are inappropriate to imagery since we would be "unable to give criteria establishing what the overlooked feature was like" (as opposed to failure to notice external things, which can be independently checked) surely only applies to mentalistic versions of pictorialism. In the materialistic theories which we are considering (Kosslyn's, or even Descartes') features of the image unnoticed by its owner might, in principle, be established by physiological tests.

12. Price, 1953 chap.X. Price's own account of how images can be indeterminate - that they may exist, as it were, only partially formed - seems to me to be entirely unconvincing within his general pictorialist framework. However, I approve of the underlying motive to defend the empirical significance of imagery, and Price's account could well be reconciled with a 'perceptual activity' theory of imagery such as we shall present below.

13. Summarised in Woodworth, 1938 p.43.

14. At any perceptible level. Quantum Mechanical indeterminacy can be safely ignored here.

15. Hannay, 1971 p.172.

16. 1975 p.191.

17. See Dennett, 1969 p.133.

18. Fodor, 1975 p.191.

19. If you need more convincing see Block [1983a].

20. This model of images plus descriptions would also seem to neatly deal with such cases of "cognitive penetration" [Pylyshyn, 1978 pp.28-9] as that of the chess masters who have excellent memories for briefly seen game positions, but not random layouts of chess pieces on a board [de Groot, 1965; Chase & Simon, 1973]. This seems to work because they are very skilled at taking in and remembering certain chess specific relationships such as attack, defence, control etc.. There seems no reason why this could not be explained in terms of a pictorial image of the board supplemented by a description in these sort of terms [c.f. Anderson, 1978].

21. Kosslyn, Holyoak & Huffman, 1976; Kosslyn, 1980.

22. See Pylyshyn, 1978 p.42.

23. Kosslyn [1980 p.32], seems to accept this consequence, but elsewhere he clearly still hankers after the old, important, rôle for imagery [1983 pp.72-3,90]..

24. Kaufmann [1980] takes this view.

25. Fodor, 1975, 1981. His claim that his account of thinking in "Mentalese" is no more than a philosophically defended and tidied up version of the mainstream theoretical assumptions of contemporary 'Cognitive Scientists' seems to me to be on the whole quite justified. See, e.g.: Pylyshyn [1973, 1980, 1984 esp. pp.193-4]; Anderson & Bower [1973]; Kintsch [1974]; Norman, Rumelhart et al [1975]; Kosslyn [1980]; Olsen & Bialystok [1983]; Anderson [1983].

26. 1953.

### Notes to §II.B.5.

1. See Woodworth, 1938 p.42.

2. 1974.

3. An informal, but perhaps even more convincing, version of this is attributed by Block [1983a] to Geoffrey Hinton. Instead of someone being shown II.B.5\_1(a) it is described to them in terms of two interpenetrating equilateral triangles (i.e. (c) and its upside-down twin) and they are asked to form an image of that. They will probably find it quite easy. They are then asked to find parallelograms in their image. That they will almost certainly find very hard.

4. Palmer, 1977 p.463.

5. See the next chapter.

6. See Kosslyn, 1980 p.262-3.

7. Kosslyn & Pomerantz, 1977 p.57.

8. Kosslyn, 1980 p.263.

9. Fodor, 1975 p.191n. See also Taylor, 1981.

10. What is more, they are a lot simpler than the images from which Kosslyn ~~does~~ take his own subjects to be 'directly reading off' information. I have in mind his experiments which call upon subjects to find various, often quite small, features of imaged animals [Kosslyn, 1975, 1976a,b], or to 'mentally scan' across imaged pictures or maps [Kosslyn, 1973; Kosslyn, Ball & Reisser, 1978; Kosslyn & Shwartz, 1978]. He is simply not consistent.

11. Hinton, 1979 p.232.

12. Hinton, 1979 p.233.

13. Shepard & Metzler, 1971; Pinker & Finke, 1980.