manipulative (bodily-kinaesthetic) skills.

Gardner further proposes that it should be possible to encode the operation of any faculty in a symbol system. This criterion is in part empty since almost all conscious thought processes can be so encoded. However, one of Gardner's faculties, bodily-kinaesthetic, is very difficult to encode as anyone who has attempted to teach golf to beginners well knows. Moreover, it is extremely difficult to encode unconscious aspects of other faculties, for example, syntax, and Gardner's use of this criterion is obscure.

His final criterion is that there should be more correlation between the results of tests that depend on the same faculty than between those that depend on different ones. This appears to be true of tests of linguistic and spatial skill, and although Gardner does not mention it, it is also true of tests of bodily ability. Less favourable to Gardner's thesis is the fact that whenever a battery of tests is given, the results on all tests tend to correlate with one another (with the possible exception of tests of body skill). It is of course precisely on these correlations that the notion of general intelligence (or *g* as Charles Spearman called it) is founded. Gardner does little or nothing to explain why, if the different faculties are completely independent, there should be such a high correlation between tests that ostensibly draw on several of them.

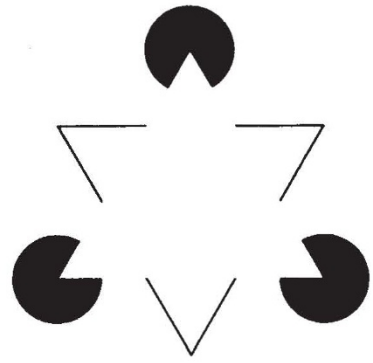
I have already noted that the development of the faculties may not be independent and that more than one may be used in the same task. The latter point Gardner himself acknowledges, but he fails to draw an important conclusion. In order to integrate the results of computations performed by two or more faculties, there must be some further computational mechanism at work that lies outside the individual faculties. Gardner decries the need for such a "horizontal" mechanism, but does not consider the question carefully enough. In the extreme case, the system could break down because one faculty was waiting on an input from a second in order to do further computation, while the second was waiting for an input from the first. For the same reason, Gardner's treatment of metaphor is weak: how could one faculty take as a metaphor something drawn from another unless it had a knowledge of how the other worked? A further argument that there is a superordinate mechanism to coordinate the knowledge processed in each of the faculties may be drawn from the effects of frontal lobe lesions, which often severely impair the ability to plan: this impairment is not limited to any one of Gardner's seven faculties.

If Gardner is weak on the horizontal organization of the mind, he is even weaker on its vertical organization. By almost all of the criteria he lists, vision and audition should be special faculties though much of their output is fed to other faculties (for example, audition makes possible both language and music). Again, it is well known that anterograde amnesia can be produced in all domains by damage to the hippocampus. Even if memory is not a horizontal ability, this finding suggest that the different faculties share some common mechanism for the laying down of new memories.

One can also ask whether Gardner has cut his faculty cake correctly. It is in fact not easy to think of tasks whose performance cannot be accounted for by knowledge embedded in his seven faculties, but this is partly because several may be employed in the same task. Nevertheless, one could ask in which faculty resides a wine-taster's skill or even the ability to discriminate sounds that are neither verbal nor musical.

Despite the interest of Gardner's general thesis, his book has several annoying defects. The worst is a trait that he shares with his predecessors in the grand tradition — vagueness. Nowhere does he try to characterize in rigorous terms the operations carried out by the different faculties. Indeed, he decries computer simulations (which are the only rigorous theories of mental activities yet constructed), largely on the grounds that they are not biological. If he examines the work of David Marr and others, he will find that computer models can take into account neurophysiological findings. There are other passages where he is alarmingly naive: for example, he avers that work demonstrating the existence of cells that respond selectively to complex objects, like a hand or a face, has thrown much light on object recognition. Such research has not in fact illuminated this problem, since to understand how an object is recognized we would need to know how the cell is wired-up. He also has a habit of ducking difficult issues: he writes, for example, "The philosophical ambiguity that surrounds the concept of mental imagery can also be left to the experts".

Trick of perception



In this diagram the eye sees contours that are not present (illusory contours), and the figure so defined seems whiter than the surrounding area. The illustration is taken from Irvin Rock's *Perception*, a volume in the Scientific American Library. See footnote on p.791 for publication details.

Gardner is an enthusiast, who, like the Beaver, goes "bounding along on the tip of his tail". He is extremely discursive, a trait that will please anyone wanting a superficial romp through science, music, painting, architecture, dancing, baseball and so on, but that may well dismay anyone interested in rigorous arguments and upset anyone with much knowledge of the topics covered. His surveys too often lead him to such unremarkable conclusions as "One cannot aspire to be a poet without sensitivity to the interaction among linguistic connotations", "painting and sculpture involve an exquisite sensitivity to the visual world as well as an ability to recreate it in fashioning a work of art", or "certain features typically characterize the baseball player . . . there is . . . the ability to throw the ball where one wants it". It is perhaps no accident that in discussing science, Gardner fails to mention that one of its main attributes is the rigour with which its theories are expressed. His book also contains potted accounts of such figures as Von Neumann, Einstein and Rubinstein, and lengthy excursions into anthropology to illustrate how the different faculties are exhibited in different cultures. It ends with a lengthy section in which Gardner attempts to apply his notion of faculties to education. Much the most interesting part is an account of the Suzuki method of musical education developed in Japan. Infants are trained almost from birth, and can often play violin concerti faultlessly by seven years of age. But Gardner's own recommendations are as vague as those of most other educationalists. "Early assessment . . . allows an individual to proceed as rapidly as seems warranted in those intellectual channels where he is talented, even as it affords an opportunity to bolster those intellectual endowments that seem relatively modest".

Gardner is a polymath, who has clearly developed all seven faculties, though as the quotations from his book suggest, his linguistic faculty could, in his own words, do with bolstering. His main thesis is interesting, but it is a pity he did not cut the trimmings, many of which are banal, and concentrate on working it out in more detail. In particular, he might have attempted to characterize more carefully some of the operations conducted in each domain, to give a more detailed and careful account of the horizontal interactions between faculties, and to deal more thoroughly with perception, memory and planning. Too often he prefers to leave the hard work to someone else. One suspects that once we know what are the computations performed by the mind and how the requisite software comes into existence, it will become clear that human faculties are much more blurred than he would have us believe or even that they are as elusive as the Snark itself. □

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