BARLOW, H.B. Intelligence: the art of good guesswork.
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INTELLIGENCE: THE ART OF GOOD GUESSWORK. We think that intelligence is a quality easily recognizable in other people's talk, deeds, or writings, yet the current trend among psychologists is to deny that it can be succinctly defined or described. This avoidance of the most interesting of all general questions about intelligence results partly from intellectual revulsion against the psychometricians' simplistic arrogance in promoting the IQ as an adequate measure of an individual's mind, and partly from moral revulsion at the degradation and insult to whole racial groups that has resulted from this approach. It is also partly a historical relic, for the early discussions of the topic were singularly inconclusive and unproductive (Thorndike *et al.*, 1921). However, intelligence is something to do with the way the mind processes information and handles data, and there have been great advances in information science since the early days of intelligence tests; for this reason one's intuition that intelligence is not only recognizable, but also definable, should now be given more theoretical attention. Heat, like intelligence, shows itself in many different ways: it gives the feeling of warmth, it melts solids and vaporizes liquids, it accelerates chemical reactions, it comes from the sun or the fireplace, and so on. Where would thermodynamics be if everyone had accepted the pervasive but pleomorphic manifestations of heat as proof that the theoretical problem of its nature was insoluble?

The notion that the biological role of intelligence is to produce good guesswork comes from a suggestion that it is the capacity to detect new, non-chance, associations (see Fatmi and Young, 1970; Barlow, 1970). Further consideration suggests that the most important use of newly detected associations is to improve the quality of the decisions that are made, and it is easy to see that anything that does this will be highly prized and sought after. It is reasonable to define intelligence in terms of the main benefits it confers, but the basic capacity is that of detecting new associations whose importance has long been recognized; here are some illustrations.

Consider the hungry (and intelligent) dog that leaps from its comfortable rug in front of the fire when it hears the sound of the refrigerator door being opened. That sound is associated with the availability of food, and the recognition of such associations has obvious value. But in pointing to this particular association of sensory stimuli with reward we have only skimmed the surface, for there is no unique component to the sound of the refrigerator door; what is unique is the collection of sounds made by the door, and to determine what makes up this collection is itself an associative task. Since we are primarily concerned with human intelligence we must also point to uniquely human aspects of the structure of associations: we have spoken language with words representing associations of sensory stimuli, written language compiling those associations into sentences, and books, libraries, and whole academies whose purpose is to explore and elaborate associations among mere words.

Two more points about spotting associations need emphasis. First, the *newness* of the associations that are detected is important, for we do not really grant that someone is intelligent because he is full of knowledge of past discoveries and as a result can point to associative structures that would otherwise have been missed. We feel intuitively that a bright mind discovers associations anew from direct experience, rather than relying on memory, hearsay, or the knowledge contained in books. 'New' in the definition must therefore be taken to mean new for the mind in question, not new in the sense of 'never previously detected'.

The second point is that the associations discovered must be genuine ones and not due to chance. The mind that seizes on any random coincidence and sees it as a sign of an important permanent association will not guess right and is not conceded to be intelligent, though it may at times be entertaining.

Linking intelligence to guesswork captures the common-sense view of intelligence rather than the psychometrician's, but it is worth pointing out that some of the questions in tests, empirically developed as they have been to probe the capacity of the mind thought to correspond with intelligence, do indeed probe the capacity to detect new associations and relationships. This is the case for questions that require the completion of sequences or recognition of analogies. Many other questions merely probe something more appropriately termed 'general knowledge'; however, these too would be justifiable in terms of the definition to the extent that general knowledge represents the result of past applications of the capacity to detect associations.

If guessing right depends on spotting new associations, and if this is central to intelligence, what do we learn about its measurement? In order to guess right there are three conceptually distinct tasks, namely formulating possible guesses (i.e. hypotheses about new associations), testing them to find the right ones, and working out the implications of those that escape disproof. Of these three, it is easiest to imagine an objective measure of the testing process, because the theory and practice of statistical tests for associations are well developed, and this makes it possible to compare the performance of an individual at an associative task with that of an 'ideal statistician'. The ideal will make the best possible use of the evidence, and a measure of 'associative efficiency' is obtainable from the ratio of the amounts of evidence required by the ideal and the individual being tested, when each performs at the same level of reliability; this is an absolute measure of how well the subject utilizes the information available—how well he guesses in fact. The concept of statistical efficiency (Fisher, 1929) has been used to measure human perceptual tasks (Rose, 1942; Tanner and Birdsall, 1958; Barlow and Reeves, 1979), but has not yet been applied to the associative tasks that underlie intelligence (nor to learning for that matter). It is satisfying that the definition allows one to point to one aspect of intelligence that could in principle be measured objectively and in absolute terms, knowing precisely what one was measuring.

The next question is 'How does the possibility of a particular association enter someone's mind?' One naturally attributes intelligence to a mind that generates its own array of plausible possibilities, and stupidity to a mind that produces inappropriate ones or has to be fed with suggestions in every new circumstance. Seeing possible solutions is an essential part of good guesswork, and the nature of this imaginative ability is a more difficult and interesting question than that of assessing statistically whether a given association is present or not. The main difficulty here is the astronomical number of possible associations: it is certainly *not* intelligent to point to any or all of them for testing, whereas it would, for instance, show a glimmer of intelligence to start looking for associations between those events which occur with approximately the same overall frequency. It would be a formidable task to specify a catalogue of good tactics for imaginative guesswork in order to measure how well an individual was able to devise them, and a single numeric measure of imaginative inventiveness is most unlikely to emerge from such an effort. One must also pay attention to the third distinct part of intelligence.

It is not intelligent to claim as a new association something that can readily be deduced from associations that are already known. Every moment we see sights and hear sounds that can be predicted from associations already established by our own minds, or implanted in them by others. To distinguish what is new, knowledge of these pre-existing associations must be organized so that they are taken into account. Thus the deductive reasoning required to use a background of general knowledge is a necessary part of intelligence on the current definition.

It will surprise no one that intelligence appears to be complex and requires imagination, judgement and reasoning. But this discussion has led to two novel conclusions: first, the part concerned with statistical judgement can in principle be measured on an absolute scale, using theoretical limits as a reference rather than population norms or anything like that; and second, the nature of intelligence is rather satisfactorily defined simply by stating its goal, namely guessing right. One must respect past psychometricians for their empirical development of practical tests of mental ability, but one should now hope that the theoretical basis will be strengthened and particularized (see Barlow, 1983; Sternberg, 1985). The diversity of minds and their aptitudes should not conceal the fact that there is a recognizable unity behind all the manifestations of intelligence. H. B. B.

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