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LECTURE OBLIGATOIRE N° 3

Information-Processing Theories for Cognitive Development: The Psychometric Approach (R. Sternberg)

1. Intelligence as speed of information processing

Is it possible that different individuals can process information at different speeds and that this is the basis of intelligence? As mentioned earlier, Galton saw mental speed as one of the best indicators of intelligence, and included reaction times (RTs) as one of his measures, though with disappointing results. We will now look at a few studies which have attempted to pursue this idea further.

Most of the recent work on speed of information processing has used the reaction time (RT) as apparatus. The subject keeps a 'home' button depressed until a light appears nearby. The subject has then to 'hit' the nearest button as quickly as possible. Although some association has been found between RT and IQ (Detterman, 1987), there have been many problems of interpretation. A closer look at RT has shown that it is not as simple a process as it at first seems. Far from being a pure, simple measure, it involves a number of complex cognitive, non-cognitive and social factors. The possible factors cited by Detterman as contributing to performance (and thus to individual differences) include understanding instructions; familiarity with the equipment; motivation in the task; sensory acuity; different strategies in various aspects of response selection and construction; and a number of others. Carlson and Widaman (1987) cite studies indicating that level of and attention strongly affect RT. This is one reason why investigators have turned to a slightly different measure.

Imagine that you are presented with two lines, close together on a TV screen, for very brief, but slowly increasing, periods (measured in fractions of a second). You are asked to judge whether they are of the same or different lengths. The duration of presentation required (or 'inspection time') before you are able to make a judgement is considered by some psychologists to be a measure of your 'processing speed' (Nettlebeck, 1987). Several studies have reported moderate correlations between inspection time (IT) and IQ in both adults and children (Nettlebeck, 1987; Nettlebeck and Young, 1989). Although these results have been questioned on a variety of methodological grounds (e.g. Mackintosh, 1986; Howe, 1988) a correlation in the range -0.3 to -0.5 seems reliable. Does this mean that development of intelligence (or IQ) is a reflection of maturation of processes like inspection time? There are some doubts about this. For example, there is doubt whether IT itself decreases with age (Anderson, 1986). Anderson concluded that IT derives from the speed of a central information-processing mechanism which does not change significantly with age. Instead, individuals have a genetically- determined speed at which that mechanism operates, and the individual level is important to the development of intelligence (as measured by IQ) because it 'constrains thought' and thereby leads to more rapid knowledge acquisition (Anderson, 1992).

Although this idea sounds reasonable, it has been questioned by Nettlebeck and Vita who found remarkable improvement in IT with practice in most subjects. They found that if children were given just a little practice, the correlations between IT and IQ 'diminished steadily, eventually to negligible proportions' (Nettlebeck and Vita, 1992, p. 189). This, again, suggests that a seemingly 'pure' measure of processing speed is grounded in other factors such as attention, confidence, motivation, and so on (Nettlebeck and Vita, 1992). Finally, note, again, the problem of interpretation of correlations wherever they are presented as developmental data. Correlations alone cannot indicate that relationships are causally connected (e.g. that differences in IT 'cause' differences in IQ).

RT and IT studies are illustrative of those that have, as it were, taken IQ as a starting point and attempted to discover a cognitive basis for IQ (in effect, thus explaining 'what IQ is') and for its development. There are many other cognitive theories, however, that have started from quite different positions. The remaining parts of the text will look at some of these.

2. The development of cognitive processes underlying intelligence

Instead of viewing intelligence simply as a basic unitary power, a broader information-processing approach has attempted to characterize it in terms of specific cognitive processes or components. The developmental problem is then one of describing those that change with age, and how they do so. Sternberg (1988) considers several possible candidates:

- the development of control strategies such as monitoring, chunking of information, and selectivity of responses in problem solving;
- increase in the amount of information that can be processed by the individual at any one time;
- ability to analyze increasingly complex, or 'higher order' relations (as in analogies between analogies);
- increase in flexibility of thinking.

Pascual-Leone (1970) has suggested that general cognitive ability develops through increase in size of a 'central computing space'. Other authors have noted that as children get older they tend to use more complex rules or strategies of reasoning or knowledge management. For example, they use more efficient and more productive computational strategies in simple arithmetic (Kail and PeIlegrino, 1985). They are capable of using more complex rules in problem solving (Siegler, 1976). And they may be said to construct more complex 'mental models', and better procedures for constructing and testing them with age (Oakhill, 1988). We will now look at two relatively well worked out theories of this kind.

3. Cognitive components and intelligence

Sternberg (1984) has suggested that development in intelligence consists of increases in the efficiency of quite discrete mental operations which he calls 'components'. A 'component is an elementary information process that operates on internal representations of objects or symbols' (Sternberg, 1984, p. 281). A good illustration of the approach is that of research into 'analogical reasoning', using IQ test items ('A is to B as C is to?'). The research has entailed breaking subjects' responses down, impressionistically, into various steps (the putative components) and comparing individuals' performance on them. Such steps or 'components' have included:
- *encoding*, or the representation of the salient information in memory;
- *inference* - e.g. of the changes in A necessary to produce B;
- *mapping* - e.g. the correspondence between A and C;
- *applying* - the changes inferred in (ii), to C, to produce the 'best' D;
- *evaluation / justification* of the selection;
- *response*.

Sternberg's results have suggested that individuals who perform well on tasks like analogies tend to spend most time in the encoding component, but less in most other components. Development is considered to consist of improvements in efficiency in the operation of components like this. Thus, children (or less accurate adults) who fail such items tend to perform the inference and application components less readily, and tend to be more easily distracted. In most of the research, though, it has to be said that the relationships described have tended to be weak ones. The componential approach has also been criticized because it reduces intelligence to sequences of quasi- mechanical operations: i.e. it is excessively mechanistic. Although such operations may have been identified on the surface, how they actually work in the cognitive system underneath, remains unclear.

4. Multiple intelligences

Another theory that looks for cognitive grounding of intelligence -although avoiding the mechanistic nature of componential theories- is Gardner's (1984) theory of 'multiple intelligence'. The basic suggestion, here, is the existence within the cognitive neurobiological system of discrete information-processing operations which deal with the specific, but different, kinds of information which humans encounter in the course of their regular activities. These have evolved by natural selection and their development is genetically determined. 'One might go so far as to define a human intelligence as a neural mechanism or computational system which is genetically programmed to be activated or 'triggered' by certain kinds of internally or externally presented information. Examples would include sensitivity to pitch relations as one core of musical intelligence, or the ability to imitate movement by others as one core of bodily intelligence' (Gardner, 1984, p. 64).

Among these different 'modules', Gardner includes linguistic intelligence, musical intelligence, logico-mathematical intelligence, spatial intelligence, bodily kinaesthetic intelligence, and personal intelligence (access to personal feelings and relationships with others). Although development of their respective processes is conceived to be essentially genetically pre-programmed, they may be subject to some developmental plasticity and thus amenable to cultural specialization and to educational assistance). Individuals differ in the ‘strength’ of these intelligences and thus possess personal ‘profiles of intelligences’ (Gardner, 1993).

Gardner has spelled out some far reaching implications of his theory for education, arguing that children already enter school with distinctive 'profiles of intelligences'; that these need to be cultivated through suitable activities that will shape children to adult social roles; using 'assessment procedures that can provide reliable information about … a student's profile of capacities at a given moment in his development' (Gardner, 1993, p. 210). There are a number of possible criticisms of such a theory, though, and Gardner (1984) acknowledges and discusses some of these himself. Perhaps the most serious is that the theory is rather vague in that the way that intelligence develops from 'dumb', innate, computational processes.

Source: Lee, V., & Das Gupta, P. (1995). *Children’s cognitive and language development* (pp. 164-168). Cambridge, Mass.: The Open University.