FORUM ON INTELLIGENCE

DIFFICULT QUESTIONS ABOUT G

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1. The notion of g has been established from a psychometrician's point of view for the better part of a century now - but it has almost been totally ignored within cognitive psychology – why?

Here are some suggestions:

a. The desire to produce a universal architecture had primacy. The logic was that characterising individual differences would involve variations in this universal architecture which had to be specified first.

b. A majority of cognitive/experimental psychologists are very narrow in their scope. Most theories of short-term memory phenomena, for example, while focussing on the phonological basis of such phenomena, have historically failed to take serious account of the cognitive structures required for speech production. Cognitive consideration of intelligence requires a broad picture since it is pervasive.

c. The IQ battles of the 60's were traumatising for the first generation of cognitivists who could not bear having sociologists yelling at them. So they stayed away.

d. People working in problem solving, probably the closest cognitive area, got tied up in the technology of implementation or in charting the peculiarities of human logic.

e. Developmentalists were confused about the distinction between behaviour and cognition.

2. Why should cognitive psychologists pay any more attention when John Duncan claims that frontal functions and g are synonymous?

The claims are in need of careful analysis. For example, the design of the Duncan experiments makes it clear that there is no simple task analysis that could point to cognitive factors that would map onto g. What we do not know, however, is whether the selective recruitment of lateral frontal cortex that Duncan has found when subjects are performing high g tasks corresponds directly to a high g function. To quote Duncan et al. (2000) this would be "a specific frontal system important in the control of diverse forms of behavior." If it does, then the notion of synonymity is plausible. However, we are still no closer to a cognitive characterisation. On the other hand, this selective recruitment might actually correspond to some side effect of high g tasks, such as the need for special attentional control, special workspace manipulation or similar computational requirement.

3. Under what conditions should neuropsychologists take g seriously – when it has been localized or when it has a cognitive theory?

This seems to me to be a category error. "g" *is* a psychometric derivative. It should not occur as a label on an information processing model or on a map of the cortex. We can ask what function(s) it corresponds to in cognitive theory and then draw the conclusion that this function is implemented in the frontal lobes (treating the Duncan claims as data). This might seem pedantic but we have to avoid the urge to think of g in the singular outside the confines of psychometrics. To start with, there are likely to be developmental factors to be taken into account – which, inevitably, will have broad ramifications. Such factors would in effect specify parameters that would affect a range of processes. Speed of processing is an example of this. In addition, there will be specific factors that will respond to what Duncan et al. call "a broad range of different cognitive demands." Such constructs could have the same psychometric status.

4. What might a cognitive theory look like?

One framework that might be useful is Causal Modelling (Morton and Frith, 1995; Morton, 2004). This makes an explicit distinction between behaviour and cognition and between cognitive and biological representations and constructs. A sample model is given in Figure 1. The arrows in this diagram are to be interpreted in terms of "X is essential for the development/operation of Y". The framework is a device for representing specific theories, though in the figure I have imagined a theory with elements from a number of places rather than taking any particular one.

We start with genetic influences which are shown as affecting the development of four brain regions as well as something I have called "factor G". This, in turn, is shown as affecting the four brain regions. If factor G is a variable, then all the brain areas will be correlated with respect to that parameter.

Of the four brain areas specified, three of them map onto relevant cognitive functions. Thus br_1 is specified (in this hypothetical theory) as the locality where the cognitive processes responsible for knowledge acquisition can be found. The more efficient the neural functioning of br_1, the more efficient will knowledge acquisition be. The acquisition of knowledge will also require an input from the environment, of course. The area br_2 has an equivalent relationship to the acquisition of symbolic skills. A frontal area of the brain is mapped onto executive functions. Of course, in any

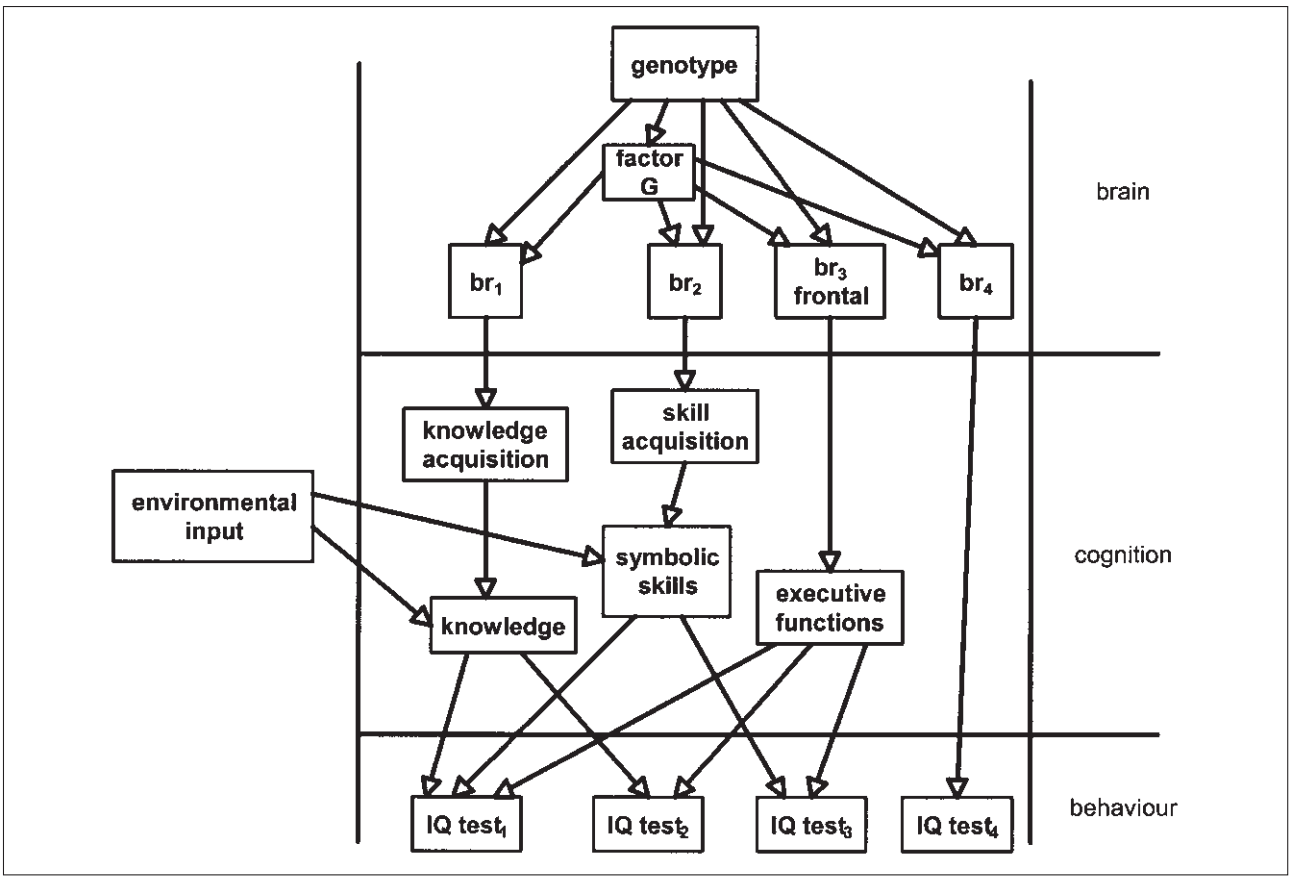

Fig. 1

proper theory the term "executive function" would be seen as far too vague, and we expect the precise nature of the function to be specified in the context, since there is ample evidence from the literature on executive dysfunction to show dissociations between functions.

The final stage of the causal model is the inclusion of behaviour. In this case we include four different IQ tests. Two of them have been specified as knowledge rich, two of them as involving symbolic skills and three of them as involving executive functions. The fourth test is envisaged (idealistically) as not being dependent on any cognitive function.

Within this particular causal model, we can see that performance on all four tests would be correlated by virtue of the common influence of factor G. Performance on the first three of the tests would be more highly correlated because of the common influence of executive functions/br_3 – if, that is, that we assumed that it was the same executive function involved in all three cases. If different executive skills were involved in the tasks then the theory, and so the model, would have to change.

Of course, the model put forward is far too simple minded, but gives an indication of the degree of complexity we have to be able to represent as cognitive psychologists if we are to become interested in "g".

References

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