Spearman and the Theory of General Intelligence

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The early 1900s saw Charles Spearman using a mathematical approach to the question of measuring human intelligence. Using statistical factor analysis Spearman identified *g* , a single underlying intelligence factor he believed accounted for the variety of observable abilities.

Spearman noticed that children's grades across all school subjects tended to be highly correlated. If a child did well in one subject, they generally also did well in another subject, and vice versa. What did this say about the nature of intelligence?

He devised factor analysis to measure the relationships between seemingly varied cognitive abilities and account for the correlations he saw between scores on different tests.

The result was Spearman's two-factor theory which attempted to show that all cognitive performance can be explained by two variables: one *general* ability (*g*) and the many *specific* abilities (*s*) it gave rise to. Later, however, further analysis showed that *g* alone was enough to explain the correlations between different tests. When people talk about IQ or intelligence, it's usually this general mental ability that they are referring to.

> Psychometrically, *g* as a construct refers to the overall mental capacity behind a person's performance on any number of cognitive tasks.
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> Statistically, *g* is a way to account for variance. This single factor has been shown to explain 40 - 50% of the variance in individual performance on IQ tests. This is why a composite score of many different tests is assumed to give an estimation of *g*.

Today, almost all IQ tests are factor models inspired by Spearman's work on *g*. As an example, consider the Stanford-Binet test, which measures different areas of performance that contribute to general intelligence, like working memory and visual-spatial reasoning.

Today intelligence is usually understood as a hierarchy: smaller factors manifest in the ability to do highly specific tasks, but those factors can be arranged into broader intermediary categories which in turn are encompassed within the most general factor, *g*.

Alternatives and Criticisms

The existence of a single quantifiable factor for human intelligence has been hotly debated ever since Spearman proposed it.

Criticism came from one of Spearman's own students, Raymond Cattell, who thought that intelligence could be understood as *two* main capacities: "fluid" (Gf) and "crystallized" (Gc).

Cattell thought that crystallized intelligence was a kind of cemented knowledge bank acquired over time, representing all those abilities that were already familiar from previous learning. On the other hand, fluid intelligence was the ability to acquire that knowledge in the first place, i.e. to learn in the moment. He saw *g* as more accurately Gc, and that tests focusing only on *g* would omit an important developmental factor in human intelligence.

Others were similarly critical for the reductive nature of *g*, including psychologist L.L. Thurstone and J. P Guilford. Both believed that there were several, irreducible and independent domains of intelligence, however many have since found correlations between their tests which strongly suggest a general factor.

Still more criticism came from Howard Gardener who proposed nine domains of intelligence, including some decidedly non-cognitive ones like musical, existential and bodily-kinesthetic intelligence. Almost everyone can think of a person who performed poorly at school but excelled in sport or dance, perhaps, or a person with musical genius that didn't translate to any other area in their life.

Gardner argued that the academic environment over-emphasized verbal and logical skill while ignoring these other forms of intelligence. However, his critics have responded that we think of something like athletic skill as just that – a *skill* and not strictly intelligence.

Currently, the g factor theory of intelligence is largely undisputed and has been established through experimental cognitive research, brain anatomy and molecular genetics – where it has also been shown to have a strong heritable component. Though it is taken as true that there is a high correlation between performance on different skills tests, research is still underway to determine what causes that correlation and how.