Mind Matters: Intelligence is determined by genes, environment

Rex Jung, UNM
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TODAY'S EXPERT *Rex Jung* is a research assistant professor at UNM's Department of Neurology and Psychology, and a research scientist at the Mind Institute.

University of New Mexico: Define intelligence and explain how it's been measured up to this point.

Rex Jung: In the research community, intelligence is loosely defined as having the capacity to solve abstract problems by rapidly integrating ideas to formulate (usually) one correct response. This involves the ability to limit a problem's scope, come up with possible solutions and quickly identify the one best fit to solve a particular problem.

It is estimated that about half of our intelligence is related to genetics, and the other half arises from environmental influences on the brain. So, you get half of your intelligence from your parents' genes and most of the other half from your parents through environmental influences in your formative years. Interestingly - and as yet to be fully explained - genes appear to become more important to intelligence as we age.

Intelligence commonly has been assessed with paper-and-pencil IQ tests, like the Stanford-Binet or Wechsler Intelligence scales, which have been around for at least 50 years. But what in the brain "creates" higher or lower intelligence has largely been a mystery.

UNM: So where in the human brain does intelligence reside?

Jung: It's in several places not just one and not in the entire brain. Intelligence is comprised of a network of processing centers spread throughout very distinct parts of the brain. The left hemisphere of the brain appears to be more related to intelligence than the right. But the function of intelligence resides in particular regions in the front, the back and both sides. We have been able to pinpoint through very advanced neuroimaging technology discreet areas within each of the lobes where information comes together and is processed more richly.

Using specific imaging techniques, we can actually see brain activity as it's happening.

Of course, you need some parts of your brain to function in a very predictable way or you will die. What we are interested in at the Mind Institute is identifying regions in the brain where there is greater variability in brain activity, size, blood flow and the like, in order to locate where individual differences are most pronounced.

Most of the research to date has been looking at gray matter - the processing centers - of the brain. But at the Mind Institute, we've also been investigating white matter, which provides the "wiring" that links these processing centers, particularly between the front and back of brain. It's the combination of gray and white matter, and how well they work in concert, that is significant to understanding intelligence.

UNM: How do we know this; how long has humankind been studying this?

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Jung: We know that since the earliest days of recorded history humans have been interested in what makes us smart. And only now, with modern neuroimaging tools, are we able to peer into the brain itself and attempt to better understand why people might score differently on intelligence tests. A hundred years ago, intelligence was thought to be based on brain size, so science's most powerful tool was a tape measure around the head.

Now, we can see how normal brains appear and function while people are still using them and compare those measurements to neural activity of individuals who are missing some processing centers - folks who have had frontal lobotomies, accident victims, gunshot wound victims and the like.

Interestingly, damage to certain regions of the brain doesn't seem to affect intelligence, while damage caused by stroke or other focal injuries often results in significant drops in intelligence.

UNM: How much variation is there in where and how intelligence asserts itself among healthy people?

Jung: There's tremendous variability in human intelligence, ranging from profound mental retardation to genius. In humans, the average IQ is between 90 and 109, which accounts for about half of the population. Only 25 percent of the population has IQs at 110 or above, and this number goes down rapidly as IQ increases: 10 percent have IQs 120 or above, 2 percent are 130 or above, and less than half of 1 percent are at an IQ of 140 or above.

To put this in some perspective, people in the average range with an IQ score of about 100, are capable of earning a college degree. People in the 110-119 or "high average" IQ range are more capable of succeeding in professional activities that are more intellectually demanding - managers, lawyers and so forth. People in this range might have better memories, faster processing speeds and higher decision-making skills. When we go up to the "superior" range, an IQ score of 120 and above, that's when you get into medical doctors, scientists, academics, engineers and the like.

That isn't to say that you can't be a professor with an IQ of 100. In fact, you could very well be a great professor. It just means that it may be somewhat harder to attain this level of education than it is for someone with an IQ of 120. Other factors besides IQ play significant roles in each of these careers, including interpersonal skill, creativity, opportunity, and so on.

UNM: How do diseases like Alzheimer's and schizophrenia affect intelligence? How can we use this information?

Jung: Basically the IQ goes down in patients suffering from these and other neurological and psychiatric diseases, as do memory, language, attention, visual processing and so forth; but in different sequences and magnitudes according to the specific disease.

Those two disorders represent a kind of an unraveling of the brain, function by function. Generally, we first see a chemical imbalance in the brain, then we may see a lack of brain activity corresponding to some behavioral decline; and then we see atrophy, or actual brain shrinkage.

If we can better understand how intelligence "normally" works in the brain, perhaps we can slow down or arrest altogether the decline in intelligence for those who suffer these devastating diseases. Rebuilding the brain after it's been damaged is difficult. So our best bet is to prevent this decline before it occurs.

Studies of intelligence have rarely been funded by the National Institutes of Health or National Science Foundation, but these funding agencies are becoming increasingly interested as neuroimaging reveals more about the importance of intellectual functioning and the brain. We believe that as support grows, our potential successes in understanding and treating mental illness and a wide range of neurological disorders get exponentially closer.

Mind Matters runs every other Monday. Have a question about mental health? Send it to lfrank@salud.unm.e