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Brain Scans Reflect Problem-Solving Skill

By ERICA GOODE

Scientists have spent decades arguing over whether intelligence is best conceived as a generalized ability or as the capacity to excel in particular areas of mental, social or emotional functioning.

The debate encompasses a variety of incendiary issues, including whether I.Q. tests have any value, and it is likely to continue.

Meanwhile, a new brain imaging study offers the first glimpse of how differences in the ability to reason and solve problems might translate into differences in the firing of neurons in the brain.

People who scored high on Raven's Advanced Progressive Matrices, an intelligence test, also showed more neural activity in specific brain regions while performing an exacting memory task, the researchers found. The matrices tap what experts call "general fluid intelligence," which studies suggest is strongly influenced by heredity. Raven's test scores correlate highly with scores on I.Q. tests and other standardized measures of intelligence.

"To our knowledge, this is the first large-sample imaging study to probe individual differences in general fluid intelligence, an important cognitive ability and major dimension of human individual difference," wrote the researchers, led by Dr. Jeremy R. Gray, a research scientist in the department of psychology at Washington University in St. Louis. The paper, in the March issue of the journal *Nature Neurosciences*, will be published tomorrow on the journal's Web site. The other researchers were Christopher F. Chabris of Harvard and Todd S. Braver of Washington University.

Dr. Gray said the findings indicated that the variations in test performances were mirrored by differences in brain activity in the lateral prefrontal cortex, a brain region involved in working memory, planning and goal-directed activity. The subjects who did well on the intelligence tests also showed greater activity in several other brain areas, including the anterior cingulate cortex and the cerebellum. The brain activity was measured with functional magnetic resonance imaging.

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Dr. John Duncan, the deputy director of the Medical Research Council's Brain Sciences Unit in Cambridge, England, and the author of a commentary with the journal article, called the study "a significant step" toward understanding the specific brain mechanisms that were recruited into action by the kinds of problems found on intelligence tests.

"The fact remains," Dr. Duncan wrote, "that standard intelligence tests do measure something important." But he added that it might take "50 years of research or more" for scientists to really understand what was happening and how different brain systems worked together.

In a study published in 2000, Dr. Duncan demonstrated that on positron emission tomography scans, the lateral prefrontal cortex lights up, indicating increased activity, when people solve problems like those on I.Q. tests. But he noted that some other studies, using other types of mental tasks, had found reduced brain activity in the lateral prefrontal cortex in people who did well on the tasks.

"This, too, is plausible if you think that people who are having trouble are spinning their wheels to solve the problem and don't achieve as much," he said.

The new study, however, supports Dr. Duncan's findings of increased activity and extends that work.

The findings, Dr. Gray said, suggest that fluid intelligence involves the ability to stay focused and keep new information in mind in the face of distraction.

In the memory task, the subjects were presented with a series of words or pictures of faces on a computer screen and asked to quickly identify whether each was the same as that presented three screens before. In some cases, the subjects were shown words or faces that had appeared two, four or five screens before, complicating the assignment.

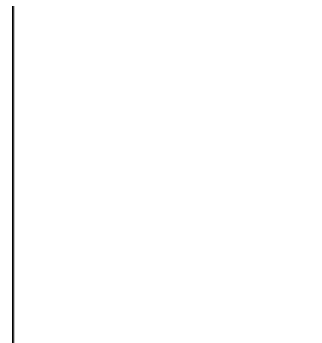
It was in these more difficult cases that the subjects with high scores on the intelligence test performed more accurately and showed greater brain activity than those with lower scores.

Dr. Gray likened the task to trying to remember a 10-digit phone number while listening to an interesting conversation. "Presumably, people of higher intelligence should be able to resist that distraction and to retain the phone number in what psychologists call working memory."

But the increased brain activity in people who performed well could also represent other mental activities, like inhibiting incorrect responses and reducing or monitoring conflicting perceptions.

Dr. Gray said he and his colleagues were still debating whether intelligence was best thought of as an innate general ability or as the ability to succeed in different domains. "You could spin it both ways."

Several researchers, including Dr. Robert Sternberg at Yale and Dr.



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Howard Gardner at Harvard, have argued that the notion of general intelligence has little value and that it makes more sense to measure people's strength or "intelligence" in different types of activities.

But Dr. Earl Miller, a professor of neuroscience at the Picower Center for Learning and Memory at the Massachusetts Institute of Technology, said, "The idea that performance on a task that's supposed to tap into general intelligence can predict real differences in activity in the brain lends support for the idea that there is a general intelligence."

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