Brain Circuitry Changes Growing Up Influence Moral Development

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People's moral responses to similar situations change as they age, according to a new study at the University of Chicago that combined brain scanning, eye-tracking and behavioral measures to understand how the brain responds to morally laden scenarios.

Both preschool children and adults distinguish between damage done either intentionally or accidently when assessing whether a perpetrator had done something wrong. Nonetheless, adults are much less likely than children to think someone should be punished for damaging an object, especially if the action was accidental, said study author Jean Decety, the Irving B. Harris Professor in Psychology and Psychiatry at the University of Chicago and a leading scholar on affective and social neuroscience.

The different responses correlate with the various stages of development, Decety said, as the brain becomes better equipped to make reasoned judgments and integrate an understanding of the mental states of others with the outcome of their actions. Negative emotions alert people to the moral nature of a situation by bringing on discomfort that can precede moral judgment, and such an emotional response is stronger in young children, he explained.

"This is the first study to examine brain and behavior relationships in response to moral and non-moral situations from a neurodevelopmental perspective," wrote Decety in the article, "The Contribution of Emotion and Cognition to Moral Sensitivity: A Neurodevelopmental Study," published in the journal Cerebral Cortex. The study provides strong evidence that moral reasoning involves a complex integration between affective and cognitive processes that gradually changes with age.

For the research, Decety and colleagues studied 127 participants, aged 4 to 36, who were shown short video clips while undergoing an fMRI scan. The team also measured changes in the dilation of the people's pupils as they watched the clips.

The participants watched a total of 96 clips that portrayed intentional harm, such as someone being shoved, and accidental harm, such as someone being struck accidentally, such as a golf player swinging a club. The clips also showed intentional damage to objects, such as a person kicking a bicycle tire, and accidental damage, such as a person knocking a teapot off the shelf.

Eye tracking in the scanner revealed that all of the participants, irrespective of their age, paid more attention to people being harmed and to objects being damaged than they did to the perpetrators. Additionally, an analysis of pupil size showed that "pupil dilation was significantly greater for intentional actions than accidental actions, and this difference was constant across age, and correlated with activity in the amygdala and anterior cingulate cortex," Decety said.

The study revealed that the extent of activation in different areas of the brain as participants were exposed to the morally laden videos changed with age. For young children, the amygdala, which is associated the generation of emotional responses to a social situation, was much more activated than it was in adults.

In contrast, adults' responses were highest in the dorsolateral and ventromedial prefrontal cortex areas of the brain that allow people to reflect on the values linked to outcomes and actions.

In addition to viewing the video clips, participants were asked to determine, for instance, how mean was the perpetrator, and how much punishment should he receive for causing damage or injury. The responses showed a clear connection between moral judgments and the activation the team had observed in the brain.

"Whereas young children had a tendency to consider all the perpetrator malicious, irrespective of intention and targets (people and objects), as participants aged, they perceived the perpetrator as clearly less mean when carrying out an accidental action, and even more so when the target was an object," Decety said. When recommending punishments, adults were more likely to make allowances for actions that were accidental, he said. The response showed that they had a better developed prefrontal cortex and stronger functional connectivity between this region and the amygdala than children. Adults were better equipped to make moral judgments.

"In addition, the ratings of empathic sadness for the victim, which were strongest in young children, decreased gradually with age, and correlated with the activity in the insula and subgenual prefrontal cortex," which area areas associated with emotional behavior and automatic response to stresses, Decety said. Together, the results are consistent with the view that morality is instantiated by functionally integrating several distributed areas/networks.

The research was supported with a grant from the National Science Foundation. Joining Decety in writing the paper were Kalina Michalska, a postdoctoral scholar, and Katherine Kinzler, an assistant professor, both in the Department of Psychology.

Exploring The Mechanics Of Judgment, Beliefs: Technique Images Brain Activity When We Think Of Others

May 18, 2008 — How do we know what other people are thinking? How do we judge them, and what happens in our brains when we do?

MIT neuroscientist Rebecca Saxe is tackling those tough questions and many others. Her goal is no less than understanding how the brain gives rise to the abilities that make us uniquely human--making moral judgments, developing belief systems and understanding language.

It's a huge task, but "different chunks of it can be bitten off in different ways," she says.

Saxe, who joined MIT's faculty in 2006 as an assistant professor of brain and cognitive sciences, specializes in social cognition--how people interpret other people's thoughts. It's a difficult subject to get at, since people's thoughts and beliefs can't be observed directly.

"These are extremely abstract kinds of concepts, although we use them fluently and constantly to get around in the world," says Saxe.

While it's impossible to observe thoughts directly, it is possible to measure which brain regions are active while people are thinking about certain things. Saxe probes the brain circuits underlying human thought with a technique called functional magnetic resonance imaging (fMRI), a type of brain scan that measures blood flow.

Using fMRI, she has identified an area of the brain (the temporoparietal junction) that lights up when people think about other people's thoughts, something we do often as we try to figure out why others behave as they do.

That finding is "one of the most astonishing discoveries in the field of human cognitive neuroscience," says Nancy Kanwisher, the Ellen Swallow Richards Professor of Brain and Cognitive Sciences at MIT and Saxe's PhD thesis adviser.

"We already knew that some parts of the brain are involved in specific aspects of perception and motor control, but many doubted that an abstract high-level cognitive process like understanding another person's thoughts would be conducted in its own private patch of cortex," Kanwisher says.

Breaking down the brain

Because fMRI reveals brain activity indirectly, by monitoring blood flow rather than the firing of neurons, it is considered a fairly rough tool for studying cognition. However, it still offers an invaluable approach for neuroscientists, Saxe says.

More precise techniques, such as recording activity from single neurons, can't be used in humans because they are too invasive. fMRI gives a general snapshot of brain activity, offering insight into what parts of the brain are involved in complex cognitive activities.

Saxe's recent studies use fMRI to delve into moral judgment--specifically, what happens in the brain when people judge whether others are behaving morally. Subjects in her studies make decisions regarding classic morality scenarios such as whether it's OK to flip a switch that would divert a runaway train onto a track where it would kill one person instead of five people.

Judging others' behavior in such situations turns out to be a complex process that depends on more than just the outcome of an event, says Saxe.

"Two events with the exact same outcome get extremely different reactions based on our inferences of someone's mental state and what they were thinking," she says.

For example, judgments often depend on whether the judging person is in conflict with the person performing the action. When a soldier sets off a bomb, an observer's perception of whether the soldier intended to kill civilians depends on whether the soldier and observer are on the same side of the conflict.

In a future study, Saxe and one of her postdoctoral associates plan to study how children develop beliefs regarding groups in longstanding conflict with their own group (for example, Muslims and Serbs in the former Yugoslavia, or Sunnis and Shiites in parts of the Middle East).

They hope to first identify brain regions that are active while people think about members of a conflict group, then observe any changes in brain activity following mediation efforts such as "peace camps" that bring together children from two conflict groups.

Big questions

Saxe earned her PhD from MIT in 2003, and recently her first graduate student, Liane Young, successfully defended her PhD thesis. That extends a direct line of female brain and cognitive scientists at MIT that started with Molly Potter, professor of psychology, who advised Kanwisher.

"It is thrilling to see this line of four generations of female scientists," Kanwisher says.

Saxe, a native of Toronto, says she wanted to be a scientist from a young age, inspired by two older cousins who were biochemists.

At first, "I wanted to be a geneticist because I thought it was so cool that you could make life out of chemicals. You start with molecules and you make a person. I thought that was mind-blowing," she says.

She was eventually drawn to neuroscience because she wanted to explore big questions, such as how the brain gives rise to the mind.

She says that approach places her right where she wants to be in the continuum of scientific study, which ranges from tiny systems such as a cell-signaling pathway, to entire human societies. At each level, there is a tradeoff between the size of the questions you can ask and the concreteness of answers you can get, Saxe says.

"I'm doing this because I want to pursue these more-abstract questions, maybe at the cost of never finding out the answers," she says.