THE DANA FOUNDATION'S

BRAINWORK

The Neuroscience Newsletter

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News FROM THE FRONTIER

••• **Hostile teens may be prone to heart disease.** Among adults, "type-A" behavior and heart attacks go together like business suits and three-martini lunches, but new research suggests that as early as childhood or adolescence, a hostile personality may set the stage for cardiovascular disease. In an initial screening and again after an average of three years, researchers at the University of Pittsburgh and the University of Helsinki evaluated groups of children ages 8 to 10 and 15 to 17 for signs of hostility, with a standard scale that used the subjects' own self-assessments as well as reports by trained observers. The team also measured blood pressure, body mass index, insulin resistance, and levels of blood triglycerides. If two or more of these factors were in the top 25 percent for the subject's age, race, and gender group, the child was considered to have "metabolic syndrome," a cluster of conditions known to lead to cardiovascular disease.

The researchers found that in both children and adolescents, those with high hostility scores at the first screening were more likely to show the

(Continued on page 7)

Inside:

I Feel Your Pain (and Joy):

New Theories About Empathy

BY ANN MACDONALD

A man winces while recalling a painful medical test, and a friend listening to the account grimaces in response. A woman beams as she tells a business colleague about receiving a promotion and the colleague smiles back. Empathy—the ability to share another person's emotions, thoughts or feelings—is generally believed to be one of three capacities that distinguish people from other animals (along with language and the ability to make tools). Yet even as neuroscientists have identified brain processes involved in language and learning, the neural roots of empathy remained elusive.

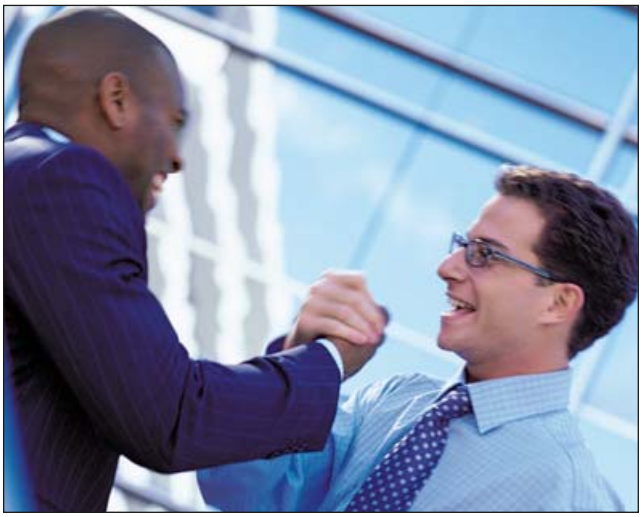
That may be changing, thanks to several lines of research that have recently converged. In the process, new findings about empathy are providing support for controversial ideas first raised centuries ago. Among those receiving renewed interest is the philosopher Benedict (Baruch) Spinoza, who in the late 1600s proposed that body, mind, and emotions are linked—and was denounced for it.

Although today's researchers differ on some details of how empathy occurs, they all agree the issue is significant.

"Empathy is an incredibly important feeling," says Antonio Damasio, head of neurology at the University of Iowa Medical Center and author most recently of *Looking for Spinoza: Joy, Sorrow and the Feeling Brain*. "Without compassion and empathy, it's hard to imagine human relations or the construction of a normal society."

In studying empathy, "neuroscientists are now going for the motherlode, the seat of understanding others," says Andrew Meltzoff, co-director of the Center for Mind, Brain and Learning at the University of Washington in

(Continued on page 2)



I feel you! Our ability to empathize sets us apart from other animals, but understanding the brain mechanisms behind empathy has proved challenging.

EMPATHY, continued from page 1)

Seattle and a coauthor of *The Scientist in the Crib*. "I know of no question more exciting, or in today's world more important."

Clues Accumulate

Current insights into empathy build on nearly 40 years of clues about the nature of facial expressions of emotion and the human ability to imitate someone else.

Paul Ekman, a psychologist at the University of California, San Francisco and author most recently of *Emotions Revealed*, began his pioneering studies on facial expressions in 1965, when the conventional wisdom held that they were learned and culturally specific. In a series of studies, including one that involved a tribe in New Guinea who had little contact with outsiders, Ekman proved otherwise—that facial expressions of emotion are understood around the world. This confirmed what 19th century evolutionary biologist Charles Darwin first proposed: that such expressions relate to universal expressions of emotion and are probably innate. Subsequent research by Ekman and others has shown that facial expressions enhance the internal experience of emotion: frown and you feel sad; smile and you feel happy.

Other researchers debunked the once-conventional wisdom that mimicry was learned and showed that it was innate. In the 1970s and 1980s, Meltzoff and colleagues found that 12- to 21-day-old infants could imitate four distinct adult gestures such as sticking out their tongues and opening their mouths. Even newborns less than an hour old engage in rudimentary forms of imitation.

Studies in the 1990s concluded that both mimicry and facial expressions of emotion could occur unconsciously, indicating that some automatic brain process was involved. Using electrodes to measure electrical activity in relevant muscles, the psychologist Ulf Dimberg and colleagues at Uppsala University in Sweden found that people unconsciously react to pictures of happy and angry faces by making similar facial expressions—even when instructed to remain neutral or to do the opposite, such as frown in response to a smile. Tanya Chartrand and John Bargh at New York University described a "chameleon effect" in which people unconsciously mimic both facial expressions and mannerisms when interacting with others. The more empathetic the person, the more he or she unconsciously mimicked another person's behavior.

The brain processes underlying both interpretation and mimicking of facial expressions remained unclear. A crucial clue was provided by the mid-1990s discovery of "mirror neurons" in monkeys, by Giacomo Rizzolatti and colleagues at the University of Parma in Italy. Such mirror neurons become active in a monkey's brain whether the animal is performing a particular action or merely observing it in another monkey. In subsequent research, Rizzolatti proposed that a similar "mirror system" in people might explain how people understand and imitate other people's gestures.

Neuroscientists posed another question: could this mirror system somehow be involved in empathy?

"In many ways the current view is counterintuitive: we don't smile because we share someone's joy; we share the joy—at least in part—because we are smiling."

A New Paradigm

In answering that question—thanks in large part to brain imaging techniques—researchers have developed a new paradigm about empathy. In many ways the current view is counterintuitive: we don't smile because we share someone's joy; we share the joy—at least in part—because we are smiling.

Damasio is probably the best-known proponent of this way of thinking about emotions and feelings. In Damasio's view, mirror neurons and other body-sensing areas of the brain constitute a type of theater. Empathy involves a brain simulation in these theaters, so that one person's emotions and feelings play out in an observer's body and mind—as if generated by the observer himself.

Two recent papers suggest that imitation is key to the process. In a study published in March in the *Philosophical Transactions of the Royal Society of London-Biological Sciences,* Meltzoff and Jean Decety, an internationally known expert in neuroimaging, propose a three-phase developmental process that begins with imitation and culminates in empathy.

During the first phase, newborns mimic adults, demonstrating an innate ability to make connections between

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A PUBLICATION OF THE DANA PRESS

Jane Nevins, Editor in Chief
Walter Donway, Director

Editorial office:
The Dana Center
900 15th Street, NW
Washington, D.C. 20005
E-mail: danainfo@dana.org

THE DANA FOUNDATION
745 Fifth Avenue Suite 900
New York, New York 10151

For free subscription or change of address:
rtalley@dana.org, or fax to 202-408-5599

BrainWork on the Internet: www.dana.org

their own actions and those observed in others. The next step occurs as infants use proprioception (the ability to sense muscle movement and tension) to associate certain facial expressions with particular emotions. Muscle movements that create a smile, for instance, become associated with joy. The final step toward empathy occurs when children notice that other people make the same expressions they do, and infer that other people must feel the same way the child himself does when making that expression.

The process takes about two to three years: a toddler who hugs a crying playmate is probably showing the first signs of empathy. "We think empathy is a developmental outcome of the baby recognizing similarities between the self and others," a process that begins with imitation, Meltzoff says.

Further support for this theory is provided in an April paper in the *Proceedings of the National Academy of Sciences*. Marco Iacoboni and colleagues at the University of California, Los Angeles describe a brain circuit that may underlie empathy. Using functional MRI, the researchers identified a circuit that extends from areas in the cerebral cortex that are critical for executing and representing actions (similar to the "mirror system" identified in monkeys) to areas in the limbic system that process emotions. The executive and emotional sections of the circuit are linked by the insula, an area within the cortex.

Twelve- to 21-day-old infants imitate adult facial actions, indicating that infants are innately "connected" to others from birth. Imitation may lay the foundation for feeling empathy later on.

The researchers found that this brain circuit is activated whether someone merely observes facial expressions of emotion or actively imitates them—but that imitation significantly heightens activity in the circuit (and presumably the intensity of emotions). "Our findings show for the first time how reflexive facial expressions prompt our brain to heighten empathy for the feelings of someone else," Iacoboni says. "We think this is the neurobiological mechanism that might explain what has been observed behaviorally" in other studies.

Chicken/Egg Question

Debate continues about which comes first, imitation or empathy—or even if one is required for the other.

"Facial expressions are very important" for empathy, Damasio says, but are not the whole story. "A person experiences a feeling not only because he imitates facial expression but also because of visceral changes" such as increased heart rate.

"I don't think we know whether imitation is required to understand expression or is an empathetic response to observed emotion," Ekman says, noting that people with Moebius syndrome, a rare disorder that causes facial paralysis, "can't make facial expressions, but they have no problem recognizing and interpreting emotions." What's more, emotion can be triggered in milliseconds, he says, and "we don't yet have the tools to provide that time resolution when observing changes in the brain."

Other unanswered questions include whether gender differences exist in empathy, and how different types of empathy (emotional, cognitive, and compassionate) are processed in the brain. Answering such questions may raise new ones.

"We are at the beginning of a new wave of research in neuroscience," Meltzoff predicts.

Ann MacDonald writes about science and medicine from Wakefield, R.I.