

CRIME Times

Linking **Brain** Dysfunction to
Disordered/Criminal/Psychopathic Behavior

Volume 15, Number 3, 2009

Glucose metabolism may influence violence in antisocial men

Abnormal glucose metabolism may play a role in repeat offending by antisocial men, according to a new Finnish study.

Matti Virkkunen and colleagues measured glucose metabolism in 49 impulsive, violent, antisocial male offenders. The researchers report, "Those offenders who committed at least one new violent crime during the eight-year follow-up had a mean non-oxidative glucose metabolism (NOG) 1.4 standard deviations lower than non-recidivistic offenders." NOG data alone, they say, could explain 27 percent of the variation in repeat offending.

The researchers conclude that altered glucose metabolism "may be a crucial component in the pathophysiology of habitually violent behavior among subjects with antisocial personality disorder." They suggest that treatments that normalize glucose metabolism may help reduce impulsive violence in this population.

"Low non-oxidative glucose metabolism and violent offending: an 8-year prospective follow-up study," M. Virkkunen, A. Rissanen, A. Franssila-Kallunki, and J. Tiihonen, *Psychiatry Research*, May 15, 2009 (epub prior to print publication). Address: Matti Virkkunen, matti.virkkunen@hus.fi.

Can a gene variant make you more likely to join a gang?

Boys with low-activity variants of a gene that determines MAOA activity are more likely than other boys to join gangs and use weapons, according to a new study.

MAOA (monoamine oxidase A) is an enzyme that breaks down several neurotransmitters (messenger chemicals) that affect mood and aggression. Low-activity variants of the MAOA gene decrease MAOA function.

Kevin Beaver and colleagues studied data collected from 1,155 females and 1,041 males participating in the National Longitudinal Study of Adolescent Health. The researchers divided participants into two groups: those with low MAOA activity (2- or 3-repeat alleles) and those with high activity (3.5-, 4-, and 5-repeat alleles). The researchers found that for males but not for females, "The low MAOA activity alleles conferred an increased risk of joining a gang and using a weapon in a fight." Males with low-activity alleles were 1.94 times more likely to be gang members, and 1.82 times more likely to have used a weapon in a fight, than those with high-activity alleles.

In addition, the researchers report, male gang members with low-activity alleles were 4.37 times more likely to use a weapon than male gang members with high-activity alleles. This finding is intriguing, they say, because "it indicates that variation in violence among gang members may be partially circumscribed by genotype."

The lack of an association between MAOA and gang membership or violence in women is not surpris-

ing, the researchers say, because MAOA is X-linked. This means that the gene's effects will be strongest for males, who only have one copy of the gene.

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The first clues pointing to MAOA's role in violence emerged in 1995, when a study by H. G. Brunner (see *Crime Times* Vol. 1, No. 3, 1995, page 1) linked a mutation in a gene coding for MAOA to impulsive aggression in the male members of an extremely violent family. In 2002 (see *Crime Times* Vol. 8, No. 4, 2002, Page 1), Avshalom Caspi and colleagues studied people abused as children and found that those with a low-activity MAOA gene variant were extremely likely to become antisocial adults, while those with higher MAOA activity almost never grew up to be antisocial. And in 2008 (see *Crime Times* Vol. 14, No. 2, page 2), Guang Guo and colleagues found that men with a rare low-activity variant (2R) of the gene reported levels of serious delin-

continued on page 2

Twin study: Are genes partly to blame for a person's risk of becoming a crime victim?

Studies show that your genes influence the odds that you'll become a criminal. But could they also affect your risk of being a *victim* of a crime?

To find out, Kevin Beaver and colleagues studied data collected from identical and same-sex fraternal twins participating in a large national study of adolescents (the "Add Health" Study). The data included information on the participants' family life, social life, romantic involvements, extracurricular activities, drug and alcohol use, and personal victimization.

The researchers found that genetic factors explained 40 to 45 percent of the variance in adolescent victimization, while non-shared environment (environmental influences that weren't the same for both twins) accounted for the rest. Shared environment—for instance, poverty experienced by both twins—did not account for any of the variance.

Moreover, genetic factors accounted for 64 percent of the variance when the researchers analyzed

The most surprising finding was that genetic factors accounted for 64 percent of the variance in the risk for victimization when the researchers analyzed repeat victims.

data from adolescents who reported being victimized repeatedly.

"It is possible that we detected this genetic effect on victimization because it is operating indirectly through behaviors," Beaver says. "The same genetic factors that promote antisocial behavior may also promote victimization, because adolescents who engage in acts of delinquency tend to have delinquent peers who are more likely to victimize them. In turn, these victims are more likely to be repeatedly victimized, and to victimize others."

The strong genetic influence they detected for repeat victims

is of particular importance, the researchers say, because most victimization research views victims solely as innocent bystanders. "[I]f the results of the current study are to be believed," they say, "then victimization researchers will need to reexamine their theories and research and begin to integrate genetic factors."

But Beaver adds, "We're not suggesting that victimization occurs because a gene is saying, 'Okay, go get victimized,' or solely because of genetic factors. All traits and behaviors result from a combination of genes and both shared and non-shared environmental factors."

—
"The biosocial underpinnings to adolescent victimization: Results from a longitudinal sample of twins," Kevin M. Beaver, Brian B. Boutwell, J. C. Barnes, and Jonathon A. Cooper, *Youth Violence and Juvenile Justice*, May 11, 2009 (epub prior to print publication). Address: Kevin Beaver, College of Criminology and Criminal Justice, Florida State University, 634 West Call Street, Tallahassee, FL 32306-1127, kbeaver@fsu.edu.

—and—

"For adolescent crime victims, genetic factors play lead role," news release, Florida State University, May 14, 2009.

Does MAOA gene affect gang membership risk? (cont. from p. 1)

quency and violent delinquency in adolescence and young adulthood "that were about twice as high as those for participants with the other variants." Women showed a similar but weaker pattern.

Beaver says, "While gangs typically have been regarded as a sociological phenomenon, our investigation shows that variants of a specific MAOA gene . . . play a significant role." He and his colleagues suggest that males with low MAOA activity may be more attracted to violence and seek out gangs for that reason—or, conversely, that the

most violent teens are sought out by certain gangs.

(Editor's note: See related article by Dr. Beaver and colleagues on this page.)

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"Monoamine oxidase A genotype is associated with gang membership and weapon use," Kevin M. Beaver, Matt DeLisi, Michael G. Vaughn, and J. C. Barnes, *Comprehensive Psychiatry*, May 5, 2009 (epub prior to print publication). Address: Kevin M. Beaver, kbeaver@fsu.edu.

—and—

"FSU study links 'warrior gene' to gang membership, weapon use," news release, Florida State University, June 5, 2009.

Quotable...

Sadly, too few disruptive, learning disabled, depressed, or delinquent children ever see the few doctors who are really aware of the damage that toxic chemicals can do to vulnerable brains. Instead, many wind up being referred to psychologists or 'anger control counselors' who can't fix brain dysfunction."

Dr. Bernard Rimland, in *Dyslogic Syndrome*, Jessica Kingsley Press, 2008

Children in homes with gas appliances score lower on measures of cognition, attention

Children in homes with gas appliances may be at heightened risk for attention problems and cognitive impairment, according to a new study.

Eva Morales and colleagues assessed 398 children at four years of age. The children were part of a long-term study that initially collected data when participants were three months old. This data included information on whether or not the children lived in homes with gas appliances, as well as measurements of the levels of nitrogen dioxide (a pollutant released by gas appliances) in their homes.

The researchers report that compared to other children, those in homes with gas appliances were more likely to have attention problems. They also scored significantly lower on tests measuring memory, verbal skills, and motor skills. In particular, the children showed impairments in verbal skills and executive function—a group of skills necessary for impulse control and long-term

planning. The findings were not affected by parental social class, parental educational level, breastfeeding, maternal alcohol consumption or tobacco use during pregnancy, or number of smokers at home.

Children in homes with the highest levels of nitrogen dioxide had the most marked cognitive impairments and the highest risk for attention problems. While the study focused on nitrogen dioxide, the researchers note that children may also be vulnerable to other toxins produced by gas appliances.

Morales and colleagues also investigated whether children with a particular variant of the glutathione-S-transferase gene (GSTP1) were at heightened risk. They report, “The deleterious effect of indoor pollution from gas appliances on neuropsychological outcomes was stronger in children with the GSTP1 Val-105 allele.” Glutathione S-transferases (GSTs) are enzymes that play a key role in cell detoxification.

The researchers, who conducted their study in Spain, note that the butane bottles used in the region contain more toxins than the natural gas widely used in the U.S. However, they conclude, “Current data provide preliminary evidence that early-life exposure to indoor air pollution from gas appliances may be related to impaired cognitive functioning among preschoolers and may increase their risk of developing ADHD symptoms.”

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“Association of early-life exposure to household gas appliances and indoor nitrogen dioxide with cognition and attention behavior in preschoolers,” Eva Morales, Jordi Julvez, Maties Torrent, Rafael de Cid, Mònica Guxens, Mariona Bustamante, Nino Künzli, and Jordi Sunyer, *American Journal of Epidemiology*, April 24, 2009 (epub prior to print publication). Address: Jordi Sunyer, Center for Research in Environmental Epidemiology, Parc de Recerca Biomèdica de Barcelona, C/ Dr. Aiguader 88, Barcelona E-08003, Catalonia, Spain, jsunyer@creal.cat.

Quotable...

“We see on TV every day somebody who has been stabbed or shot. That is often a consequence of people not being able to control their anger, and being unable to focus their attention on the consequences of their actions. I think this can be caused by a slight impairment of the prefrontal cortex — the part of the brain that is most sensitive to lack of key nutrients.”

Neurophysiologist John Stein, who is heading a three-year project investigating the effects of improving prison diets, discussing his research in the London Times, January 2008

“A steady supply of carbohydrates, fats, amino acids, vitamins and minerals, and dietary antioxidants are essential to brain structure and function throughout life. For example, complex carbohydrates supply a steady stream of fuel, amino acids make up the brain communication chemicals called neurotransmitters, fats make up the structure of the nerve cell walls, and vitamins and minerals work the machinery. Certain of these dietary items, particularly the antioxidants and good fats, also help protect the delicate nerve cells against the aging process.

“We take for granted that these same nerve cells are responsible for intelligence, memory, motivation, mobility, attention, and so much more. Despite the wealth of research in the area of nutritional influences over behavior, mental and neurological health, and day to day mental edge, it really surprises me that the connection remains undervalued.”

Alan Logan, N.D., FRSH, author, The Brain Diet, (Cumberland House, 2007) in an interview with Dr. John Berardi

“There’s a growing body of evidence making a connection between how well children perform in school and life and toxins in their environment.”

Dan Orzech, in Today’s Dietician, April 2008

FASD kids poor at social cognition, emotion processing

Children with fetal alcohol spectrum disorders (FASD) have poor “social cognition” and difficulty processing facial emotions, a new study reports. These findings may help explain the high rates of severe behavior problems associated with FASD.

The research, by Rachel Greenbaum and colleagues, involved three groups of children: 33 with FASD, 30 with ADHD, and 34 with neither disorder. All of the children were around nine years of age. Parents and teachers used standard questionnaires and scales to rate the children’s behavioral problems and social skills. The children also participated in tests designed to measure two types of abilities:

—Social cognition, which study co-author Joanne Rovet defines as “the ability to consider and differentiate between the beliefs, thoughts, feelings, and intentions of oneself and others.” This skill, she says, “involves understanding the meaning of social information and knowing how to interact appropriately.”

—Emotion processing, which Rovet defines as “understanding and processing information related to feelings.” She notes, “This includes the ability to recognize and differentiate between varied emotions in others and in oneself.”

Both sets of skills, the researchers note, are crucial for communicating and getting along with others.

The researchers found that the children with FASD had more severe behavioral problems than those with ADHD. The behavior problems of the FASD children included high distractibility and restlessness, as well as behaviors the researchers say could be described as “out of control” and juvenile. This is consistent, Rovet says, with earlier work by her

lab showing that “children and adolescents with FASD were more likely than children with ADHD to engage in antisocial behaviors, such as cheating, stealing and acting young, as well as sociopathic behaviors including lying and stealing.”

In addition, the children with FASD exhibited weaker social cognition and facial emotion processing skills. “In terms of social cognition and emotional processing,” Rovet says, “the core deficit in FASD appears to be in understanding and interpreting another’s mental states and emotions.”

Commenting on the study, pediatric neurologist Piyadasa Kodituwakku says it reveals that “a child with ADHD may be able to predict how another child would feel in a certain situation, but he or she may do something to hurt that child’s feelings despite this ability. On the other hand, a child with FASD may do something to hurt someone else’s feelings because of an inability to appreciate that person’s reactions.” Kodituwakku says this difference suggests that the two groups of children may need different types of social skills training.

—
“Social cognitive and emotion processing abilities of children with fetal alcohol spectrum disorders: A comparison with attention deficit hyperactivity disorder,” Rachel L. Greenbaum, Sara A. Stevens, Kelly Nash, Gideon Koren, and Joanne Rovet, *Alcoholism: Clinical and Experimental Research*, July 15, 2009 (epub prior to print publication). Address: Joanne Rovet, Psychology Department, The Hospital for Sick Children, 555 University Avenue, Toronto, ON M5G1X8, Canada, joanne.rovet@sickkids.ca.

—and—
“Children with FASD have more severe behavioral problems than children with ADHD,” news release, EurekaAlert, July 16, 2009.

High-fish diet linked to higher IQ in male teens

Male teens who eat diets high in fish score higher on intelligence tests than boys who eat low-fish diets, according to a recent study. The research adds to a growing body of evidence that the omega-3 fatty acids found in fish contribute to healthy brain function.

Maria Åberg and colleagues analyzed data from nearly 4,800 male teens in Sweden who completed questionnaires on their diets and lifestyle habits when they were 15. When participants turned 18, they took standard IQ tests.

“The main finding,” the researchers say, “was that frequent fish intake compared with infrequent fish intake at age 15 was associated with significantly higher cognitive performance as measured by combined intelligence, verbal and visuospatial skills three years later.” The association remained significant when the researchers controlled for ethnicity, body mass index, physical exercise, place of residence, parental education levels, and the children’s socioeconomic status.

“These findings are significant,” Åberg said in a Reuters interview, “because the study was carried out between the ages of 15 and 18, when educational achievements can help to shape the rest of a young man’s life.”

—
“Fish intake of Swedish male adolescents is a predictor of cognitive performance,” Maria Åberg, Nils Åberg, Jonas Brisman, Rosita Sundberg, Anna Winkvist, and Kjell Torén, *Acta Paediatrica*, Vol. 98, No. 3, March 2009, 555-60. Address: Maria Åberg, Centre for Brain Repair and Rehabilitation, Institute for Neuroscience and Physiology at Sahlgrenska Academy, University of Gothenburg, S-405 30 Gothenburg, Sweden, mab@neuro.gu.se.

—and—
“Fish may be brain food for teenage boys,” Amy Norton, Reuters, March 16, 2009.

High lead levels in early years may hike risk of psychopathy

Young children with high blood lead levels may be at elevated risk for adult psychopathy, according to a new study.

John Paul Wright and colleagues used data from the Cincinnati Lead Study (CLS), which recruited women in the first trimester of pregnancy from clinics in areas high in environmental concentrations of lead. The study excluded women with known psychiatric, neurological, or drug addiction problems, and excluded premature or very underweight babies and those with serious problems at birth.

The current study involved 250 of the CLS participants followed from birth to adulthood. Wright's research team analyzed data from blood lead tests performed at 78

months and from a self-reported Psychopathic Personality Inventory (PPI) the participants completed in adulthood.

Wright and colleagues found that participants' blood lead levels at six years "modestly predicted variation in the PPI measured 13 to 18 years later." The findings remained significant, the researchers say, when they controlled for sex, race, maternal IQ, home environment, and academic achievement. In particular, they note, children with elevated lead levels scored higher on four dimensions of the PPI that "portray an individual that is callous and unemotional, that is highly egocentric, that deflects blame for his or her behavior onto others, and that consciously manipulates others for his own gain."

The researchers say their findings suggest that "[b]ehaviors and beliefs that appear highly manipulative and callous and that advance the individual's self-interest may be partially the result of damage to the central nervous system."

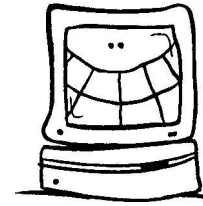
In addition, they say, their study shows the intertwined effects of biology and environment. "Psychopathy may have strong genetic roots but may still be affected by biological toxins that subtly, and sometimes not subtly, damage the brain and central nervous system of the individual," they conclude.

"Blood lead levels in early childhood predict adulthood psychopathy," John Paul Wright, Danielle Boisvert, and Jamie Vaske, *Youth Violence and Juvenile Justice*, May 11, 2009 (epub prior to print publication). Address: John Paul Wright, Division of Criminal Justice, University of Cincinnati, P.O. Box 210389, Cincinnati, OH 45221-0389, john.wright@uc.edu.

QUOTABLE

"In the past decade, clinical neuroscientists have begun to study mental illnesses as disorders of brain circuits. This change may prove to be a fundamental transformation in how we study, diagnose and treat these very disabling illnesses. For instance, we may discover that the behavioral and cognitive manifestations of these illnesses are a late stage of a chronic brain process that could be detected years before psychosis or mood disturbance.... At the very least, we will need to begin training a new generation of mental health workers in cognitive and affective neuroscience so that they will be able to expand our understanding of mental disorders just as neuroscientists are expanding our understanding of mental life."

*Thomas R. Insel, M.D.,
in the foreword to
Cerebrum 2009, Dana Press*



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Abnormal connections between brain regions may contribute to psychopathic behavior

Psychopaths—people characterized by callousness, lack of empathy or remorse, shallow emotions, and manipulative behavior—make up much of the prison population and commit far more crimes than non-psychopathic criminals. Many studies hint that defects of the orbitofrontal cortex (OFC) play a role in psychopathic behavior, while other research implicates the amygdala. A new study, however, suggests that psychopathy may involve altered “connectivity” of a network that includes these two brain regions.

M. C. Craig and colleagues studied nine male psychopaths, all repeat violent offenders convicted of rape,

attempted murder, or other serious crimes. Using diffusion tensor magnetic resonance imaging (DT-MRI), the researchers investigated the uncinate fasciculus (UF)—a band of fibers connecting the amygdala and orbitofrontal cortex.

The researchers say that compared to healthy male controls, the psychopaths showed evidence of reduced microstructural integrity in the UF. Within psychopaths, Craig and colleagues detected a correlation between measures of antisocial behavior and anatomical differences in the UF. Analysis of two tracts connecting other regions of the brain to the amygdala or OFC did not reveal similar anomalies.

To rule out the possibility that the findings stemmed from substance abuse, the researchers also compared the results from the psycho-

paths with results from a psychiatric control group with a history of drug and/or alcohol abuse and institutionalization. The psychopaths showed anomalies compared to this group as well.

The researchers say, “Taken together, our findings suggest that abnormal ‘connectivity’ in the amygdala-OFC limbic network may contribute to the neurobiological mechanisms underpinning the impulsive, antisocial behavior and emotional detachment associated with psychopathy.”

—
“Altered connections on the road to psychopathy,” M. C. Craig, M. Catani, Q. Deeley, R. Latham, E. Daly, R. Kanaan, M. Picchioni, P. K. McGuire, T. Fahy, and D. G. M. Murphy, *Molecular Psychiatry*, June 9, 2009 (epub prior to print publication). Address: m.craig@iop.kcl.ac.uk.

Why Crime Times?

The more we learn about the brain dysfunction that underlies much delinquency and criminal behavior, the more successful we will be in truly rehabilitating offenders and preventing at-risk children from turning to lives of crime.

The purpose of *Crime Times*, a free publication sponsored by the Wacker Foundation, is to foster this effort by reporting state-of-the-art worldwide research on biological causes and treatment of aberrant behavior. It is our hope that physicians, researchers, educators, law enforcement professionals, and parents can use the information in *Crime Times* to build a better, safer future for at-risk children and for the communities in which they live.

Even mild early head trauma can lead to behavior woes

Children who suffer even mild brain injuries during their preschool years may be at heightened risk for behavior problems as teenagers, a new study indicates.

Audrey McKinlay and colleagues evaluated data on 19 children admitted as inpatients to hospitals for mild traumatic brain injury (MTBI) before the age of five years; 57 children with any episode of MTBI before age five who were seen by a general practitioner or emergency room but not hospitalized; and a control group of 839 children. The researchers report, “At age 14 to 16 years, children who had been hospitalized for MTBI during preschool years were significantly more likely to show symptoms of attention deficit/hyperactivity disorder, conduct disorder/oppositional defiant disorder, substance abuse,

and mood disorder but not anxiety disorder.”

The researchers conclude, “Preschool MTBI is associated with persistent negative effects on psychosocial development.”

—
“Adolescent psychiatric symptoms following preschool childhood mild traumatic brain injury: evidence from a birth cohort,” A. McKinlay, R. Grace, J. Horwood, D. Fergusson, and M. MacFarlane, *Journal of Head Trauma Rehabilitation*, Vol. 24, No. 3, May-June 2009, 221-7. Address: Audrey McKinlay, Department of Psychology, University of Canterbury, Christchurch, New Zealand, audrey.mckinlay@canterbury.ac.nz.

MOVING?

Please let us know well ahead of time, so we can be sure your next issue reaches you!

**Book Review:
OPTIMUM NUTRITION
FOR THE MIND,
by Patrick Holford**

**Basic Health Publications, Inc.,
2004, Paperback, 381 pages**

Professionals and lay readers interested in keeping up with the newest findings on nutrition and the brain will find this book a valuable addition to their libraries.

In it, Patrick Holford—director of the Optimum Nutrition Center in London—explores how the food we eat affects our thinking, memory, mood, and behavior. Part 1 offers a general review of nutrition's effects on cognition and behavior, and Part 2 covers the effects of pollutants and allergens. Parts 4 and 5 discuss mental illness, while Part 6 covers child learning and behavioral problems, criminality, and substance abuse. The book ends with a section on the role of nutrition in promoting brain health in the elderly. The range of topics covered will interest both readers focusing specifically on criminality and those with a more general interest in brain health and behavior.

**Quotes from OPTIMUM NUTRITION FOR THE MIND,
by Patrick Holford**

“Of the few studies so far conducted, all show dramatic reductions in reoffending rates among offenders maintained on low-sugar, high-nutrient diets. Although much harder to identify (and eliminate), it is certainly possible that the introduction of 3,500 new chemicals into the food supply could be contributing to deviant behavior.”

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“The levels of neurotoxins like lead, cadmium, copper, and mercury needed to produce an effect on behavior is around one percent of the level needed to produce physical symptoms. This indicates how sensitive that part of the brain involved with socialization is to environmental and nutritional changes.”

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“[Research] suggests that the effect of... vitamin and mineral supplements is to increase the speed of processing, which is clearly a significant factor in IQ and presumably in intelligence, as well as attention span. In other words, you think faster and can concentrate for longer.”

—

“You can't just psychoanalyze away deficiencies in essential fats, vitamins, minerals, and other key brain nutrients. We must think our way out of the box and wake up to the fact that chemistry directly affects how we think and feel.”

—

“When you're having difficulty concentrating, when your mood is low, when you struggle to find a memory, do you consider that you may be poorly nourished? Why not? Every one of these states—your thinking, feeling, mental energy, and focus—happens across a network of interconnecting brain cells, each one of which depends on an optimal supply of nutrients to work efficiently.”

New findings: Prenatal exposure to high levels of pollution may significantly reduce IQ

Children exposed prenatally to high levels of pollutants may be at risk for lower IQs, according to a recent study in New York City. Even slight reductions in IQ are associated with poorer performance in school, and low IQ is a risk factor for delinquency and adult criminality.

Frederica Perera and colleagues assessed the impact of exposure to polycyclic aromatic hydrocarbons (PAHs) by having 249 mothers in low-income neighborhoods in Washington Heights and Harlem wear air monitors for 48 hours dur-

ing their pregnancies. All of the mothers were between 18 and 35; none of them smoked; and none had diabetes, HIV, high blood pressure, or a history of illicit drug use.

Air quality measurements showed that 140 of the children were exposed prenatally to high levels of PAH. After adjusting for factors including maternal IQ and home environment, the researchers found that children exposed to high levels of PAH *in utero* scored an average of more than four points lower on full-scale IQ tests (and nearly five

points lower on verbal IQ tests) at the age of five than children with lower exposures.

—

“Prenatal airborne polycyclic aromatic hydrocarbon exposure and child IQ at age 5 years,” Frederica P. Perera, Zhigang Li, Robin Whyatt, Lori Hoepner, Shuang Wang, David Camann, and Virginia Rauh, *Pediatrics*, July 20, 2009 (epub prior to print publication). Address: Frederica Perera, fpp1@columbia.edu.

—and—

“Exposure to common pollutant in womb might lower IQ,” *HealthDay*, July 20, 2009.

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QUOTABLE "I talk to a lot of teachers, and any of them who have been in the classroom the last 20 or 25 years will tell you, 'I used to have one kid or two kids who had learning problems or were disruptive, and now, half my class has behavioral issues.' That's not necessarily all because of environmental exposures, but genes don't change that quickly. So social, nutritional, and environmental factors have got to be playing a significant role."

—*Elise Miller, Executive Director of
the Institute for
Children's Environmental Health
and National Coordinator of the
Learning and Developmental
Disabilities Initiative*

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