The unique identification of accused individuals from evidence obtained with scent-following dogs is routinely accepted by the criminal courts, yet "[t]he small amount of peer-reviewed research that has been published in this field has documented...that many trained law enforcement dogs cannot perform the tasks that are routinely claimed." Influences on the development of violent behavior in people, and intergroup versus intragroup aggression in primates are two of the topics discussed in response to *Science*'s special issue about violence. And two episodes of die-offs of harbor seals, one in 1988 and one this year in the Caspian Sea, have been attributed to morbillivirus infections, but the question of whether pollutants increased the susceptibility of the seals to such infections is not settled.

Canine Detectives: The Nose Knows—Or Does It?

In the field of forensics, scientific experimentation and technological developments can make important contributions in both the prosecution and defense of criminal cases, as Andrew Watson discusses in his News Focus article "A new breed of high-tech detectives" (11 Aug., p. 850). There is, however, one area of criminal investigation that is still accepted by many courts of law with little or no underlying body of scientific evidence affirming the validity of its use. That area is the use of bloodhounds and other scent-following dogs to identify individual people or their scent trails in the environment on the basis of a previously offered reference scent article such as a handkerchief, hat, or other item of clothing (*1*).

The stuff that legends are made of—but is there much science to back up such legend status?

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Canine scent-identification evidence is usually presented in court to suggest the unique identification of an accused individual in the same way that fingerprints are used. DNA evidence, on the other hand, is usually represented only to include or exclude an individual in relation to a group of possible perpetrators with a similar genetic profile; it is not offered for unique identification. DNA evidence is premised on almost universally accepted theories of biochemistry and population genetics, whereas canine scent-identification evidence is premised on the alleged factuality of the "individual odor theory," which holds that each person has a unique scent that can be identified by the dog and related back to a specific individual.

In fact, our research suggests that either the individual odor theory is incorrect or that trained dogs do not automatically generalize certain features of scent (for example, that imparted by the palm of the hand in touching an object) to other scents from the same individual (*2*). Nevertheless, courts have accepted the performance of such dogs, even when it is claimed that they are detecting the scent of a specific individual at the scene of a crime nearly 2 years after the crime was committed (*3*). In that juries have found individuals guilty almost solely on the basis of dog evidence subsequently shown to be unreliable, if not fraudulent (*4*), it would seem imperative for organizations such as the National Institute of Justice or the Forensic Science Service to support studies of the abilities of such scenting dogs.

The small amount of peer-reviewed research that has been published in this field has documented, contrary to much "popular wisdom," that many trained law enforcement dogs cannot perform the tasks that are routinely claimed. These include the ability to enter a scent trail at right angles and automatically determine the direction of quarry movement (*5*) and the ability to scent-match odors from individuals to handled objects, under controlled laboratory conditions (*6*). Although in some of these studies dogs have proved capable of performing such scent-matching tasks at levels greater than chance, their error rates are seldom better than 10 to 20% (*7*), levels substantially above those expected of scientifically validated forensic evidence. The U.S. Supreme Court has stated that "known or potential rate of error" is a significant factor a court should consider in the admission of scientific evidence (*8*).

Well-trained bloodhounds and other scenting dogs certainly are capable of performing important tasks in law enforcement: when properly controlled double-blind testing shows the ability of individual dogs to perform specific tasks at acceptable levels of correctness, their performance in such tasks might be considered as valid evidence in a court of law. Perhaps now, in an age of sophisticated forensic technology in such fields as physics and biochemistry, some careful, controlled research in the area of animal behavior could shed light on the acceptance of what is still the almost mythological ability of scenting dogs to provide forensic evidence.

I. Lehr Brisbin Jr.
Savannah River Ecology Laboratory, Aiken, SC 29802, USA. E-mail: brisbin@srel.edu

Steven Austad
Department of Biological Sciences, University of Idaho, Moscow, ID 83844–3051, USA. E-mail: austad@uidaho.edu

Steven K. Jacobson
Deputy State Public Defender, State of Colorado Office of the State Public Defender, Boulder, CO 80301, USA. E-mail: steve.jacobson@state.co.us

References

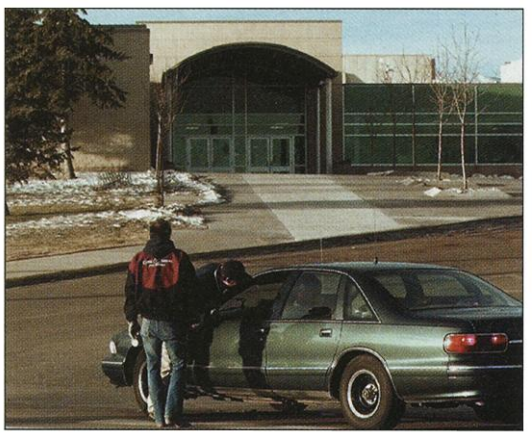
1. A. E. Taslitz, *Hastings Law J.* **42**, 15 (1990).
2. I. L. Brisbin Jr., S. N. Austad, *Anim. Behav.* **42**, 63 (1991).
3. *State v. Eugene Wiley*, Case No. 8001659, 18th Judicial Circuit, Brevard County, FL (1982).
4. *State v. Kevin Roscoe*, CR-127656, 11-20-90, Maricopa County, Arizona Superior Court, Judge Paulson.
5. S. A. MacKenzie, J. A. Schultz, *Appl. Anim. Behav. Sci.* **17**, 353 (1987).
6. G. A. A. Schoon, J. C. deBruin, *Forensic Sci. Int.* **69**, 111 (1994); G. A. A. Schoon, *Appl. Anim. Behav. Sci.* **49**, 257 (1996).
7. I. L. Brisbin Jr., S. N. Austad, *Anim. Behav.* **46**, 191 (1993).
8. *Daubert v. Merrell Dow Pharmaceuticals Inc.*, 509 U.S. 579, 594 (1993).

Ideas About the Development of Violent Behavior

Any meaningful discussion of violence research or violence policy must include a biological perspective and take into account that behavior cannot be divorced from its origins in the brain. As Steven Hyman of the National Institute of Mental Health points out in Eliot Marshall's News article "The shots heard 'round the world" ("Violence" special issue, 28 Jul., p. 570), the study of violence has moved beyond determinism. In a review of the available data on the neurobiological origins and consequences of violent behavior, I have collected evidence that this is as true for biological studies in particular as it is for the field of violence research in general (*1*).

As Klaus Miczek, a psychopharmacol-

ogist at Tufts University, points out in another article in the same issue (*2*), complexity isn't an easy sell, especially to a public interested in quick fixes. But complexity is exactly what biological research on violence tells us we must accept. Violence is not a program, but the result of a process, emerging from the interaction between the physical human being and his or her environment. The brain perceives and interprets events in the surrounding world but, as R. J. Davidson and colleagues note in their review in the issue (*3*), the circuitry that regulates that world view can be profoundly altered by experience. Similarly, neurotransmitter pathways implicated in the expression of aggressive behavior are themselves changed by the very act of behaving (*4*).



The deaths at Columbine High School focused a spotlight on the unpredictablity of violence.

Biological studies of violent behavior cannot reveal who may be plotting an event as horrifying as the deadly shooting spree conceived and carried out by two students at Columbine High School in Littleton, Colorado ("The shots heard 'round the world"), but they do tell us that events in the social environment, such as the loss of a caregiver early in life, can have a profound impact on the neurobiological mechanisms underlying the perception of threat and the response to stress (*5*). Like the social science research discussed by Marshall, biological studies confirm that much of what we do to reform violent individuals actually causes more harm than good. For example, social isolation has clearly been demonstrated to exacerbate aggression (*6*), yet solitary confinement remains the "treatment" of choice for our most violent offenders.

We are blindsided by violence because we remain blind to the steady decline in self-control and empathy that are the hallmarks of a toxic interaction between life experience and the brain's emotion-related circuitry. Neuroscience and social science studies indicate that the most effective way to reduce violence is to prevent it, through policies that value the safety of children, the quality of the social environment, and the efficacy of reconciliation over ideology and political expediency.

Debra L. Niehoff
5 Market Place, New Hope, PA 18938, USA. E-mail: niehoff2@aol.com

References

1. D. L. Niehoff, *The Biology of Violence: How Understanding the Brain, Behavior, and Environment Can Break the Vicious Circle of Aggression* (The Free Press, New York, 1999).
2. M. Enserink, *Science* **289**, 575 (2000).
3. R. J. Davidson, K. M. Putnam, C. L. Larson, *Science* **289**, 591 (2000).
4. A. M. M. van Erp, K. A. Miczek, *Soc. Neurosci. Abstr.* **22**, 161 (1996).
5. M. J. Meaney *et al.*, *Dev. Neurosci.* **18**, 49 (1996); G. W. Kraemer, A. S. Clarke, *Ann. N.Y. Acad. Sci.* **794**, 125 (1996).
6. L. Valzelli, in *Aggressive Behavior*, S. Garattini and E. B. Sigg, Eds. (Wiley, New York, 1969), pp. 70–75; J. L. Gariépy, M. H. Lewis, R. B. Cairns, in *Aggression and Violence*, D. M. Stoff and R. B. Cairns, Eds. (Erlbaum, Hillsdale, NJ, 1996), pp. 41–63.

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Contrary to the title of the introduction to the 28 July special issue, "Violence: no silver bullet," there is indeed a "silver bullet" for violence—or at least an evidence-based, tested, and testable model of violence development predictive of effective measures of prevention and intervention. It is criminologist Lonnie Athens' 1992 identification of a four-stage process of violent socialization ("violentization") common to all of the incarcerated violent criminals he interviewed, but incomplete or absent in nonviolent individuals with experience of violence who were interviewed as controls (*1*).

The four stages that Athens identified, typically traversed in childhood and early adolescence, consist of (i) brutalization (being violently subjugated physically and/or psychologically, experiencing valued primary group members being violently subjugated, being violently coached); (ii) belligerency (taking stock of brutalization in the light of violent coaching, culminating in a qualified resolution to respond to further serious provocation with serious violence); (iii) defensive violent performances, which, if successful, culminate in (iv) virulency (responding to the empowering social trepidation and violent notoriety evoked by successful violent performances with a more fundamental, unqualified resolution to use unprovoked violence).

Athens' violentization model implies that many different strategies of prevention and intervention can successfully prevent violent behavior by diverting candidates from proceeding further through the stages of the violentization process. Protecting children from brutalization should be the single most effective public health measure, because individuals who are not brutalized do not need to make the further choices that lead to violent outcomes.

Violent behavior is a consequence of violent socialization. Soldiers and police officers learn it through institutional, truncated forms of violentization and apply it defensively in our behalf. Any theory of the etiology of violent behavior should explain professional violence as well as criminal. Athens' model does. It deserves to be included in any discussion of violence and "silver bullets."

Richard Rhodes
609 Summer Hill Road, Madison, CT 06443, USA.
E-mail: rhodesr@pantheon.yale.edu

References

1. L. Athens, *The Creation of Dangerous Violent Criminals* (Univ. of Illinois Press, Urbana, 1992).

Conflict and Resolution in Primates—All Too Human?

In his review "Primates—a natural heritage of conflict resolution" ("Violence" special issue, 28 Jul., p. 586), Frans de Waal provides three examples of conflict resolution involving third parties: policing and pacification, triadic reconciliation, and third-party mediation. He suggests that all of these interactions might be variations on a basic behavioral mechanism. Indeed, such a mechanism, known as the triangle, has been described in models of human family dynamics (*1*). If a relationship between two individuals is disturbed, enlisting a third party may defuse the disturbance, thus activating a triangle (two interactants and one intervener).

Relationships among three individuals have emergent behavioral properties (*2, 3*). Triangles should be more stable than relationships between two people because the multiple interconnecting relationships provide pathways for anxiety to shift among individuals. As long as a low-stress situation can be maintained, two individuals can minimize the costs of stress and maintain a stable relationship. How-