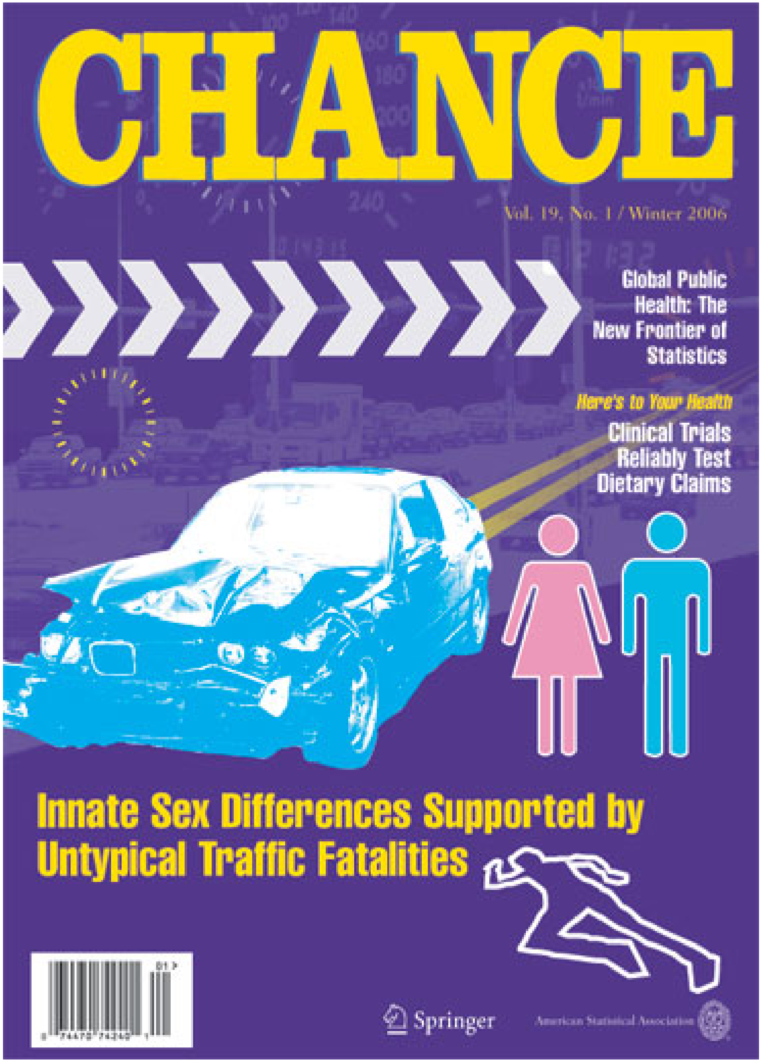

Uses material in Chapter 9 of ***Traffic Safety*** which shows additionally how pervasive these effects are in the world's traffic

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Latest *Traffic Safety* YouTube

Some think intrinsic behavioral differences between genders originate at a hormonal level. Do hormones, namely testosterone, play a role in traffic crashes?

Innate Sex Differences Supported by Untypical Traffic Fatalities

Leonard Evans

As males and females are treated differently in all societies from birth (today possibly even before birth), socialization explanations are always possible for any observed sex-dependent outcome. While 73% of the more than a million people killed annually in all types of road traffic crashes are male, sex-dependent treatments, expectations, and laws can contribute hugely to this disparity. In an extreme example, societies that do not issue drivers' licenses to females find that nearly all driver fatalities are male. On the other hand, there is evidence hinting that some behavior differences may be rooted in innate or biological differences between the sexes, contributing to an ongoing nurture versus nature debate.

For every age, all the way through the mid-90s, male fatalities are typically 3 to 5 times that of female fatalities.

Table 1—The Number of Baby, Infant, and Child 'Driver' Fatalities versus Sex and Age

Age (years)	"Driver" fatalities		Cumulative		Boy-to-girl ratio
	Boy	Girl	Boy	Girl	
0 *	1	0	1	0	
1	1	0	2	0	
2	0	0	2	0	
3	1	0	3	0	
4	5	0	8	0	
5	9	0	17	0	
6	14	2	31	2	15.5
7	25	3	56	5	11.2
8	55	4	111	9	12.3
9	82	10	193	19	10.2
10	127	11	320	30	10.7
11	183	8	503	38	13.2
12	285	31	788	69	11.4
13	420	38	1,208	107	11.3
14	809	92	2,017	199	10.1
15	*1,552*	*247*	*3,569*	*446*	*8.0*
16	*5,318*	*1,934*	*8,887*	*2,380*	*3.7*

*Ages follow common usage. For example, age = 3 is from the 3rd birthday to just prior to the 4th birthday. Age = 0 refers to the first year of life, from birth to just prior to the first birthday. These are plotted at age = 3.5 years and age = 0.5 years. The two bottom rows are to indicate the transition into licensed driving and the more stable male-to-female ratio of around four for lone drivers.

Here, we provide information relevant to this debate from traffic fatality data. The number of traffic fatalities is so enormous that highly specific outcomes that have a greater chance of revealing innate sex differences can be examined.

Data

The Fatality Analysis Reporting System (FARS), a file maintained by the U.S. Department of Transportation, provides about 100 data elements for each fatal crash (supplied mainly by police officers called to crash scenes). FARS data provide detailed information about 1,284,629 people killed on U.S. roads in the 29-year period from January 1, 1975, through December 31, 2003.

The data are collected for the purpose of reducing the enormous harm from traffic crashes. I have performed many analyses sharing much in common with those presented here for that purpose and reported them in traffic safety literature as documented in my 2004 book *Traffic Safety*. Here, the same traffic data and methods are used to address not traffic safety, but sex differences.

One year's collection of FARS data costs about $7 million. While this is less than 0.003% of the $231 billion annual cost of the traffic crashes it aims to reduce, the approximately $200 million cost of collecting 29 years of FARS data would not be allocated to collect data to examine sex effects.

Baby, Infant, and Child 'Driver' Fatalities

Table 1 shows subjects extracted from the 29 years of FARS data satisfying the following selection criteria: The subject was alone in a vehicle traveling on a public road, seated in the driver's seat, and killed. There is no indication of how the subjects set vehicles in motion or what they were doing prior to crashing. However, it seems plausible that, when left alone in vehicles with engines running or with ignition keys available, the babies, infants, and children ventured into drivers' seats. With increasing age, subjects may have been attempting to drive by copying observed adult behavior, and at later ages independently may have entered vehicles. Subjects are called "drivers" to acknowledge that their role differs from that of usual drivers.

One baby boy less than one year old was killed as such a "driver." One boy aged 1 and another aged 3 were killed. At age 5 or younger, 17 children were killed. The sex mix is 17 boys, no girls. The youngest girl killed was age 6, at which age there were two girl fatalities compared to 14 boy fatalities. For every age before eligibility for a driver's license (15 in most states), the cumulative male total exceeds the cumulative female total by at least a factor of 10.

Two distinct processes could contribute to more male fatalities. More boys could be left alone in vehicles because of a greater protective adult attitude toward girls, or boys could be more likely to set vehicles in motion when left alone. While socializing processes could contribute to both effects, I find it implausible that they could generate outcomes as quantitatively different as those found.

After the legal age of licensure, the number of fatalities soars. For every age, all the way through the mid-90s, male fatalities are typically 3 to 5 times that of female fatalities. For example, at age 20, there were 14,325 male and 3,238 female drivers killed while traveling alone during the 29-year period.

Baby, Infant, and Child Pedestrian Fatalities

Baby and infant pedestrian fatalities provide additional information on sex differences that are possibly innate. While sample sizes are larger, differences are not as clear as for "drivers." Factors central to the child's behavior prior to being killed are not coded in FARS data. The child independently may have crawled, walked, or run from a safe location. As suggested by the "driver" results, such behavior could be strongly sex dependent. However, the behavior of the child would not affect the outcome if the child had been held in the arms of an adult or controlled by the hand of an adult. We accordingly anticipate that any real differences will be diluted by many cases in which the child's behavior was irrelevant to the outcome.

Table 2—The Number of Baby and Infant Pedestrian Fatalities versus Sex and Age

Age (years)	Pedestrian fatalities		Boy-to-girl ratio	Standard error in ratio
	Boy	Girl		
0	110	77	1.43	0.21
1	715	496	1.44	0.08
2	1,336	826	1.62	0.07
3	1,513	829	1.83	0.08
4	1,458	821	1.78	0.08
5	1,708	1,007	1.70	0.07

In the 29-year period, 187 babies less than one year old were killed as pedestrians (Table 2). Of these, 110 were boys and 77 were girls. That is, for the first year of life, (43 ± 21)% more boy babies than girl babies were killed as pedestrians. After the first birthday, when self mobility increases, sample sizes increase sharply. For age one, 715 boys compared to 496 girls were killed, or (44 ± 8)% more boy babies than girl babies.

Because there are 4% to 5% more boys than girls in the U.S. population, it is appropriate to examine the more detailed risk ratio, R, defined as:

$$R = \frac{\text{Male pedestrian fatalities per capita}}{\text{Female pedestrian fatalities per capita}}$$

Figure 1 shows R versus pedestrian age for all 182,384 pedestrians (126,715 males and 55,669 females) killed in the 29-year period.

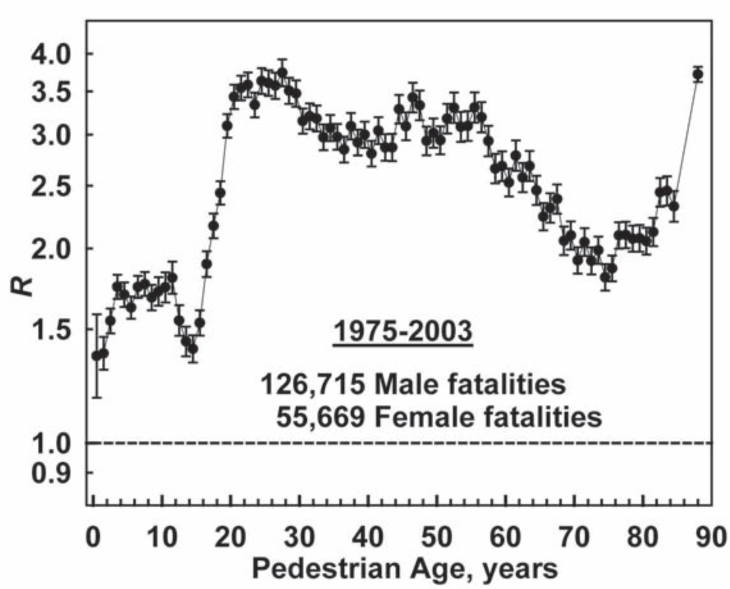

Figure 1. The ratio, R, of the number of male pedestrians killed per capita to the number of female pedestrians killed per capita versus pedestrian age

Sex Differences Stable as Society Changed

All the data were divided into three periods: (A) 1975–1982, (B) 1983–1991, and (C) 1992–2003. Each contains as closely as possible one third of the data. The periods are of

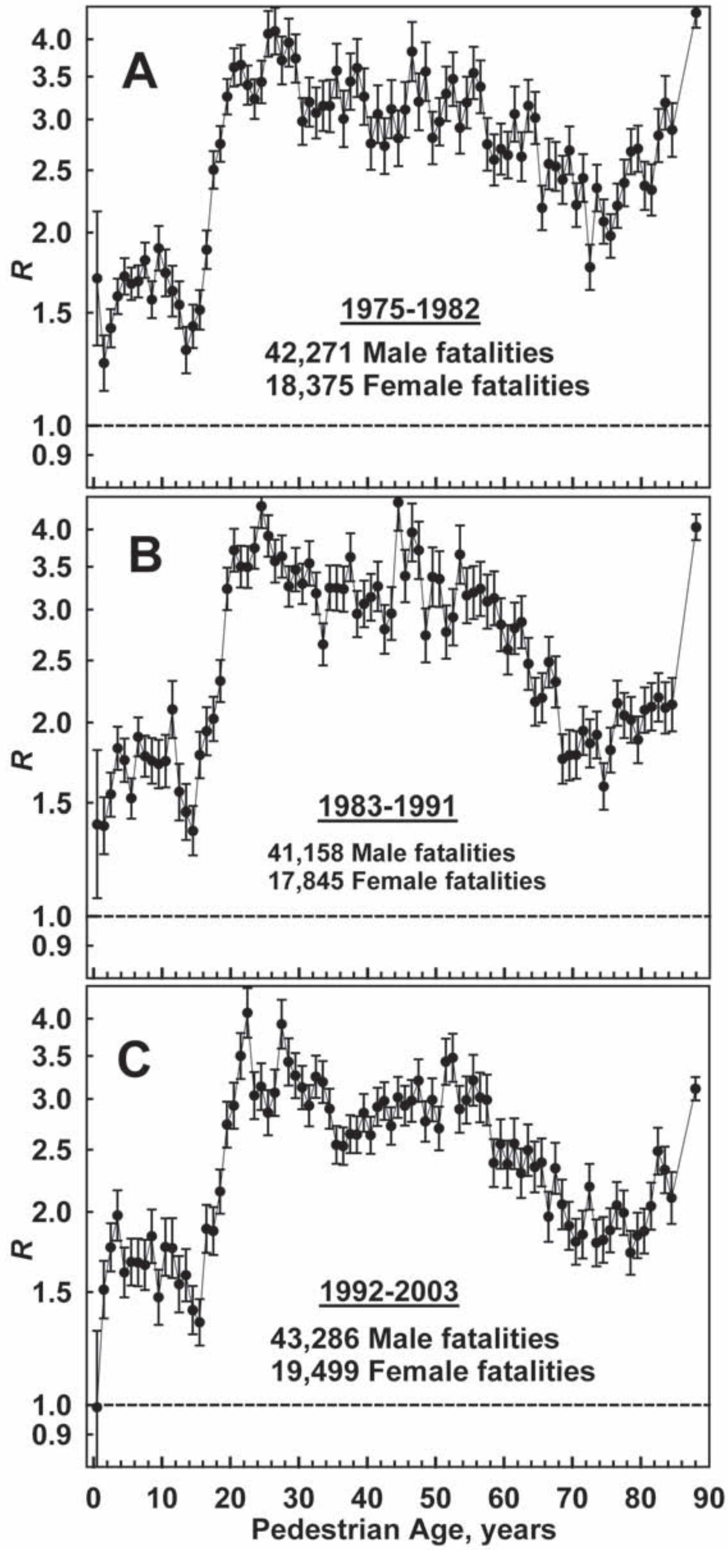

Figure 2. The data in Figure 1 divided into three subsets, each containing as closely as possible one third of the sample. The data for Figure 2C are typically about 19 years later than the data for Figure 2A. Although many societal factors changed in the 19-year period, the graphs show no notable changes.

unequal duration because the annual number of pedestrian fatalities trended downward from 7,516 in 1975 to 4,749 in 2003.

The midpoints of the 1975–1982 and 1992–2003 periods are January 1, 1979, and January 1, 1998. Many changes in law, attitudes, and norms regarding sex occurred between these dates; indeed, language also changed as the word sex was often replaced by gender. The total number of pedestrians killed per year also declined. Despite such changes, R shows no indication of any large or systematic change throughout this 19-year period (Figure 2).

The similarity of the dependence of R on age during each period shows robust stable effects. Detailed features in the aggregate data in Figure 1 appear in each of the three independent data subsets. All show boy pedestrian risk 20% to 80% higher than girl pedestrian risk for ages above 2.

A feature common to the data for the three periods is a local minimum of $R \approx 1.3$ at age 13 to 15, followed by a steep increase to $R \approx 3.5$. The sharp transition occurs at an age similar to puberty and invites the speculation that hormones play a role.

The dashed line, $R = 1$, in Figures 1 and 2 indicates no sex-dependent difference. Note how systematically, and by what large amounts, the data show higher male risk.

Traffic, Crime, and Testosterone

Figure 3 plots three seemingly unrelated phenomena. Figure 3A shows the number of involvements in potentially lethal single-vehicle crashes per capita. This is inferred from fatality counts and the dependence of fatality risk on age and sex; from the same severity impact, females are 28% more likely than males to die. Figure 3B shows the number of arrests for nontraffic offences per thousand population derived from FBI Uniform Crime Reports. Figure 3C shows the average testosterone level measured in the saliva of large samples of people as reported in Dabbs and Dabbs 2000 book *Heroes, Rogues, and Lovers: Testosterone and Behavior*.

The similarities between Figure 3A and Figure 3B suggest crashing and committing crimes share common origins. The similarities between both these and Figure 3C suggest testosterone may be the common origin. The two local testosterone peaks for males under three years of age produce higher average male testosterone levels at the youngest ages, which may relate to the elevated male "driver" and pedestrian fatalities for babies and infants. Note there is a minimum in the ratio of male to female testosterone levels between infancy and puberty, just as there is in the ratio of male to female pedestrian fatalities (Figures 1 and 2).

Conclusions

Seventeen children aged 5 or younger were killed as sole occupants sitting in driver seats of vehicles traveling on public roads. The sex mix was 17 boys, no girls. More male than female pedestrians are killed at all ages, including the first year of life. The ratio of male to female pedestrian risk, while greater than one at all ages, increases rapidly to more than three at an age close to puberty. The sex and age dependence of involvement in traffic crashes, arrests, and measured testosterone are similar.

This paper cannot establish that the effects found are innate. However, I believe the simplest and most plausible interpretation is that the effects reported reflect intrinsic behavioral differences between the sexes originating at a hormonal level.

Raw Data

Two user-friendly Excel files with one sheet for each of the 29 years of raw data, plus summary sheets, are available at *www.scienceservingsociety.com/Dr.xls* and *www.scienceservingsociety.com/Ped.xls*.

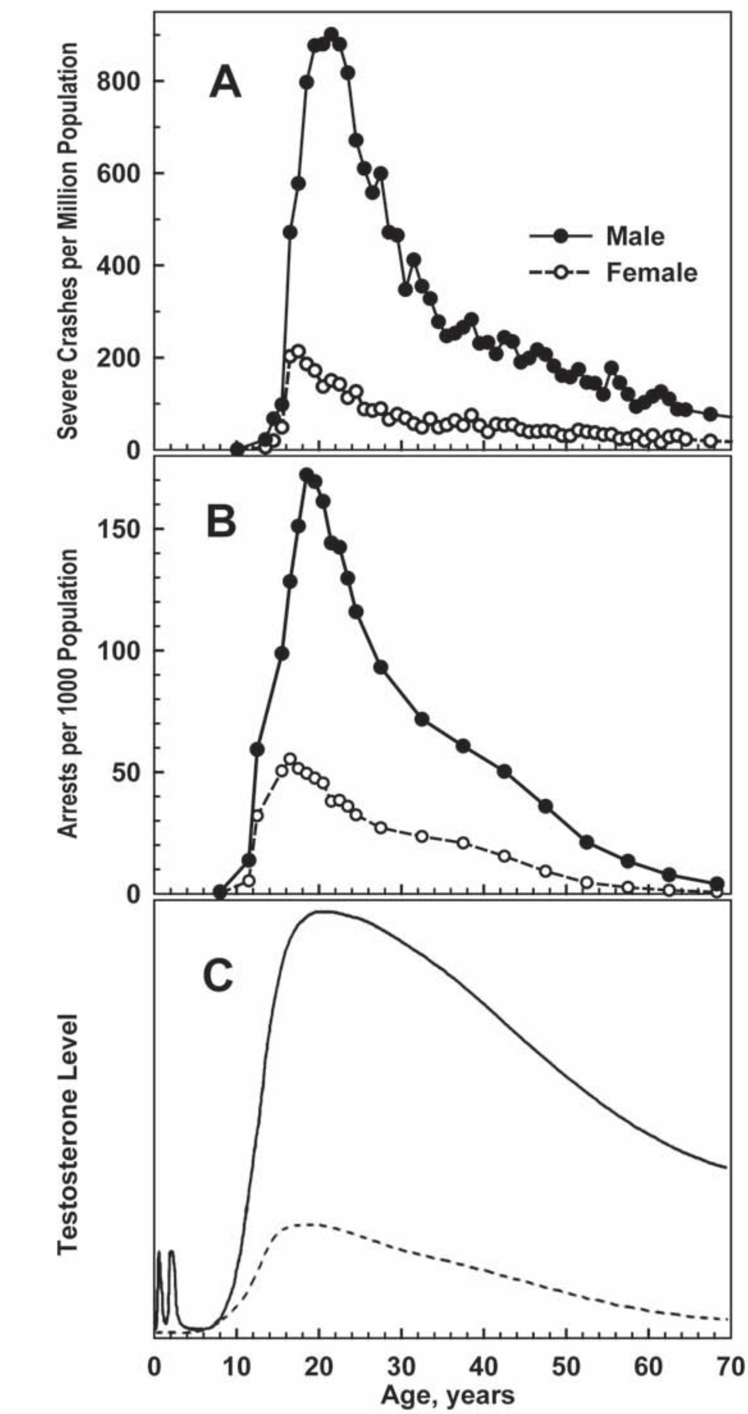

Figure 3. Three graphs of seemingly unrelated phenomena that show similar sex and age dependence. Figure 3A shows involvements per capita in potentially lethal traffic crashes versus driver age. Figure 3B shows arrests per capita for crimes unrelated to traffic. Figure 3C shows average testosterone levels of large samples of subjects measured in a simple saliva test. The similarities between the graphs suggest testosterone plays a role in involvement in traffic crashes and in crime.

(All three graphs in Evans, L. (2004). *Traffic Safety*. Figure 3C reproduced with permission from Dabbs & Dabbs (2000). *Heroes, Rogues, and Lovers: Testosterone and Behavior.*)

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Comment: David C. Geary

With the use of a national database and some statistics, Leonard Evans documented an unfortunate but all too common finding of a much higher frequency of premature mortality for boys and men as compared to same-age girls and women. In this case, premature death due to traffic accidents, either as a driver (loosely defined) or as a pedestrian. Among the strong points of this analysis is the inclusion of all or nearly all traffic fatalities in the United States throughout a 29-year time frame and spanning infancy to old age.

The use of a national database for fatalities rules out alternative explanations for the reported sex differences, such as sampling or definitional bias. Definitions for serious physical injury, for instance, can be fuzzy in the sense that the threshold for what is defined and thus categorized as a serious injury can vary greatly across research settings or historical periods. With a fuzzy definition, researchers cannot be completely certain they have fully sampled the phenomena of interest, as it occurs in the real world. With the use of standardized reporting measures and fatalities—there is no fuzzy boundary here—this is not an issue (e.g., Daly and Wilson, 1988a). We can thus be certain the phenomena report by Evans is real: As a group, boys and men experience a higher frequency of accidental death and serious injury (requiring a hospital visit) than do girls and women throughout much of the lifespan.

The question then becomes: What is the cause of these sex differences? Evans demonstrates the sex difference in the pattern of age-related fatalities does not vary across three historical periods during which there were significant changes in "gender roles" (e.g., Wood and Eagly, 2002). That is, the pattern did not change despite changes in the number of women entering higher education, the workforce, and so forth. Moreover, using several national databases, Evans demonstrates a similar pattern of age-related sex differences for severe traffic accidents and arrests; this same pattern also has been found for homicides for both the perpetrator and the victim. As Evans notes, it is not likely to be a coincidence that the sex difference in circulating testosterone levels shows a similar age-related trend. Evans concludes—and I concur—that there is an inherent or biological contribution to these sex differences (see Geary, 1998). This does not mean social or cultural factors (e.g., speed limits) are not important, as they almost certainly are; homicide rates in Western Europe, for instance, have declined dramatically during the past several hundred years—likely due to changes in policing, economic opportunity, gun control, and so on. Set against the background of social, cultural, and historical change is a persistent pattern of sex differences in risk taking, aggression, and premature death. The study of potentially inherent influences requires an examination of the proximate or "here and now" expression of the behaviors that results in these sex differences, as well as consideration of potential mechanisms that might have contributed to the evolution of these sex differences.

Sex Differences in Proximate Behaviors

The sex differences illustrated by Evans are not limited to traffic accidents. As soon as children can walk and extending throughout the lifespan, boys and men are injured and killed by accidents much more frequently than are same-age girls and women. In a comprehensive assessment of childhood injuries and deaths in the United States, researchers B. N. Rosen and L. Peterson documented a much higher frequency of accidental death and injury in boys than in girls. Boys experience near drowning nearly twice as frequently as girls and die as a result of drowning almost four times as frequently. Boys are injured and killed more frequently than are girls while riding bicycles, playing on recreational equipment, and during unorganized (i.e., not supervised by adults) sports activities. For every girl injured on a playground, four boys are injured. For every girl who sustains a serious burn, three boys sustain an equally serious burn (e.g., while playing with fireworks). Rosen and Peterson concluded that the sex differences in accidental injury and death rates are related to the sex differences, favoring boys, in activity levels, risk taking, and the frequency of engagement in rough-and-tumble and competitive play.

Sexual Selection and Evolved Sex Differences

The evolutionary processes that can explain the above listed sex differences, as well as many others, are called sexual selection. These processes involve competition with members of the same sex over mates (intrasexual competition) and discriminative choice of mating partners (intersexual choice). The most common dynamics involve male-male competition over access to mates and female choice of mating partners, and the most common result is the evolutionary elaboration of the traits that facilitate competition and choice. Figure 1 shows a few examples of how male-male competition has resulted in the elaboration of physical traits and the emergence of sex differences for these traits; the physical differences are accompanied almost always by higher levels of male-on-male behavioral aggression and often engagement in risky activities. It is now understood that the dynamics that create any such sex differences arise from the degree to which each sex invests in parenting, and this in turn emerges from more fundamental differences in the potential rate of reproduction; for female mammals, the potential reproductive rate is limited by gestation time and length of postpartum suckling, whereas the theoretical limit for males is determined by the number of females for which they gain sexual access.

The basic cross-species pattern is that the sex with the slower potential rate of reproduction—typically females—invests more in parenting, is selective in mate choices, and exhibits less intense intrasexual competition over mates. The sex with the faster potential rate of reproduction—typically males—invests less in parenting, is less selective in mate choices, and exhibits more intense intrasexual competition. The details are beyond the scope of my comments, but humans fit this basic pattern, although with a few twists. Compared to women, men invest less in parenting, are less choosy when it comes to mates, and compete with one another more intensely. In traditional societies and likely during human evolution, male-male competition includes coordinated group-level conflict for control of ecologically rich territories and for social and political influence (e.g., Chagnon, 1988), which is manifested often in terms of low-level but frequent raiding, warfare, and political manipulation. Within-group competition manifests in the formation of dominance hierarchies and for control of in-group politics. Across these societies, about 25% of men are killed as a result of between- or within-group competition. These levels of aggression are observed because polygyny is the norm and results in the most dominant men having several wives and many more children than other men (e.g., Chagnon, 1988). In fact, the least successful men are completely cut out of the mating pool. As with most other species that exhibit intense male-male competition, the reproductive stakes for men in traditional societies and almost certainly throughout human evolution are high, which in turn creates conditions that provide potentially large reproductive advantages to status seeking, aggression, and risk taking.

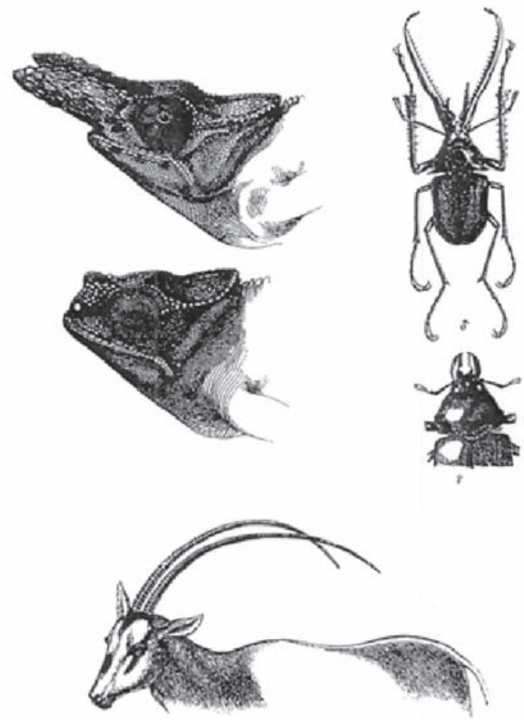

Figure 1. **Examples of sexually selected characteristics used in physical, male-male competition as seen in Darwin's *The Descent of Man, and Selection in Relation to Sex*. To the upper left are the male (top) and female (bottom) of the *Chamaeleon bifurcus*; to the upper right are the male and female of the beetle *Chiasognathus grantii*; at the bottom is a male *Oryx leucoryx*, a species of antelope.**

These activities in adulthood are preceded by sex differences in children's behavior. Among other things, children's self-initiated play and social activities provide practice for the forms of adult roles that were common during human evolution, including practice for group-level and one-on-one, male-male competition. Indications of the latter emerge during the preschool years and continue throughout the lifespan. The earliest manifestation of dominance-related behavior in boys is physical contests over control of desired objects, but one of the more common manifestations is rough-and-tumble play; that is, playful (e.g., as indicated by facial expressions) hitting, pushing, shoving, and so forth. This form of social behavior emerges at about 3 years of age, occurs three to six times more frequently in boys than in girls (when adults are not watching), likely is related to prenatal and circulating male hormones, and is found in every culture in which it has been studied. Rough-and-tumble play peaks between the ages of 8 and 10, at which time boys spend about 10% of their free time in these activities. As with other species, there is recent evidence that the relation between these activities (e.g., bullying) and social dominance becomes more obvious and serious in early adolescence; that is, the line between play and use of outright physical aggression to assert dominance begins to blur.

This developmental trend mirrors the age-related patterns shown in Evans' figures of the ratio of male to female traffic fatalities, severe crashes, arrests, and testosterone level. The acceleration of these differences in late adolescence and early adulthood coincides with physical maturation and the initial time in a male's lifespan in which there is serious competition for mates—a pattern found in nearly all, if not all, species with intense male-male competition. The intensity of male-on-male competition ratchets up during these ages, and the behavioral traits that result in successful competitive outcomes also are expressed in higher frequencies, including physical aggression and risk taking.

Traffic Fatalities and Sexual Selection

The sex differences reported by Evans are a reflection of these evolved sex differences. Of course, driving is not in our evolutionary history, but in comparison to girls and women, a tendency for boys and men to approach life in a more aggressive and risky manner is a reflection of our evolutionary history—male-male competition in particular. Finally, I should add testosterone probably acts to increase the vigor with which boys and men engage in competitive and many other behaviors, but does not add to behavioral skill—this requires practice. The sharp increase in the tendency to engage in aggressive, risk-taking behaviors in adolescence and lack of driving skill result in an unfortunate and often deadly combination, as Evans demonstrates.

Comment: Mary Meyer

The National Highway Traffic Safety Association (NHTSA) maintains extensive databases that are available to the general public. One of these, the Crashworthiness Data System, is a careful compilation of information about a random sample of police-reported automobile accidents across the United States from which at least one vehicle is towed. A simple tabulation of data shows about 56% of the cars in these accidents had male drivers.

A second database is the Fatality Analysis and Reporting System, containing information about all crashes in which at least one fatality occurred. From the 2003 FARS (or from the fatal-accident subset of CDS), we find that about 73% of the drivers in fatal accidents are men, so there are about 2.7 times more male drivers in severe accidents.

To compare rates, it is crucial to use the correct denominator. Using raw numbers is appropriate only if, on average, women and men drive approximately the same number of miles under roughly the same conditions and there are the same numbers of male and female drivers. According to the U.S. Department of Energy, men averaged 65% more driving miles than women in 2001. A Department of Transportation web site lists numbers of licensed drivers by sex: Women make up 50% of drivers. The number of fatalities divided by the number of driver-miles gives a fatality rate per mile of driving. We find this rate is about 70% higher for men—much less than the 270% higher found by comparing raw numbers. Interestingly, the overall accident rate per driver-mile (found using numbers from the CDS) is about 30% higher for women.

The 2001 National Household Travel Survey reports that while men log more travel miles, women log more trips (on average). It seems likely the more frequent, shorter trips are typically at lower speeds. This would at least partly explain why more female drivers are involved in minor accidents while more male drivers are involved in more severe accidents.

Is the higher fatality rate for miles driven by men an indication of innate sex differences, or due to socialization? In his Figure 3a, Evans presents plots of per capita severe crashes by sex and argues the shape is similar to the distributions of testosterone levels over age. However, if the plots were per driving mile rather than per capita, the shapes would not be as similar.

While the hormone explanation can't be completely ruled out, the NHTSA datasets provide information pointing to more direct causes. A cursory inspection of drivers in the 2003 FARS reveals that about 27% of the male drivers in fatal crashes had been drinking, compared to only about 12.5% of the female drivers. Of male drivers, 34% were wearing no seatbelt, while only 24% of female drivers were unrestrained. Finally, we find from the CDS data that, on average, male drivers crash at significantly higher impact speeds than female drivers. These behaviors all result in higher fatality rates; whether the behaviors are socialized or innate is open to question.

Evans presents data about very young "drivers"—cases in the FARS where the age is less than the legal driving age. There are 17 cases in which the driver's age is listed as 5 or younger, some at impossibly young ages such as 0 or 1; all of these are listed as male. I checked the CDS for young drivers and also found several 0–5-year-old "drivers." The advantage to the CDS is there is an accident description file written by the officer on the scene. I could look up the first case of a driver aged zero easily, and I found the following (V1 is the vehicle with the driver's age listed as zero):

> *"V1 was traveling southwest in the left of two southwestbound lanes on a divided trafficway. V1 was at the point where a third southbound lane begins. It was raining and the road surface was wet. V2 was traveling northeast in the left of two northeastbound lanes, and V3 was traveling northeast in the right northeastbound lane. V1 departed the left road edge and..."*

This description indicates the age of the driver was incorrectly entered into the database. For all cases of 0–5-year-old drivers in CDS, the description file provides evidence that each involved human error and the drivers were not really small children. While the FARS does not provide such descriptions, it seems likely that these 17 cases in FARS—out of more than 12 million observations—are simply data entry mistakes, rather than evidence of sex differences.

The next male/female difference is in pedestrian fatalities: A disproportionate number of male pedestrians are killed across the age spectrum. This is an interesting and surprising social phenomenon. A web search reveals patterns vary over region and ethnicity. For example, in metro Atlanta, three times more male pedestrians were killed, but nationwide, a little more than twice as many male pedestrians were killed. A plot of pedestrian fatalities per capita population is shown for males and females in Figure 1. More male pedestrians are being killed across the age spectrum, but here the plots do not reflect the testosterone levels across ages shown in Evans' Figure 3c. Other possible explanations are found using the FARS dataset. For example, in the 2003 FARS data, about 40% of the male pedestrians had been drinking compared to only about 20% of the female pedestrians.

In metro Atlanta, we find twice as many black pedestrians were killed (per capita) compared to white pedestrians—and six times as many Hispanics compared to white non-Hispanics. It seems unlikely that anyone would claim these disparities are due to "innate differences." Rather, differences in walking patterns and lifestyles are adequate explanations.

The plots show boy pedestrians are also more likely to be killed at very young ages compared to girls. The explanation for this is unlikely to involve either alcohol or testosterone. One possibility is that boys are less likely to be as closely supervised compared to girls. In our society, it is traditional for mothers to be the

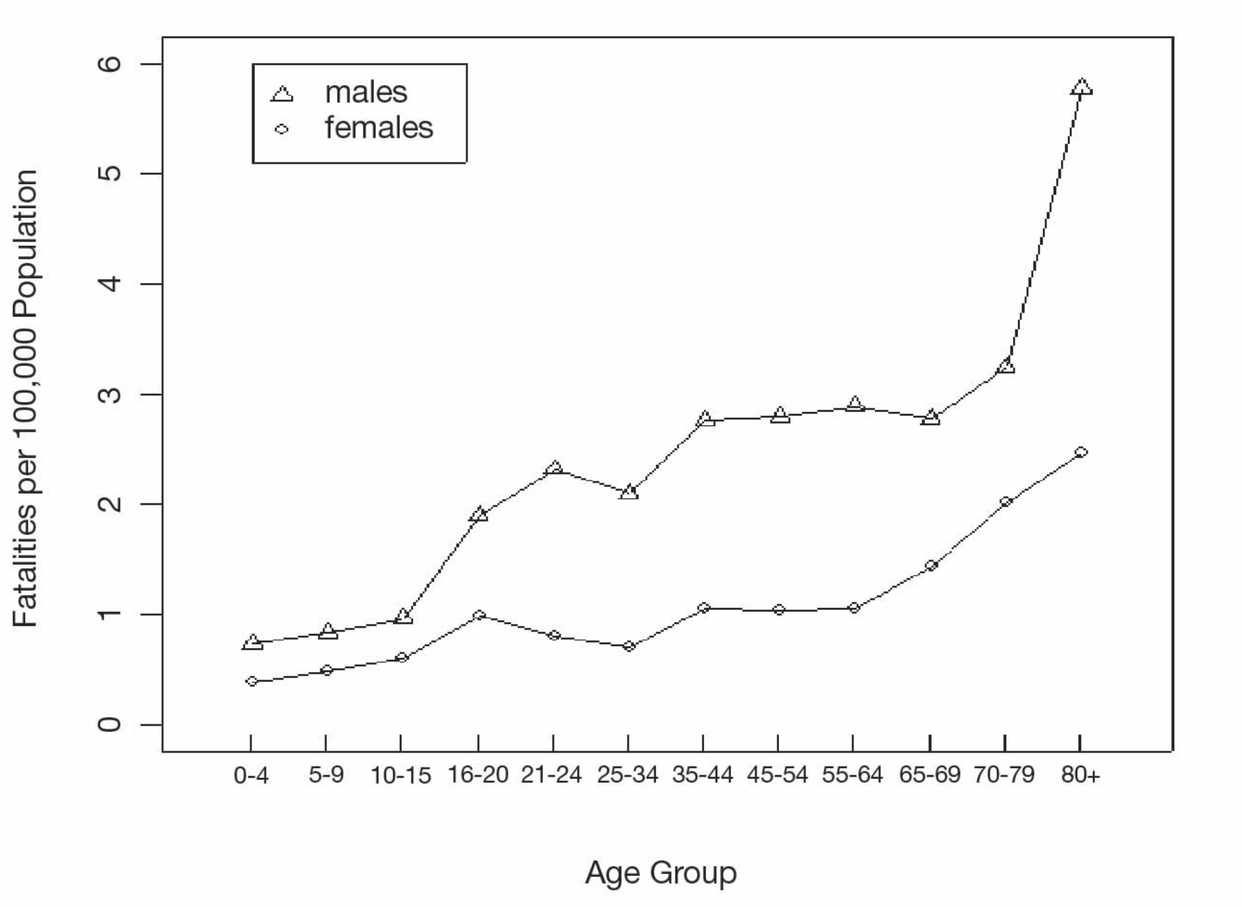

Figure 1. U.S. Pedestrian Fatality Rates per Capita, 2001 (from DOT HS 809 478)

primary caretakers. If less experienced fathers are more likely to take sons on outings compared to daughters, this might account for more boy pedestrian deaths. The CDS shows children passengers are significantly less likely to be properly restrained if the driver of the vehicle is male; this provides some evidence that men are, on average, less careful about children's safety.

The graphs comparing per capita fatal crashes for male and female drivers, male and female arrest rates, and male and female testosterone levels across ages have similar shape and size. This, Evans argues, is evidence for sex-based differences. The "most plausible interpretation," he says, is that the differences "originate at a hormone level." However, the plots of pedestrian fatality rates are markedly different, as are plots of per-driving mile fatality rates.

The differences in fatal accident rates for male and female drivers and the differences in pedestrian fatality rates can be explained at least in part by alcohol use, seatbelt use, and average crash speeds. It could be argued that these causes are themselves due to differences in hormone levels. It is a question that is difficult to answer without directly measuring testosterone levels of individuals and comparing these to behaviors.

It is interesting that the proponents of innate differences don't suggest what would be the obvious solution. While we are quick to treat perceived problems concerning women's hormones (estrogen is one of the top-selling drug in the United States), the idea of hormone treatments for men is not seriously discussed. In our society, men commit the vast majority of violent crimes; they are more likely to drive drunk and abuse children and partners; they vandalize, rob, rape, and murder at higher rates than women. If this is due to their hormones rather than their socialization, lowering testosterone levels should be an urgent social concern.

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Evans Responds

The points raised by Mary Meyer all are discussed in considerable depth and detail in my 2004 book *Traffic Safety,* which summarizes what science has taught us about traffic crashes. Given the availability of this resource, I will answer Meyer's points briefly, but encourage readers to seek deeper understanding from the pages of *Traffic Safety*.

There are thousands of studies using many traffic safety datasets. The current paper differs from these in selecting specific crashes that focus on innate sex-dependent behavior. The CDS data Meyer offers concentrates on vehicle design. (I participated in some of the meetings that helped define the stratified sampling procedure adopted.) The majority of cases in CDS are relatively low-severity, two-vehicle crashes. A simple, two-vehicle crash model assumes half the drivers are involved only because of the risky behavior of the other driver. Many female drivers are involved because male drivers crash into them, thus moving the male to female ratio closer to unity. That is why my study must use only single-vehicle crashes of high severity, in which involvement does not depend on the behavior of any driver other than the deceased.

Meyer writes, "To compare rates, it is crucial to use the correct denominator." Indeed! Large numbers of rates (including all those Meyer mentions) are plotted in *Traffic Safety*, together with commentary about how each provides the answer to a different question. It is stressed that it is crucial to choose the rate that answers the question being asked. (See the section "Simple Questions without Simple Answers" on Page 9 at *http://scienceservingsociety.com/ts/text/ch01.pdf*). The current paper compares one type of adverse outcome per capita (arrests) to another (involvement in serious crashes). Crashes per mile measures something quite different, the closest crime analogy being the (unknown) number of arrests per crime. The comparison I present is appropriate; the one suggested is not.

Compared to the strength of the effects reported, sex-dependent differences in belt wearing and alcohol consumption make only minor differences. And even if the effects were large, the question remains why the riskier behaviors are associated with males. Alcohol affects males and females (of equal weight) differently—and that is a biological difference. Yes, males do crash at higher impact speeds. How could males end up with more fatalities than females if everything they did was identical to everything females did? (This point is discussed on pages 10-11 at *http://scienceservingsociety.com/ts/text/ch01.pdf*).

Meyers attaches importance to finding errors in the coding of one untypical crash. (Only 8% of CDS crashes involve three vehicles.) Such errors are not surprising. The more minor the crash, and the less centrally involved a particular driver, the greater is the likelihood of that driver being coded incorrectly. The CDS data are unrelated to the FARS data used in the subject paper. FARS data include only fatal crashes, which are universally recognized to be better documented than crashes at lower severity levels. One thousand people each year are coded in FARS as "unknown sex" and "unknown age," showing that if the information is not known, it is coded as unknown. There is an important subset of road-users in FARS whose coding is considered particularly reliable—namely those who are killed. (On average, a fatal crash has 1.1 fatalities and 1.5 survivors.) In our society, it is unlikely that the age and sex of someone killed in a crash will be miscoded, especially as FARS runs consistency and other checks and autopsy reports are examined in many cases. The now-available 2004 FARS data show the following deaths to baby and infant passengers.

Passenger Age	Male	Female
0	65	56
1	38	52
2	57	55
3	40	58
4	46	37
5	49	46

The cumulative result is that 295 male and 304 female passengers aged 5 or younger were killed. As the behavior of baby and infant passengers is unlikely to affect crash risk, the lack of a systematic male-female difference rejects any massive bias in favor of coding males. If there is no systematic error for babies and infants killed in passenger seats, why should there be for driver seats in which 17 males and 0 females (aged five or younger) are coded as being killed?

Additional relevant information from the 2004 FARS is that one 5-year-old boy and two 8-year-old boys were killed traveling alone in driver seats, compared to no girls aged 8 or younger. One baby boy and one baby girl in the first year of life were killed as pedestrians. For all later ages through 70, male pedestrian fatalities exceeded female pedestrian fatalities. Even the small sample sizes for this latest single year show effects consistent with those more reliably established by data for 29 years.

Well-known variations throughout regions and demographics (and many other factors) are irrelevant to this study. The text, itself, reports large variations throughout time—pedestrian fatalities trended downward from 7,516 in 1975 to 4,749 in 2003. The fact that, for example, rural fatalities are twice urban fatalities (or that urban crashes are twice rural crashes) is irrelevant for this paper.

The relationship Meyer presents in graphical form of the increase in pedestrian fatality risk with age is given and explained in a more detailed graph on Page 159 of *Traffic Safety*. A crucial contributor is increased fragility with increasing age. An 80-year-old is about 4.5 times as likely to die as a 20-year-old from the same-severity blunt trauma impact. While very important when discussing older road users, it is irrelevant to the present paper.

Meyer suggests the data in the most reliable of all traffic crash datasets are unreliable. If there were random coding errors, this would lead to any real effect being measured as less strong than it really is, so that the study would underestimate the greater involvement of males. Any claim of a systematic bias must be backed up with some

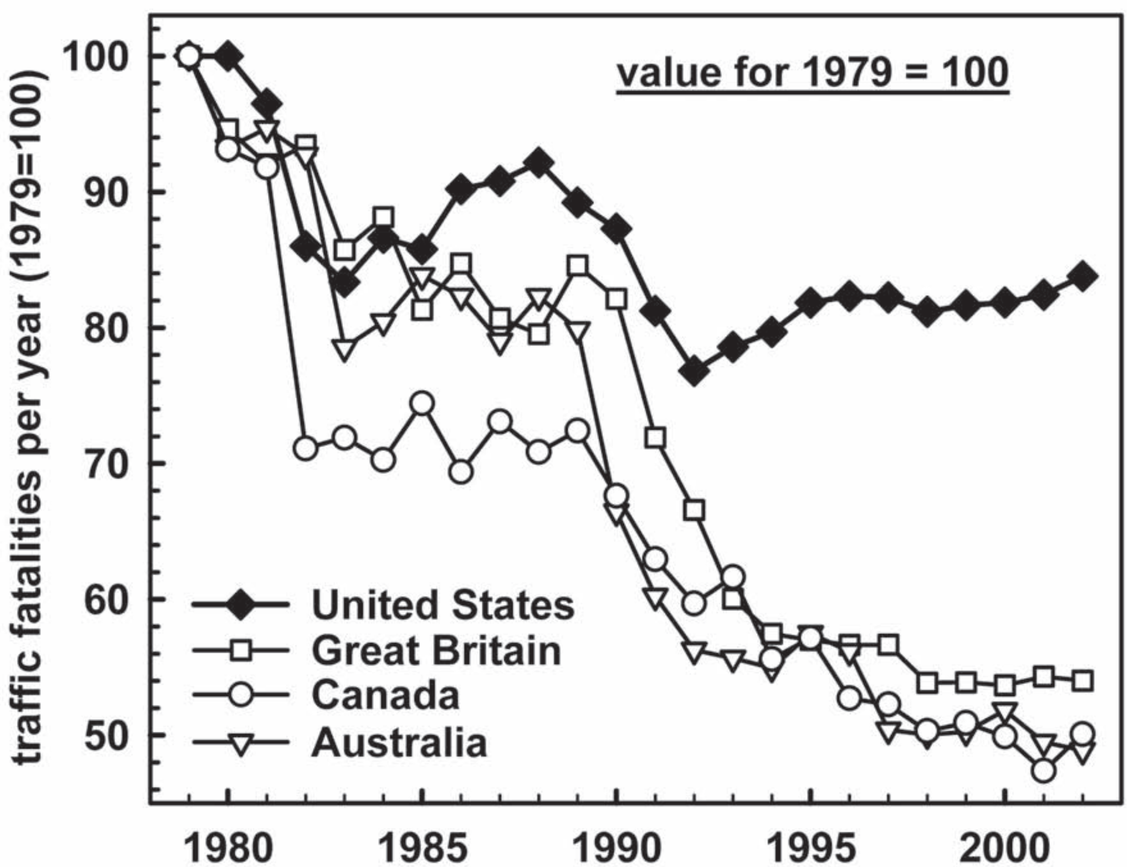

Figure 1. **The Dramatic Failure of U.S. Safety Policy. Traffic fatalities per year in the United States and three comparison countries. All values are rescaled by dividing the actual number for each year by the number in 1979 and multiplying by 100. (Reproduced from *Traffic Safety*.)**

explanation of its source—or evidence of its existence.

David Geary's commentary adds a great deal of insightful and corroborative evidence supporting intrinsic higher risk taking by males and presents evidence of how ubiquitous the phenomenon is. The most commonly derived relationships in traffic provide yet more corroborative evidence of ubiquitous sex-dependent differences. Of the 1.2 million people killed on the world's roads annually, 2.3 males are killed for every female. Most of these fatalities are from countries that treat men and women more differently than the United States. Yet in the United States, 2.2 males are killed for every female. This suggests large differences in social customs, law, and attitudes have little effect on the male to female fatality ratio and invites an interpretation involving fundamental sex-based differences in behavior.

It is universally found that young males are at the heart of the traffic crash problem. The interpretation here that the difference originates in fundamental immutable biological differences does not mean nothing can be done to reduce harm in traffic—quite the contrary. Figure 1 shows data for three of the many countries that have achieved safety progress that shames the United States; if the United States had matched their declines, 200,000 fewer Americans would have been killed in the period plotted. Such declines have been achieved by understanding and applying knowledge generated by the scientific study of traffic safety. While deaths declined, the ratio of young-male fatalities to old-female fatalities remained stable. The aim is not the futile one of getting young men to behave like old ladies, but, through the more effective public policies described in *Traffic Safety*, to reduce risk to all road users.

Reference and Further Reading

Evans, L. (2004). *Traffic Safety*. Bloomfield Hills, MI; Science Serving Society. *ScienceServingSociety.com*