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Alcohol and Highway Safety

Melvin L. Selzer
Robert F. Borkenstein
M. W. Perrine

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North Carolina Symposium
on highway safety

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Melvin L. Selzer — *University of Michigan*

Robert F. Borkenstein — *Indiana University*

Discussant: L. Poindexter Watts, Jr.

M. W. Perrine — *University of Vermont*

Discussant: Joan C. Cornoni

NORTH CAROLINA SYMPOSIUM ON HIGHWAY SAFETY

Chapel Hill, N. C.

Volume three **Fall 1970**

The University of North Carolina Highway Safety Research Center
Chapel Hill, North Carolina 27514 • B. J. Campbell, Director

a few words about the symposium topic . . .

- half of the adult population combine driving and drinking at one time or another
- immoderate use of alcohol is found to be a major factor in highway crashes, particularly the most violent ones
- at least half of all fatal accidents involve a drunk driver
- the heavy, abusive drinker is a primary problem on the highway

These reasons are ample justification for devoting the Fall 1970 Symposium on Highway Safety to alcohol and its relation to highway deaths and injuries. Our goal was to bring professionals and students alike to grips with the alcohol problem, both to gain better insight into the problem and also to appreciate its pervasiveness and magnitude in our society.

TABLE OF CONTENTS

LIST OF FIGURES AND ILLUSTRATIONS

About the Center . . .

At the request of the Governor of North Carolina, the 1965 North Carolina State Legislature provided for the establishment of the University of North Carolina Highway Safety Research Center. Dr. B. J. Campbell, then Head of the Accident Research Branch of Cornell Aeronautical Laboratory, was invited to return to his alma mater to direct the new Center. He accepted, and in 1966 the Center officially began operation. Since then the staff has grown to more than fifty, representing skills in experimental psychology, clinical psychology, mathematics, transportation engineering, computer systems, journalism, library science, biostatistics, graphic arts, epidemiology, experimental statistics, general engineering, human factors engineering, and health administration. The University of North Carolina Highway Safety Research Center is the first institution in the South devoted exclusively to research in highway safety.

About the Symposium . . .

The North Carolina Symposium on Highway Safety is a semiannual event sponsored by the North Carolina State University School of Engineering, the University of North Carolina School of Public Health, and the University of North Carolina Highway Safety Research Center. First held in the fall of 1969, the symposium has three major purposes. First, it is designed to attract students to acquaint them with the problems and possibilities for research in the field of highway safety.

Second, it is a means of bringing together professional workers in the greater North Carolina area whose interests are related to this field.

And, third, the published papers from the symposium will provide on a regular basis major positions and summaries of research in the field of highway safety. It is hoped that these volumes will provide ready resource material for persons interested in this field.

INTRODUCTION

Of all the factors involved in highway safety, one stands out as the single most important element in fatal crashes: Alcohol. Yet only recently has serious attention been focused on this problem. For years it was believed that any alcohol was likely to seriously impair driving ability. Because most people who drive also drink, and at times drive after drinking, the public was reluctant to unequivocally condemn the drinking driver. "There but for the grace of God go I."

Recent evidence suggests that the drinking driver who is involved in a fatal crash is qualitatively different from the average driver who at times combines driving with drinking. The drinking driver in fatal crashes is usually not the social drinker, but the *problem* drinker who has blood alcohol levels far higher than most drivers could tolerate and still attempt to drive.

Drivers in alcohol-involved crashes do not represent a random sample of drinking drivers, much less the entire population of drivers. Rather, it appears that for serious accidents at least, the alcohol-impaired driver represents a very small portion of drivers, namely, those drivers who combine heavy drinking with driving. Such drivers constitute an identifiable group that is small enough to be treated by programs developed specifically for its members.

Our three speakers represent three different disciplines, and accordingly their presentations reflect their special interests and experiences. Dr. Selzer brings his psychiatric training to bear on the problems posed by the drinking driver. Dr. Borkenstein's unique career in enforcement and law provides an unusual opportunity for a different view of the drinking driver. Finally, Dr. Perrine applies the refined skills of a careful and innovative researcher to obtain solid data on which conclusions can be based and programs can be developed.

Dr. Selzer examines some of the reasons for traffic injuries and deaths. He first indicts the automotive industry for failing to take steps until pressured to do so. He presents evidence to support the idea that persons in the industry may be responding to a territorial instinct which they are unaware of and have no control over.

A second reason for highway crashes stems from the role of stress in human behavior. Dr. Selzer describes a study that compared drivers involved in fatal accidents with a control group of drivers. A much greater proportion of those involved in fatal accidents was found to have been experiencing serious stress, including personal conflict, death or serious illness of a close tie, and vocational and financial difficulties. Dr. Selzer feels that these findings may be especially significant if unrest and consequent stress are continually generated within our society.

A third major factor contributing to serious accidents is alcohol. Here Dr. Selzer briefly describes how the drinking driver has been dealt with by society in the past. He makes a distinction between the way the problem is formulated by enforcement personnel and medical personnel. The enforcement approach has led to legislation promoting the use of objective measures of the blood alcohol levels, and such measures have facilitated convictions. Nevertheless, an increase in convictions is not necessarily a gain if we are indeed dealing with the problem drinker or the alcoholic. Dr. Selzer feels it would be much more appropriate to help these drivers with their problems rather than to try to increase our arrest and conviction rates. He suggests that traditional approaches are reminiscent of the rituals performed by primitive people to ward off evil spirits and other dangers.

Dr. Borkenstein addresses himself to the question of whether the public perception of the laws dealing with the alcohol-impaired driver has resulted in misunderstanding and consequent failure to deal effectively with the problem. Our present system of dealing with the drinking driver rests primarily on methods devised more than thirty years ago. While they may have been sufficient then, the enforcement systems of today would do well to incorporate into their methodology the abundant information now available. We need no longer lump all drinking drivers into one category because we now know how to classify them. We can educate the public to appreciate what a blood alcohol level of .10% means, so that jurors will be able to recognize how seriously deviant the drunk driver really is. We can accomplish this by allowing persons to test their own blood alcohol levels during normal drinking. We can then encourage them to associate their subjective experiences with the corresponding blood alcohol levels. In this manner, they can learn first hand how much is too much.

The law, Dr. Borkenstein feels, is for the benefit of all; yet it cannot be a constructive influence if it is viewed as unfair and vindictive. While the first impressionistic observations made between drinking and accidents were indeed valuable, he argues that they should now give way to more careful analyses, which will clearly describe (distinguish between) the kinds of drinkers who do and do not get into difficulty. Only with such detailed information can we hope to develop effective countermeasures.

In commenting on Dr. Borkenstein's paper, Dr. Watts suggests an analogy between the reasoning for universally adopting speedometers and the reasoning behind the need for readily available breath tests. He points out that at one time traffic speed was controlled by the principle of whatever was "reasonable and prudent under the existing conditions." Such a principle is difficult, if not impossible, to enforce, and gradually we moved to absolute speed limits. This shift was possible only because cars were equipped with speedometers so that every driver knew how fast he was going. Absolute speed limits are much simpler to enforce than a law based on what is "reasonable and prudent."

In the same way, the drinking driver could be much more readily controlled if we set absolute limits on blood alcohol level and further made it possible for drivers to know their blood alcohol level. If we can provide readily available means for self-testing of blood alcohol level, then the drinking driver laws should become easier to enforce. Until the public is able to estimate at least roughly what its blood alcohol levels are, it will not be possible to have meaningful enforcement of drinking driver laws.

Dr. Perrine first deals with how the problem of alcohol-involved crashes is conceived. The way a problem is conceptualized, he notes, to a large extent determines both the kinds of research that will be done and the results that will be obtained. He therefore believes that early formulations, based on incomplete information, have led to simplistic conclusions. He prefers to recognize the complexity of the problem and proceed to analyze it accordingly.

Dr. Perrine develops a probabilistic approach to the drinking driver problem and describes his current research in Vermont. He has collected extensive data from a range of drivers, including those who

have been convicted of driving while intoxicated and those who have died in automobile crashes. Road block surveys provided data on the at-risk population, and subsamples thereof were constituted on the basis of driving records. Data on drinking patterns were collected from interviews with the drivers in the road block surveys and from interviews with the next-of-kin of the deceased drivers. Chemical test results were obtained from road block drivers, deceased drivers, and drivers convicted of driving while intoxicated.

Dr. Perrine's data very clearly demonstrate the unequivocal differences between drivers who are involved in fatal crashes, drivers who are convicted of drunk driving, and at-risk drivers on the same roads where serious crashes occur.

Dr. Perrine feels that the full impact of such data cannot be transmitted through the usual channels of communication. While it is essential that the public know that the problem drinking driver is qualitatively different from most drinking drivers, there should also be the opportunity for persons to associate their subjective feelings with information concerning their blood alcohol levels. One way to accomplish this would be to have a Breathalyzer (or some other instrument to measure blood alcohol level) present at social functions where people drink. As the participants drink the amount of alcohol they usually consume, they could check themselves on the Breathalyzer to determine exactly what their blood alcohol levels are.

Dr. Perrine has made a major contribution to highway safety by reformulating the problem of the drinking driver and by presenting fascinating data based on methodology derived from his original formulation. His results hold the promise of even more exciting data to come. Certainly anyone working in this field, or interested in becoming involved in this area, could profit from the kinds of research Dr. Perrine has conducted.

In discussing Dr. Perrine's presentation, Dr. Cornoni endorses the attempt to define the range of variables that may be contributory to highway crashes. She recommends a cluster analysis of such variables and illustrates the technique with original data concerning drinking habits in a Southern community. Personality test results are related to reported drinking habits, and, based on their similarity to each

other, individuals are clustered into groups. The characteristics of these clusters are identifiable and provide the basis for the development of predictors.

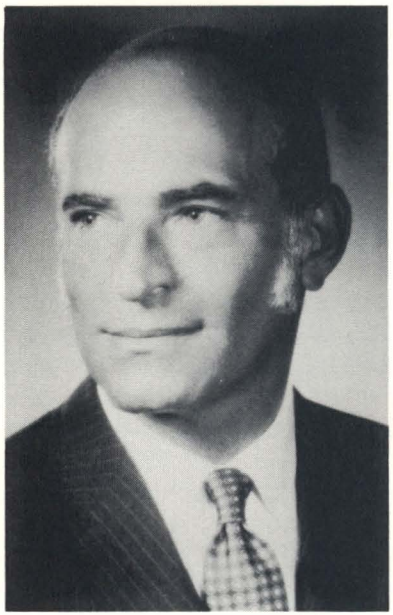
All our speakers have underscored the need to analyze highway crashes and create refined classifications that permit the development of countermeasures appropriate to the kind of crash we are attempting to influence. Dr. Selzer ponders the reasons why society has taken the stance it has in response to traffic deaths. He rejects the emphasis that has been placed on enforcement in favor of a medical approach that would view the problem drinking driver as a person with problems. Dr. Borkenstein, on the other hand, sees the law and its fair enforcement as the basis of freedom for all. The law is an instrument through which greater justice can be secured for both the innocent and the guilty. His development of an easily administered, objective test for ascertaining blood alcohol levels (the Breathalyzer) represents a milestone in the history of the treatment of alcoholically impaired drivers. With Dr. Borkenstein, Dr. Perrine recommends the education of the public, including the opportunity to associate their own drinking experiences with the corresponding blood alcohol levels attained. In this way the general public would be better able to recognize the need for countermeasures to deal with the heavy drinker who shares the highway with us. In addition, Dr. Perrine presents a model for research in this area that other scientists could well afford to emulate.

Patricia F. Waller

Section I

Myths, Ritual and Traffic Safety

Melvin L. Selzer



MELVIN L. SELZER

Dr. Selzer is Professor of Psychiatry at The University of Michigan Medical Center. Recognized for his pioneer research linking chronic alcoholism and serious traffic accidents, he is currently developing a structured interview questionnaire for evaluating drivers and other persons in whom alcoholism is suspected. He has served as Resource Consultant to the President's Committee for Traffic Safety and is now consultant on driver behavior to a number of traffic institutes and regulatory groups.

MYTHS, RITUALS AND TRAFFIC SAFETY

Melvin L. Selzer

We Americans are being killed and maimed at an unprecedented rate. This fact is all the more remarkable because the carnage is being accomplished without the use of mass starvation, gas chambers, armies, nuclear bombs or other modern weaponry. This is not to say that strenuous efforts have not and are not being made to ameliorate what is in effect a vast traffic injury epidemic. However, it is obvious to even a casual onlooker that such efforts have not had any apparent effect in terms of reducing serious injuries and fatalities. It is time to examine some of the possible major causes of traffic accident injury and to explore reasons for the failure to alter present conditions as well as to explore the possibility of significant salutary changes.

Despite a growing, and not entirely unwelcome, interest in the driver who causes traffic accidents, any program to reduce traffic death and injury must begin with the automobile. It is a stark fact that automobiles are produced in factories where assembly line technology can produce desired modifications, while drivers are created in a somewhat different and perhaps more prosaic manner. A driver's development as a human being and as a driver is far less subject to modification, particularly in a pluralistic and democratic society. Furthermore, every injurious traffic accident involves contact between the vehicle and the injured person. Nevertheless, the automotive industry has been quite tardy in meeting the challenge of producing safer and more crashworthy vehicles. The industry has employed a number of myths which for many decades prevented or delayed meaningful changes which would make the motor vehicle less hostile to its occupants in the event of a collision.

One defense was to complain that safety changes would be expensive, would raise prices and would reduce sales. One must be skeptical of this argument since it is difficult to see why safety changes such as recessing knobs in order to prevent children's skulls from being penetrated would significantly raise prices. Another mythical contention of the industry was that any attempt to promote car safety tended to drive customers away. An attempt was made to invoke an image of happy, carefree people coming in to their local, friendly

car dealer to buy without having this holiday-like spirit impaired by the sight of anything as grisly as a safety belt or a collapsible steering column. Another automotive industry favorite was to repeatedly inform the American public that American cars were indeed safe, perhaps the safest in the world. This was partially accomplished by equating speed and power with safety. We were asked to believe that a little extra power for passing another vehicle on the road conferred a major degree of safety upon the vehicle's occupants. Although the industry resisted federal regulation, it also largely ignored the possibility of voluntary changes that would make automobiles safer despite the very real threat of government intervention. The industry still pours a great deal of money into certain traffic safety organizations such as the National Safety Council, which, in turn, avoids any overt criticism of the industry and its products.

How can we account for this massive intransigence on the part of the industry's decision makers? Perhaps part of the explanation lies in the industry's marketing philosophy, which has become the lifeblood of American automobile production. Like the women's clothing industry, the automobile industry relies on frequent styling changes, as well as built-in functional obsolescence, to create a desire in the motoring public for new cars. However, the industry's powerful and at times frantic recalcitrance in regard to safety changes, as well as a similar and equally inimical stance in regard to changes that would reduce the major contribution that automobile emissions make to the pollution of our atmosphere, has obviously not been in the best interests of the industry itself nor the public which it serves. Despite federally imposed changes, automobile interiors and exteriors still bristle with hostile knobs, hard surfaces, and unnecessary projections while the sky grows darker over our major cities.

Since we can presume that those making the decisions in the automotive industry are as intelligent, as humane, as public spirited as anyone else, we are left to ponder why they have so long resisted changes that would redound to the benefit of all. It is the author's contention that there is no completely logical reason and we must seek the answer either in a concept of a collective unconscious or in a better understanding of our own origins. Robert Ardrey, who has written extensively on territorial instinct, cites Carpenter as saying, "man is rarely conscious of the ultimate reasons for his actions."

Ardrey considers territorial instinct to be a basic instinct in most animal species and again citing Carpenter,

> Monkeys were gathered from random sources in India and settled in a spacious natural setting in Puerto Rico, a veritable monkey utopia. There was ample space, thirty-six acres for a few hundred individuals. There were no natural enemies and food was distributed in abundance daily and evenly by their caretakers. Yet within one year the whole monkey community divided itself into social groups, each holding and defending a permanent territory and living in permanent hostility with his neighbors.

It is not difficult to make the analogy of the automobile industry as a territory and its executives in effect exercising a territorial instinct, whether or not benefit will accrue to anyone. If so, what solutions are available in regard to stimulating the manufacture of more crashworthy cars? In the animal kingdom, a larger, smarter, or more aggressive protagonist of the same species does occasionally emerge to drive the settled individual away from his terrestrial or aquatic territory. If we are indeed dealing with ancient phylogenetic instincts, then it is obvious that voluntary changes will be slow in coming. Only by mobilizing and arousing the American public to demand its territory, namely crashworthy, non-hostile, non-polluting vehicles, and doing so more intelligently and more powerfully than the industry, will any meaningful changes occur. This fact was long ago recognized by Ralph Nader, a genuine American hero of our times, who, through the publication of his book and his ability to organize and channel public opinion into appropriate political channels, has done more for traffic safety than any other single individual. However, the issue of whether the modern automobile is going to be a cross or a convenience is still unresolved. Its successful resolution will require that each of us act in our collective best interests to bring about humane and meaningful changes in all motor vehicles.

SOCIAL STRESS, SOCIAL TURMOIL AND ACCIDENTS

Several excellent studies have revealed that many, if not most, human illnesses are a function of stress, with the stress taking the form of acute or chronic life crises (Hinkle et al., 1958; Rahe, McKean and Arthur, 1967). That social stress is also related to the incidence

of automobile accidents should occasion no surprise. Table 1 depicts the results of a study of 96 drivers who were at fault in fatal accidents and a similar group of control drivers not involved in a fatal accident (Selzer, 1969; Selzer, Rogers and Kern, 1968). In that study personal conflict was defined as serious and disturbing conflict with significant others that arose during the twelve-month period preceding the fatal accident or interview, for the fatal and control groups respectively, and which still affected the driver at the time of the fatal accident or interview. Personal tragedy referred to the death or serious illness of a person close to the driver during the same time span. All disturbing vocational or financial difficulties arising during the same prior twelve months that were a source of aggravation to the driver at the time of the accident or interview are also shown in Table 1. Among the vocational stresses were actual, or impending, demotion, promotion, discharge, or job change as well as exasperating conflicts with foremen, employers, or fellow employees. Fifty-two percent of the fatal accident drivers were subject to one or more of these stresses compared to only 18 percent of the controls, a threefold difference which may be of deeper significance in the immediate future than it has been even in the recent past. We are undoubtedly entering a period of increasing social turmoil and unrest which in turn will increase the degree of social and personal conflict, to say nothing of vocational and financial stresses which various segments, if not all segments, of our population will have to overcome.

Table 1

Stresses on 96 Fatality and 96 Control Drivers

GROUP	NUMBER OF DRIVERS	PERSONAL CONFLICT		PERSONAL TRAGEDY		VOCATIONAL FINANCIAL		ONE OR MORE STRESSES	
		N	%	N	%	N	%	N	%
FATALS	96	31	32%	9	9%	35	36%	51	52%
CONTROLS	96	7	7%	5	5%	8	8%	17	18%

The Department of Pharmacology of the University of Michigan Medical School has each year put on a toxicity demonstration for the freshman medical students. Several mice are placed in a bell jar while a single mouse is placed in an identical jar. All of the mice are then injected with the same dose of a toxic drug. Although there is an ample oxygen supply, the crowded mice panic, run around the jar and eventually all die. The lone mouse almost always survives. Although this is a rather melodramatic demonstration and findings based on mice cannot be directly transposed to people, one cannot help but wonder if the conditions under which we live are beginning to resemble those of the crowded mice. Nor can there be much question that the crowding problems engendered by a burgeoning population, to say nothing of air pollution and noise pollution, contribute to human stress and human conflict. It would not be too far fetched to think that these deleterious developments will be reflected in higher accident rates.

In addition, our highways themselves are becoming scenes of turbulence, with the driver subject to myriad distractions including greater numbers of vehicles, sign boards and his own blaring radio, which at times seems to produce more exhortation than music. All of these factors will probably result in an increase in accidents; hence making it even more imperative that all vehicles be manufactured in a manner that prepares them for and protects the driver from the inevitable.

ALCOHOLISM AND TRAFFIC SAFETY

Let us turn now to a very clear cut and indisputable "driver problem" that has for years preoccupied legislators, law enforcement agencies, and the traffic safety establishment. The deleterious relationship between drinking and driving was recognized at least forty years ago. In recent years, with methods available to accurately determine blood alcohol levels, it became possible to document the greater accident liability of drivers as their blood alcohol levels rose. In addition, studies of fatal accidents made it quite clear that approximately one half of all fatal accidents were caused by drivers who were heavily intoxicated. In the past forty years state legislatures have passed very stringent legislation making it a criminal offense to drive a motor vehicle with a blood alcohol level of 0.15 percent or over. No doubt laws making

heavy fines and license suspensions mandatory have restrained some drivers from driving in a drunken state, but drunk driving and alcohol-related serious and fatal accidents remained a fairly constant problem regardless of penalty.

In 1955, Goldberg provided the first clue as to why stringent drunk driving legislation and appeals to the general public to not drive after drinking had not resulted in any reduction of the drunk driving and alcohol-related accident problem. He reported that 45 percent, or the 2,100 persons arrested in 1955 for drunk driving in Sweden, were known chronic alcoholics. In 1957, Schmidt and Smart of Toronto reported the results of a traffic violation and accident survey of 98 men treated at an alcoholism clinic. This group had an accident and moving violation record that far exceeded that of the general population from which they were drawn. Similar studies in the United States also pointed to the problem drinker or alcoholic as being a major contributor to serious and fatal alcohol-related accidents (Selzer, M. L., 1969 and Task Force Report: Drunkenness, 1967). It soon became apparent that in dealing with the accident-involved drinking driver we were dealing with people whose very addiction conferred an immunity against the usual exhortations and threats. Since the promulgation and implementation of traffic safety laws and procedures is largely in the hands of persons trained to think and act in a police tradition, the above essentially medical information has had relatively little impact on subsequent events.

In recent years many states have passed implied consent laws which require a driver to permit the police to take a blood or breath sample to determine his blood alcohol levels. If the driver refuses, his license may be suspended. Implied consent legislation has been hailed as a solution to the problem of the drunk driver, and it has certainly increased the number of convictions in those jurisdictions which have implied consent laws. Unfortunately, there has been no concomitant reduction in serious or fatal accidents. State legislatures are now being urged to reduce the permissible blood alcohol level to 0.10 percent, thus assuring that there will be an even greater number of convictions for driving while intoxicated. In pressing for this reduction, the alleged success of similar programs in various European countries, particularly Sweden, is cited. Unfortunately, that data provided from these European countries are not at all reassuring, and it may be high time

that someone challenges the notion that merely passing legislation and reducing permissible blood alcohol levels from 0.15 to 0.10 percent will have any impact on the alcoholics generally responsible for serious alcohol-related accidents. It would be more worthwhile to carefully examine those who are convicted of driving while intoxicated to determine whether or not they are alcoholic and to assist them either toward rehabilitation or toward an ability to drink in a place or a manner that will not require that they drive from one place to another. Unfortunately, most police and traffic agencies are more punishment oriented and for some misbegotten reason equate bigger and more frequent penalties with accomplishment, although our ultimate data belies this contention. An historical parallel is available if we would but look at it. In most cities in the United States, more than 50 percent of *all* arrests are for drunk and disorderly offenses. (Task Force Report: Drunkenness, 1967). The typical drunk arrested is an individual who will be arrested a number of times during his lifetime with no particular change in his drinking behavior. This has led court officials to refer to these individuals as persons doing a "life sentence on the installment plan." A few jurisdictions are moving toward a more enlightened approach to the chronic inebriate and requiring treatment and rehabilitation rather than merely throwing them in the drunk tank of the local jail.

In a very real sense, our approach to the handling of drunk drivers has been as primitive as the treatment of the simple drunk defendant of the past. Punishment alone for drunk drivers will not solve a very serious public health problem, which annually proves fatal to thousands of Americans, since ultimately the drunk driver returns to the roadway without any basic changes in his drinking patterns. In effect, we are witnessing ancient rituals which cannot be modified by new knowledge. Anthropologists tell us that primitive peoples recognized their total vulnerability to many violent and otherwise harmful natural phenomena. Floods, droughts and disease created a need for a countermeasure system which took the form of prayers, offerings and other rituals. In a very real sense, the dependence of drunk driving programs on breathalyzers, lowering permissible blood alcohol levels, increased police patrols and more punitive legislation is repetitious and ritualistic and ultimately doomed to failure, since it does relatively little to alleviate many of the root causes of alcoholism which in turn spawns most serious alcohol driving problems.

A vast federal effort under the auspices of the Highway Safety Research Bureau of the Department of Transportation is now under way. It is still too early to determine whether this program, aimed at reducing drunk driving in a number of American cities and counties, will have sufficient rehabilitative emphasis to make any worthwhile difference. While it is infinitely less expensive initially to hit a man over the head than to actively assist him, the punitive approach has thus far not been auspiciously successful in dealing with the problem of alcohol-related accidents nor with the problem of alcoholism itself. Most importantly, we must not permit the current "drunk driving" campaign to deter us from the more realistic goal of modifying the automobile so that more people can survive collisions. The American public is slowly turning against the use of capital punishment. In Michigan it was abolished over one hundred years ago. Even if an accident occurs as a result of driver error, is it necessary that the driver pay for the error with his, or someone else's, life?

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Section II

The Public and Official Perception of the Laws Dealing with the Alcoholically Impaired Driver

Robert F. Borkenstein

Discussant

L. Poindexter Watts, Jr.

ROBERT F. BORKENSTEIN

Combining a most unusual set of experiences, Dr. Borkenstein is a professor in the College of Arts and Sciences at Indiana University where he chairs the Department of Forensic Studies. For years he directed the laboratory services of the Indiana State Police. Best known as the inventor of the Breathalyzer, he has also been recognized for his contributions to the public understanding of the law. His advice is widely sought by decision-makers in the fields of traffic safety, alcohol and drug addiction, and law enforcement.

THE PUBLIC AND OFFICIAL PERCEPTION OF THE LAWS DEALING WITH THE ALCOHOLICALLY IMPAIRED DRIVER

By Robert F. Borkenstein

"He that will not apply new remedies must expect new evils for time is the greatest innovator."—Francis Bacon

Possibly the most pervasive attribute of today's U.S.A. is possibilism. This, in part, accounts for the tremendous strides that we have made over the past hundred years in the technical and scientific aspects of our lives.

The strident advances in medicine and public health have increased our life expectancy from 45 to well over 70 years in much less than a century. Smallpox, the greatest destroyer of young people a century ago, has been conquered to a degree that the slight hazards of universal vaccination are greater than the danger of the disease itself. Rapid communications and transportation have advanced to a point where, except in space conquest, the need for increased rapidity is being subjected to severe cost-benefit analysis. Debate on the need for supersonic transport jets is an example of this.

We have adopted as our credo a "can do" philosophy. Give us a problem, like heart transplants or moon landings, and we go forward believing that with enough money, time, and effort we can discover and demonstrate the answer to that, or any other human problem. We are attacking frontally problems such as pollution, racism, criminality, education, traffic safety, and many others. Even though we are frustrated in not achieving instant results in many of these areas, we are making real progress. In spite of our self-criticism, we still set the pace for the world. We are, as F. C. Ward of the Ford Foundation has called us, America the Resilient.

When we entered this century we were an agrarian culture. Transportation was still on hooves and rails. By 1940 and World War II, we were solving problems with machines and gadgets through an expanding technology. This era is subsiding and the age of ideas is emerging. Our colleges, universities, and evening schools are bulging with enrollment.

We are experiencing the effects of a phenomenal knowledge explosion. Knowledge has become our capital and our commodity. If we start with the birth of Christ as the base point, man's knowledge doubled for the first time by about 1750. The second doubling of man's knowledge occurred by 1900. With the acceleration of an industrial and business economy, man's knowledge doubled a third time by 1950 and fourth by 1960. Since 1960 knowledge has increased at a rate of speed reaching exponential proportions. The "can do" philosophy has lead us to attack problems and tasks which no one would have dreamed or dared to do a few years ago. In short, in recent years we have changed from a culture which believed in simple solutions to big problems into a thinking culture which has become increasingly more critical of its methodology of problem solving. The times and the problems we face are too complex to be dealt with and solved by a "more of the same" attitude. We cannot bowl over our scientific and social dilemmas by sheer weight of determination and increased application of obsolete panaceas. The challenge we face is to apply the products of the knowledge explosion to our benefit in solving our problems and to harness them so that we are not trampled in their paths.

Two opposing laws seem to be in contest: one, a law of blood and death which opens out each day new modes of destruction, among these, the motor car; the other, a law of health and safety, whose only aim is to deliver man from these calamities which beset him. The one breeds violence among men, the other offers relief to mankind. The one sacrifices thousands of lives—the other places high value on a single life. The law of which *we* are the instrument strives even through the carnage to cure the wounds. Which of the two laws will prevail, no one knows. But of this we may be sure, that science, in obeying the law of humanity, will always labor to enlarge the frontiers of life, thereby feeding both the law of destruction and the law of mercy.

As never before, ethics to control science in its application to solving social problems must be faced. The power of technology will soon afford us the means through pharmopsychology and genetic alteration to "correct" many types of social misfits. Even today the XYY chromosome mutation has been used as an excuse for murder. What would

be the side-effects of altering mutations? The possible misuse of such enormous powers is frightening. It is obvious from this illustration that the new knowledge is invading all facets of life and that law is no exception. But have law and law enforcement embraced the new knowledge? I should like to limit this question to the field of traffic safety, traffic law, and its enforcement.

The motor age descended precipitously about a half century ago on a world unprepared intellectually or technologically to cope with the public safety problems it generated. Answers were hasty and simplistic, a situation to be expected in a field without tradition.

Public safety problems of the newly emerging automobile age began to manifest themselves in crashes of varying degrees of severity in terms of life and property. These crashes were "caused" by something." The activity of investigating such crashes soon became a part of the police repertory. The describable, visible factors that by frequency of association and by common-sense seemed to cause such crashes became the bulwark of traffic law and its administration.

The frequency of associating traffic crashes with (1) high speed, (2) alcoholic impairment of the driver, (3) improper lane usage, (4) following too closely, and (5) driving with license revoked or suspended resulted in the labeling of these acts or conditions of the driver as "causes." These became the 'big five" serious traffic offenses. The "big five" and the methods of administering laws based on them became hardened in the years immediately following 1938 when the Automotive Safety Foundation furnished grant-aid to establish the National Committee of Traffic Law Enforcement. The recipient and organizer was a noted jurist and former president of the American Bar Association. This National Committee on Traffic Law Enforcement conducted a two-year study of the courts and the police. These studies resulted in a set of fifty-seven recommendations, among them those for handling the drinking driver, which were endorsed by the American Bar Association's Judicial Conference, the Criminal Law Conference, and the Junior Bar. They were also adopted by the National Safety Council and the International Association of Chiefs of Police in 1940. A book *The Traffic Court,* based on the 57 recommendations, was published in 1942 and distributed to all chief justices, attorneys

general, and governors. This book became the bible of the field and, in the overwhelming majority of cases, it remains the bible today. This is in spite of the galloping world we live in and the unbelievable changes and demands that the last thirty years have thrust upon us.

The pace of change in our time is an insult to our ability to keep up and adjust. Are 1940 recommendations adequate for 1970? I believe the answer is obvious. The axiomatic system of thought and laws that became enshrined three decades ago has been largely unquestioned until now. It was axiomatic to call the drinking driver a principal cause of serious traffic crashes. Axioms are based on invariability but not on scientific proof. Thus they are intuitive. Unless they are accepted dogmatically, they serve little purpose. Legal restraints on the drinking driver were instituted on this basis, but they left more questions unanswered than answered. Is it an offense to drive after consuming *any* amount of alcohol? When is one alcohol-free after drinking? Why are some people, who drink and drive repeatedly, never involved in crashes? What do the numbers which express blood-alcohol concentration mean to *me*? How much alcohol do I have to consume to attain a dangerous blood alcohol concentration?

When a factor such as alcohol is so intimately woven into the social fabric, it cannot simply be legislated away. To compound this problem, drinking driving per se is not prohibited. Only after a prescribed, numerical blood-alcohol limit is exceeded, affording a presumption of impairment, does it become an offense. This mystifies rather than enlightens the average driver as to the permissible limits of drinking before driving.

This lack of understanding has led to widespread distrust of the drinking-driving laws, a distrust that persists despite the thirty-year old efforts of important organizations to inform the public about the facts of drinking in relation to the driving task.

Few people have had the opportunity to associate blood alcohol numbers with the subjective impression of their impairment and their drinking habits. Blood alcohol numbers specificed in the law are mere abstractions that are very silent about their inner meanings. No matter how much we rattle the term .10%, tap it, or squint at it, it remains silent. The lack of understanding that results is not limited

to the general public. It persists even among police officers, judges, prosecutors, and jurors. Add to this the folklore that surrounds the use of alcohol and the problem becomes abundantly clear. Historically, man has tended to avoid use of abstract numbers and to substitute descriptive images in their stead. Are we not violating this human penchant when we expect even the least scientific among us to know what blood alcohol numbers mean? We exhort him to avoid driving when his blood alcohol exceeds some chosen numbers, vague even to the law makers and enforcers. And to compound this problem, blood alcohol numbers, very significant in terms of driver impairment, are often not associated with the traditional concept of overt drunkenness.

How can this help but result in less than effective control? The police officer, the prosecutor, the judge, the juror are hesitant to enforce the law without "overwhelming evidence," which usually means to them gross drunkenness. The result is that the blood alcohol concentration of greatest frequency in an average jurisdiction is .23%, a number that *is* associated with gross drunkenness. Yet we are aware of the enormous contribution to fatal crashes made by drivers beginning at .10%. We must dispel the notion that evidence of alcoholic impairment of the driving task must be accompanied by violent physical manifestations. There is a worldwide tendency to make the blood alcohol number the sole criterion of impairment. Under these conditions the distrust and level of misunderstanding will go even higher. This negative response is clearly illustrated by press reaction.

Researchers and traffic safety administrators have long sought a method of teaching drivers the facts of drinking driving. This has taken the form of slogans "if you drive don't drink, if you drink don't drive" or nomographs expressing blood alcohol as a function of body weight, amount of alcohol consumed, and time. An "average drink per hour" has been suggested. There is no way to know how much effect these approaches have had. One thing is certain. They are so highly imperfect because of variables in intake and metabolic tolerance that *doubts* could negate their value.

The only criterion on which impairment can be based is the blood alcohol number, since this is independent of the intake and metabolic variables. It is a measure of the concentration of alcohol affecting the brain and higher nerve centers.

Crude "baggy" tests have been offered for self-testing to measure this criterion. Birrell of Australia has taken a Breathalyzer to parties and has tested thousands of subjects. This has provided feedback information to those tested. They could, in this manner, associate their blood alcohol number with their drinking pattern and their subjective feelings. Thus the numbers can take on meaning. We have also done such testing. It is interesting that the "norm" for such parties is about .06%. Few guests attain concentrations in excess of .10%. In my opinion, it is as important for the moderate to know his attained blood alcohol numbers as it is for the excessive drinker to know. Only by this means will the overwhelming number of moderate drinkers know that they are within the law. This perception of the numerical law will dispel fear and distrust. It will produce an out-group of the very small percentage of excessive drinkers.

We have recently developed an instrument to provide this information. It will provide the opportunity for every drinker to associate his drinking habits and his self-assessed impairment with the blood alcohol numbers. Most drinkers who drive have negligible blood alcohol concentrations *but they do not know it.* Similarly, those with excessive blood alcohols can live in a fool's paradise through self-justification. Widespread self-testing can factualize both these situations by providing the necessary feedback information, without the necessity of providing impossibly elaborate drinking instructions that vary for each individual. The blood alcohol concentrations are objective numbers directly associated with the law.

Thus a condition of freedom under law through knowledge will be achieved, not only for the abstainer but for the very moderate drinker. Today laws breed fear, even among the moderate, through lack of understanding. If abstainers and law-abiding drinkers can join hands, with belief based on self-acquired knowledge, and direct their social and legal sanctions against the very small dangerous deviant group, real inroads can be made. The idea, based on ignorance of facts, that "there but for the grace of God go I," will vanish.

Ideally, a law is a codified social norm while a moral norm in a society is uncodified and informal. They must both be directed toward the same goals but may be of different intensity. Generally, the law must be more liberal than the uncodified or informal norm to which

it is related; otherwise through perceived over-control, the law may become democratically unacceptable and therefore unenforceable because of public, official, and jury negative response. Thus it is of great importance in a democratic society that for effective law enforcement and a maximum of public compliance with law that the law be perceived as reasonable, relevant, and fair. But even a reasonable, relevant, and fair law is not always perceived as such.

The crude cause-effect relationship that arose forty years ago was grounded in intuitive interpretation of observed, describable regularities in traffic crashes. They apparently have not been without their value. The streets and highways of the United States are the safest in the world. Japan kills 400 people per year for each of its 100,000 motor vehicles, Italy kills 250, England and Canada about 80, and we kill about 56. A few years ago we had half of the improved roads of the world, three-fourths of all the automobiles, but one-fourth of the fatalities. Therefore, please do not interpret my criticisms of the traffic safety "establishment" as totally critical. Devotion to axioms and to crude cause-effect relationships in a new and rapidly evolving field is not necessarily bad. It becomes negative only when the present is committed to the past rather than to the future. We must test the methods of the past and replace them if they have become obselete.

Alcohol in drivers has occurred with such regularity in traffic crashes, especially serious ones, that it has been labeled as a "cause" of traffic crashes. Bertrand Russell, in his excellent essay on "The Notion of Cause with Applications to the Free-Will Problem" did not deny that labeling such a regularity as a "cause" is useful *in the infancy* of a science. What he does criticize is the perpetuation of the notion that such regularities are *ultimate* "causes" when the means to sweep vagueness aside are readily available. The statement that gravity causes bodies to fall toward the earth is axiomatic. It is a describable, visible event. But what it does not say is that such bodies fall toward the center of the earth; it does not say how fast they fall; it does not describe the effects of such parameters as shape, size, weight, and density, or the effects of atmospheric density, altitude, and latitude. Theoretically, the positions of the sun and the moon make a difference. In short, every advance in science takes us farther away from the crude uniformities first observed in new fields

of endeavor into greater differentiation of relevant nuances. Thus, instead of lumping all drinking drivers together, we must classify drinkers, then drivers, and then create a cross-classification of drinking drivers. Even total abstainers must be considered as a class in assessing the dynamics of the drinking driving laws. Drinkers are often described as chronic alcoholics, heavy drinkers, social drinkers, teen-age drinkers, occasional drinkers. Each of these categories, by the use of well-chosen adjectives, can be sub-classified.

Sub-classifications give rise to more specific countermeasures to negate the undesirable characteristics of each group. This is a "divide and conquer" approach. Such classifications and sub-classifications of drivers are equally feasible. Personality, reasons for driving, types of vehicles, time and driving, and other parameters can be the basis of such classifications. By combining classifications of drinkers and drivers, an extensive array of combinations of the two can be listed. Feasibility of application of countermeasures for control of the negative aspects of each combination will establish priority for allocation of available resources. For instance, improved records and their analysis have identified two groups of drinking drivers as high-priority targets for countermeasures, the problem drinker and the young driver. This can result in time and place enforcement and to alternative sentences by judges, a process that will pin-point countermeasures against the Achilles' heel of each classification, without the fear that we, the reasonable, will be caught in the snare of over-control. This will result in the yoke of law resting lightly on the shoulder of the abstainer and the moderate, and heavy on the shoulders of the immoderate. It will make it easy for us to be slaves to the law, the condition of our freedom.

DISCUSSION

Lewis Poindexter Watts, Jr.

Dr. Watts received his J.D. from the University of North Carolina at Chapel Hill, where he is now Professor of Public Law and Government. He is also Assistant Director of the University of North Carolina Institute of Government. His major interest has been in the field of alcohol and traffic safety. He has drafted regulations and statutes concerned with the legal aspects of chemical tests and serves in an advisory capacity to state and national bodies concerned with this problem. He authored, "Some Observations on Police-Administered Tests for Intoxication," which appeared in the North Carolina Law Review.

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THE SPEEDOMETER ANALOGY

My first reaction to Dr. Borkenstein's paper was that he had written a sophisticated, philosophical essay on the impact of enforcement, the public perception of law, and aspects of causation but that the major new point was to promote a gadget—the coin-operated Breathalyzer. After mature consideration of Dr. Borkenstein's presentation, however, I find myself in complete agreement with him, and would like to develop an aspect of his thesis somewhat by making a rather extensive comparison between the speed laws and laws relating to control of the driver who has consumed alcohol.

If one traces the development of the laws in this country relating to the speed of motor vehicles on the highways, I think he will find that in most jurisdictions the first law was a simple one making it unlawful for a person to drive a motor vehicle at a speed faster than reasonable and prudent under the circumstances then existing. As the volume of traffic increased, as cars got faster, and as traffic safety authorities began to build up experience as to the hazards created when one went faster than certain speeds in particular situations, the legislatures of the states began to change the laws.

There was a considerable period of time in which the basic law remained the same, but speeding over a certain limit in town, or over a different limit in open country, was made *prima facie* evidence that the motorist was traveling at a speed faster than reasonable and prudent under the conditions then existing. Now the defendant could come in with rebuttal evidence to show that in his particular situation there was no violation of the law—that for him, with his vehicle, there was no speeding in excess of the limit dictated by the existing conditions.

One by one, however, the states found this an ineffective way to deal with the speeding problem. The case always turned on the particular defendant, his vehicle, and the special conditions existing at the time of the alleged speeding offense. The states began a process of replacing their *prima facie* evidence laws as to speed limits with absolute speed limits. I believe every state now sets absolute speed limits, and states use their speeding-faster-than-prudent-under-conditions-existing laws only in case special conditions mandate that one drive at a speed *less* than the absolute limit set.

In retrospect we can see that the shift to the absolute speed limit could not have occurred without the almost universal presence of a "gadget" in motor vehicles—a reliable speedometer.

Let the point be clear: I do not scorn gadgets. History tells us of the profound importance of certain inventions, certain technological changes. It would be difficult to overstate the impact on Western civilization of such inventions as the movable-type printing press or the introduction of gunpowder. I believe that when the history of the United States during this century is written the development of the mass-produced automobile will stand out as perhaps the most pervasive single event in reshaping our lives.

To return to the speedometer, the important thing about it is that it was installed as a matter of course on all motor vehicles used for highway transport. This allowed the drivers to gauge their own speeds. It also facilitated enforcement of absolute limits; the citizens could be held accountable practically, as well as upon some theory of strict liability, for exceeding the posted limit.

Some might question whether this trend toward observance of absolute speed limits is desirable. Much is made of the "cause" problem with speed: that is, whether speeding "causes" accidents. I think, however, that conventional wisdom is acceptable here; more severe injuries and an increased fatality rate are associated with increasing speed of the vehicle, and it takes costly, carefully engineered highways to permit fast speeds with relative safety. The traffic safety statistics for the United States compared with the rest of the world show us to have the best safety record, and our more stringent control of speeding than that of other countries may be one of the prime factors involved. (This idea is given some support by the fact that the alcoholically-influenced driver accounts for such a relatively large portion of our fatal highway accidents; we have been more effective than others in controlling the attitudes, and rates of speed, of our sober drivers.)

It should be obvious by now that I strongly believe the United States should adopt the speed-limit approach in controlling the drinking driver. The English, by being slow to come to grips with the problem of the drinking driver, had the advantage of studying what others had done. They favored the Scandanavian approach, and enacted an excellent law. It is flatly illegal to drive with more than a certain amount of alcohol in your system—and how well or how poorly you drive, or whether the alcohol has any effect on your driving, is irrelevant. It drastically reduces the number of issues to be contested in court.

In the traffic area it is legally possible to enact strict liability laws. One is guilty if he parks overtime even if his watch stops and he did not intend to exceed the time limit; one is theoretically guilty of exceeding the speed limit even if his speedometer is inaccurate and he does not realize that he is committing the offense. But in fact in a democratic society, judges and juries will take factors of subjective innocence into account. It seems to me that an essential precondition to effective enforcement of laws based solely on the driver's blood-alcohol level is some general community understanding as to the varying blood-alcohol levels and what they represent. This becomes especially important as legal limits (including limits stated in terms of *prima facie* evidence) go below 0.10 percent.

Therefore I applaud all attempts to educate members of the public as to blood-alcohol levels reached *by them* under varying drinking circumstances. Various slide rules and charts based on the Widmark hypothesis have been developed, and others are in preparation. One day we may even see the Widmark formula taught in school, but there are enough biological variables and other variables of condition, such as when and how much one ate before drinking, that I am not sure the public will ever be able to calculate probable blood-alcohol percentage very well using pencil and paper alone. Wide availability of self-testing chemical-test devices, though, would marvelously improve skill in allowing for variables; such wide availability would allow drivers to develop the ability to calculate their blood-alcohol levels with some certainty even when no self-testing instrument was present. The public needs a speedometer-equivalent.

It is not yet clear to me how accurate these self-testing instruments or devices need be. Only law enforcement officers need to have certified speedometers on their cars, and the public makes do with ones that may be off the mark by as much as ten percent or more. There is obviously a minimum level of accuracy that will be needed if the self-testing program is to be effective. A major obstacle, so far as I am concerned, is not with the precision of various breath-testing instruments that may become available; it is control of the waiting period after drinking. I feel confident, though, that we have the imagination and ingenuity to address the problem and reach an acceptable solution.

[At the conclusion of Mr. Watts' remarks, Dr. Borkenstein came to the platform to protest that the Breathalyzer is not a "gadget" and to summarize eloquently his views on coping with the drinking driver.]

Section III

The Spectrum of Drinking Drivers

M. W. Perrine

Discussant

Joan C. Cornoni

M. W. PERRINE

Dr. Perrine has served on the faculty of the University of Vermont since 1961. He received his Ph.D. in psychology from Princeton University before spending three years in Germany where he taught and directed the Research Center for Visual Perception, Hochschule fur Gestaltung, Ulm, Germany. At the University of Vermont he is Director of Project ABETS (Aspects Behavioral and Environmental in Traffic Safety), which has focused on drinking drivers and highway crashes. His research is providing much needed information on those drivers who combine heavy drinking with driving as well as those who do not.

THE SPECTRUM OF DRINKING DRIVERS

By M. W. Perrine

Despite the emerging body of evidence which implicates alcohol in approximately half the fatal highway crashes in our country, there is as yet no consensus on the exact components of this alcohol contribution. Some say, "It is all persons who drive after drinking"; others say, "It is the problem drinker, but not the social drinker"; and still others say, "It is just the alcoholic." Nevertheless, it is generally assumed that alcohol is a causative factor in highway crashes; in other words, that alcohol causes crashes. The fallacy of this simplistic assumption is readily exposed by the fact that many adults drive after drinking and yet have never been involved in a crash. Thus, it becomes necessary to consider other dimensions and variables if we are to gain a more accurate understanding of what is not in fact a simple problem. The quantity of alcohol present in the driver is one obvious dimension which has already been well documented. Several groups of investigators have already demonstrated that the risk of being involved in or being responsible for a fatal crash increases very sharply with elevated blood alcohol concentrations, especially with concentrations greater than 80 mg percent per 100 ml (or 0.08 percent by weight).

One of my primary purposes today consists of critically examining some of these issues and some of their underlying assumptions on the basis of recent findings from our research in Vermont.

WHAT IS THE ACTUAL PROBLEM?

Recently, one of our prominent public figures was quoted as having stated that "56,400 persons were killed in highway accidents last year, and 23,000 of these deaths were caused by alcohol." He continued by labeling this as one of the biggest single domestic problems facing the American people today. While all of us certainly regret the tragic losses reflected in these data, many of us would not agree with the speaker's particular statement of the problem.

First, he has named alcohol as the responsible, causative agent in 50 percent of the events called death. Second, he has described all

these deaths in the passive voice ("were killed") as opposed to the active voice. Third, he has termed the critical incident an "accident." And finally, he has labeled this enormous accumulation of individual data as a single problem.

Webster defines a *problem* as "a question raised for inquiry, consideration, or solution." An adequate understanding of the so-called problem identified by the speaker can perhaps best begin by re-examining the original data or phenomena on the basis of which appropriate questions can then be formulated and raised for inquiry and, subsequently, problems can in turn be structured for attempted solution.

Regarding the phenomena, it is a matter of public record that last year on our highways approximately 56,400 individuals sustained bodily injuries assumed to have been fatal. The first step in traditional scientific inquiry would be to seek *common elements or common factors in these observed deaths.* Upon examining the data, we find that vehicles were involved in approximately 100 per cent of the cases, more or less by definition. We also find (1) that drivers (as opposed to passengers and pedestrians) constitute approximately 50 percent of the deceased, (2) that severe head injuries were found in approximately 50 percent of the deceased, and (3) that alcohol was present in the blood of approximately 50 percent of the deceased. According to fundamental research strategy, as well as to common sense, any single factor found in such a large proportion of the cases should receive high priority for investigation.

Since our primary concern here is alcohol, we would therefore seek *common factors among those cases in which alcohol was present.* And we find, first, a relatively large proportion of drivers with blood alcohol concentrations higher than 50 mg percent, or 100 mg percent, or 150 mg percent, or even 200 mg percent. Second, we find that the more severe the crash had been, the more likely that the deceased driver manifested a high blood alcohol concentration.

Thus, our next question would focus on possible *common elements among those deceased drivers with the higher blood alcohol concentrations.* And we find that a large proportion of these drivers had been in single car crashes, that a very large proportion were deemed to

have been responsible for their particular crash, and that a relatively large proportion had a history of previous alcohol-involved incidents, both on and off the highway.

Although we might pursue this line of inquiry even further, it would seem appropriate at this point to return to the matter of the *problem,* that is, the particular problem which is being raised for attempted solution. One might hear the problem stated variously as "reducing the number of accidents *caused by alcohol,*" or "reducing the number of accidents *in which alcohol is present,*" or "reducing the number of accidents *in which elevated blood alcohol concentrations are present.*"

Before attempting to achieve a final statement of the exact problem, however, it would be more productive for subsequent understanding *first to determine the exact role of alcohol in highway crashes, that is, the exact contribution of alcohol to crashes.* The rationale for this decision stems from a basic strategy for scientific research. Thus, if we are concerned with a systematic approach to the phenomena of highway crashes involving alcohol, we would be well-advised to avail ourselves of some of the established tenets of scientific inquiry, bearing in mind that the basic reason for scientific inquiry is essentially the same reason for any inquiry, namely, to solve a problem.

Different Levels of Conceptualizing the Problem

It is generally acknowledged that the fundamental aim of science is encompassed by the word *understanding,* that is, increasing the range of our conceptual knowledge. As our understanding increases, our accuracy in predicting, as well as our ability to control and to apply our knowledge will also inevitably increase. However, a critical examination of our view of the world and our assumptions about it is a necessary pre-condition for conceptual understanding.

Historically, there have been three levels of thought, according to Dewey and Bentley (1949), who named these three levels: *self-action, inter-action,* and *trans-action.* These levels refer to man's view of the world and to his behavior with respect to this world. *Self-action* is "where things are viewed as acting under their own powers," as in primitive animism. For example, a person operating at this level

might see a fatal injury crash and conclude that "cars kill people," or that "accidents kill people"; or, if the presence of alcohol were pointed out to this person, he might conclude that "alcohol kills people in cars."

Second, *inter-action* is "where thing is balanced against thing in casual interconnection," as in the reciprocal action-and-action of Newtonian mechanics. For example, a person operating at this level might say that the part of the car that causes the most accidents is the nut that holds the wheel, especially if it is too "tight." Or he might say that "alcohol causes accidents."

Third, *trans-action* is where things don't exist in and of themselves; rather they exist because of other entities or things, as in Einstein's theory of relativity. A transaction has been defined as a psychological event in which all aspects of the concrete event derive their existence and nature from active participation in the event (Ittelson and Cantril, 1954). Thus, driving can be conceptualized as being transactional since it is impossible to define the functional nature of the driver *as* driver apart from his transaction with the vehicle in a driving situation. Likewise, it is impossible to define the functional nature of a motor vehicle in operation *as such* apart from the transactional nature of its relationship to the driver.

For the purpose of analysis, a single-car, fatal injury crash can also be conceptualized as a transactional process, and we can then attempt to abstract those aspects of the total process *except for which* the process (or event) itself would not occur as it does. Thus, it is not necessary to attribute causal relations, but rather it is sufficient to identify and abstract those requisites or "except-fors" without which the event would not be what it appears to be. Such a list would include: the driver, the vehicle, the object into which the car crashes, the fatally injured person, and the driving environment including the traffic, the highway surface conditions, the lighting conditions, etc. If the driver had been drinking, then the alcohol influences would also have to be included in the list, but this particular element can be considered at a later point.

The Problem of Problemization

Just as our level of thought constrains our possible range of understanding, the way a specific problem is initially formulated will to a

great extent constrain not only the particular phenomena selected for observation and the methods used, but also the very nature of the ultimate results and conclusions. Accordingly, over-emphasis on method and technique *prior* to adequate formulation of the problem can easily mislead research efforts and retard eventual understanding. Thus, the problem of formulating a problem for scientific investigation should receive paramount consideration. Among other benefits, proper formulation leads toward relevant specificity, and away from simplistic overgeneralizations which cloud issues and discourage thought and action.

Furthermore, the formulation of the problem must contain within itself the possibility of going beyond what is now scientifically established if it is to satisfy the definition of scientific research. If the formulation of the problem does not do so, then succeeding steps in investigation are futile. Or, as Einstein and Infeld have written, "the formulation of a problem is often more essential that its solution, which may be merely a matter of mathematical or experimental skills. To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and makes a real advance in science (1942, p. 95)." Whitehead had pointed out that "no systematic thought has made progress apart from some adequately general working hypothesis, adapted to its special topic. Such an hypothesis directs observation, and decides upon the mutual relevance of various types of evidence. In short, it prescribes method (1933, p. 286)."

Other modern scientists have pointed out that "if an hypothesis is to be regarded as adequate, it must be more than a statement or description of current data and more than a prediction that data will reproduce themselves. An hypothesis must be tested both in terms of its ability to predict immediate events and its promise of leading to further, more adequate hypotheses. For in scientific procedure there is a never ending process of hypothesizing, a constant flow of one hypothesis from another, with each hypothesis trying to go beyond established formulation in its inclusiveness (Cantril, Ames, Hastorf and Ittelson, 1949, p. 491)."

In the area of highway safety, simplistic formulations of the problem are frequently reflected in slogans, such as "Speed Kills!" or "Alcohol

Causes Accidents!" or "Scream Bloody Murder!" Thus, the interactional view that "alcohol causes accidents" could well lead to a search for mechanistic ways of prohibiting all drinking of alcoholic beverages prior to driving. Indeed, this approach is already manifest in one well-known slogan, "If you drink, don't drive; if you drive, don't drink!" Since there is no published scientific evidence for the efficacy of this action-reaction approach in actually reducing highway crashes involving alcohol, reformulation of the problem would clearly seem appropriate.

Furthermore, the very use of the term *highway accidents* reflects an especially unfortunate and simplistic formulation of the problem that has doubtless contributed to the general attitude that nothing much can be done about these so-called highway accidents. This level of thought indicates a reification of the term *accident* since thing-like qualities are attributed to it, such that it acts under, or with, mysterious powers of its own. Evidence for this reification of the term is found in such accepted folk expressions as "accidents will happen," an expression which is frequently offered with a shrug as an "explanation" of a particular, unfortunate occurrence.

The word *accident* stems from the Latin for *happening* and is defined in Webster as "an event which takes place without one's . . . expectation, especially one of an afflictive or unfortunate character." The term *accidental* is defined as "happening by chance or unexpectedly, without design, or wholly outside of the regular course of things." Thus, it is small wonder that many people still assume an accident is some sort of bad luck or act of fate over which they have no control. This prescientific formulation of a highway crash as an "accident" has no doubt contributed to the prolonged absence of a systematic behavioral approach to the tragic phenomena of highway fatalities.

Reformulation of the event in more operational, if interactional, terms has led to its modern scientific conceptualization as a *crash*, which is defined in terms of abnormal, uncontrolled energy transfer. This reformulation of the problem has also led to isolating three phases for the purpose of study, namely: (1) the pre-crash phase; (2) the crash itself, consisting of the abnormal energy exchange; and (3) the post-crash phase.

More specifically, if the problem is posed in terms of reducing the number of highway *crashes* in which alcohol is involved (or is involved at significant blood alcohol concentrations), the research is oriented almost exclusively toward the pre-crash phase, and accordingly toward investigations of alcohol dose-response functions, or specific driver characteristics or behavior, for example. On the other hand, if the problem is formulated as reducing the number of highway *deaths* in which alcohol is involved (or is involved at significant blood alcohol concentrations), then the research quite properly includes not only the pre-crash considerations just mentioned, but also the crash considerations which may or may not have alcohol-specific aspects (such as those hostile intra-vehicular elements assumed responsible for the secondary impact injuries, etc.), as well as post-crash aspects (such as emergency medical care, etc.). Since the behavioral scientist is typically oriented toward understanding behavior, his contributions to the study of highway crashes will most likely focus on pre-crash factors. Thus, the crash and post-crash phases are more typically the areas of research concern for the physician, the automotive engineer, and the forensic pathologist. However, our discussion today will be limited to the pre-crash phase, or, more specifically, to driver characteristics, behavior, and alcohol.

Recent scientific research has significantly increased our understanding of certain common factors and recurring patterns in some types of crashes. Through such understanding, we should now at least be able to *begin* to predict — and thus eventually prevent — some crashes. Alcohol, of course, is one factor for which a recurring relation to crashes has been demonstrated, and a reformulation of the earlier approaches is therefore clearly appropriate. Thus, the development of our conceptual knowledge has progressed from the self-action level, at which, "accidents kill people" and "accidents will happen," to the inter-action level, at which "alcohol causes accidents," to our description of the current data as "alcohol is involved in or associated with highway crashes."

An adequate and heuristic hypothesis must not only incorporate the current level of understanding and provide for predicting immediate highway events, but must also lead to further, more adequate hypotheses. One such *working hypothesis* might be, "The risk of crashing

increases as blood alcohol increases" or "The risk of crashing increases geometrically (or logarithmically) as blood alcohol concentration increases." A more detailed version might even be offered, such as "The probability of crashing is an increasing logarithmic function of blood alcohol concentration, plus driving experience, plus drinking experience, plus risk-taking behavior, plus selected personality characteristics, plus selected attitudes, plus emotional conditions at the time, plus motivational factors, etc."

It is actually possible for such a formulation to be more than a mere cataloging of all factors assumed to increase the risk of crashing *if* the relative weight of the contributing factors can be calculated and entered into the proposed function. Thus, a statement of working hypotheses in these terms leads to a probabilistic, multivariate approach to the problem of highway crashes. And, if nothing else, this approach represents a distinct advance through its emphasis on probability, rather than causality, and its emphasis on multiplex constellations of variables, rather than simplex slogans, as a basis for our range of conceptual knowledge today and in the foreseeable future.

A Probabilistic Approach to the Problem of Drinking Drivers

A fatal highway crash may represent enormous human suffering and great personal tragedy, but *statistically* it is a rare event. In fact, traffic safety authorities estimate the rate of occurrence as being one fatal crash per 200,000 miles driven. Furthermore, it is an especially elusive subject for systematic study since each fatal crash is both a rare and a unique event. It is therefore virtually impossible to predict a particular crash in advance. Thus, the antecedent conditions actually preceding any given fatal crash must be inferred through post hoc reconstruction of "the events which led to the crash."

Although this reconstructive approach may be the best we have available at the moment, we must nevertheless be aware of its possible limitations; namely, (1) it is based upon an interactional level of thought; (2) it attributes causality through simple or correlational or post hoc inference, which may well be inaccurate; and (3) it may therefore not be conducive to attempting necessary reformulations of the problem. Despite these limitations, however, certain antecedent conditions are assumed to contribute to fatal crashes on the highway.

Specifically, a motorist's ability to drive is presumed by federal standards (and by many state laws) to be impaired if his blood alcohol concentration is at least 100 mg percent. Since alcohol is so heavily implicated in this presumably lawful relation, it is essential to relate pre-crash drinking variables to pre-crash driving variables in an empirically testable manner.

A method has been developed in recent years that provides a basis for designing appropriate tests of the inter-relations between these variables, namely, "multiple discriminant analysis," a computer-dependent technique that permits the classification of individuals in terms of relevant variables, which are selectively weighted on the basis of their relative importance, that is, their relative contribution in correctly discriminating or classifying the individuals under consideration. Although time does not allow a detailed description of this technique, it should at least be noted that the resulting discriminant function enables us to determine the proportion of individuals who have been correctly classified by means of the relevant variables versus the proportion of those incorrectly classified or, in signal-detection terminology, the proportion of "hits" and "misses."

Unfortunately, investigations of highway safety problems using multiple discriminant analysis are extremely rare, and, to the best of my knowledge, no research using this technique to study fatal crashes involving alcohol has ever been published or even conducted. At the University of Vermont, however, we have recently been doing some pilot work on this problem, and I will mention some of the more promising preliminary results later.

Although full-scale use of multiple discriminant analysis on the alcohol/crash problem needs much more development, a first approximation of a useful probabilistic approach can nevertheless be presented in the interim. Fortunately, this approach also serves as preparation for subsequent tests using multiple discriminant analysis. Thus, as a *first approximation,* we can propose that for a given individual: (1) the probability of having a fatal crash involving alcohol is contingent upon (2) the frequency with which he drives after drinking, which is assumedly related to (3) his usual *frequency* of alcohol consumption and to (4) his usual *quantity* of alcohol consumption, which in turn will yield (5) his probable level of blood alcohol

concentration, which will be taken as (6) the chemical indication of his degree of impairment. It should be obvious that the contingency relations outlined for this approximation are based not only upon limited empirical data, but also upon many *assumptions*. Therefore, let's examine the assumptions underlying the proposed probabilistic approach, and then look at some actual data.

First, let's assume that the transaction of driving, with all that could appropriately be included under this rubric, is represented by an irregular, topological surface (see Figure 1a). Of all the possible variables we could abstract from the transaction of driving, the one which best serves our present example is *crashes,* more specifically, personal injury crashes as opposed to those involving only damage to property (see Figure 1b). Therefore, let's focus first on personal injury highway crashes and examine a hypothetical distribution of the vast proportion of drivers (assuming correction for driver exposure per 10 million miles), plotted as a function of the severity of crash injury to the *driver* (ranging from minor bumps and lacerations, to injuries requiring hospital examination or admission, and finally to fatal injuries, see Figure 2). Since we are investigating alcohol involvement in fatal crashes, let's focus further on blood alcohol concentration (at the time of the crash) among those deceased drivers at the fatal injury end of the severity distribution. More specifically, let's examine the empirically determined distribution of fatally injured drivers who had detectable alcohol (and who died within six hours of the crash), plotted as a function of blood alcohol concentration (see Figure 3).

Next, in an attempt to locate the source of these fatalities, let's shift back to the pre-crash phase and focus on the population-at-risk of crashing. More specifically, let's examine the empirically determined distribution of drivers tested at roadblocks who had detectable alcohol, plotted as a function of blood alcohol concentration (see Figure 4). We can assume (1) that these drivers constitute the most probable pool from which the fatally injured drivers with alcohol are sampled, i.e., self-selected, and (2) that, therefore, a certain proportion of these drivers who are at the more elevated blood alcohol concentrations are also at higher risk of being involved in a fatal crash. (Based on our Vermont study, the relative probability of having a fatal crash as a function of blood alcohol concentration is discussed later and is

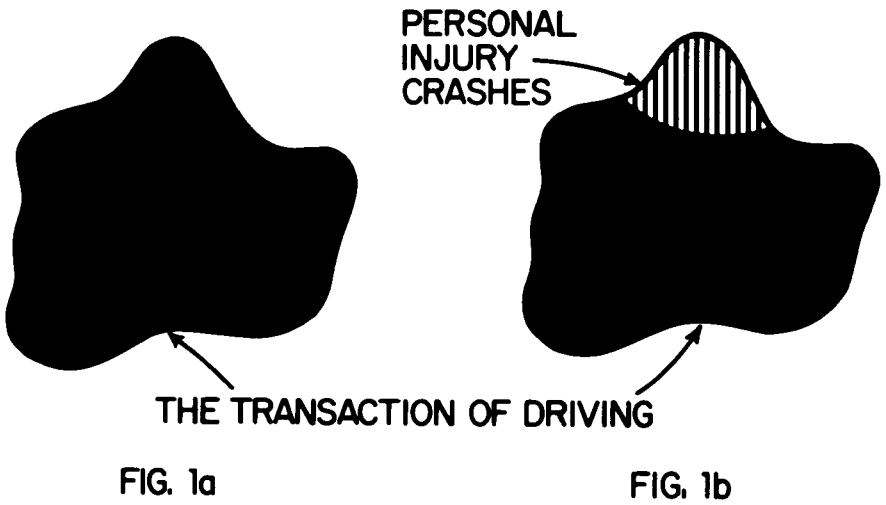

FIGURE 1. *A topological representation of the transaction of driving (1a), with the abstracted variable of personal injury crashes (1b).*

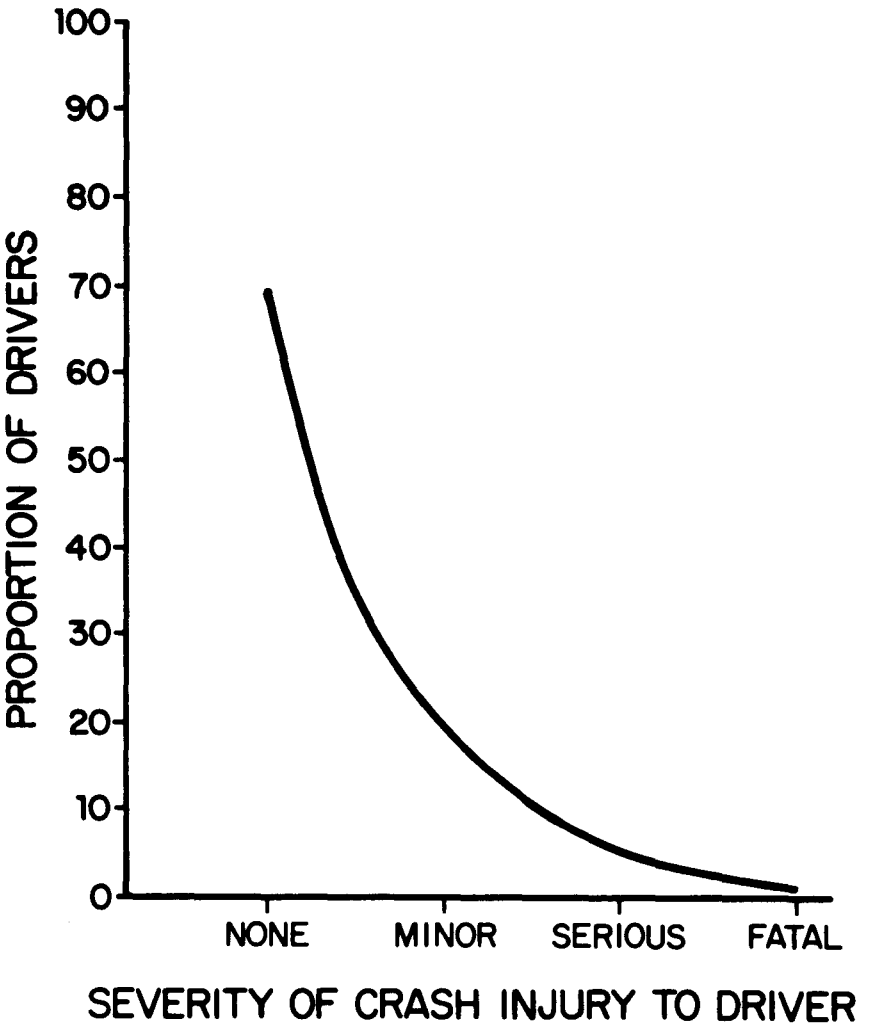

FIGURE 2. *The vast proportion of drivers (assuming correction for driver exposure per 10 million miles) as a hypothetical function of the severity of crash injury to the driver in terms of outcome.*

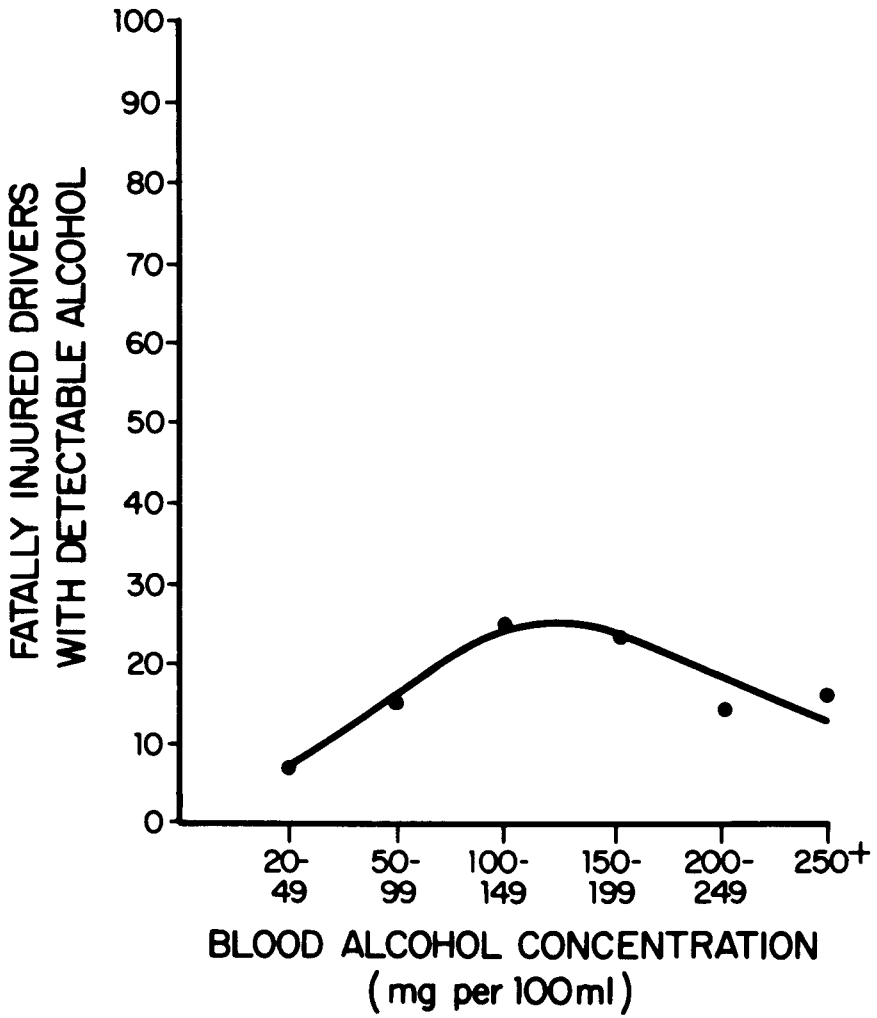

FIGURE 3. *The proportion of fatally injured drivers with detectable alcohol (at least 20 mg percent) as a function of blood alcohol concentration. (Vermont data; N = 57)*

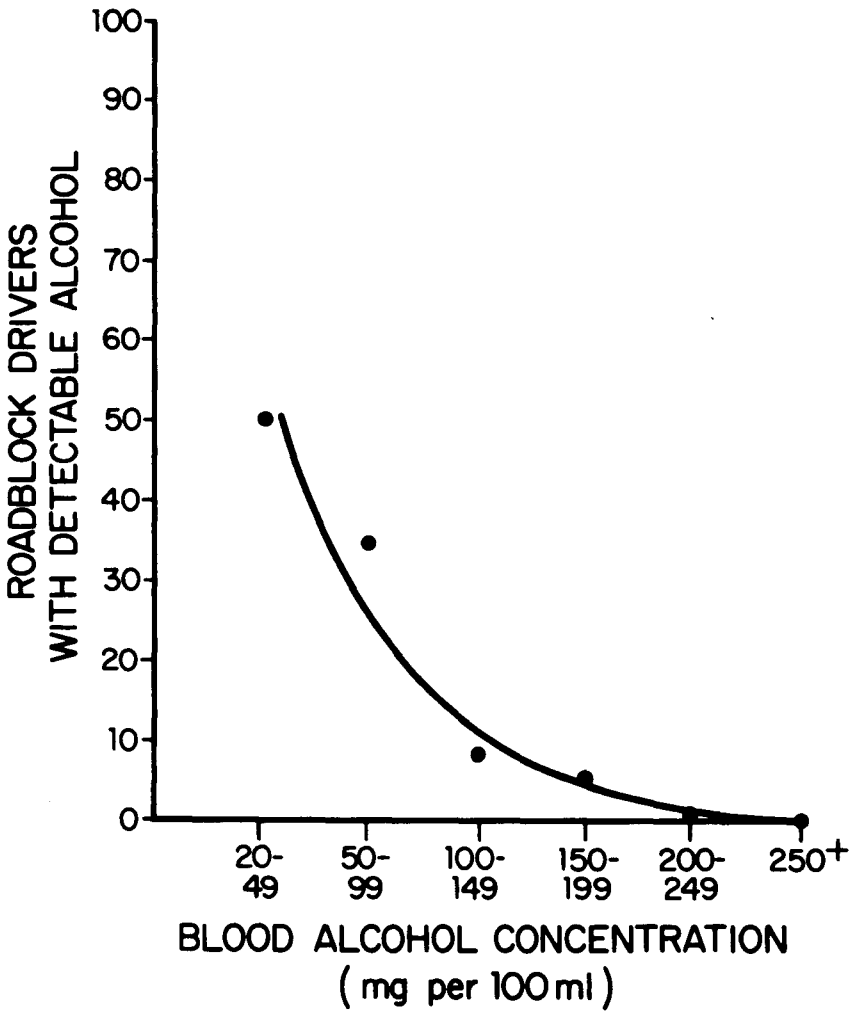

FIGURE 4. *The proportion of drivers tested at roadblocks who had detectable alcohol (at least 20 mg percent) as a function of blood alcohol concentration. (Vermont data; N = 156)*

represented graphically in Figure 13.) Thus, we would expect these drivers with elevated blood alcohol concentrations to be over-represented in our next analysis which should examine those drivers who have been drinking *and* who will die imminently in a highway crash.

We now reach a pragmatic impasse, however, because we have no feasible means of obtaining exact data on this last distribution of drivers. Nevertheless, a useful approximation and alternative might be provided by interviewing the roadblock drivers with elevated blood alcohol concentrations, obtaining data on their drinking patterns as well as their patterns of driving-after-drinking, and then comparing these data with corresponding data from fatally injured drivers with elevated blood alcohol concentrations. This rationale was in fact used as part of our Vermont study, details and results of which are presented below. Therefore, before being inundated by conjecture and assumed distributions, let's examine some relevant real-world data obtained by sampling along the spectrum of drinking drivers.

Research Results from Project ABETS[1]

As I have already indicated, the alcohol-involved-crash problem cannot be defined in terms of one single dimension, even though alcohol may indeed be a common factor. However, several significant aspects of the problem are beginning to emerge from the relatively limited body of research. First, alcohol has been found to be the largest single factor involved in fatal crashes. Second, regarding the degree to which alcohol may be contributing to the actual initiation of crashes, the distribution of the blood alcohol concentrations of drivers in fatal crashes has been found to be very different from those of drivers who are *not* involved in crashes at matched places and times.

Six previous studies have attempted to compare the presence of alcohol in persons involved in crashes with its presence in persons using the roads, but not involved in crashes (Holcomb, 1938; Lucas, Kalow, McColl, Griffith and Smith, 1955; Haddon, Valien, McCarroll

[1]The research was funded by the National Highway Safety Bureau of the U.S. Department of Transportation (Contracts FH-11-6609 and FH-11-6899), and a comprehensive report of the findings is available (Perrine, Waller, & Harris, 1971). The opinions, findings, and conclusions expressed in this publication are those of the author and not necessarily those of the National Highway Safety Bureau.

and Umberger, 1961; McCarroll and Haddon, 1962; Vamosi, 1963; Borkenstein, Crowther, Shumate, Ziel and Zylman, 1964). These studies, as well as others, have shown that about half the drivers and adult pedestrians fatally injured in highway crashes have been drinking and that the overwhelming majority of these individuals had sufficient alcohol to be considered legally impaired. It has also been found that the more severe the crash, the higher the probability that alcohol was involved—and in substantial amounts. In other words, the higher the driver's blood alcohol concentration, the higher his risk of having a fatal crash for which he was responsible.

Thus, we know that many individuals drive, that many drink, and that many do both. We also know that, of those who drive after drinking, some get into trouble and some do not. The basic question here is, "Are there *systematic* differences between those drinking drivers who neither become involved in crashes nor otherwise get into trouble on the highway and those drinking drivers who do?" This issue was examined at the University of Vermont's Project ABETS, which was charged with determining "the extent to which drinking and driving problems involve alcoholics and other abnormal drinkers, and ways by which these individuals can be identified."

Specific Aims

Project ABETS had four interrelated aims. The first two are medico-legal in orientation, while the last two are essentially behavioral:

1. To determine the distribution of blood alcohol concentrations (a) in drivers fatally injured in Vermont highway crashes, and (b) in a corresponding sample of drivers using the roads under similar conditions of time and place but not involved in highway crashes at the time.

2. To determine the relation between blood alcohol concentration and the degree of fat present in the livers of adults fatally injured in motor-vehicle crashes.

3. To compare persons at selected points along the continuum of drivers in order to determine differences in psychological and biographical variables, particularly patterns of alcohol use and driving record.

4. To investigate the influence of selected blood alcohol concentrations on perceptual-cognitive performance, and to relate these effects to differences in psychological-biographical variables (especially driving record and patterns of drinking behavior).

METHOD

Because drinking-and-driving experiments cannot readily be conducted on public roads and because of the problems that might result if representative samples of citizens ranging across the full spectrum of drivers were encouraged to be subjects in induced-intoxication experiments, two separate types of samples were required: *driver respondents* and *drinker subjects.* To the extent possible, however, the same or equivalent data sources were used for each type of sample in order to provide a basis for post hoc comparison and extrapolation.

The experimental plan specifies eight different *driver samples,* of which six can be considered as study groups and the other two as comparison groups (see Figure 5). It is assumed that the total sample (two crash, two citation, and two clear-record study groups, plus two roadblock comparison groups) includes motorists from points along the full continuum of driving behavior.

FIGURE 5. *Overview of experimental plan for driver samples and drinker samples at Project ABETS, University of Vermont*

Sample	Number	Site	Data Sources
A. *Driver samples*			a. Accident report b. Post-mortem
1. Fatality crash (deceased driver)	122	1ab	c. Biography
2. Hospitalization crash	26	ABETS	a. Biography b. Personality c. Attitudes d. Perceptual-cognitive
3. DWI citation	33	ABETS	
4. Non-DWI citation	30	ABETS	
5. Clear record: fatality roadblock	31	ABETS	
6. Clear record: hospitalization roadblock	32	ABETS	
7. Roadblock comparison: fatality crash	809	Roadside	a. Biography b. Breath sample
8. Roadblock comparison: hospitalization crash	375	Roadside	
B. *Drinker samples (induced intoxication)*			a. Biography b. Personality c. Attitudes d. Perceptual-cognitive e. Psychomotor f. Breath samples g. Blood samples
1. Small group ("simulated cocktail party")	16 each	ABETS	
2. Individual subject in lab	25	ABETS	
3. Individual subject in car	12	Parking lot	

Respondents

Fatality crash (Crash-F). The first sample consists of the *deceased drivers* from all fatal crashes that occurred in Vermont during the ten-month period, July 1, 1967, through April 30, 1968. Although the forensic pathology portion of the study is concerned with all highway fatalities, including passengers and pedestrians, the rest of the study focused specifically on the behavior and characteristics of the drivers only. Despite these various limitations, Crash-F is the most crucial single sample of the present study, if only because it constrained the subsequent selecting of respondents for all but the two citation samples.

Roadblock-F. In order to obtain a comparison group for Crash-F, a roadblock was conducted at the site of each fatal crash on the same day of the week and at the same time of day, but (during the first year of study) within a few weeks following its occurrence or (during the second year) on the first anniversary day. The interviewing goal for each roadblock was six motorists traveling in the same direction as the crash vehicle had been.

Clear-record drivers (Clear-F). In order to study one particularly important portion of the population-at-risk more closely, a sample of drivers with clear records was selected from the roadblock comparison population. This sub-sample consisted of the following roadblock motorists: (1) those who stated during the roadblock interview that they had had no crashes or citations within the previous five years, (2) those who said that they would be available for further interviewing if called upon, and (3) those whose no-crash and no-citation responses were subsequently confirmed by an offical record check.

Hospitalization crash (Crash-H). In order to obtain information on drivers involved in serious, but not fatal injury crashes, a hospitalization crash was selected from the Vermont Motor Vehicle Department files to match one of the fatal crashes as closely as possible for season, day of week, time of day, and type of road. A hospitalization or serious-injury crash was defined as one in which one or more persons received injuries sufficient to require treatment at a hospital.

Roadblock-H. In order to obtain a comparison group for Crash-H, a roadblock was conducted at the site of each serious-injury crash

selected for best match on exactly the same basis described above for Roadblock-F. Since both these roadblock comparison groups were matched to the fatality- and hospitalization-crash samples in terms of time and place of incident, they serve as an estimate of the actual population-at-risk. In other words, these two comparisons consist of motorists who were driving at the same place at an equivalent time, but who were not involved in a crash.

Clear-record drivers (Clear-H). The drivers in Clear-H were selected from Roadblock-H on the same basis, noted above, and the Clear-F were selected from Roadblock-F.

Driving-while-intoxicated (Citation-DWI). One of the major concerns of the present study was the problem drinker on the highway. Accordingly, a sample was drawn from among in-state drivers in the Vermont Motor Vehicle Department files who had been cited and convicted of driving-while-intoxicated (DWI) during the previous year.

Non-DWI citations. In order to obtain a type of comparison group for the DWI's (i.e., a group of individuals convicted of some serious motor vehicle violation, but with no official charge of alcohol involvement), a corresponding sample was selected from the Vermont Motor Vehicle Department files of motorists cited and convicted of other serious moving violations.

Procedures for Roadblock Comparison Samples[2]

The roadblock procedures had the prior approval of the Vermont Governor's Office, Attorney General, State's Attorneys, and State Police. Roadblocks were scheduled to begin 30 minutes prior to the actual time of the crash for which they were being conducted. All motor vehicles, ranging from motorcycles and farm tractors to passenger cars, vans and trucks, were stopped with the exception of interstate trucks and buses. The actual stopping of the motorists, as well as the on-highway safety, was the responsibility of the state or local police assigned to that particular roadblock.

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[2]In addition to the comprehensive report of Project ABETS findings (Perrine, Waller, & Harris, 1971), a much more complete discussion of roadblock procedures and methodological considerations has been published separately (Perrine, 1971).

Upon being halted by the police officer, the selected motorist was briefly informed that he had not been stopped for a driving violation, but rather was part of a research survey; he was then immediately referred to Project ABETS staff. An interview team, consisting of a male and a female, then approached the driver in his vehicle, handed him a letter from the Governor introducing and supporting the study, and invited him to participate in the research project by joining them in the interview vehicle for 10 to 15 minutes. The cooperating drivers (93%) then answered a limited number of the more important psychological-biographical questions selected from the extensive battery given to the drivers in the non-fatality study groups, namely, *biographical data* (items on age, sex, parents, earlier years, education, occupation, military service, home, marriage, religion, smoking history, and health); *driving history* (items on driving educaton, experience, occasions, companions, exposure and mileage, record of crashes and citations, and vehicle information); and *drinking history* (items on preferred beverage, frequency, quantity, occasions, and companions).

A breath sample was requested toward the end of the interview and was obtained in most cases. During the first year of study, the Mobat Sobermeter (SM2) was used to obviate having immediately available data on a driver's breath alcohol concentration since this device required subsequent laboratory analysis. However, during the second year, the Borkenstein Breathalyzer was used. Breath alcohol concentrations less than 20 milligrams/100 milliliters (20 mg%) were considered to fall within the range of instrument and random error for individuals who in fact had no alcohol present. Therefore, all concentrations under 20 mg% were grouped in the no-alcohol category.

Procedures for Non-fatality Study Groups

Each driver selected for hospitalization crash, clear record, drunken driving, and non-DWI citation samples was sent a letter in which he was invited to participate in Project ABETS and was offered $15.00, plus travel expenses. The cooperating motorists were asked to volunteer information on their biographical background, driving history, drinking history, smoking history, and delinquency history, as well as data on selected attitude and personality instruments (e.g., the Schuster and Guilford *Driver Attitude Survey* and the *Eysenck Personality Inventory).*

Procedures for Postmortem Examination

The postmortem examination of each deceased driver (as well as deceased passengers and adult pedestrians) included the determination of blood alcohol concentrations, extent of hepatic fat, and an estimation of which injuries probably were crucial in bringing about death. In addition, a retrospective case study of each deceased driver who was a Vermont resident was conducted by interviewing next-of-kin, close friends, and the investigating police officer in an attempt to obtain information on approximately the same psychological-biographical variables that were analyzed for the living drivers.

RESULTS AND DISCUSSION

Although an enormous mountain of data has been collected (well in excess of 1,000,000 bits of information), time does not permit presentation of much more than a very small fraction of a mole hill. Findings will be presented from a small selection of variables which are presumed to be most relevant for depicting the spectrum of drinking drivers, namely, *alcohol variables* (including distribution of blood alcohol concentration, reported alcohol consumption, the alcohol consumption index, frequency of driving after drinking, and the relation of crash risk and blood alcohol concentration) and *driving history variables* (including previous crashes, citations, and license suspensions), as well as the results of a *discriminant analysis* based upon some of these variables.

Alcohol Variables

Blood alcohol concentration. Chemical test data were obtained from six of the eight samples of drivers. However, the data from both roadblock samples have been combined, as have the data from both clear-record samples, since very few differences within the two sets of samples were found on key variables. Accordingly, the data are presented in terms of four groups: (1) fatally injured drivers, (2) roadblock drivers, (3) clear-record drivers, and (4) DWI drivers. The distributions of blood and breath alcohol concentrations are presented in Figure 6.

The distribution of blood alcohol concentrations among *deceased drivers* appears to be bimodal, that is, appears to be comprised of two

different distributions. The first includes the lower blood alcohol concentrations and is probably similar to that of the roadblock drivers, whereas the second includes the higher blood alcohol concentrations and appears more congruent with that of the convicted DWI drivers. At this point in time, however, we cannot prove this suspicion of bimodality with data from only one dimension, that of blood alcohol concentration. In any case, detectable alcohol (at least 20 mg%) was found in 54 percent of deceased drivers, the presumptive limit of 100 mg% was reached or exceeded by 42 percent, and the presumptive limit of states with 150 mg% was reached or exceeded by 28 percent.

In seeking a definition for *problem drinker,* the National Highway Safety Bureau is currently recommending, as duplex de facto evidence, a blood alcohol concentration in excess of 150 mg% plus one other selected characteristic (such as a previous conviction or crash involving alcohol), or, as simplex de facto evidence, a blood alcohol concentration in excess of 250 mg% as a solitary criterion. Thus, 28 percent of our sample of driver fatalities would qualify as problem drinkers if they had additional characteristics, but the 8.5 percent exceeding 250 mg% would definitely be labeled problem drinkers.

The data from the *roadblock drivers* are the best estimates we have of the population-at-risk, although these samples were deliberately biased by matching the time and place of contact to the times and places of previous fatal or serious crashes. In contrast to the deceased drivers, relatively few (14 percent) roadblock motorists were found with detectable alcohol, only two percent exceeded the 100 mg% presumptive limit of impairment, only one percent exceeded the higher presumptive limit of 150 mg%, which some states still have, and none of these drivers qualified as a problem drinker on the basis of the single 250 mg% criterion recommended by the National Highway Safety Bureau.

The data from the *clear-record drivers* were very unambiguous, with 98 percent showing no detectable alcohol and the remaining two percent appearing in the lowest category of blood alcohol concentration, namely, 20-49 mg%.

In striking contrast, 100 percent of the convicted *DWI drivers* were legally impaired, by definition, since they exceeded 100 mg%; but fully 80 percent would also have been convicted in states with 150

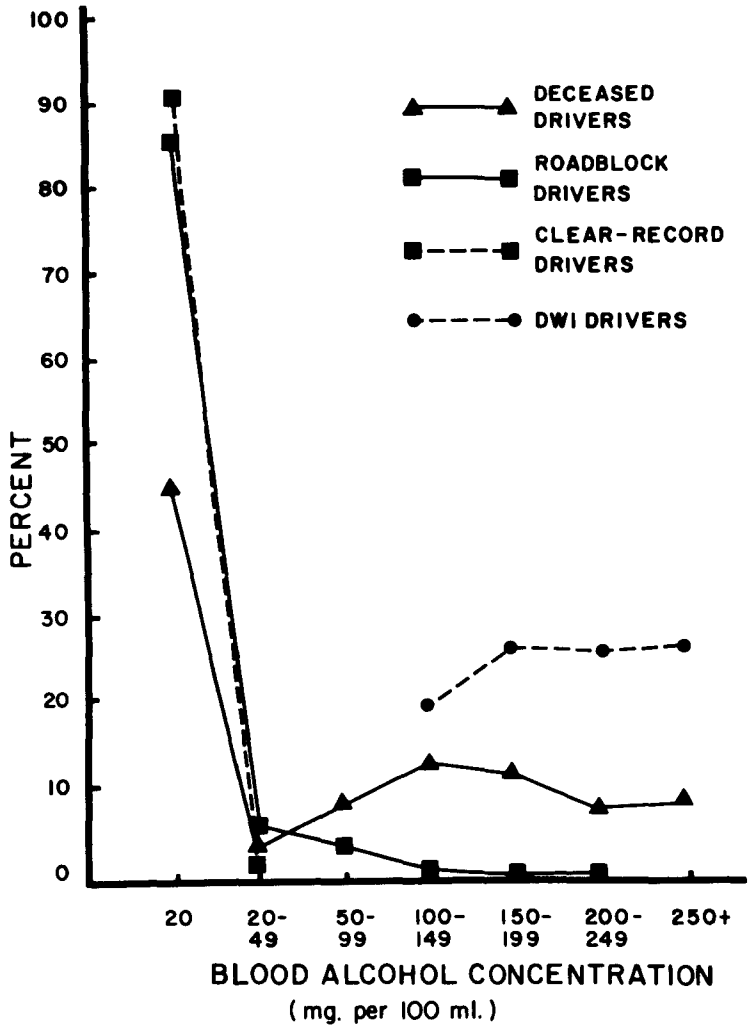

FIGURE 6. *Distribution of blood alcohol concentration (in milligrams per 100 milliliters) for roadblock, clear-record, DWI and deceased drivers.*

mg% laws (and may also qualify as problem drinkers), and 27 percent qualified as problem drinkers on the basis of the simplex criterion of 250 mg%.

Two very compelling questions emerge from these clear-cut differences in distribution: *Which roadblock drivers with high blood alcohol concentrations will be tomorrow's DWIs, and which of today's DWIs will be tomorrow's high-alcohol driver fatalities?*

Reported alcohol consumption. Each interviewed driver was asked how often he usually drinks beer (or liquor or wine). Unless he stated that he never drinks alcoholic beverages, he was then asked how much beer (or liquor or wine) he usually drinks at one time.

Regarding *beer,* the differences between the observed and the expected frequencies and quantities of consumption were significant ($p < .01$). Although usual frequency of alcohol consumption is probably not as important for highway safety as usual quantity of consumption, it is nevertheless noteworthy that the proportions of daily beer drinkers among DWIs and deceased drivers were the highest found in any group (see Figure 7). The DWI drivers were also outstanding on usual beer quantity (see Figure 8). That is, the proportion of heavy beer drinkers among DWIs (the 50 percent who reportedly drink five bottles or more at a sitting) was significantly greater than that found in any other group ($p < .01$). In contrast to the DWIs, most beer drinkers in the other groups reported consuming light quantities of beer (one to two bottles per sitting). Thus, *DWIs drink beer significantly more frequently and more heavily than drivers in any other group* (excepting frequency of consumption among deceased drivers).

Regarding *liquor,* the differences between the observed and the expected quantity (but not frequency) were significant ($p < .01$). Again, the DWI data were most striking, with almost one-third of the liquor drinkers among them reporting that they usually consume a pint or more at a sitting (see Figure 9). In fact, the proportion of DWI drivers who typically drink at least three shots at a sitting (80 percent) was significantly greater than that in any other group ($p < .01$).

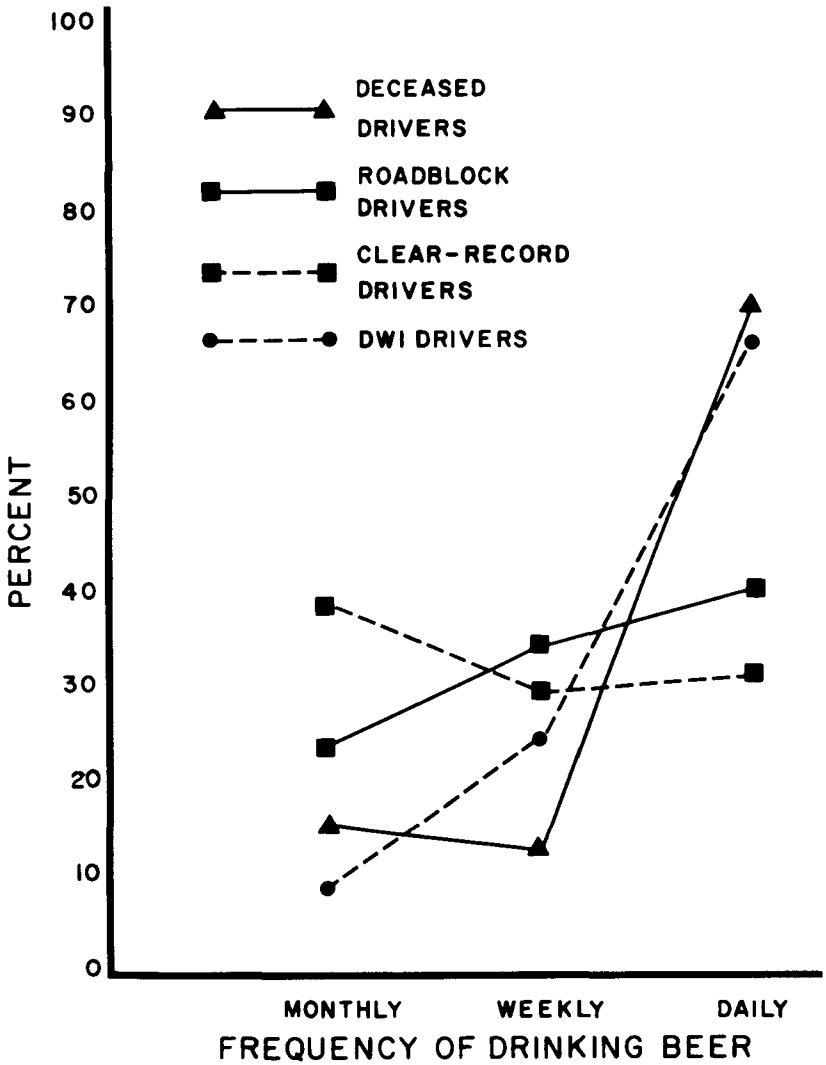

FIGURE 7. *Proportion of roadblock, clear-record, DWI, and deceased drivers reporting typical monthly, weekly, or daily frequency of beer consumption.*

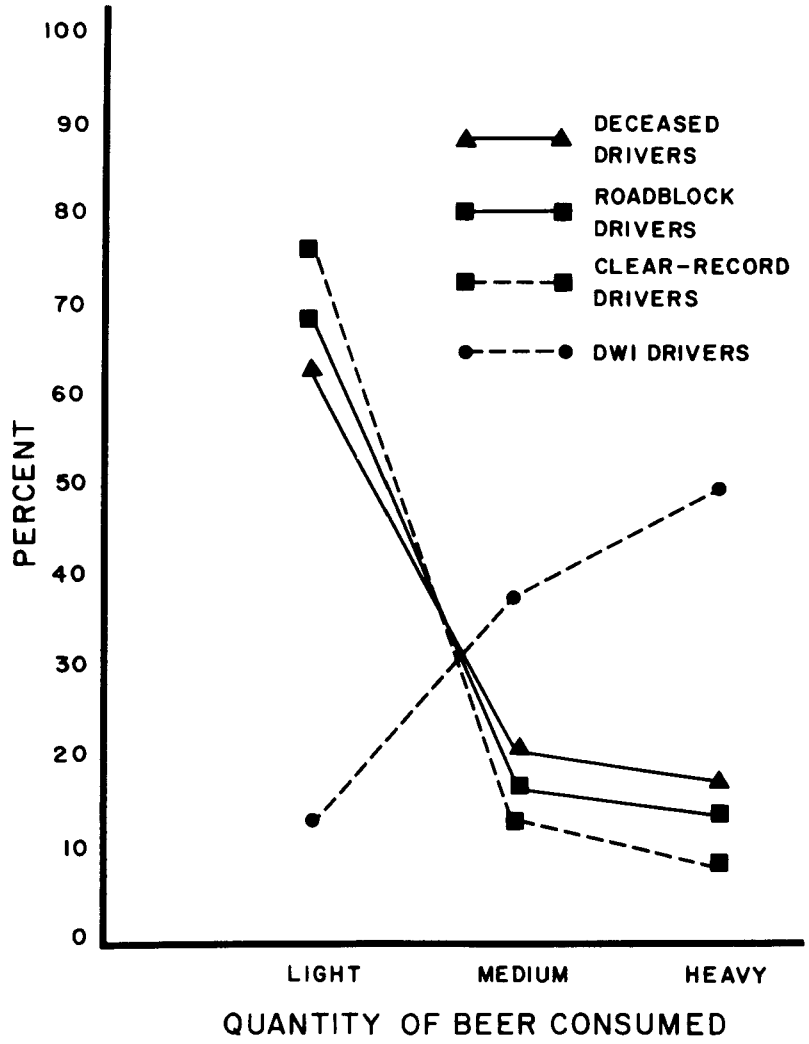

FIGURE 8. *Proportion of roadblock, clear-record, DWI, and deceased drivers reporting typical light, medium, or heavy quantity of beer consumption.*

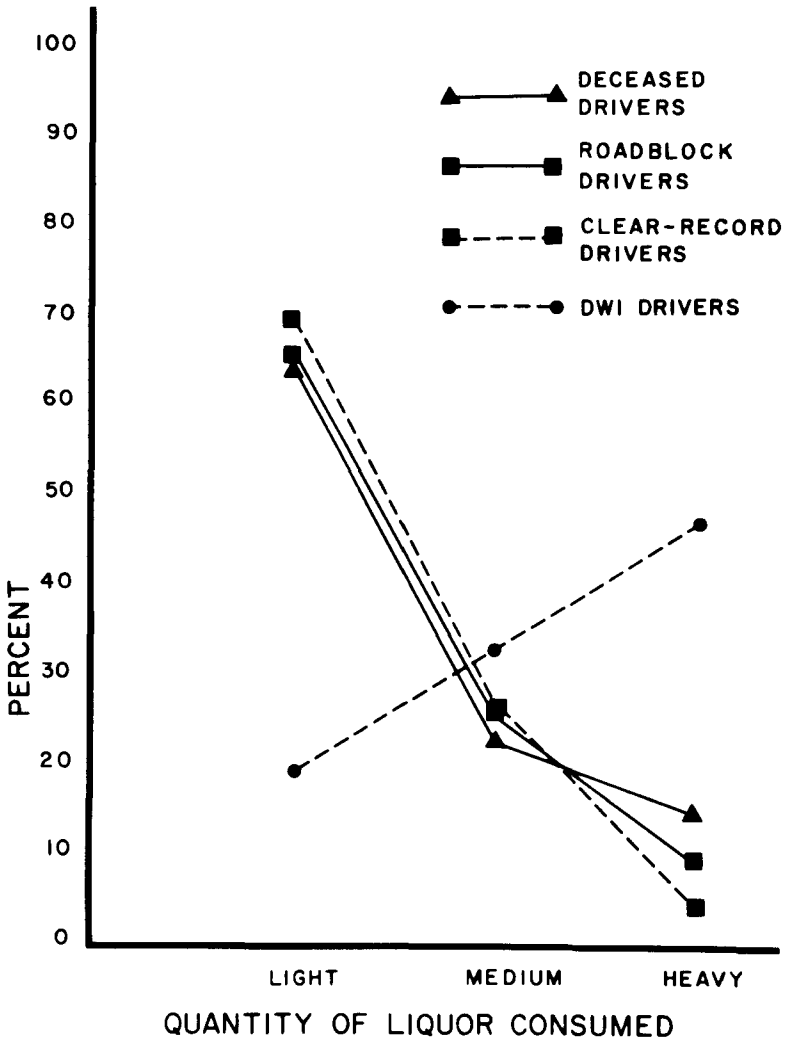

FIGURE 9. *Proportion of roadblock, clear-record, DWI, and deceased drivers reporting typical light, medium, or heavy quantity of liquor consumption.*

Group comparisons of the *wine* data are not presented here due to the small proportion of drivers in most groups who reported drinking wine.

The alcohol consumption index. A classification system based on reported usual frequency and quantity of alcohol consumption per sitting has been developed to reflect the likelihood that a driver would attain an impairing amount of alcohol in his blood. The resultant *Quantity-Frequency Index (QFI)* is based upon the beverage that is consumed most frequently and in largest quantity, regardless of whether it is beer, liquor, or wine. Distributions of drinking patterns according to QFI for preferred beverage are presented in Figure 10, and according to quantity of preferred beverage in Figure 11. It is clear from these data that *the DWI patterns of drinking are distinctly different from the typical pattern in the other groups, especially in any consideration involving the usual quantity of alcohol consumption.*

The relation between reported usual alcohol consumption and the actual blood alcohol concentration measured at the time of either contact, crash, or citation was examined by cross-tabulating these two variables. The general findings from all four groups were:

1. *The higher the observed blood alcohol concentration, the heavier and more frequent the reported alcohol consumption, and vice versa.*
2. *The lighter and less frequent the reported alcohol consumption, the lower the blood alcohol concentration, and vice versa.*

Thus, a high degree of congruity was found between reported and observed drinking behavior, even among most deceased drivers whose usual frequency and quantity data were reported by their next-of-kin. This correspondence between the verbal report and the chemical test data has greatly increased our confidence in the information obtained from the respondents. It has also encouraged our efforts to use reported QFI information as an important parameter of our probabilistic formulation of the problem of the problem drinker.

Drinking-and-driving patterns. Another important and obvious dimension of the contribution of alcohol to highway unsafety derives from the reported patterns of driving after drinking. The living drivers

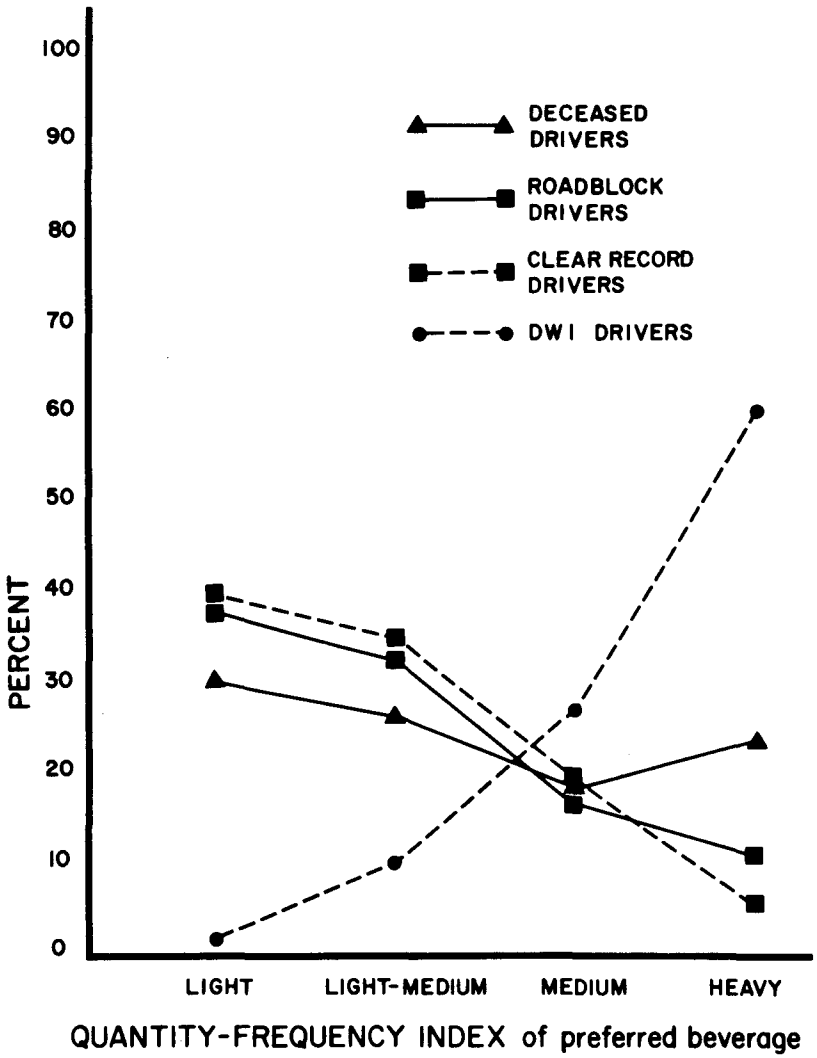

FIGURE 10. *Proportion of roadblock, clear-record, DWI, and deceased drivers reporting typical light, medium, or heavy quantity of preferred beverage consumption.*

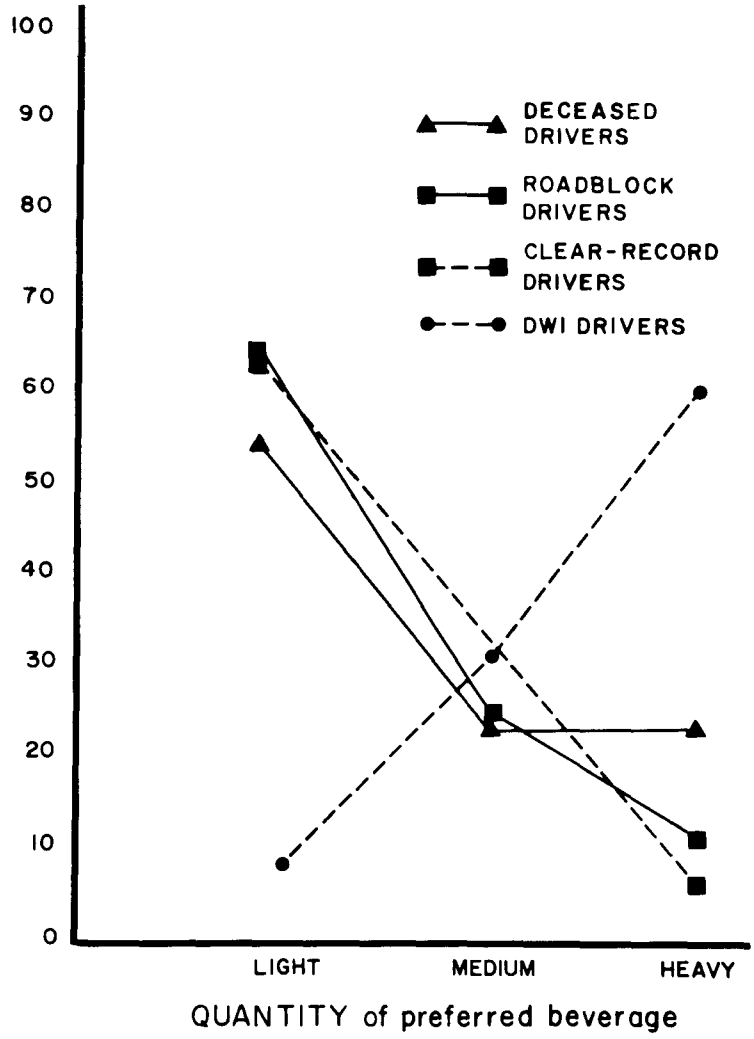

FIGURE 11. *Proportion of roadblock, clear-record, DWI, and deceased drivers with light, medium, or heavy Quantity-Frequency Index for preferred beverage.*

in our study were asked to report the relative frequency of such behavior and the results are presented in Figure 12. It can be seen that the roadblock drivers were rather evenly distributed across the three code categories: "never drive after drinking," "do so less than half the time," "do so half the time or more." With our probabilistic orientation, we are primarily concerned with those drivers who acknowledge that they indulge in this behavior relatively frequently. Thus, we will concentrate on the upper end of the distribution, that is, those individuals who stated that they drive after drinking "half the time or more," which represents a combination of three original code categories, namely, "about half the time," "more than half the time," and "all the time." Thus, among drivers who reported driving after drinking half the time or more, we find that the proportion of DWI drivers (40 percent) was twice as large as the proportion of clear-record drivers (20 percent) and half again as large as the proportion of roadblock drivers (30 percent).

The functional, real-world impact of these reported differences becomes strikingly clear when we re-examine the relation between actual blood alcohol concentration and reported usual frequency and quantity of alcohol consumption. Thus, the *statistically typical* DWI drinks impairing quantities of his preferred beverage on a daily basis, and acknowledges that he drives after drinking approximately half of the time; furthermore, he came to the attention of the police as a result of a nocturnal crash at which time his blood alcohol concentration was 200 mg%. Similar analyses of these relations among the roadblock and clear-record drivers permit the following generalization: The frequency of drinking impairing quantities of alcohol appears to be related to the frequency of driving after drinking, which is probably related in turn to the risk of being involved in a fatal crash.

Crash risk and blood alcohol concentration. According to Dr. Julian Waller, the most important single question in comparing the groups in this study is the relationship between the blood alcohol concentration of the fatally injured driver and of the drivers exposed to similar circumstances of time and place, but not involved in a crash. Previous studies in urban areas by Borkenstein and others had demonstrated that risk of crashing begins to rise at blood alcohol concentrations between 50 and 99 mg% and then rises sharply at concentrations above 100 mg%. Such was the conclusion of the present study as well.

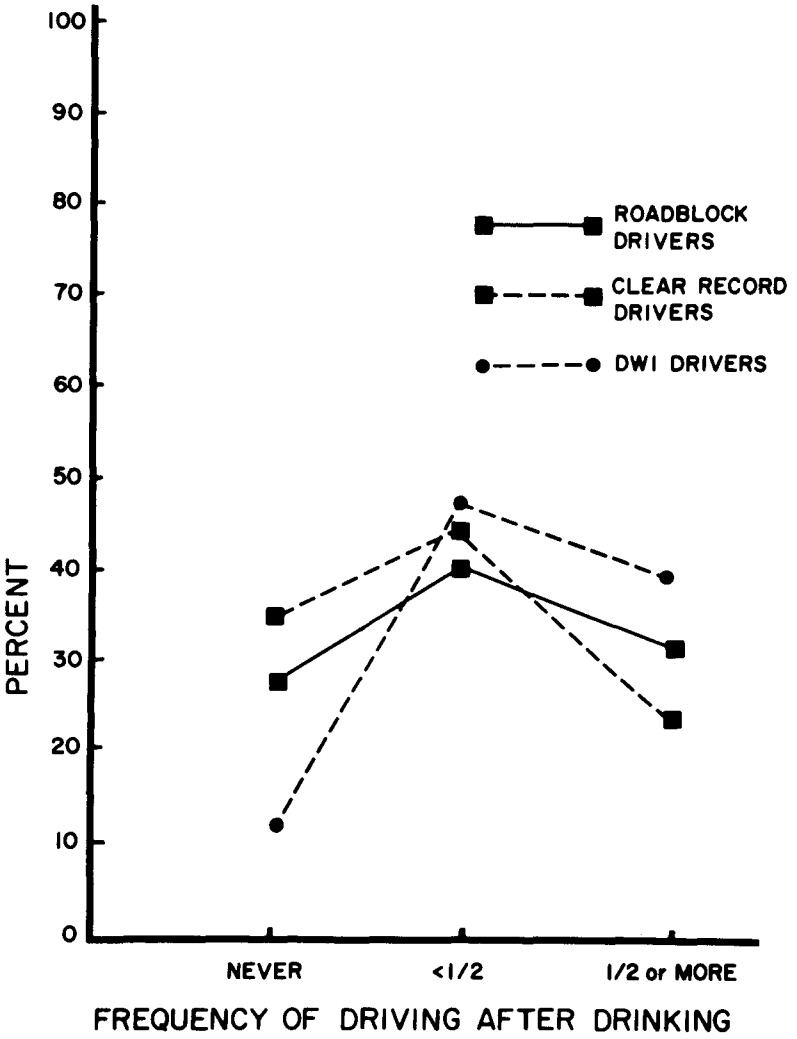

FIGURE 12. *Proportion of roadblock, clear-record, and DWI drivers reporting typical frequency of driving after drinking.*

The distributions of blood alcohol concentration among driver fatalities and roadblock drivers were presented earlier. On the basis of these data, Figure 13 shows the risk of crashing at each concentration when the risk with no alcohol is set at 1.0. Clearly, low blood alcohol concentrations do not appear to be significant with respect to the occurrence of highway crashes. But just as clearly, *concentrations of 80 mg% or higher are incompatible with safe driving; and the higher the concentration, the greater the incompatibility.*

Driving History

One of man's basic assumptions in carrying out the business of living is that the past is the best single predictor of the future. The most relevant corollary here is that past driving behavior is the best single predictor of future driving behavior. Since a fatal injury crash is a *very* rare event and a serious injury crash is a *relatively* rare event, several interrelated assumptions are usually made in an effort to reduce the probability of crash occurrence and thereby to protect the driving public from the assumedly more dangerous elements within its own ranks. Some of these assumptions are as follows:

1. There is a relation between a driver's crash history and his risk of future crashes.
2. There is a relation between deviant driving and manifest traffic violations, some of which lead to traffic citations, some of which in turn lead to convictions, and some of which in turn lead to suspensions of the driving privilege.
3. There is a relation between deviant driving, manifest violations, and crashes.
4. There is a high relation between previous convictions for driving-while-intoxicated and risk of future crashes.

On the basis of these assumptions, let's examine the recent crash, citation, and suspension history of drivers at selected points along our spectrum.

Crashes. Distributions of crashes in the previous five years, according to self-report, are presented in Figure 14 for DWI and roadblock drivers. Data for the other two samples are omitted because:

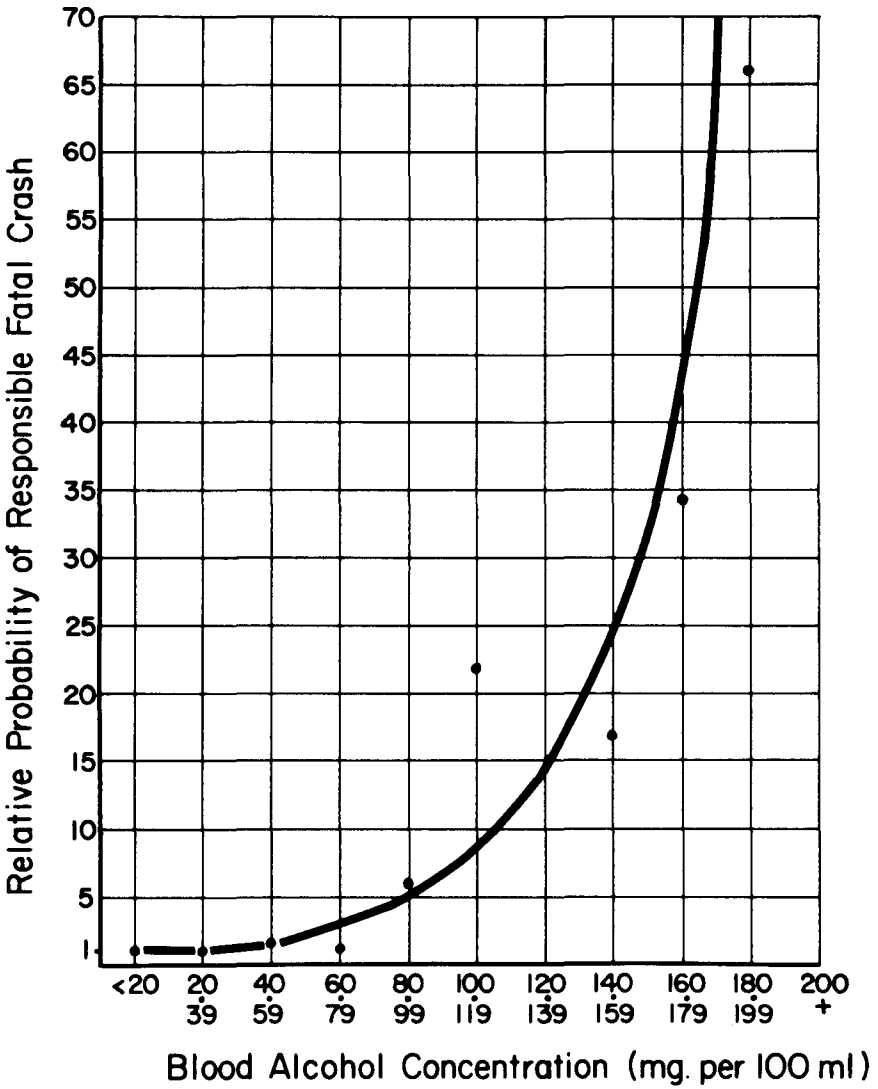

FIGURE 13. *Relative probability of having a fatal crash as a function of blood alcohol concentration (in milligrams per 100 milliliters).*

(1) the lack of having had a crash during the previous five years was one of the two criteria for selecting clear-record rivers, and (2) no self-report data were available for deceased drivers. Despite similar proportions of DWI and roadblock drivers who reported having had one or less crash in the previous five years, the proportion of DWI drivers who claimed two or more previous crashes (20 percent) was two and one-half times greater than the proportion of roadblock drivers in this category (8 percent).

Citations. Distributions of citations received during the previous five years, according to offical record checks, are presented in Figure 15 for roadblock, fatally injured, and DWI drivers. It should be noted that we excluded from the data the DWI citation that led to a particular DWI driver's being sampled for our study. Nevertheless, the DWI drivers were clearly outstanding in their accumulation of previous citations. In fact, the proportion of DWI drivers with two or more previous citations (30 percent) was three times as large as the proportion of deceased drivers in this category (11 percent) and 10 times as large as the proportion of roadblock drivers with two or more previous citations (3 percent). The same general proportions also hold for the data concerning number of citations in *all* previous years of driving, although these distributions are not being presented here. Thus, the number of previous citations seems to be worth further examination as a basis for identifying drivers who may have an elevated likelihood of receiving DWI citations.

License suspensions. Distributions of suspensions during all previous years, according to offical record check, are presented in Figure 16 for roadblock, fatally injured, and DWI drivers, as well as for clear-record drivers, since they were not directly selected on the basis of this criterion. The results are similar to the citation data, which is understandable since every license suspension results from conviction for a traffic citation. Thus, the proportion of DWI drivers with two or more previous license suspensions (47 percent) was four times greater than the proportion of deceased drivers in this category (11 percent) and nine times greater than the proportion of roadblock drivers in this category (5 percent). Although eight percent of clear-record drivers had received one license suspension during all previous years of driving, none of these drivers had received two or more license suspensions.

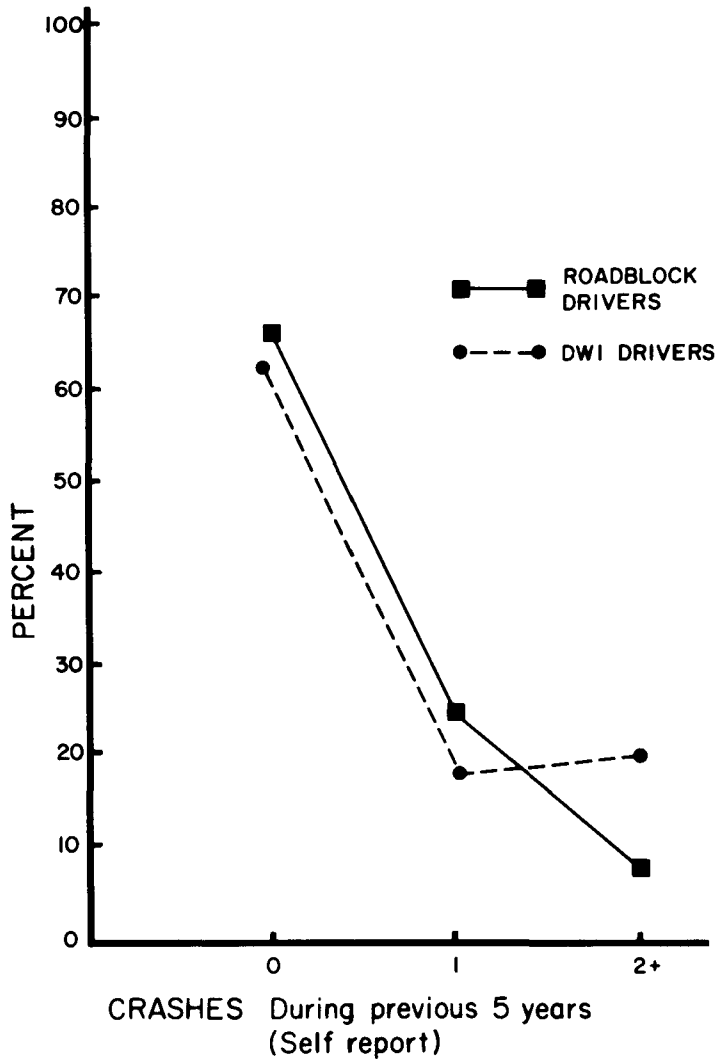

FIGURE 14. *Distribution of crashes during the previous five years as reported by roadblock and DWI drivers.*

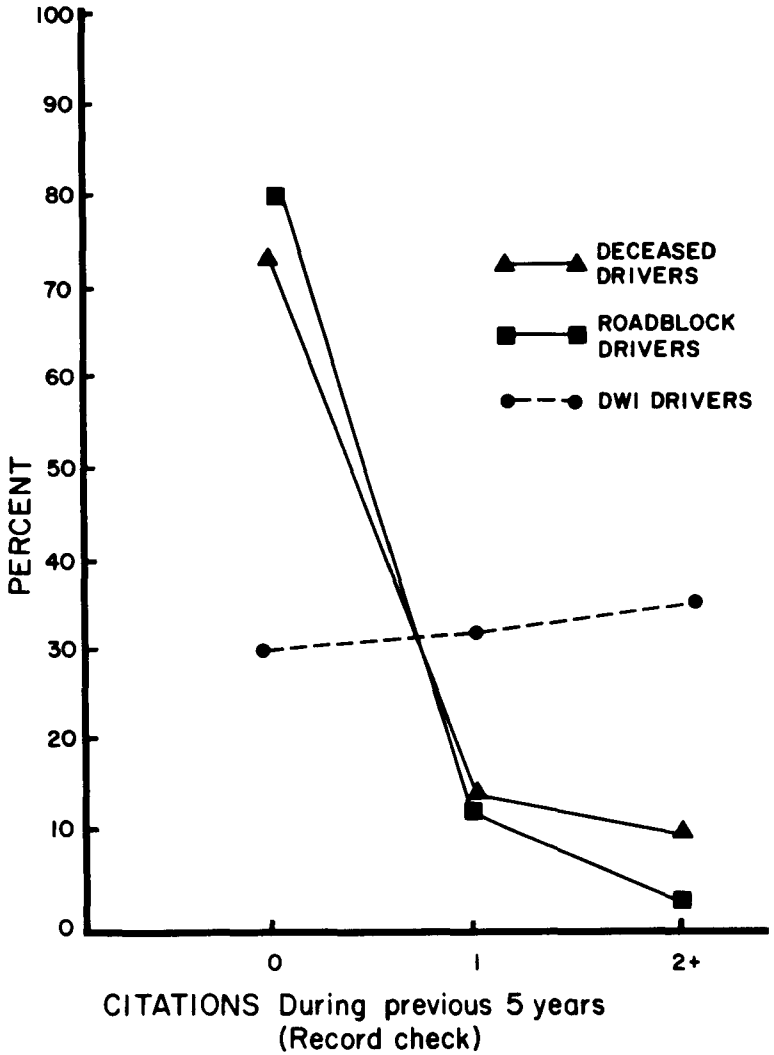

FIGURE 15. *Distribution of citations for serious moving violations during previous five years according to offical record check for roadblock, clear-record, DWI, and deceased drivers.*

Summary. Thus, the driving history data generally tends to support the popular assumption that past driving behavior is the best single predictor of future driving behavior. However, a major question which awaits further investigation concerns the extent to which this assumption holds *within individual,* as opposed to within group. In other words, with an event as relatively rare as a crash, to what extent can we make predictions which are individual-specific, as opposed to predictions simply based upon group or category membership. We have no ready answers to this question at the moment, but expect to be able to formulate more adequate hypotheses on the basis of future use of multiple discriminant analysis.

Discriminant Analysis

Dr. Gene Laber of the Economics Department at the University of Vermont has recently completed a discriminant analysis of 104 Project ABETS subjects classified into two groups: (1) clear-record drivers (N=56), and (2) DWI drivers (N=48). Twelve variables were tested for significance in discriminating between these two groups, namely, (1) sex, (2) age, (3) number of lifetime citations, (4) number of citations in past five years, (5) license suspensions, (6) occupation (grouped into 13 classifications), (7) number of jobs in past five years, (8) marital status, (9) frequency of beer consumption, (10) quantity of beer consumption, (11) frequency of liquor consumption, and (12) quantity of liquor consumption.

The four variables which were significant ($p \leqq .025$) in discriminating between these two groups were, in order of importance: (1) number of lifetime citations, (2) occupation, (3) frequency of beer consumption, and (4) quantity of liquor consumption. Quantity of beer consumption was the next variable in this series, but was only significant at $p = .10$. Dr. Laber has determined that, on the basis of a discriminant function using the first four variables, 95 percent of the clear-record drivers could be correctly classified and 87 percent of the DWIs could be correctly classified.

Thus, we have preliminary indications that it is in fact possible to determine classification "hits" and "misses" (at least for these two extremely divergent samples) on the basis of a weighted function that incorporates components from an individual's driving record, from his socio-economic status, and from his reported patterns of alcohol use.

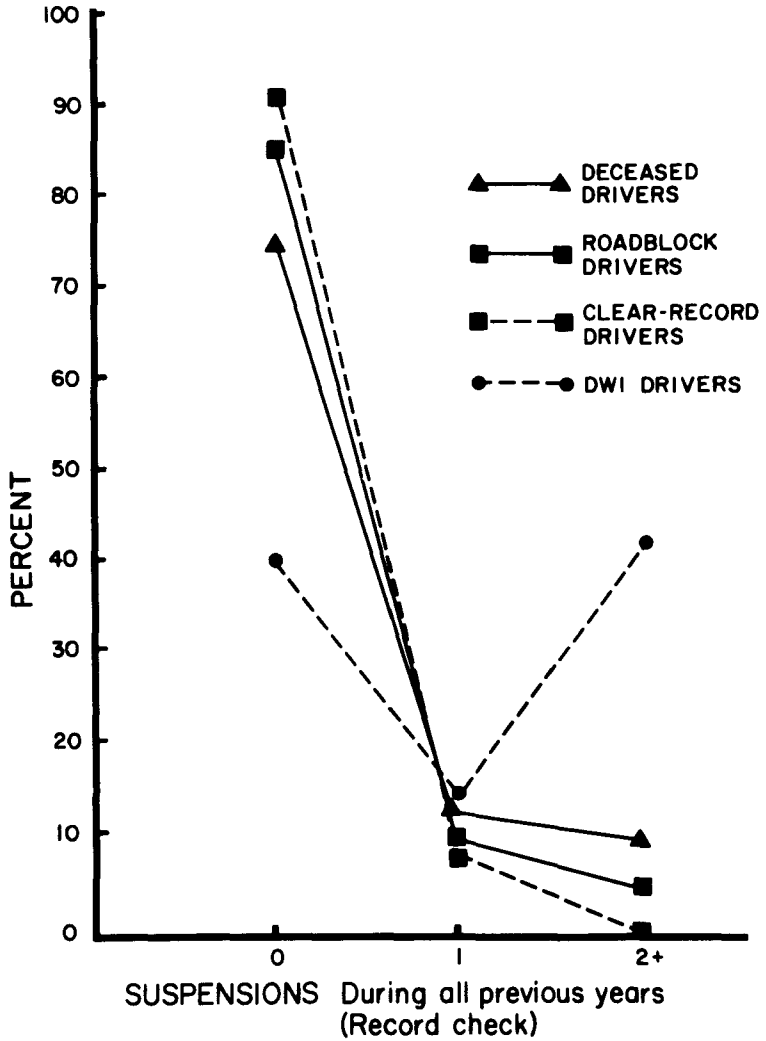

FIGURE 16. *Distribution of license suspensions during all previous years according to offical record check for roadblock, clear-record, DWI, and deceased drivers.*

IMPLICATIONS AND CONCLUSIONS

Current needs. During the course of examining the spectrum of drinking drivers, a number of needs have been identified, the fulfillment of which should lead to the emergence of more adequate hypotheses and to subsequent reformulations of the problem, which in turn should permit going beyond what is scientifically established at this point in time. One of these needs consists of *a more accurate specification of those "except-fors" without which a fatal alcohol crash would not be what it appears to be.*

An extremely important component of this first need is the necessity for *more systematic research on alcohol dose-response functions across the full spectrum of driving behavior.* For example, we must consider the risk and exposure factors involved in the frequency of drinking impairing quantities of alcohol and then driving. Furthermore, we must consider the specific influences of selected dosages of alcohol upon particular aspects of driving behavior, especially as these effects may differ from individual to individual as a function of his driving experience, drinking experience, personality characteristics, etc.

Fulfillment of these needs should in turn provide a more adequate basis for *testing the accuracy of specific parameters of the alcohol-crash problem* by means of such multivariate techniques as discriminant analysis and the resultant assessment of the proportion of hits and misses with the target population. Such tests would in turn facilitate *the conceptualization of more accurate probabilistic models* and, in fact, would no doubt indicate that the unidimensional continuum or spectrum concept (as we have discussed it today) is far too simple for the multidimensional problem at hand. However, at least for the present moment, we propose to use the spectrum notion as the foundation for the improved multivariate conceptualizations to be developed in the future.

The continuum of drinking drivers. One of the main conceptual advances manifest in the proposed first approximation of a useful probabilistic approach is that *"drinking drivers" do not occupy one separate box or one discrete category* resulting from semantic and pragmatic convenience of labeling, but *rather that they are continuously distributed along some dimension* which, as a minimum, must

include: frequency of driving after drinking, usual frequency of alcohol consumption, and usual quantity of alcohol consumption. Although this approach strongly suggests focusing special attention on those drinking drivers who have a highly elevated risk of having a fatal alcohol crash, such as the so-called problem drinker, it also suggests not neglecting the adjacent individuals on the continuum who are known as (heavy) "social drinkers."

It would perhaps be especially opportune to spell out several implications of the proposed approach for the issue concerning *the difference between the problem drinker and the social drinker.* In terms of alcohol consumption per se, there is no clear-cut definition or chemical test criterion which differentiates unequivocally between the social drinker and the problem drinker. What differences there may be between these two types of drinkers are only manifest in concomitant or resultant behaviors that are assumed to be influenced by or caused by alcohol consumption. Therefore, *meaningful differences between these two types of drinkers can only be specified in terms of situational and operational terms.*

Thus, the *social drinker* may be thought of in normative terms as one whose behavior during and following the consumption of alcoholic beverages falls within the acceptable limits of his particular group at the particular time. For example, my drinking behavior at a white-tie champagne reception would hardly be the same as it would be at a stag beer party.

On the other hand, the *problem drinker* must also be defined in normative and situational terms since the so-called problem occurs at a particular point in time. The repetitive occurrence of such problems for a given individual is usually sufficient to designate him as a "problem drnker," but the chronic repetition need not be a necessary condition for the functional, situational designation of the person as a problem drinker, especially when he is driving after drinking. Thus, the problem drinker usually exceeds the acceptable limits of behavior, either for this patricular group (be it his family, his work associates, his gang, etc.) or for society (in the form of neighbors, police, etc.). In any case, most of us *seem* to know what is meant by the two terms, both in general and in particular; that is, *social drinkers* are "healthy, enlightened persons like you and me," whereas *problem drinkers* are

"the ailing, uncouth others" (usually people who are not taking part in our conversation at the moment).

On the highway, the criteria for differentiating between social and problem drinkers are much more unequivocal and abrupt since the problem is defined as a crash. Thus, *a "problem drinking driver" can be defined operationally as one who is involved in a crash and had been drinking.* Furthermore, societal agents have specified that certain chemical tests should be used to determine the amount of alcohol present in the driver's body and that the test results should be used for the purpose of presuming the individual's impairment at certain concentrations. Therefore, by definition, a driver with a blood alcohol concentration of 100 mg% or more is presumed to be impaired and to be at a higher risk of becoming a "problem," i.e., of having a crash. In fact, the definition recommended by the National Highway Safety Bureau adds a 50 mg% buffer (or margin for error) and then designates the person as a "problem drinker" if he also has one or more other characteristics (such as a previous conviction or crash involving alcohol). *The important pragmatic point,* which is apparently not generally understood, *is that the typical "social drinker" seldom, if ever, achieves a blood alcohol concentration exceeding 100 mg%.*

For example, let's assume that the average adult male in this country is a light to medium drinker, weighs 180 pounds, and does not know how many drinks he needs to reach the presumptive limit, to say nothing of his ignorance of the way he feels when he is actually at the presumptive limit of 100 mg%. Would he really believe us if we told him that in order to reach 100 mg%, he would have to have 6 drinks (such as 6 standard bottles of beer or 6 one-ounce glasses of whiskey) within one hour on an empty stomach? Furthermore, would he really believe that he would need 12 such drinks within an hour in order to reach the level of the average DWI in our study (200 mg%), or that in order to tie the highest blood alcohol concentration we observed among our DWI drivers (400 mg%), he would have to drink approximately 20 beers or 20 whiskeys within one hour on an empty stomach?

The odds are that our average 180-pound male could accept this dosage information intellectually, but not at the gut level. Therefore, if we are to receive his support for any sort of countermeasure pro-

gram, it is extremely important that he be able to obtain both the intellectual and the gut-level knowledge. The former can probably be accomplished by some form of public education program, whereas *the latter requires a massive innovation to develop a system through which he can readily obtain feedback about his blood alcohol concentration at the same time that he is obtaining behavioral, gut-level feedback about the way he actually feels at that particular concentration.* I have discussed various aspects of this approach elsewhere and, in the interest of time, will refrain from presenting further details at the moment. However, the basic considerations are related to a concept developed and expounded in a broader framework elsewhere by Professor Robert Borkenstein in his "freedom under law through knowledge."

In conclusion, one could say that the problem has been structured in terms of reducing the problem-drinking-driver crashes. If it is defined in these terms, however, we must either wait for each crash event in order to detect our problem drinker driver, or we must develop a basis for identifying and predicting in advance. A probabilistic approach to the latter alternative has been proposed here and is based upon the following points:

(1) *the probability of a fatal crash occurring at specified, elevated blood alcohol concentrations:* a point which is based upon a substantial body of data;

(2) *patterns of alcohol use* (including the usual frequency of consumption and the usual quantity of consumption, perhaps in the form of a weighted index based upon both dimensions): a point which is based upon some previous work, but needs refinement and further research;

(3) *relevant psychological-biographical variables:* a continuing search for these variables is currently being conducted; and,

(4) *a multivariate integration of the relevant dimensions:* pilot work in this area has been done and leads to the hope that in the future we will be able to use multiple discriminant analysis to determine hits and misses.

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DISCUSSION

Joan C. Cornoni

Dr. Cornoni completed her doctoral studies in epidemiology at the University of North Carolina. She previously had collaborated on research at Harvard and Yale Universities. Presently she is Assistant Professor in the Department of Epidemiology, School of Public Health, University of North Carolina at Chapel Hill. She has also served in an advisory capacity to the University of North Carolina Center for Alcohol Studies.

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Dr. Perrine has referred to patterns of drinking and driving and to the many dimensions of highway safety research. It is generally assumed that alcohol is a causative factor in highway crashes, but not that it is a causative factor in combination with other factors. I would like to expand on the notion of seeking the common elements or factors in highway deaths or injuries.

Assume that there is an array of definable characteristics associated with each driver. A driver may drive after drinking frequently, sometimes, or never. He has a certain blood alcohol level at a particular time. Other driver characteristics include age, sex, race, behavioral and social variables. A driver uses a particular type of car on certain roads. Such characteristics can be used to create a typology of a driver.

Dr. Perrine has mentioned the constraint that is placed on studying a problem by the initial formulation. I think this is very true, and I think that the approach to the studies should be broadened to include the combination of characteristics occurring together. I am suggesting that we look at the complete typology of characteristics of drivers and group these together into homogeneous clusters.

What I am proposing is a cluster analysis of these variables. The cluster analysis would not be used in place of the multi-variate discriminant function, but prior to it. The cluster analysis, it is hoped, would identify groups of drivers for which certain characteristics were common. The clustering process could be used in either of two ways: The characteristics of those persons known to have had a crash could

be clustered separately from the characteristics of those who have not had a crash. That is, in the cluster analysis one would control for the occurrence or non-occurrence of a crash, and in this way one could compare the distributions of the characteristics and the combination of these characteristics within the clusters for the two categories.

A second approach would be to compare characteristics obtained for all drivers and combine into clusters the characteristics obtained for all drivers. Then the proportion of crashes within each cluster could be examined in relation to the distributions and combinations of the characteristics within the clusters.

To demonstrate this method I have some data from a study by Dr. John Ewing, director of the UNC Center for Alcohol Studies and professor of psychiatry. Dr. Ewing conducted a survey in Chapel Hill and Carrboro for the purpose of obtaining basic data on the use of alcohol in these communities. A stratified random sample of the resident population was obtained. A questionnaire was administered to 358 individual residents, representing a 90 percent participation rate. The questionnaire include basic demographic variables, such as age, sex, occupation, and education, as well as detailed information on the consumption of alcohol in regard to amount, frequency, and attitude. In addition, the Eysenck Personality Index (EPI) was administered. I used the cluster analysis method with the EPI data and related the results to alcohol consumption. Specifically, I cluster the results of the EPI into groups of persons who answered similarly. We are interested in whether there are patterns of answers that are associated with the amount and frequency of alcohol consumption.

The clustering was done only on the responses to the EPI, and considers all arrays of answers that occurred in all the individuals as opposed to looking at average values only. The questions which distinguish clusters of persons can be identified. However, at this point we have not yet taken into account all the other information we have about the respondents.

The procedure first compares the array or typology of answers for the EPI from each person with the array of every other person and evaluates this quantitatively by means of a similarity coefficient. As a result a matrix is created giving the similarity of each individual to every other individual. From this, matrix units are then combined into

clusters, and the individuals with the highest similarity coefficients form the first cluster. This method identifies clusters of individuals based on the level of similarity between individuals. For an individual to be included in a cluster, he must have a similarity with all other individuals of the existing cluster that is equal to or greater than the similarity level at which the alteration occurs. With a decrease in the level of similarity more individuals are combined into clusters until all individuals are joined into one cluster. At an arbitrarily chosen level of similarity the characteristics of the individuals within the clusters can be analyzed.

The results are quite interesting. I arbitrarily chose the point in the clustering process where there were five clusters because of the practicality of being able to examine and describe five clusters as opposed to fifteen or twenty. Also the size of the clusters was adequate at that point.

Of the five clusters, one showed significant differences from the total population on six questions that, according to Eysenck, measure introversion-extroversion. Persons in this cluster answered all of the questions in the direction of introversion. They reported:

I do not like plenty of excitement and bustle around me.
I am not rather lively.
I do not like mixing with people.
I would not call myself happy-go-lucky.
I can not usually let myself go and enjoy myself a lot at a gay party.
I do not like practical jokes.

This group had low quantity-frequency index of alcohol consumption. Forty-five percent were abstainers; 29% light drinkers; 11% moderate drinkers, and only 14% heavy drinkers.

Another cluster answered in the following way:
I do like plenty of excitement and bustle around me.
I sometimes feel "just miserable" for no good reason.
When I get annoyed I need someone friendly to talk to about it.
I would not call myself happy-go-lucky.
I am often troubled about feelings of guilt.

This group had an overall high distribution of alcohol consumption with only 22% abstainers. Another 22% were classified as heavy drinkers.

The cluster with the highest proportion of heavy drinkers (55%) and the lowest proportion of abstainers (10%), with 15% light and 20% moderate drinkers, reported the following:

I do not like plenty of excitement and bustle around me.

I am rather lively.

I never feel "just miserable" for no good reason.

When I get annoyed I do not need someone friendly to talk to about it.

I can usually let myself go and enjoy myself a lot at a gay party.

There is also a cluster who answered affirmatively four of the six questions measuring extroversion. Among these, 31% were abstainers, 29% light, 18% moderate, and 22% heavy drinkers.

The questions which best differentiated the clusters were:

Do you like plenty of excitement and bustle around you?

When you get annoyed do you need someone friendly to talk to about it?

Those which showed little differentiation among clusters were:

Does your mood often go up and down?

Would you call yourself jumpy or nervous?

Do you suffer sleeplessness?

This analysis is not complete but is an attempt to get a total picture.

Other characteristics such as age, sex, education and social class should also be taken into consideration. Because these data were not collected in connection with highway safety, driver records are not available on these subjects. I have presented the data merely to illustrate a particular methodology. It may be possible in a similar way to identify characteristics of drivers involved in highway crashes. We must identify the contributing factors and combinations of factors. We could subsequently use them as predictors in a multiple discriminant function analysis.

INDEX

Fall 1970 Symposium