5 *BEHAVIORAL RESEARCH ON ACCIDENTS*

THE READINGS:

BEFORE WE EMBARK upon the first of four chapters dealing with behavioral approaches to accident prevention, it would be well to attempt a clarification of the role of behavior in accidents, a role that is often as ambiguous to the research worker as it is to the general public.

In the compiling of accident data it has become almost traditional to use a classification system which dichotomizes accidents due to human behavior and those in which human behavior apparently played no part. Thus an accident attributed to "driver error" is regarded as clearly due to human behavior, whereas an accident resulting from the failure of a mechanism—the tire of an automobile, the fuel system of an aircraft, an automatic alarm system—is classified as having no human cause.

Such a scheme is misleading for several reasons. First, it implies that enough is known about accident causation to permit accurate attribution to human or nonhuman factors. In the present state of our knowledge such an implication is not warranted. Secondly, what we do know about accident causation leads to the conclusion that behavioral elements, far from being discretely present or absent, are present to a greater or smaller extent in virtually every accident. Even the most obvious case of "driver error" may involve a nonhuman environmental situation in which "error" was greatly favored if not, indeed, inevitable. Similarly, even an accident that seems due to a mechanical failure[1] involves the human element of failure to inspect the device adequately or to provide it with fail-safe features,* just as an accident due to a hurricane or other "act of God" involves the behavioral element of the victims, who failed to predict the occurrence of the damaging winds or to remove or otherwise protect themselves from the effects.

Even when the magnitude of the human element in a certain kind of accident can be accurately assessed, it is important to note that its sheer magnitude does not inevitably make it the most appropriate target for preventive measures. The amputations and other injuries common in industry during the late nineteenth century, for example, could be clearly attributed to "human error," but the most effective countermeasure proved to be not a program to change human behavior—that is, to make the worker "more careful"—but rather the installation of machine guards which made the human error noninjurious to the person involved. On the other hand, such largely "nonhuman" kinds of accidents as those due to the failure of electric wiring, boilers, and elevators, and to spontaneous combustion have been effectively reduced by altering human behavior—through legislation requiring building codes, periodic inspection, and the provision of police and fire department personnel to prevent o reduce damage and injury.

Yet another difficulty stems from the use, in the literature, of the term "huma factors" to cover a wide range of meanings. (See McFarland, Chap. 2.)[2-6] Vascula accidents, the physical dimensions of the human body, reaction time, color blindness drunkenness, attitudes toward the police, emotional disturbances—in short, a wid variety of elements, modifiable and nonmodifiable, close to and remote from acci dents—have at one time or another been labeled as "human factors." The ambiguit of this term can be a major obstacle, both to the research worker who uses it loosel and to the reader seeking to identify the objectives, the point of view, and the pu poses of the studies in which it is thus used.

* See reference 5 for a discussion of fail-safe devices.

Within the limits delineated by the foregoing caveats, however, there exists a vast array of accident phenomena that lend themselves to study by behavioral scientists from various disciplines. The psychologist may examine the personalities, perceptions, and response characteristics of those involved in accidents; the sociologist, the characteristics of social groups which influence exposure to danger; the anthropologist, cultural values concerning safety; the economist, the relative costs of safe and less safe industrial processes; the historian, the development of safety legislation and other safeguards; and the political scientist, the political forces that influence safety legislation. Accident research thus oriented has not yet made great advances, but the causes and results of many types of accidents can be studied as productively from the behavioral-sciences point of view as other aspects of human experience.

Because of the several disciplines and numerous approaches represented in the behavioral sciences, we have devoted four chapters to this aspect of accident research, and additional examples are included in Chapter 3. The present chapter begins with excerpts from four papers that reflect the general emphasis and present level of development of various behavioral-science approaches to accident research. These indicate some of the current theoretical and methodological problems and provide background for the selections in the next three chapters.

SOME COMMENTS ON ACCIDENT RESEARCH

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Although it does not present a systematic analysis of behavioral approaches, this paper is a refreshing departure from most of the behaviorally oriented accident literature by virtue of its sophistication and its wide-ranging concern with aspects of accident research and causation (such as the role of cultural factors) which have received insufficient attention from behavioral scientists. It is especially noteworthy for its avoidance of the narrow and exclusive emphasis on personality factors, which has long dominated the accident literature. Although concerned primarily with childhood accidents, its points and emphasis are of general relevance.

UST AS THE STUDY of childhood diseases can-
1ot be meaningfully separated from general problems of health and disease, so the study of childhood accidents must be related to a general investigation of accident phenomena.

The big question is where, to begin, beause the different backgrounds and predilections of people interested in accidents nake themselves *strongly felt. Fortunately,* esearch workers have become sophisticated nough not to permit their special interests o distort their views. Most dedicated workers have come to realize that the approach which they see most clearly because of their special interest or special training is only one of several and that ideally the several approaches should complement one another instead of struggling for primacy in matters of attracting researchers and public support and implementing proposed corrective measures.

However, a proper integration of effort is easier asked for than accomplished. Even aside from competition for effort, even if

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funds and manpower were unlimited, we would still be divided by differences of opinion about what to do first, because of differing notions of what constitutes a logical sequence. The situation is the same in any large-scale planned activity. For instance, when a society is industrialized, a certain rhythm must be preserved in expansion of capacity, expansion of market, training of cadres, and changes in patterns of living. When resources are as strictly limited as they are in research and action in the field of accident phenomena, organization of effort becomes a crucial task if any sort of effectiveness is to be expected.

The question, then, is where to begin. There are those who will not feel comfortable unless they have precisely defined the problem area. Thus we have energetic searches for a definition of "accident." The various points of view from which "an accident" can be defined have been ably summarized by Dr. Suchman. I think it should be granted that in some problem areas precision of definition is prerequisite to the effectiveness of measures undertaken to solve the problems. Thus, in medicine, nosology is of prime importance, and the reason is not far to seek. Most spectacular advances in medicine crystallized around the discovery of "specifics"—as in chemotherapy and in the discovery of the importance of vitamins and trace elements in diets. Here, of course, precise classification and identification of diseases were of supreme importance to the extent that very fine distinctions had to be introduced before progress could be made. Obviously the very nature of the specific requires that the situation in which it applies be specifically recognized.

Nevertheless it should be borne in mind that equally dramatic advances in man's war against disease were made with the discovery of the importance of nonspecific factors—*e.g.*, public hygiene and general levels of nutrition. In this connection it should be emphasized that factors not directly connected with medicine or even with the general problems of health and disease played an equal or a more important role in improving the general level of man's health and longevity. It is possible to argue that Euclid may have contributed more to medicine than all the medical discoveries from Hippocrates to Pasteur. For Euclid systematized geometry; systematized geometry made possible the science of optics; optics gave us the microscope; and the microscope led to the discovery of microorganisms and eventually to the first major breakthrough in medicine and hygiene.

We have, then, in medicine, two types of advances: dramatic discovery of specifics and a gradual, rather uneven amelioration of *conditions* in which man can safeguard his health and can come to grips with specific problems of health and disease. And while we speak of "conditions," we should certainly not forget the general philosophic orientation, the world view, the mood in which man faces the problems confronting him. In this respect the activist mood, characterizing Western society, was certainly more conducive to medical advances than the fatalist mood; naturalistic philosophy was more favorable than an animistic one, and so forth.

In dealing with accidents we can also distinguish between specific and global approaches. The discovery and removal of a structural defect in an airplane, improvements in road engineering, industrial safety devices, etc. are all obvious examples of specific measures. Their importance is by no means to be discounted, especially since the "yield" of these measures in terms of lives saved, even if small, is usually clearly demonstrable. The situations allow for "before and after" tabulations with the consequent identification of "causes." This specificity makes the fight against the accident clear and attractive. I venture to say that it taps a particularly regrettable but on occasions useful facet of human motivation—namely, the identification of a "culprit." I shall have more to say on this subject a little later.

The discovery and implementation of "global" measures analogous to public hygiene or to cultural attitudes is, in the prob lem area of accidents as elsewhere, a much more difficult matter. Here precise definitions will not help us, because we are not dealing with a search for precise measures. To resort once more to the analogy with medicine, the value of eliminating superstition, for example, although it was probably very great in improving public hygiene, could never be ascertained exactly. We still do not know how to measure the "amount" of residual superstition or misconceptions in a population or to correlate this amount with the level of attainable hygiene. Results in such an area, then, are not bound to be dramatic, nor even precisely demonstrable. Yet their importance would be difficult to deny. I, for one, am firmly convinced that our cultural climate, our aspirations and myths, find definite reflection in the prevailing attitude toward the automobile and that these contribute in no small degree to a basic accident rate which would remain, even if all the specific measures of accident prevention were realized. This idea lurks in the paper by McFarland and Moore, *Youth and the Automobile*. Other factors contributing to accident rates, as officially recorded, factors having to do with deep-seated attitudes rather than with explicit exercise of safety measures, were soberly discussed by Dr. Foote. These matters are difficult to demonstrate, and even if some of them could be proved, we would be at a loss as to what to do about them now.

We have, then, these two extremes. On the one hand, there are the demonstrable specific accident-conducive situations. The only problem here is to induce people to recognize the situation and to do something about it. This is sometimes formidably difficult, as Dr. Freedman has shown so convincingly in his discussion of a specific type of accident—namely, lead poisoning in children eating paint in poor homes. But at least we know where to direct our efforts when we face a situation of this kind. At times such efforts are rewarded, particularly when the removal of the situation depends on people who can be made targets of campaigns: landlords, industry, common carriers, government, etc. Witness the speed with which action was taken in the polio vaccine deaths of a few years ago.

At the other extreme, we have diffuse factors, difficult to identify and even more difficult to demonstrate as relevant, but which may nevertheless be of great importance. I shall return to these factors later, but first I would like to ask this question: Do we have intermediate situations? In other words, do we have factors of importance in the area of accident phenomena which could in principle be demonstrated but which have not yet been demonstrated? In the light of the history of medicine, which, I agree with several of the participants, is entirely relevant to our topic of discussion, the answer should certainly be "yes." In fact the history of medical discovery is overwhelmingly a record of identifying factors specifically relevant to health or disease which had not been previously recognized. What had been a vague notion that low, marshy places are conducive to malaria became very specific knowledge about just what it was about these places that gave man malaria—namely, not *mal aria* (bad air) but certain definite species of mosquito, and not even these directly, but rather the protozoa parasitic on the insect.

It is axiomatic that scientific research is the discovery of causal chains, the establishment of the form "If so, then so." Now we have been amply warned, and rightly so, against the facile singling out of causes. We are shown innumerable instances of how the same alleged cause produces different effects in different contexts. However, illegitimate extrapolations of the causality principle and unwarranted simplifications do not by their failure invalidate the principle. Is not the whole notion of controlled experiment a successful circumvention of this pitfall? Wherever it is possible to reproduce essentially identical conditions except for the value of one independent variable, the "effect" of that variable on some other variable of interest can always be studied. This is not, of course, falling into the trap of single-cause single-effect fallacy. The end result of a controlled experiment is not the answer to a question of the form "What causes *X*?" but rather to a question of the form "To what extent does the variation of *Y*, other things being equal, effect variations in *X*?"

Now this is known as the analytic method, time-honored in the classical physical sciences of the nineteenth century. There has been a reaction in twentieth-century philosophy against this method of inquiry. We are told that "the whole is greater than the sum of its parts" and that it is a mistake to regard the entire situation as additively composed of its components, that the entire situation has emergent properties of its own which we cannot discern as long as we contemplate only the parts, and so on. I suppose the position of Kurt Lewin must be so understood.

Now, I usually lend a sympathetic ear to the holists' objections to the analytic approach. Indeed, some entirely convincing examples can be given. Our music has a vocabulary of 12 tones—call it 72 tones if we multiply by the six-octave range of the orchestra. It is ludicrous to insist that a Beethoven symphony is essentially represented by such and such frequency of occurrence of each of these 72 tones. We know, of course, that wholes are composed of parts *arranged in patterns*. Analysis presumably destroys the pattern and is therefore irrelevant in revealing the nature of the "whole."

This criticism is valid, I believe, when it is applied to attempts to explain perception or integrated action in terms of isolated units, be they stimuli or muscular actions. These attempts fail because they ignore patterns which mold the parts into the whole. I have serious doubts, however, that this criticism is relevant when applied indiscriminately against analysis of complex situations just because the situations are complex. Analytic methods can be much misused. But this does not mean that they cannot be used to advantage if used properly.

When used properly, the analytic method does not presuppose that all causative factors are linear or that they are additive. Naive elementalism is not inherent in the analytic approach. Admittedly the analytic approach emphasizes the study of one component of the situation at a time. How the components are to be put into the whole picture is a separate problem, but the two problems should not be confused with each other.

In a controlled experiment, components are studied one at a time by a deliberate structuring of the experimental situations. The handicap under which social science must operate is the well-known fact that experiments involving the society *in vivo* are often impossible for practical or ethical reasons. The social scientist, then, must select from naturally occurring situations those aspects which best approximate controlled experiment. This is possible wherever the gross situation is composed of so many minute components that the law of large numbers has a chance to operate.

The law of large numbers is to social science what deterministic causality is to physical science. Indeed, many of the so-called deterministic laws of physical science have been definitely shown to be simply instances of statistical regularity resulting from the operation of the law of large numbers. Although the numbers involved in man's behavior are, of course, nowhere near the magnitude of numbers of molecular events involved, say, in chemical reactions, nevertheless the regularities of accident statistics are respectable, to the extent that we can speak of an operation of quasi-causal relations.

We are, then, in principle, enabled to single out differential causative factors of accidents. To do so we must select for comparative study classes of events with as much care as a sophisticated experimenter controls the conditions in his laboratory. Accidents are, to be sure, rare events in the life of a single individual. But there are so many of us that the absolute number of accidents is prodigious. The 100,000 fatalities alone are sufficient to provide statistically respectable samples for comparing