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THE STUDY OF ACCIDENTS from the perspectives of psychology hardly requires justification. To the extent that accidents involve human behavior, they must inevitably be studied with the science that deals with the behavior of the individual. And, in fact, psychological theory has been applied to accident phenomena by a wide variety of people, ranging from the layman who believes that accidents are caused by "the nut that holds the wheel" to the experimentalist studying the legibility of road signs or speedometer dials.

Potentially there is hardly a field of psychology that does not have implications for accident research. As a field of study, however, psychology has become so broad and complex that one cannot generalize about its applicability to accidents—either in terms of the utility of its conceptualizations or the value of its research findings. Therefore, instead of attempting to subdivide the field and examine the relevance and the findings of each of its subdivisions, let us examine some of the aspects of the individual that relate both to accidents and to psychology and then review examples from the wide range of psychologically oriented accident research.

Perhaps the broadest area of human behavior that is relevant to accidents—and certainly the area that has been subjected to the greatest amount of psychological research—is the capacity of the human organism to respond appropriately to sensory stimuli. Color perception, depth perception, perceptual constancy, spatial discrimination, reaction time, kinesthetics, and similar essentially psychophysical phenomena all may have relevance to the avoidance of hazards, whether in a primitive or a highly technological environment.*

Learning theory has not yet been applied systematically to the learning of accident-avoidance, but some psychologists have hypothesized that the disproportionately high frequency of highway accidents involving adolescents may be due not only to characteristics peculiar to adolescence but also to the frequency of "inappropriate responses" that is characteristic of the early stages in the learning of any complex skill (see McFarland and Moore in Chap. 8 and reference 2).

Studies of the individual's cognitive processes have implications not only for the teaching of safe practices but also for the selective screening of individuals for occupations that directly involve the safety of others as well as themselves. An understanding of his cognitive processes may yield knowledge of how an individual assesses the hazard in a given situation and would appear to be especially important not only in drivers, pilots, and machine operators but also in governmental and industrial executives, manufacturers, and other planners whose decisions influence the safety of entire populations. The pertinent characteristics of such key individuals, however, have yet to be explored scientifically. The importance of small numbers of crucially placed individuals in accident causation and prevention is easily seen day by day. The small numbers of individuals responsible for the design, course, and speed of the *S.S. Titanic*, for decisions with respect to the crashworthiness of vehicles, and for the placement and strength of dams illustrate this well, as do many other aspects of the modern environment.[4] This is perhaps the most important unexplored area of particular interest to psychologists and other behavioral scientists concerned with accident causation and prevention.

* The psychologically oriented accident research literature may be entered through the reviews prepared by Thorndike,[1] McFarland *et al.*,[2] Goldstein,[3] and Cresswell and Froggatt[3a] and through many of the papers published in the *Traffic Safety Research Review*.

The study of human development, growth, maturational processes, and aging is significant for an understanding of certain accidents because the capacities of both the child and the aging individual for concept formation, for perception, and for motor response appear to differ sharply from those of the adult in ways that may make them differentially vulnerable to environmental insult. For this reason the application to the young and the aged of conclusions reached through the study of young adults is highly questionable.

Work in social psychology—not only on the general effect of the social group on the behavior of the individual but also on the social values and processes that affect risk-taking—is also relevant. So, too, is further understanding of the effects of frustration, aggression, and various environmental distractions upon stimulus discrimination, attention, perception, and motor response.

Behavioral deviation—whether produced by transient or prolonged emotional disturbance, chemical agents, or organic deficit—may affect the safety not only of the deviant but of others. Regardless of the validity of accident proneness as a global concept, there are many indications that emotional states—acute or chronic—may alter the incidence of accidents, but the scientifically adequate supporting evidence is not extensive. Similarly, although there is much scientific information on the association between alcohol and motor vehicle accidents, little is known at a highly specific level about the effects of alcohol on many of the segments of behavior that may lead to these and other accidents. In addition, although there are various restrictions on the licensing of individuals with certain sensory impairments, the precise effects, if any, of such impairments on accident rates remain to be defined and measured, and it is likely that at least some of the current "common sense" measures will prove inappropriate when their merits are properly studied.

Despite the potential value of psychological approaches, however, psychological studies directly related to accidents have not generally been highly fruitful. In terms of practical value, it seems probable that work in visual perception has had the most profitable and widespread application—to the design of gauges, to the choice of colors for signs, aircraft, and other equipment, and to the design of various items of military and civilian hardware (see McFarland in Chap. 2 and reference 4). However, there is increasing evidence of the potential contribution of approaches outside of the psychophysical area. This is reflected in several of the papers that follow and, for example, in recent work relating psychological and other characteristics of groups of drivers to their insurer's subsequent claim experience.[5]

Despite such progress, our understanding of the relationship between personality characteristics and accidents is still seriously limited. For example, the accident experience of patients in psychotherapy has not yet been subjected to adequately systematic and extensive study; hence there is little evidence from psychotherapists as to the extent to which specific emotional states lead to accidents. Other work on personality factors has focused on various presumably stable character traits in an attempt to develop a profile of the "safe" driver, pilot, machine operator, *et al.* But this approach has both practical and theoretical limitations. Although, for example, it is sometimes feasible for a military service, an industrial organization, or a common carrier to use this type of psychological screening in personnel selection where it is

possible to reject large percentages of individually safe applicants whose characteristics cannot be differentiated from those of groups with elevated rates, it is extremely doubtful that the American public would countenance the use of personality tests as part of the driver licensing procedure, particularly since these tests currently show little reliability in predicting *individual* accident experience.[6] Perhaps more seriously limiting is the fact that this research usually: (1) omits adequate scrutiny of variations in the exposure to hazard of those studied; (2) has failed to discriminate between characteristics that are stable in time and those that are transient or situational; (3) does not attempt to verify its results by replication with other populations; and (4) does not demonstrate that the percentages of individuals who would have to be restricted in order to achieve a given reduction in accidents makes psychological screening sufficiently "economical" to be politically and socially acceptable.[6]

A related and particularly dangerous misuse of psychological approaches is to justify in a logically circular fashion administrative actions against individuals who, for whatever reason, have been involved in repeated accidents. In the present state of our knowledge, we cannot reliably attribute an individual's accident history to his psychological characteristics, and hence there are no grounds for basing administrative action upon psychological theory or for attempting to validate psychological hypotheses on the basis of administratively accumulated accident histories. As Daniel P. Moynihan has pointed out:

> It is particularly to be noted that the administration of traffic laws has generally ignored the statistical laws that govern the random distribution of comparatively infrequent events among a large number of persons. (There is only one fatality for 2000 years of average driving experience.) These laws dictate, of course, that a rather large share of the events will occur to a rather small portion of the group. This raises the possibility, even the likelihood, that many of the "persistent violators" of the traffic laws are innocent victims of the Poisson distribution whose misfortunes have been compounded by a statistically illiterate bureaucracy.[7]

Another obstacle to productive psychological research stems from the fact that, unlike many other kinds of human behavior, risk-taking or the precipitation of accidents cannot usually be elicited or effectively simulated under laboratory conditions. The kind of risk-taking behavior that can easily be studied in the laboratory consists essentially of the calculation of probability and the alteration of decision-making by various social processes. But such laboratory behavior may lack the spontaneity, the motivation, the social climate, the "punishment," and many other elements that influence risk-taking and accident precipitation in a natural setting. This raises again a point emphasized in Chapter 3—namely, the importance of studying accidents and their related phenomena in the real world in which they occur and not merely under the necessarily artificial conditions of the laboratory.

The readings selected for this chapter reflect in many ways the points we have made in the foregoing discussion. In general, their value lies more in the potentials they point to than in the excellence of their methodology or the validity of their conclusions. Thus, they are more useful in pointing out general directions for further and more rigorous research than in providing findings that can be used as a firm basis for action programs.

Psychoanalytic Approaches

Freud's emphasis on the role of subconscious factors in what he termed "the psychopathology of everyday life" has had wide influence among research workers and especially among laymen concerned with accidents. The method employed for demonstrating the importance of such factors in accident causation has, however, progressed but little since Freud's work.

PARAPRAXES AND WIT

Charles Brenner, M.D.

It is not the purpose here to discuss the adequacy of the scientific evidence underlying psychoanalytic theory. However, it must be pointed out that its applications to accident causation have yet to be substantially supported by the rigorous and systematic research that is regarded as essential in collateral fields. The evidence cited, which is essentially anecdotal, is usually derived post hoc under conditions which might be expected selectively to favor the production and reporting of information compatible with the conceptual framework employed. Case series have been statistically highly selected. Controls have been virtually nonexistent. The data have seldom been validated even when independent sources have been available. Psychoanalytic interpretations have been favored to the exclusion of alternative explanations. This is not to deny the considerable likelihood that some accidents are initiated by psychodynamic factors or to suggest that the theories themselves are incorrect. Rather, it is to point out the weaknesses of the research evidence supporting the presumption that such factors contribute to accidents. These characteristics are well illustrated by the selection that follows.

LET US NOW CONSIDER the class of parapraxes which are ordinarily referred to as accidental mishaps, whether the mishap occurs to oneself or to another as the result of one's own "carelessness." We must make it clear at the outset that the only accidents with which we are here concerned are those which the subject caused by his own actions, although he had, of course, no *conscious* intention to do so. A mishap which is beyond the subject's control is of no interest to us in our present discussion.

It is often easy to decide whether the subject was responsible for the mishap under consideration, but it is by no means always such a simple matter to do so. For example, if we are told that someone was struck by lightning during an electrical storm, we should ordinarily be quite confident that the mishap was truly accidental and could not possibly have been unconsciously intended by the victim. After all, who can tell where lightning will strike? However, if we learn that the victim was sitting under a tall, solitary tree next to a heavy, steel chain that dangled from one of the branches to within a few feet of the ground, then we might as well begin to wonder whether the victim was or was not aware, before the accident, of the relatively great danger that a person in such a situation will in fact be struck by lightning. If we then discover that this was well known to the

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victim and if, having recovered from his mishap, he honestly disclaims any conscious intent to endanger his life, we must conclude that this particular victim of lightning was deliberately, though unconsciously, trying to get it to strike him. In the same way, an automobile accident may be due to a purely mechanical failure and have nothing whatever to do with the driver's unconscious intent, or it may, on the other hand, have been either directly caused or made possible by unconsciously intentional acts of commission or omission by the driver.

The reader may ask whether we propose the view that every mishap that *could* have been caused or facilitated by an unconscious intent on the part of the subject was in fact so caused. Is there to be *no* room left for human imperfection? Are we to assume, for instance, that no one would ever have an automobile accident unless he unconsciously wanted to?

The answer to this question is, in principle, an unequivocal one. Insofar as a foreseeable mishap is caused by a "human imperfection" in the performance of some action or other, we assume that it was unconsciously intended by the performer of that action. It is true, of course, that fatigue, boredom induced by monotony, and other, similar factors may increase the frequency of such mishaps to a greater or less extent, but we are here in the same position as that which we took with respect to slips of the pen or tongue. The necessary condition for a mishap of this sort, which is often a sufficient condition as well, is an unconscious intent to produce it. Fatigue, boredom, etc., are merely accessory or adjuvant factors.

If the reader now asks how we can be so *sure* that mishaps within the control of the subject were in fact unconsciously produced by him, our answer must be that this conclusion is a generalization which has been made on the basis of those cases of such mishaps which have been accessible to direct study. Here again, as in the case of other parapraxes, direct study means the application of the psychoanalytic technique. If the subject's cooperation can be obtained, his associations will lead to an understanding of his unconscious motives for causing the mishap that seemed at first glance to be quite accidental. It happens not infrequently that, in the course of the analysis of such a mishap, the subject recalls that he knew for a moment that the "accident" was going to happen, just *before* he performed the action that produced it. Obviously, he could know such a thing before the fact only if he intended that it should happen. This partial awareness of intent is usually repressed, that is, forgotten, during or just after the mishap and is only restored to conscious memory if the mishap is analyzed. Thus, without analysis the subject himself usually is quite convinced of the purely accidental nature of the mishap that in fact he himself intentionally caused.

Naturally it is in the course of psychoanalytic therapy that the opportunity arises most often for studying such mishaps directly, as opposed to merely speculating about them in a more or less convincing way on the basis of external, circumstantial evidence. Most of our examples will consequently be drawn from this source, though such mishaps are by no means more frequent in the lives of psychoanalytic patients than they are in the lives of other persons.

On one occasion a patient, while driving to work, was making a left turn at a fairly busy intersection. Because of the number of pedestrians who were crossing, he had slowed to a speed of about five miles an hour when he suddenly struck an elderly man with his left, front fender and knocked him to the ground. As far as the patient was aware when he first told the story of the mishap, he had not seen the man at all. Later, however, he was able to recall that he was not surprised when he felt his car hit something. In other words, he was dimly aware of his unconscious intent to strike the man with his fender at the moment of the "accident." On the basis of his associations to the various circumstances of what had happened it was possible to discover that the chief, unconscious motive for the mishap was the patient's wish to destroy his father. In fact, his father had been dead for a number of years,

but the wish was one which had been most active during the patient's oedipal phase, had been energetically repressed at that time and had lived on in his id thenceforth. We can understand that this wish was displaced in the way that is characteristic for the primary process onto an unknown, elderly man who was in the path of the patient's car and who therefore became the victim of what was apparently an accident. It is understandable also that despite the fact that the victim sustained no injuries and that the patient himself was fully insured, he nevertheless felt both frightened and guilty to a degree that was considerably out of proportion to the actually trivial nature of the accident. Knowing the unconscious motives which led to his knocking the man down, we can realize that it was these motives which were the more important sources of the patient's subsequent guilt fears. In other words, his reaction to the accident was only apparently a disproportionate one. It was quite in proportion to his repressed wish to destroy his father.

Another example, which is so trivial that it hardly deserves to be called a mishap, is one which we mentioned in Chapter I. In that case a young man, driving to his fiancée's home on the morning of his wedding, stopped at a green traffic light and was not aware of his mistake until after it had changed to red. In this case the driver's associations led to the discovery of unconscious feelings of reluctance to go ahead with his marriage which were chiefly due to the guilt and fear connected with certain unconscious sexual fantasies of a sadistic and incestuous, that is, oedipal nature.

In the first of the two examples which we have just given the mishap was due to inadequate or incomplete repression of a hostile, id impulse. The id impulse in question escaped in part from repression, as it is often expressed in psychoanalytic writings. In the second example the parapraxis was the result of either a defense against certain id impulses or of a superego prohibition directed against them, or even, perhaps, of both, since in this instance it is not easy to distinguish with certainty between the two.

Unconscious activity of the superego frequently plays an important part in causing parapraxes of this sort. Many mishaps are unconsciously intended to result in loss or self-injury. In the motivation of such cases a large role is played by an unconscious need for punishment, for sacrifice, or for making restitution for some previous act or wish. All of these motives belong to the superego, as the reader will remember.

As an example of such motivation we may cite the following case. The patient of our first example one day drove the right front wheel of his car against the corner of a curbstone while attempting to park with such force as to tear the sidewall of the tire beyond repair. It is uncommon for an experienced driver to have such an accident and this one was all the more surprising because it occurred at the curb in front of the patient's own house, where he had parked many times before without incident. However, his association furnished the explanation. At the time of the mishap he was returning from a visit to his grandfather's house on the morning after the latter had died following an illness of several months. Unconsciously the patient felt guilty as a result of his grandfather's death because of his own hostile wishes toward the old man, wishes that were to a considerable degree the counterparts of similar, unconscious wishes toward his own father. He smashed the tire on his own car to satisfy the unconscious demand of his superego that he be punished for having, in his unconscious fantasy, willed his grandfather's death.

Sometimes such a mishap combines both the crime and the punishment. We may suspect, for instance, that in the example just given, some repressed fantasy of smashing his father achieved a displaced or symbolic gratification in the patient's action of smashing his car against the curb. In this particular example, as it happened, the patient's associations did not point in that direction, so that we are left with no more than a suspi-

cion or conjecture. However, in other cases, there is no doubt of the fact that crime and punishment are both contained in a single action.

For instance, a patient, while driving her husband's car, stopped so suddenly in traffic that the car behind her crumpled one of the rear fenders of the car she was in. The analysis of this mishap revealed a complicated set of unconscious motives. Apparently three different, though related ones were present. For one thing, the patient was unconsciously very angry at her husband because of the way he mistreated her. As she put it, he was always shoving her around. Smashing up his car was an unconscious expression of this anger, which she was unable to display openly and directly against him. For another thing, she felt very guilty as a result of what she unconsciously wanted to do to her husband in her rage at him and damaging his car was an excellent way to get him to punish her. As soon as the accident happened, she knew she was "in for it." For a third thing, the patient had strong sexual desires which her husband was unable to satisfy and which she herself had strongly repressed. These unconscious, sexual wishes were symbolically gratified by having a man "bang into [her] tail," as she put it.

Psychoanalytic explanations of accident causation are of sufficient interest, influence, and plausibility to justify their scientific evaluation. However, the cost and duration of the process of psychoanalysis, the special characteristics of patients, and the clinical orientation of psychoanalysts have created a widespread impression that research is more difficult in psychoanalysis than it is in many other fields. Despite these difficulties, however, there are many possibilities for the scientific study of accidents from a psychoanalytic point of view. For example, a range of appropriately chosen individuals might be diagnosed psychoanalytically by means of the Rorschach, T.A.T., or other projective test and then followed to determine whether their subsequent accident experience bore a relationship to their psychodynamic characteristics. However, even a high degree of association revealed by such a study would not of itself constitute adequate proof. It would be necessary, in addition, to demonstrate that the observed associations between the presence *or absence* of certain psychodynamic patterns and subsequent accident experience necessarily followed from psychoanalytic formulations, that other explanations did not fit the facts, and that the findings were confirmed when the same methods were applied to other groups.

Behavior in Relation to the Ecology of Dangers

In sharp contrast to the approaches of Freud and his disciples has been the work of experimental psychologists using scientific methods in the study of a wide variety of precisely definable accident variables. There have been excellent investigations of perception and reaction time as they are affected by such factors as drugs and fatigue (see Loomis and West in Chap. 3 and reference 2). Most psychologically oriented accident research, however, is narrowly focused: it views accidents in substantial isolation from the characteristics of the environments in which they occur and it fails to provide an adequate conceptual framework within which the broad gamut of accident types and circumstances may be rationally approached.

THE CONTRIBUTION OF EXPERIMENTAL PSYCHOLOGY TO THE FORMULATION OF THE PROBLEM OF SAFETY—A BRIEF FOR BASIC RESEARCH

—*James J. Gibson, Ph.D.*

The selection that follows is an exception to this general rule and is one of the most significant contributions to accident literature. Gibson, an experimental psychologist, offers a thoughtful analysis of accidents in relation to "the ecology of dangers." His formulation represents a refreshing departure both from purely statistical approaches and from the narrow study that deals only with variables of one type and neglects the ecologic context. Here we have convincing evidence that research on perceptual factors in accidents can go far beyond the standard reaction-time experiment, which has proved remarkably unproductive, popular opinion notwithstanding.

AN EXPERIMENTAL PSYCHOLOGIST is concerned with the behavior of men and other animals relative to their environment. He has no particular knowledge about the special problem of accident prevention and no practical recommendations to make. But since he is interested in motivated behavior and perception and learning, he does have a way of formulating the general problem of adaptive behavior, or adjustment, or whatever you like to call it. This can be helpful in conceiving clearly what we should mean by *safety* and *danger*. The practical business of increasing the former and decreasing the latter depends upon having a clear and explicit theory to guide us.

The experimental psychologist makes experiments, of course, mostly in a laboratory. But what he aims for is a behavior theory that is valid for the whole environment, not merely for the laboratory. He isolates and controls abstract features of the environment, and his experiments are meaningful only to the extent that the features isolated for study are genuine or typical. Hence he ought to be a student of the environment as well as of behavior. He should be something of an ecologist as well as a psychologist. He performs experiments on the development of fear and avoidance in children and animals, but he ought also to be concerned with what is fearsome, or properly to be avoided, in the environment of the individuals in question.

Man is a terrestrial animal; he breathes air and resists gravity and gets about on the surface of the earth. He cannot live in a medium of water or mud, and he is not naturally equipped to swim, burrow, or fly. He adapts his behavior to the permanent features of the earth's surface—the local terrain. He responds, also, to the flux of energies which surround him—gravitational and mechanical, radiant, thermal, and chemical. Some limited fields and ranges of energy provide stimuli for his sense organs; others induce physiological adjustments; still others produce injury. These last energy exchanges are properly called *dangerous*. A *danger* is here defined as an external source of potential injury. Injury results, of course, only if there occurs what I will call an *encounter*.

The geographical environment of man, including the local energy environment, has been considerably modified by his own efforts during the past few thousand years. There has been earth-moving and construction, and provision for artificial light, and heat, and nutritive chemical substances. By and large, the paths, bridges, fences, shelters, tools, machines, clothing, radiators, food, water faucets, air conditioners, and all other

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goods of the artificial environment have alleviated old sources of danger, but they have also introduced new ones. Human children are now in less danger from rock-falls but in more danger from electrical outlets.

The natural and the artificial environments comprise what might be called the objective environment. But this is not everything. Actually it is only a basic framework for the *animate* environment and the *social* environment—that is, the world of other animals and other persons. These are also sources of danger. Animals can bite, claw, crush, or sting. And other persons can be even more deadly, especially when equipped with weapons, or when they misuse tools, machines, or vehicles.

From this point of view, dangers are environmental facts. Theoretically it is possible to locate and specify all sources of danger in the geographical, the artificial, the animate, and the social environments. I exclude from consideration disease, or at least infection, as a source of danger because it is a special type of danger with its own peculiarities. I exclude also starvation because it is another well-defined phenomenon, fairly well understood. We are primarily concerned with safety, and, in ordinary speech, this is distinguished from health and nutrition. Allowing for these omissions, let us consider dangers in more detail.

A Classification of Dangers

Injuries to a living organism can be produced only by some energy interchange. Consequently, a most effective way of classifying sources of injury is according to the forms of physical energy involved. The analysis can thus be exhaustive and conceptually clear. Physical energy is either mechanical, thermal, radiant, chemical, or electrical.

Mechanical Energy: Physical events such as impact, breakage, shear, and flow (or stoppage of flow) all involve the expenditure of mechanical energy. The encounters of a child with his environment include seven types of such events.

1. Active impact. An active terrestrial animal, infant, child, or adult may either fall "down" or fall "off." The latter case is the more important. (In either case impact with the ground is the cause of injury. Impact can be measured as rate of change of velocity, or amount of deceleration.) A falling-off place, such as a cliff or steep slope of ground or a stairway, is a particular danger. Also, a child may collide with an obstacle during locomotion.

2. Passive impact. One may be struck by a falling object: a rock, an avalanche, a plaster ceiling, or, for that matter, a meteorite. Or one may be struck by a moving object: a moving automobile, an exploded chunk of something, or a missile. These constitute a second type of danger, but they are impermanent rather than permanent features of the environment. They are caused by melting snow, say, or by a careless or angry man. They do not stay put, like an uncovered well or a tree in the middle of a path.

3. Interference with breathing. It is possible for a terrestrial animal, young or old, to encounter the wrong medium and to be suffocated by a solid or drowned by a liquid. Sand banks and bodies of water are local and specific dangers.

4. Tool and machine forces. We primates are equipped for manipulation as well as locomotion. We have constructed tools, varying from stone chisels to stamping machines, which can shear tissue as well as wood and metal. For the unskilled user or the child, the handling of a tool involves danger as well as achievement, with a thin line between the two.

5. Machine failures. As a result of the complex and elaborate mechanical environment, and all the ways in which devices can break, explode, or otherwise fail, a vast array of dangers surrounds us all. Machines are designed not to fail, maintenance is intended to prevent failure, and "safety devices" are installed in order to signal failure. Nevertheless, flywheels and mower blades do break, tires do blow out, and airplanes do come apart in flight. But the "chance factor" in machine breakdown is theoretically capable of being eliminated. The great source of danger from machines stems from the relation between them and their operators.

6. Animal forces. Other species than our own are equipped to injure in various simple mechanical ways. They can bite, claw, kick, butt, sting, and so on. Encounters with animals, especially with those we loosely call "wild," constitute dangers.

7. Weapon-produced forces. Our fellowmen have invented tools for doing injury—that is, weapons. An armed man fairly radiates danger. A knife or an axe is lethal enough, but the weapons of high civilization will cut, or penetrate, or explode at a distance. Year by year, the distance increases.

Thermal Energy: We are animals with a closely regulated temperature, and we cannot withstand extreme or prolonged heat gain or heat loss. Extreme temperatures of the surrounding medium will damage us, and so will very hot or cold substances. Children have always had to learn just how close they can come to a fire. Between warming and burning, the gradient is fairly steep. Nowadays children are having to learn the analogous rule for dry ice. The entities in the world that cause burn or frostbite are dangerous. Visible flames are easy to detect, but some of these entities are not. Explosions, for example, which often combine heat and impact, are notoriously unpredictable.

Radiant Energy: The radiant energy of the sun, as filtered by the atmosphere, is generally not dangerous. Apart from overexposure to ultraviolet and to radiant heat—*i.e.*, sunburn and sunstroke—the danger in radiant energy comes from manmade sources of gamma rays. Atomic energy in war, however, we had better leave out of consideration. Even more than starvation and disease, this fearsome threat is unique.

Chemical Energy: We call injurious chemicals poisons. They can be absorbed by breathing, by skin contact, by eating, or by drinking. They existed in the natural environment of our ancestors, and they still exist. Primitive men developed, or learned and taught, ways of distinguishing them by sight, smell, or taste, and then avoided contact with them or rejected them as food. But new poisons continually appear in our manufactured environment, and children must learn new modes of avoiding them. Often enough they must be identified by signs or symbols.

Electrical Energy: A lethal flow of electric current is rare in the natural environment. To be struck by a bolt of lightning is the classical example of an "act of God," or an unpredictable accident. But nowadays current outlets, live wires, and so-called "shock hazards" are prevalent. They are not always easy to identify as such, but they differ from lightning in an important way: the locus of danger is fixed, whereas the location of lightning is variable. The occurrence of shock at a current source is certain. The occurrence of lightning at a given place has only a probability.

To sum up, environmental dangers can be analyzed and classified. They are physical facts or events. A much more elaborate analysis is needed than I have given, but an ecology of danger is possible. An essential part of the struggle for existence over the ages was the avoidance or the overcoming of such dangers. Falls, collisions, immersions, blows, cuts, bites, burns, and poisons were what our ancestors either survived or, more cleverly, averted. Dangers were agents of natural selection. They were also objects of discriminative perception and selective learning. They must have been closely attended to. They governed the evolution of the capacity for looking and listening. They motivated the training of children. They gave rise to rules and laws. They led to cooperative effort. In the modern world, so far as possible, we try to eliminate them from the environment. Whether complete elimination is possible (or even desirable) is another question. In any case it is academic, for new dangers seem to arise with every new invention of our technological culture, and their alleviation is an essential part of the technology.

Exploratory Behavior and Margins of Safety

Now for the second assumption in my line of reasoning—the margin of safety.