PART IV

BEHAVIORAL SOLUTIONS IN CONTEXT: ECOLOGICAL AND SOCIETAL SYSTEMS

CHAPTER 10

CHOOSING THE BEHAVIORS TO CHANGE AND THE POINTS OF INTERVENTION

CHAPTER PROLOGUE

The brief story that illustrates this chapter's main topics and themes takes place in the *mid-1970s*. The protagonists are two psychology professors, Alexandra Mason and Michael Wilson, who have just completed graduate school and have joined the faculty of a large California state university.

The United States is in the throes of an energy crisis, one that began when Middle Eastern oil-producing countries stopped petroleum shipments to the United States. The U.S. government has responded to this embargo by instituting several major energy conservation measures, including a lowered national highway speed limit (55 MPH) and year-round daylight saving time.

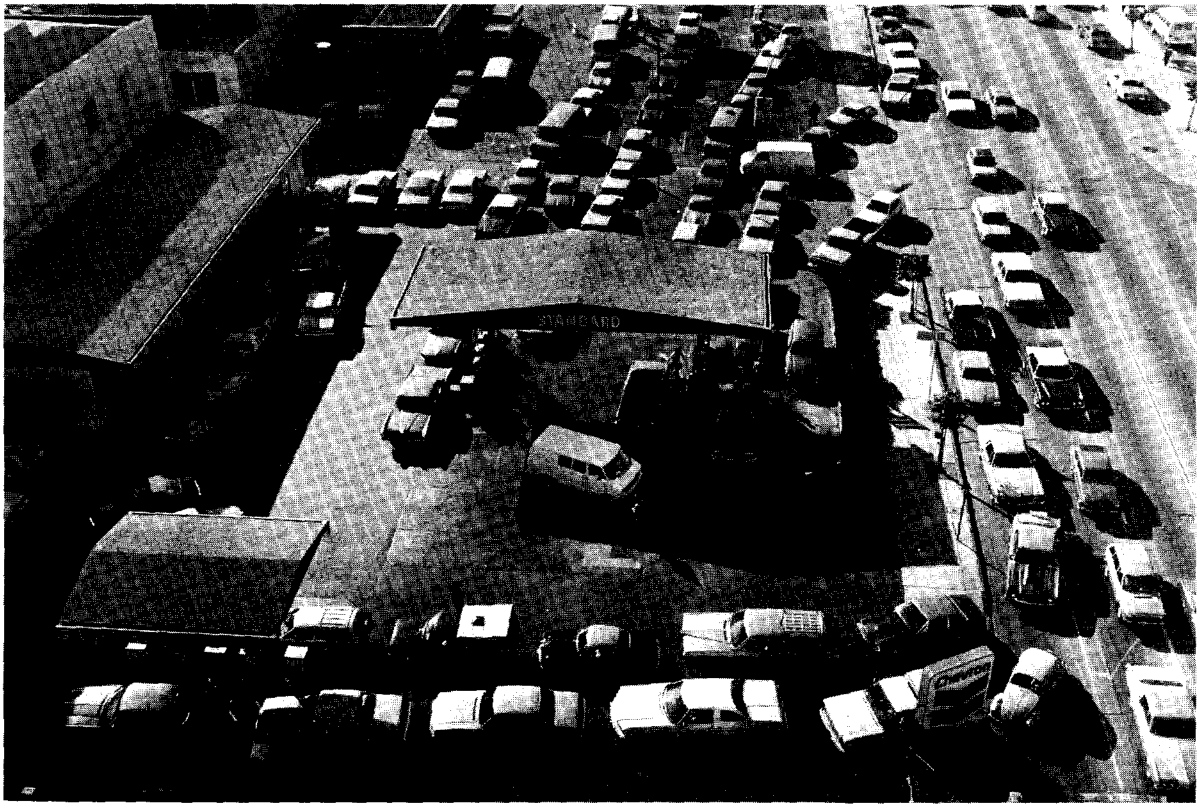
Despite these measures, domestic supplies of petroleum begin to run short. Long lines of cars appear at gas stations all across the country (photo on p. 255). A major shortage of natural gas in the winter of 1977 forces some factory closings, school closings, and worker layoffs. President Carter appears on TV and describes the energy crisis as "the moral equivalent of war." He explains the nature and severity of the crisis and urges all citizens to conserve energy.

Like most Americans at the time, our two college professors, Mason and Wilson, are preoccupied and concerned about the national energy crisis. They realize that the crisis is caused as much by the United State's excessive dependence on petroleum—a key nonrenewable natural resource—as it is caused by the actions of the Middle Eastern oil-producing countries. The two professors are concerned also about the depletion of other vital natural resources, and about air pollution, water pollution, litter/solid wastes, and other environmental problems. Mason and Wilson are young and idealistic and decide to devote all their research to the study of environmental problems, focusing mainly on the energy crisis, and specifically on developing ways to encourage the U.S. public to conserve energy.

Mason and Wilson begin their research by spending several days observing the energy-consuming behaviors of their colleagues, friends, and family. Based on these observations, they construct the following list of wasteful behaviors that Americans now engage in, and that the two researchers will try to find ways to change:

> *Failing to turn lights off in rooms that are not in use; leaving lights on all night in garages or unused outside areas; setting thermostats above the recommended 68 degree level during the winter heating season or below 78 degrees during the summer air-conditioning season; leaving outside doors or windows partially open when heating or air conditioning is running; making jackrabbit starts in autos and using excessive speed; using large stove burners to heat small cooking pots so that flames or heating elements around the sides of the pots waste energy; and using electric or gas laundry dryers, rather than outdoor line drying, during warm, sunny weather.*

Next, the two professors spend several months devising methods to get the general public to lessen the wasteful behaviors outlined above. The two researchers, for example, create highly visible stickers to be placed near light switches to remind people to turn off unnecessary lights; they develop behavior-modeling videotapes for use on television that demonstrate the



Long Lines of Cars Waiting to Buy Gas—a Common Sight in the United States in Early 1979
The lines resulted from a petroleum shortage and a national system of gasoline rationing. (UPI/Bettman Newsphotos)

proper use of refrigerators and stoves; and they adopt some of the other techniques (e.g., public commitment) we described in Chapters 4 and 5. Finally, the two professors design and run several research studies over a two-year period to test the effectiveness of the above methods.

As their energy-conservation research nears completion, the two researchers then decide to focus some of their research on one other environmental problem: garbage and litter. Mason and Wilson have been surprised by the large quantity of beverage cans, bottles, snack-food wrappers, and other trash lying around their otherwise attractive college campus and in adjacent neighborhoods and parks. And they are also aware that litter is a major problem all across the United States, not just in this particular California town. The two researchers, therefore, spend considerable time designing methods to get people to litter less. For example, they produce antilitter modeling tapes for television and design brightly colored trash barrels for use in public areas, each barrel bearing a slogan urging people to "pitch in."

As it turns out, Mason and Wilson's research programs on energy conservation and on littering are both successful: After several years of intense and imaginative work, the two professors have produced several methods that actually get people to save energy in the ways outlined above, and also get people to deposit trash in trash barrels in parks and other public places.

INTRODUCTION

Clearly, Mason and Wilson's research programs, outlined above, are well-intentioned, ambitious, clever, and creative. These researchers, furthermore, devoted large amounts of time and effort to their work. And the changes in public behavior that their methods produce do save energy and reduce litter.

However, despite all this, the authors of this book believe that Mason and Wilson's research efforts suffer from an unfortunate, major flaw: The energy conservation behaviors that the two professors are encouraging in the general public are behaviors that save very little energy. At the same time, the two are ignoring several other conservation behaviors that could save much more energy. Similarly, the decrease in littering that they are encouraging is a superficial goal, one that addresses only the tip of the iceberg of litter and solid waste problems in the United States.

We believe that these shortcomings stem from Mason and Wilson's unfamiliarity with key details: that is, with the way U.S. energy and solid waste systems actually work. The two used intuition and informal personal impressions, rather than quantitative and technical information, as a basis for choosing "target behaviors"—the public behaviors that they attempted to encourage or change. Mason and Wilson could have done a better job of choosing target behaviors if they had first gotten information from engineers, ecologists, and others familiar with the quantitative and technical aspects of U.S. energy and solid waste systems.

But before we go any further, we have a confession to make: Mason and Wilson are not real people; they are fictitious characters. Their story, however, is all too true. Psychologists in the 1970s devoted a great proportion of their research efforts on environmental problems to behaviors such as those described above. Some contemporary psychologists have done the same. Like Mason and Wilson, these real-world psychologists overlooked vitally important quantitative and technical dimensions of the problems they were studying and, as a result, chose less than optimal target behaviors. In fairness, we must point out that these psychologists exhibited what we believe is an almost universal tendency: Researchers who are interested in solving environmental problems—regardless of their discipline—tend to overlook important inputs from disciplines other than their own. For example, ecologists, economists, engineers, and others have often made intuitively appealing, but incorrect, judgments about important behavioral aspects of environmental problems; or they have overlooked these aspects altogether. Indeed, many of the behavioral aspects of environmental problems that we discussed in the prior chapters of this book (especially Chapters 4 and 5) have sometimes been misjudged or overlooked by nonbehavioral scientists.

However, this chapter is mainly addressed to psychologists and behavioral scientists (and their students), not to engineers, ecologists, and so on. Specifically, we devote the chapter to a careful review of key quantitative and technical aspects of environmental problems that psychologists like Mason and Wilson have tended to misjudge or overlook. We believe that psychologists must be familiar with these aspects so that they can choose effective behavior-change targets and contribute most to solving environmental problems.

By the way, the authors of this book don't claim to be any smarter than other behavioral scientists when it comes to these matters! Any wisdom we have can be traced to the rude awakening we experienced while participating for several years in an unusual interdisciplinary program on energy and environmental problems. We constantly rubbed elbows with scientists from other disciplines, and were forced to confront the narrowness of our own psychological perspectives.

In the pages below, we focus first on U.S. energy problems, in the context of the energy crisis of the mid- and late-1970s. We review what we believe are the most important quantitative/technical dimensions of American energy problems, the dimensions most relevant to a choice of effective target behaviors. We go on to perform a similar, but more recent, analysis of U.S. litter and solid waste problems, and, finally, to an analysis of the present-day greenhouse effect and global warming. At the end of the chapter, we apply what we've learned about choosing target behaviors to a somewhat different subject matter: We critique widely publicized programs to encourage proenvironmental public behavior that were designed as part of the U.S. observance of Earth Day 1990.

One of the themes that appears throughout the chapter is that there are different levels of intervention at which behavioral scientists (and others) can work to try to lessen or solve an environmental problem. At one extreme, psychologists can focus on target behaviors related to the negative impacts or manifestations of a problem; at the other extreme, psychologists can focus on target behaviors related to the underlying sources or origins of a problem. Usually, psychologists can be most effective if they work near the latter rather than the former, although it is usually best for psychologists to work at more than one level of intervention. We hope that this chapter provides both specific quantitative and technical information as well as a general framework useful to psychologists in mastering the behaviorally relevant technical dimensions of any environmental problem.

A final introductory note to our readers: There is relatively little psychology in this chapter, but lots of material from engineering, general ecology, and other fields. If you are a psychology student, some of this material might seem tedious, and you may not be convinced that it's relevant. However, we urge you to stick it out. We're confident the material in this chapter will provide you with important insights into the nature and causes of environmental problems and the most effective ways to help solve them.

A BEHAVIORALLY ORIENTED ANALYSIS OF THE U.S. ENERGY SYSTEM

The analysis of the U.S. energy system that we present in this section produces a better choice of conservation target behaviors than does the intuitive and informal approach that Mason and Wilson used and that we described at the beginning of the chapter.

In the analysis below, we *first* examine how energy is being used in the United States. We do this because it's impossible to figure out the best ways to conserve energy without first determining who the key users of energy in this country now are, how much energy each of them uses, and for what purposes. Once we answer these questions with relevant quantitative and technical information, we *then* can go on to determine which changes of public behavior are likely to conserve the most energy.

Major Energy Users

As we noted above, the analysis begins with a look at who the major users of energy are in this country. Table 10-1 shows the relevant data. Though the data are for the early 1970s, data from 1992 show a similar pattern.[1] The Table serves to remind us that, as we pointed out in Chapter 1, only one-third of the energy consumed in this country is consumed directly by individuals and households, while the other two-thirds is consumed by factories, businesses, and other "large actors." (Recall from Chapter 1 that the direct role of individual/household behavior is similarly limited in U.S. air pollution and solid waste problems.) And since psychology focuses primarily on the behavior of individuals and of small groups, psychology can help us understand only some, but not all, of the causes and possible solutions to energy problems. (As we discussed in Chapters 3–7, individual behaviors can have significant political and economic impact beyond the individual level, as when people join environmental groups, purchase environmentally sound consumer products, and vote for proenvironmental candidates for office; and, as we saw in Chapters 3–7, psychology can help us understand those behaviors.)

However, let's assume that Mason and Wilson already understood this limitation concerning the role of individual/household behavior, and are content, as psychologists, to limit their research mainly to this sector. After all, one-third of U.S. energy use is still a very large contribution to resource depletion, air pollution, global warming, and other problems. Let's now look more closely at individual and household energy use, to see where the greatest energy savings can be achieved through changing behavior.

Major Uses of Energy by Individuals and Households

Table 10-2 lists the major end-uses, or purposes, for which individuals and households use energy in the United States. It also shows the amounts (percent-

TABLE 10-1 Estimated Percentage of Direct U.S. Energy Use by Economic Sector (Figures Are for 1970)

SECTOR	%
Household/individual	**32.5**
Industrial	35.9
Commercial/service	19.5
Other (exports, feedstocks, etc.)	12.1
Total	100.0

From Stern, P., and Gardner, G., Psychological research and energy policy. *American Psychologist,* Volume 36, 329–342. Copyright 1981. American Psychological Association. Used with permission.

TABLE 10-2 Estimated Percentage of Total Individual/Household Sector Energy Consumed for Different End-Uses in the U.S. (Figures Are for 1970–1975)

END-USE	%
Transportation:	
Auto	41.7
Other	5.3
Subtotal	47.0
In home use:	
Space heat	29.2
Water heat	7.7
Refrigeration and freezing	4.1
Lighting	3.0
Cooking	2.7
Air-conditioning	2.4
Drying	.9
Other	3.0
Subtotal	53.0

From Stern and Gardner (1981a), see Table 10-1.

ages) of energy consumed for each of the end uses. The figures are from the early- to mid-1970s, but more recent data are similar.[2] The figures in Table 10-2 show that a lion's share of the energy that individuals and households consume in this country is used to run automobiles and heat homes. In contrast, relatively little energy is used to light homes, cook meals, or dry clothes. These big differences in amounts of energy consumed immediately suggest that conservation actions involving auto use and home heating have a greater potential to save energy than conservation actions involving the other end-uses. In the next section, we explore the conservation potential of different conservation actions more systematically and in greater depth.

The Conservation Potential of Thirty Different Energy-Conserving Actions

Table 10-3 presents estimates of the energy-saving potential of thirty different conservation actions that individuals and households could take. These actions cover a broad range: They involve each of the end-uses in Table 10-2. They include many of the actions chosen by Mason and Wilson (at the beginning of the chapter), but also actions mentioned in the popular media, as well as actions mentioned in engineering publications and other technical sources. Note the way to read the entries in Table 10-3: The "4–6" figure near the upper-left corner of the table, for example, indicates that between 4 and 6 percent of all individual/household energy consumption in the United States (1-1/2 to 2 percent of the national total) could be saved if all Americans who now drive to work alone car-pooled to work with one or two other people.

Please note that each figure in the table assumes *universal,* or nationwide, adoption of the corresponding conservation action. Note also that the figures are for the early 1980s. However, they are probably close enough to current figures to correctly indicate the *relative* energy-saving potential of the thirty different actions.

Table 10-3 is organized top to bottom from the most energy-consuming end-uses to the least, in the same order as are the end-uses in Table 10-2. The data in Table 10-3 confirm the inference we made in discussing Table 10-2 above: Those conservation actions involving auto travel and space heat (which are the most energy-consuming end-uses) have the greatest

TABLE 10-3 Estimated Percentage of Current Total Individual/Household Energy Consumption That Can Be Saved by Thirty Different Conservation Behaviors (in the U.S.) (Figures Are for the Early 1980s)

END-USE:	CURTAILMENT	% ENERGY SAVED	INCREASED EFFICIENCY	% ENERGY SAVED
		Transportation		
Automobile:				
	Car–pool to work with one to two others	4–6	Buy more fuel-efficient auto (27.5 vs. 14 mpg)	20
	Cut shopping trips to one-half of current mileage	2	Get frequent tune-ups	2
	Alter driving habits with mpg or vacuum feedback	2 (or more)	Maintain correct tire inflation	1
		Inside the home		
Space heat:				
	Set back thermostat from 72° F. to 68° F. days, 65° F. nights	4	Insulate and weatherize house	10
			Install more efficient heating equipment	8
Water heat:				
	Set back thermostat by 20° F.	1	Install more efficient unit	2
Refrigeration/freezing:				
	Decide on items you want in advance and open/close quickly	0.5	Buy more efficient unit	1.6
	Thaw frozen foods in refrigerator before cooking	0.1	Clean refrigerator coils frequently	0.1
Lighting:				
	Do not leave porch light on all night	1.0	Change one-half of all incandescent bulbs to fluorescent	1.0
	Replace all hall and ceiling fixtures with 40-watt bulbs	0.1	Clean bulbs and fixtures regularly	0.3

(continued)

TABLE 10-3 Continued

END-USE:	CURTAILMENT	% ENERGY SAVED	INCREASED EFFICIENCY	% ENERGY SAVED
Cooking:				
	Do not use self-cleaning feature of oven	0.2	Buy more efficient unit	0.9
	Use right-size pots and do not open oven door to check food	0.2		
Air-conditioning:				
	Set back (up) thermostat from 73° F. to 78° F.	0.6	Buy more efficient unit	0.7
			Insulate and weatherize home (see above under "Space heat")	0.8
Drying:				
	Do not use dryer 6 months of the year	0.5	Buy more efficient unit	0.2
Miscellaneous:				
	Do not use garbage disposal unit	less than 0.1	Fix all dripping hot water faucets	0.1
			Replace leaking refrigerator door seal	0.1

From Stern and Gardner (1981a), see Table 10-1.

potential to decrease total individual/household energy consumption.

A key feature of Table 10-3 is that it divides the thirty conservation actions into two different general categories: Actions in the left column involve *curtailing* the use of existing energy equipment (such as cutting down on auto trips for shopping by 50 percent). Actions in the right column involve *adopting more energy-efficient* equipment (such as buying and properly maintaining a very fuel-efficient auto to begin with). Before we compare the figures in two columns, we need to mention that those in the increased-efficiency (right) column assume that consumers buy autos, refrigerators, furnaces, and so on, that are among the most energy-efficient they can buy. Note also that each figure assumes that consumers buy new equipment when old equipment wears out, that is, when they would normally replace the old equipment; if consumers make purchases before this time, part of the energy they save by using the more efficient equipment is canceled out by the energy used to manufacture the new equipment.[3]

If you compare the left and right columns of Table 10-3, you'll see a consistent and important difference: Behaviors involving adoption of energy-efficient furnaces, autos, and other equipment generally save more energy than do behaviors that curtail the use of existing equipment. So, for example, installing a fuel-efficient furnace and insulating and weatherizing a house saves much more energy than does setting back the thermostat that governs an inefficient furnace operating in a poorly insulated house. Similarly, buying a very fuel-efficient auto and maintaining it properly saves significantly more energy that curtailing the use—even rather severely—of an intrinsically energy-inefficient auto. And buying and properly maintaining an energy-efficient refrigerator saves significantly more energy than trying to efficiently operate an inefficient unit (e.g., by opening and closing its doors quickly). There are similar differences for other end-uses shown in Table 10-3.

More on "Curtailment" Conservation Actions versus "Increased Efficiency" Conservation Actions

Psychological Differences Between Curtailment and Efficiency-Increasing Conservation Actions. In addition to their difference in conservation potential, note that efficiency actions and curtailment actions have different psychological properties. One major difference is that curtailment actions usually involve small, simple behaviors that must be repeated over and over again for long time periods, whereas efficiency-increasing actions are often larger-scale, one-time-only behaviors. Thus, curtailment actions, such as turning off lights when leaving a room, choosing the right size cooking pots, and so on, require that people make continual efforts to monitor and alter their own behavior. It is this type of action that is studied by Skinnerian, or "behavior modification," psychologists.

In contrast, efficiency-increasing actions, such as buying a new high-efficiency furnace, tend to be actions that people perform infrequently or only once, and that don't require continuous attention or effort. For this reason, people's performance of an efficiency action depends on several factors that just don't apply to curtailment behaviors. For example, your purchase of a new, high-efficiency furnace requires that you have several thousand dollars in cash (or access to a loan), that you've done enough research on furnaces to enable you to make your purchase decision with reasonable confidence, that you are willing to pay somewhat more for a high-efficiency furnace than for a low-efficiency one, that you can find a heating contractor that you can trust, and that you are willing to purchase this technology even if not many of your neighbors or friends yet have such a device. These factors that influence consumer purchase decisions—discussed previously in Chapters 4, 5, and 6—are generally studied by social, cognitive, and other psychologists who study consumer behavior.

A second important psychological difference between curtailment and efficiency actions involves their perceived impact on lifestyle. People may view some energy curtailment actions, such as setting space-heat thermostat back to 68 degrees (or less) in the winter, as decreasing their comfort and quality of life. As a result, they may tend to judge these actions as undesirable. For example, President Reagan was widely quoted as saying that "Energy conservation means being too cold in the winter and too warm in the summer!" In contrast, actions that increase energy efficiency do not interfere with quality of life at all, as such actions permit people to maintain existing lifestyles, but consume less energy in the process. Thus, unless or until there are changes in public values in this country, efficiency actions—the same actions that save the most energy to begin with—may be easier to encourage.

Implications for "Mason and Wilson's" Conservation Program. In the sections above we reviewed major psychological differences between curtailment and efficiency actions as well as differences in their potential to conserve energy. These differences have major implications for Mason and Wilson's research program on energy conservation, which we described in the Chapter Prologue. Most importantly, note that the conservation actions the two psychologists were encouraging the public to take—turning off lights, making thermostat adjustments, avoiding jack-rabbit starts in cars, choosing the right size cooking pots, and so on—were all curtailment actions. The two researchers ignored actions that increase energy efficiency, such as substituting fluorescent lights for incandescent, insulating and weatherizing homes, installing high-efficiency furnaces, and buying high-fuel-efficiency cars. In other words, Mason and Wilson overlooked the category of conservation behaviors with the greatest energy-saving potential, and did so because they chose target behaviors based on intuition and informal impressions.

A second, related implication for Mason and Wilson's research involves the psychological differences between curtailment and efficiency conservation actions, which we discussed above. Recall that curtailment actions are repetitive small behaviors (the kind studied by Skinnerians), whereas efficiency actions are bigger, one-time-only behaviors (the kind sometimes studied by social/cognitive/consumer psychologists). Methods that successfully encourage the two different types of behavior are likely to be quite different. Thus, the stickers, modeling videotapes, and so on, designed by Mason and Wilson to encourage energy curtailment actions may not be of much value in encouraging efficiency-increasing actions.

Reasons That Mason and Wilson's Intuitive and Informal Approach Led Them to Curtailment, Rather Than Efficiency, Actions. Why did Mason and Wilson's intuitive/informal approach lead them specifically to emphasize curtailment actions and overlook efficiency-increasing conservation actions? To try to answer this question we first note that the actions Mason and Wilson selected were the *same* ones that most members of the U.S. general public, lacking relevant quantitative and technical information, tend to select. How can we make such a statement? We do so based on the results of a study by Kempton, Harris, Keith, and Weihl (1985) discussed in Box 10-1. Kempton et al. interviewed 400 randomly selected Michigan residents and asked them to name as many actions as they could think of that would save energy in their own households. The respondents predominately named energy curtailment actions, such as turning off unneeded lights, rather than efficiency-increasing actions, such as upgrading insulation. (We assume that Michigan residents are reasonably representative of the U.S. public in general, at least concerning the subject matter of this study; indeed, Kempton et al. describe other research on both American and European subjects that yielded similar results.) See Box 10-1 for more detail.

The question then becomes: Why do *Americans and others* intuitively conceive of energy conservation mainly in terms of curtailments rather than in terms of efficiency increases? One possible answer, proposed by Kempton et al. (1985) and others, involves "visibility": People can directly perceive the operation of lights, TVs, stoves, dishwashers, and so on; they know that energy is being consumed by these devices and that energy could be saved if these devices were used less intensively. In contrast, people *cannot* directly perceive the energy consumed by poorly weather-stripped doors, inefficient furnaces, or inefficient water heaters, and also that energy would be saved if these devices were upgraded. There are other possible explanations besides the visibility explanation, which we also discuss in Box 10-1 on Kempton et al. (1885). But whatever the explanation, it appears that the general public is prone to overlook those conservation actions with the greatest energy-saving potential, unless education, feedback, financial incentive, and/or other methods can effectively convince them not to!

Curtailments and Efficiency Actions: Not a Case of Either-Or. We would like to make one final point concerning curtailment versus efficiency actions and Mason and Wilson's research program: We do *not* suggest that psychologists interested in encouraging energy conservation in this country should ignore the curtailment actions that Mason and Wilson were trying to encourage. Some curtailments—especially lowering space-heat and water-heat thermostats—*can* yield reasonably large energy savings. Also, curtailment actions may have important indirect effects by raising people's consciousness about the need to conserve energy. In addition, global energy systems that are permanently sustainable (into the long-run future) may, indeed, require major energy curtailments. However, if psychologists are concerned with saving the most energy in the United States in the immediate future, it is clearly a mistake for them to ignore the

Box 10-1

Public Conceptions of Household Energy Conservation: An Emphasis on Curtailments and a Neglect of Efficiency Increases

Research performed by Kempton, Harris, Keith, and Weihl (1985) at Michigan State University suggests that members of the U.S. general public tend to think of energy conservation mainly in terms of curtailment actions, such as turning off lights, using less hot water, and watching less TV. Conversely, the public tends to overlook such efficiency-increasing actions as weatherizing homes, installing storm windows, and buying more efficient furnaces and appliances.

Kempton and his colleagues interviewed 400 randomly selected Michigan residents by telephone. The researchers asked each respondent: "What things do you know of that a family could do to reduce energy consumption in their house?" After a respondent named several conservation actions and then paused, the researchers asked "Any more?" until the respondent had named six actions, or couldn't name any more. Note that this method of asking questions is completely open-ended in that the researchers did not give respondents any specific conservation actions to choose from.

Kempton et al. also asked half of their respondents to estimate the annual dollar savings that each of the conservation actions would yield. The researchers then compared these dollar estimates with estimates from scientific and engineering journals, government publications, and other sources.

The main results of the study are shown in Table 10B1-1. Notice that respondents mentioned energy curtailment actions much more frequently than they mentioned efficiency-increasing actions (see the left-most column of numbers). Thus 657, or 83 percent, of the total of 793 conservation actions mentioned by respondents were curtailment actions (keep in mind that most of the 400 respondents named several actions, and that different respondents could name the same action). Conversely, only 136, or 17 percent, of the actions mentioned were efficiency actions. Look-

TABLE 10B1-1 Number of Respondents (Out of 400) Who Mentioned Each of Ten Household Energy Conservation Actions, and Estimates by Respondents and by Technical Experts of Resulting Annual Savings (from Kempton et al., 1985)

ACTION	NUMBER OF RESPONDENTS (OUT OF 400) WHO MENTIONED	ESTIMATED ANNUAL SAVINGS	
		RESPONDENT ESTIMATE	TECHNICAL ESTIMATE
Turn off lights (C)**	235	$49	$10–24
Lower thermostat (C)	234	$75	$28–55
Insulate home (E)	109	$86	$46–138
Use less hot water (C)	50	$30	$40–110
Use less TV (C)	48	$48	$11
Do less cooking (C)	32	$55	$9–21
Install storm windows (E)	27	$50	$69–115
Use clothes washer less (C)	27	$69	$10–36
Use dishwasher less (C)	21	$27	$10–21
Use dryer less (C)	10	$18	$9–22
Total mentions:	793		

Adapted from Kempton, W., Harris, C., Keith, J., and Weihl, J. Do consumers know "what works" in energy conservation? *Marriage and Family Review,* Volume 9, 115–133. Copyright 1985. Haworth Press, Binghamton, NY. Used with permission.

**Legend: (C) = curtailment action, (E) = efficiency action.

(continued)

BOX 10-1 Continued

ing at the left-column data in a slightly different way, note that only one efficiency action—installing home insulation—was mentioned by more than 10 percent of the 400 respondents. Several other very effective efficiency-increasing actions were mentioned by less than 10 percent of the respondents (not all such actions are shown in the table) or were not mentioned at all. These actions include: installing storm windows, applying caulking and weather stripping, insulating water heaters, making furnace efficiency upgrades, and purchasing more efficient refrigerators and other appliances.

Note further that respondents generally overestimated the annual energy dollars that the curtailment measures would save, in some cases by very wide margins (e.g., decreasing the use of clothes washer and of TV, and decreasing cooking). Conversely, respondents, if anything, underestimated the annual dollars that the efficiency-increasing measures would save. Kempton et al. also cite two other research studies, one done in Germany and one in the U.S., that obtained similar results.

Why did members of the public mention curtailment conservation actions much more frequently than they mentioned efficiency-increasing actions, and why did they overestimate the savings that curtailment actions, but not efficiency actions, would produce? There's not enough research to answer these questions definitively. Furthermore, it is likely that more than one psychological process or phenomenon is involved. Let's briefly explore several possibilities:

One possible explanation—as we already noted in the main text of the chapter—involves visibility. Since people can directly perceive the operation of lights, TVs, and dishwashers, they know that energy is being consumed by these items and that energy could be saved if these items were used less intensively (Kempton et al., 1985). In contrast, people *cannot* directly perceive the energy consumed by poorly weather stripped doors, inefficient furnaces, or inefficient water heaters, and that energy would be saved if these devices were upgraded.[4] If this explanation is correct, feedback techniques and some of the other approaches that we discussed in Chapters 4 and 5 may help people perceive what is now almost invisible. As a similar, but alternate, explanation, people may overestimate the *total amount of household energy consumed* by visible items like lights, TVs, stoves, dishwashers, clothes washers, and dryers *in the first place,* and therefore overestimate the conservation potential of using them less intensively. (If you look back at Table 2 earlier in the main text of this chapter, you'll find that lighting, cooking, drying, and other miscellaneous end-uses actually consume only very modest percentages of the overall household energy budget.)

Another possibility is that people, when asked to think of ways to save energy, find it easier to think of alterations of acts they now frequently perform (e.g., turning lights and TVs on and off), than taking acts they have never previously performed or have performed only rarely (e.g., buying a furnace or storm windows). As a related possibility, such efficiency-increasing devices as furnace upgrade kits and energy efficient kitchen appliances may not have been in widespread use in 1978 when Kempton et al. (1985) interviewed their respondents. As a result, the idea of purchasing these devices may not have come easily to mind when respondents were asked about conservation measures.

Whatever the reason(s), given that members of the general public think of energy conservation mainly in terms of curtailment measures rather than efficiency measures, we would expect that psychologist-researchers—lacking quantitative information to the contrary—would do the same. We're referring, of course, to Mason and Wilson, the two psychologists in the story at the beginning of this chapter. Thus, Mason and Wilson's use of intuition and informal personal impressions led them to stress public target behaviors with little conservation potential, and overlook target behaviors with much greater potential. The result is that even if Mason and Wilson's programs of media ads, reminder signs, and so on, were to be successful—in other words, actually got people to conserve energy via curtailments—relatively little energy would be saved. This failure to save significant amounts of energy, despite public efforts, would be most unfortunate.

But such an outcome might also be unfortunate for a second reason, as Kempton et al. (1985) point out: The failure to save large amounts of energy via curtailment might lead the public to conclude, incorrectly, that energy conservation—besides requiring sacrifices in comfort and convenience—just doesn't work. People would then be unreceptive to any future efforts to encourage energy conservation via more effective efficiency-increasing measures.

efficiency-increasing conservation actions that Mason and Wilson ignored. In short, it's not a case of curtailments *versus* efficiency, but a case of *both*: Both curtailment actions and increased-efficiency actions have a significant role to play in any comprehensive program to conserve individual/household energy in the United States (Stern and Gardner, 1981c). But, again, the choice and mix of actions must be based on a technical analysis of the energy system, rather than merely on intuition or informal personal observations.

There's an additional example, one involving a European country, that illustrates our point above. Sweden today faces a great need to decrease energy consumption because it is phasing out its nuclear reactors (due to the outcome of a public referendum in 1980 after the U.S. Three Mile Island reactor accident), and because it has signed an international pact agreeing to freeze emissions levels of carbon dioxide and other greenhouse gases. However an analysis, like the one we outlined for the United States above, of energy use and conservation potential in Sweden done by Ragnar Löfstedt (1993) reveals the reverse of the U.S. picture: Buildings in Sweden are among the most energy-efficient in the world due to strict building codes and use of advanced technology. There is therefore little more that can be done to increase their energy efficiency. Löfstedt's analysis shows that the only efficiency increase that promises significant savings is that of making certain home appliances more energy-conserving. Conversely, there are several curtailment actions Swedes still can take that have some significant conservation potential, including lowering space-heat thermostats and decreasing hot water use. Again, the most effective mix of conservation actions is revealed only by a formal analysis of the energy system, not by intuitions or informal impressions.

A BEHAVIORALLY ORIENTED ANALYSIS OF U.S. LITTER AND SOLID WASTE PROBLEMS

We move, now, from our behaviorally oriented analysis on energy to a similar analysis on litter and solid waste. You will recall that Mason and Wilson, in the Chapter Prologue, devoted some of their research to litter control (in addition to the work they did on energy conservation). Recall that they developed modeling videotapes and other methods that actually get people to litter less, for example, the use of well-designed trash barrels in public places, each barrel bearing a slogan urging people to "pitch in." Finally, recall that the authors of this book believe that such efforts can have only a small impact at best because littering is only the readily visible tip of the iceberg of solid waste problems in the United States. We now outline the analysis that led us to this conclusion:

To begin with, let's assume that Mason and Wilson's litter control efforts are 100 percent effective and that the public places virtually all items that might potentially litter city streets, university campuses, and parks in proper trash barrels. There's now the problem of what to do with this discarded material after the city collects it and trucks it away. Most (80 percent) of the municipal garbage in this country is buried in "sanitary landfills" (Miller, 1990). Sanitary landfills are large, open areas of land onto which garbage is dumped in layers, alternating with layers of soil; when full, sanitary landfills are covered with a final layer of soil.

The problem is, however, a shortage of landfill space in many U.S. cities. Further, few new municipal landfill sites will be available in the future because few remaining sites near existing cities are suitable, and use of these sites is strongly opposed by people who live in adjacent areas—the so-called NIMBY, or "not in my backyard," phenomenon (Miller, 1994). As a result of these problems, some cities are hauling their garbage to distant locations, in a few cases other states, and even other countries. For example, Philadelphia has shipped parts of its municipal waste to Ohio, West Virginia, Kentucky, and also to Panama via boat (Miller, 1990).

But even if the problem of finding landfill space did not exist, the dumping of litter and other garbage in landfills creates yet another serious problem: Dumping in landfills wastes the large amounts of energy and raw materials consumed in producing the items dumped. For example, enough aluminum beverage cans and other aluminum items are littered or discarded in the United States to rebuild this country's fleet of commercial airplanes every three months, and enough ferrous metal is littered or discarded to totally meet the needs of the U.S. auto industry (Miller, 1990)!

These resources and the energy now wasted by dumping garbage in landfills can be recovered via an alternative to dumping known as *recycling.* In recycling, aluminum, glass, paper, and other recoverable materials in solid wastes are separated and then used to manufacture new cans, bottles, newsprint, and so forth. Recycling saves large quantities of energy and raw materials: For example, the manufacture of aluminum beverage cans from melted-down discarded cans consumes 95 percent less energy than mining and processing raw aluminum ore. It also produces 97 percent less water pollution and 95 percent less air pollution (Miller, 1990). Overall, Miller (1990) claims, a comprehensive national recycling program "could save 5% of annual U.S. energy use—more than the energy [now] generated by all U.S. nuclear power plants." Recycling, in turn, requires either voluntary efforts by citizens to collect and sort wastes (and sometimes deliver the sorted wastes to neighborhood recycling centers), or voluntary efforts motivated, in part, by beverage container deposits, or mandatory citizen efforts (ones required by law). In some cases, the sorting and separating of collected wastes is done at a central municipal garbage processing plant.

But desirable as recycling is, there is another method—*reuse*—that can save even *greater* amounts of energy and raw materials. A good example is the use of returnable and refillable glass bottles for soft drinks and other beverages. After each use, consumers bring bottles back to stores or other collection sites. The bottles are then sterilized, refilled, and resold, in a cycle that can repeat as many as fifty times. According to Young (1991), a glass beverage bottle refilled and resold only ten times consumes only one-quarter of the energy needed to produce ten one-use-only glass bottles from recycled materials. (A reusable glass bottle also consumes only one-eighth of the energy used to produce ten one-use-only glass bottles from virgin raw materials.)

But there is an even *better* strategy than reuse, one that saves even greater amounts of energy and raw materials, and that produces less pollution: *waste prevention* (sometimes called "source reduction"). In waste prevention, fewer materials that could end up as solid waste are produced and distributed in the first place. For example, many items now sold in the United States have packaging that could well be done without. A quick trip into any store will reveal a profusion of large plastic blister packs and cardboard backing sheets, as well as containers that are considerably larger than the volume of material they contain; some of this packaging could be eliminated. Another waste prevention approach is to increase the durability of consumer goods, so that they can be used for longer periods of time before they need to be discarded. For example, tire companies can readily manufacture radial auto tires that last 80,000 miles. (Indeed, at this writing, at least one tire company has already started to sell such tires). Similarly, appliance manufacturers can make stoves and refrigerators that last much longer than do ones that are now available, and/or make them with standardized replaceable parts.

To summarize our discussion, so far, of the four solid-waste strategies, waste prevention is generally preferable to reuse, which is preferable to recycling, which is preferable to discarding. We must, however, make one additional point: It turns out that there are some major restrictions on the ability to choose which of the four solid-waste strategies or methods to use. Many types of waste can be dealt with using *only one or two* of the four strategies. For example, waste prevention efforts can't eliminate *all* packaging of consumer goods, and many cardboard boxes or cans—for example, for food—cannot be readily reused. Conversely, some types of solid waste are reducible via waste prevention, but they cannot easily be recycled. For example, auto tires and the porcelainized sheet metal used in many home appliances cannot easily be melted down and recycled into new tires and appliances, given currently available technologies.

The above restrictions imply that optimal solid waste management requires a complex mix of the four intervention strategies. In other words, different strategies need to be used for each of the basic types of waste: containers and packaging, durable goods (like

tires and appliances), nondurable goods (newsprint, office paper, magazines, cloth, and so forth), and food and yard wastes. Clearly, such a complex, multipart management scheme can only be the product of a technically sophisticated analysis of the U.S. solid waste "system"—and this is the punch line of our solid waste discussion!

This punch line brings us back to Mason and Wilson's research program on litter control presented at the beginning of the chapter. Their efforts to prevent littering seem superficial in light of the complex technical analysis, outlined above, required for an informed program on solid wastes. Note especially how Mason and Wilson's antilitter program—based on intuition and informal observation, rather than on a technical analysis—focused only on getting discarded items, which are highly visible, into refuse cans for collection. Conversely, their program ignored less visible but more important issues such as the exhaustion of landfill sites, the waste of the energy and raw materials used to manufacture and distribute the discarded items, the pollution generated, and so on.

The authors of this book are not criticizing the study of litter control by psychologists or the positive aesthetic, public health, and consciousness-raising effects of antilitter efforts. However, we are suggesting that psychologists interested in litter control can, in addition, apply their expertise on human behavior to other important parts of a comprehensive, technically sophisticated solid waste program. So, for example, psychologists can do more research on ways to encourage the public to participate in curbside or other voluntary community recycling programs (Chapters 4 and 6), to buy recyclable and reusable products if there is a choice, and to buy more durable tires, appliances, and other products, even if these items are initially more expensive than products with shorter life spans. Also, because direct proenvironmental individual actions are sometimes blocked by limited market availability, prohibitive costs, and some government regulations (as we have discussed in prior chapters), psychologists can further study the factors that affect people's voting behavior and their joining of environmental groups (Chapters 4 and 5).

THE GENERAL SUPERIORITY OF "UPSTREAM" RATHER THAN "DOWNSTREAM" SOLUTIONS (OR OF PREVENTION RATHER THAN CURE)

Before we move on, we would like to highlight in this section an important general principle, one that emerged in our litter/solid waste analysis above. The principle concerns different levels at which one can intervene in an attempt to solve an environmental problem, and the preferability of some levels over others. The same principle actually emerged in our analysis of the U.S. energy system, though we didn't note it at the time. The principle will emerge again in our analysis of the greenhouse effect in a later section, and in many, many other examples.

Going back to the solid wastes analysis, recall that the four waste strategies discussed in the section above form a progression, or hierarchy, of environmental desirability. This is shown in Figure 10-1. Waste prevention is generally more desirable than reuse; reuse is generally more desirable than recycling; and recycling is generally more desirable than discarding (Stern and Gardner, 1981b; Young, 1991). In discussing progressions of this type (and not just this particular progression of solid wastes), ecologists and other scientists often use the terms *upstream* and *downstream,* as follows: Strategies that attempt to solve an environmental problem by intervening on the left end of a progression like the one in Figure 1 are called "upstream" strategies; those on the right are called "downstream" strategies (Fischhoff et al., 1978; Hohenemser et al., 1983).

Technical analyses of many environmental problems reveal that upstream intervention strategies are

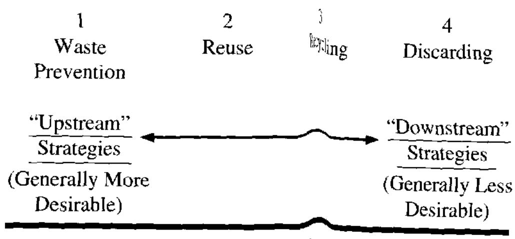


FIGURE 10-1 Order of Preference of Four Solid Waste Treatment Strategies

These resources and the energy now wasted by dumping garbage in landfills can be recovered via an alternative to dumping known as *recycling.* In recycling, aluminum, glass, paper, and other recoverable materials in solid wastes are separated and then used to manufacture new cans, bottles, newsprint, and so forth. Recycling saves large quantities of energy and raw materials: For example, the manufacture of aluminum beverage cans from melted-down discarded cans consumes 95 percent less energy than mining and processing raw aluminum ore. It also produces 97 percent less water pollution and 95 percent less air pollution (Miller, 1990). Overall, Miller (1990) claims, a comprehensive national recycling program "could save 5% of annual U.S. energy use—more than the energy [now] generated by all U.S. nuclear power plants." Recycling, in turn, requires either voluntary efforts by citizens to collect and sort wastes (and sometimes deliver the sorted wastes to neighborhood recycling centers), or voluntary efforts motivated, in part, by beverage container deposits, or mandatory citizen efforts (ones required by law). In some cases, the sorting and separating of collected wastes is done at a central municipal garbage processing plant.

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usually superior to downstream strategies. This superiority repeatedly emerges for a surprisingly diverse set of problems. The superiority of upstream solutions appears to be a manifestation of an even more general prevention versus cure principle, as in the folk expression "An ounce of prevention is worth a pound of cure": It is usually better to stop or prevent *any* problem at its source than it is to deal with the negative consequences of the problem after they have already occurred.

There are many examples of the superiority of upstream solutions in the areas of air and water pollution. Thus, stopping the emission of a harmful chemical air pollutant at its source is usually less expensive and more effective than trying to clean up the pollutant after it is already out of the smokestack and widely dispersed. In some cases it is essentially impossible to cleanse the environment of dispersed nondegradable pollutants—for example, those that have found their way into underground drinking water aquifers or into the world's oceans.

Our discussion earlier in the chapter of the greater effectiveness of energy conservation actions that increase efficiency versus those that curtail the use of existing equipment may be seen as another example of the same general prevention versus cure principle. Thus, trying to save energy by curtailing the use of intrinsically wasteful automobiles, appliances, heating systems, and so on, is less effective than adopting equipment that wastes less energy by design.

Yet another, though similar, example of the principle involves auto exhaust emissions. Federal regulations in the 1970s required automakers to redesign vehicles so as to greatly reduce these emissions. The required reductions were much sharper than people's curtailed use of older, more polluting cars could reasonably have produced. Specifically, between 1976 and 1981 the permissible levels of hydrocarbons, carbon monoxide, and nitrogen oxides emitted by new autos dropped by 73 percent, 77 percent, and 68 percent, respectively (Stern and Gardner, 1981b). Again, it is hard to imagine people's decreasing their driving of older, pollution-emitting cars enough to produce so large an effect.

In Box 10-2, we further discuss the preferability of upstream versus downstream intervention strategies (or of prevention versus cure). First, we illustrate the basic principle and its generality using a nonenvironmental example—fire safety in the home. We then present a new environmental example concerning agricultural pesticides.

BEHAVIORALLY ORIENTED ANALYSES OF GLOBAL ENVIRONMENTAL PROBLEMS: THE GREENHOUSE EFFECT AND GLOBAL CLIMATE CHANGE AS AN EXAMPLE

In previous sections of this chapter, we presented behaviorally oriented analyses of energy and solid waste problems in the United States. Analyses like these help psychologists identify the individual and household behaviors responsible for an environmental problem, and the behavior changes most effective in solving the problem. Such analyses can be similarly helpful in the case of global—rather than regional or national—environmental problems. Global analyses are, however, more difficult to carry out. For one thing, ecologists, meteorologists, and other scientists do not yet completely understand the ecological processes underlying such global problems as the greenhouse effect and global warming (as we noted in Chapter 1). Second, data that can help us identify the best individual/household behavior-change targets are either not available, or are available but require complex analyses yet to be carried out (Stern et al., 1992). With these limitations in mind, consider, below, a very brief behaviorally oriented analysis of the greenhouse effect and global warming.

The Analysis

To begin our greenhouse/global warming analysis, we look at the major types and amounts of greenhouse gases released into the atmosphere by human activity. Recall from Chapter 1 that these gases act like the glass windows of a greenhouse, allowing light from the sun through but trapping the resulting heat and reflecting it toward the ground. The most important of these gases appear as *column headings* in Table 10-4. The percentage that each gas contributes to the overall global greenhouse effect appears at the bottom of each column. Thus, carbon dioxide emissions are respon-

Box 10-2

More on "Upstream" versus "Downstream" Solutions, and Prevention versus Cure

As mentioned in the text, "upstream" solutions to environmental problems are usually superior to "downstream" solutions; in other words, prevention is usually better than cure. (There are, however, exceptions, and cases in which upstream solutions can't be used; for example, we can't use source reduction or reuse for all types of solid wastes, as we pointed out in the main text).

Let's further explore the superiority of upstream solutions by means of the following two examples. The first, a nonenvironmental example concerning home fire safety, illustrates the broad generality of the prevention versus cure principle; that is, for quite a wide variety of subject matters, it is usually better to address a problem at its origin, rather than trying to alleviate (or mitigate) the negative consequences of the problem after they have already occurred. The second example is an environmental one, not discussed in the text, concerning agricultural pesticide use.

The generality of the "prevention versus cure" principle: Fire safety in the home. This simple, prosaic example, adapted from Fischhoff et al. (1978) and Hohenemser et al. (1983), involves the risks posed by a fire burning in a home fireplace. The fire occasionally shoots sparks into the room that could ignite the clothing of people nearby and lead ultimately to injury or even worse. Figure 10B2-1 shows a causal sequence of fire-related events that unfold over time that could lead to a person's death.

Note that the figure shows five different levels at which we can intervene in an effort to prevent or address the negative outcomes or consequences caused by the flying sparks. The least desirable level of intervention is, clearly, the last, or fifth level—the

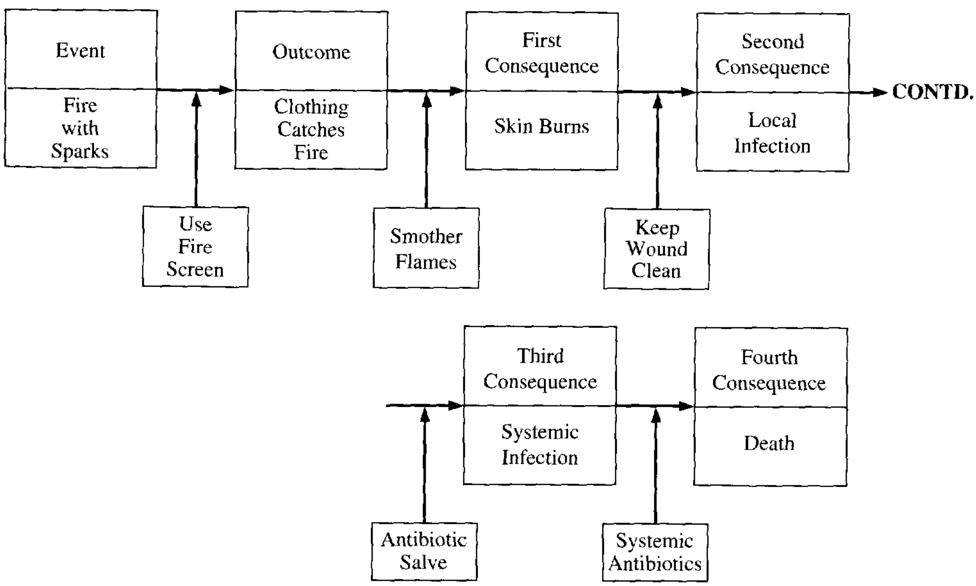

FIGURE 10B2-1 Fire Causal Sequence

Adapted from Fischhoff, B., Hohenemser, C., Kasperson, R., and Kates, R. Handling hazards. *Environment,* Volume 20, 16–20ff. Reprinted with permission of the Helen Dwight Reid Educational Foundation. Published by Heldref Publications, 1319 Eighteenth St., N.W., Washington, D.C. 20036. Copyright 1978.

(continued)

BOX 10-2 Continued

use of systemic (whole-body) antibiotics to treat a systemic infection caused by the burn from the ignited clothing. At this level, the person faces a direct and immediate threat to his/her life. Obviously, it would be much better to intervene one level earlier—the fourth level, that is, use topical antibiotic ointment to prevent the localized skin infection caused by the burn from becoming a systemic infection. Better still would be to keep the wound from the burn clean so as to prevent even a local infection. Even better would be to use a fire extinguisher or blanket to put out the clothing fire before it burns the skin. The best intervention, however, is to place a wire-mesh screen between the fireplace and room occupants to prevent sparks from igniting someone's clothes in the first place.

Once again, we see that—as with many other examples from diverse subject matters—upstream solutions are usually more effective and desirable than downstream solutions.

An additional environmental example: The impacts of agricultural pesticide use. The second example, also from Fischhoff et al. (1978) and Hohenemser et al. (1983), concerns a cancer-causing chemical pesticide used in agriculture. As shown in Figure 10B2-2, the pesticide is applied to farm fields to lessen insect damage to food crops. However, after the pesticide is applied to the fields, some of it runs off into adjacent bodies of water. The fish that live in these bodies of water then ingest the pesticide, which produces pesti-

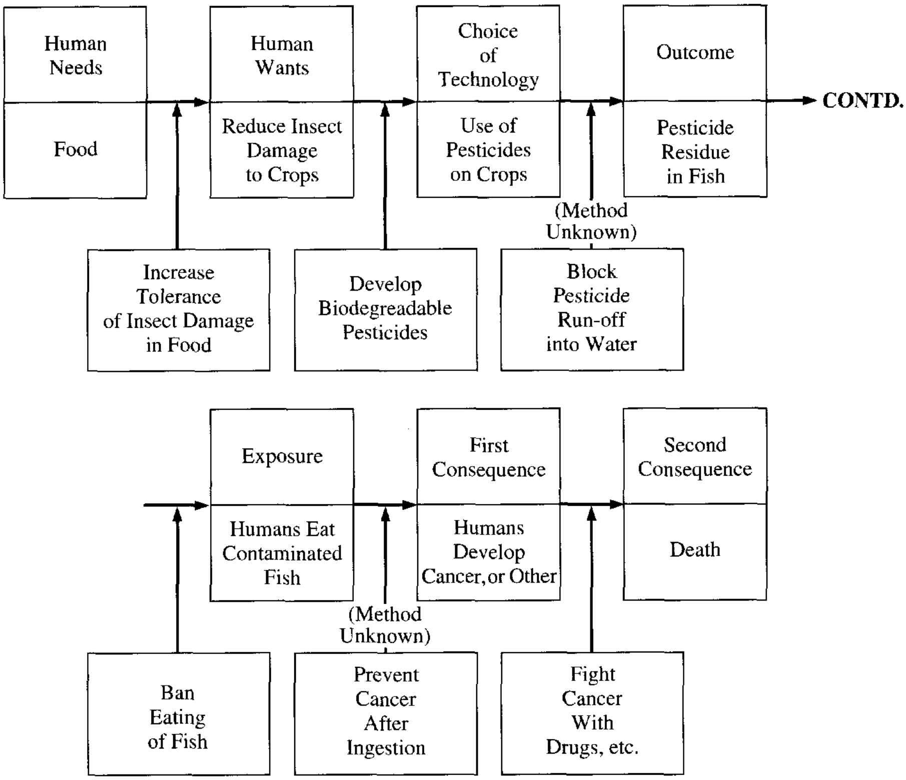

FIGURE 10B2-2 Pesticide Causal Sequence

Adapted from Fischhoff, B., Hohenemser, C., Kasperson, R., and Kates, R. Handling hazards. *Environment,* Volume 20, 16–20ff. Reprinted with permission of the Helen Dwight Reid Educational Foundation. Published by Heldref Publications, 1319 Eighteenth St., N.W., Washington, D.C. 20036. Copyright 1978.

cide residues in their flesh. These chemical residues, in turn, pose a potential cancer threat to people who eat the fish.

Note that in this example there are *six* different levels of intervention, as shown in Figure 10B2-2. As is true for the other examples we have discussed, the upstream solution strategies are preferable to the downstream strategies. Indeed, in this case, two of the more downstream strategies are simply not physically possible: There is no currently known way to block the biological action of carcinogens once people ingest them. Similarly, it is not possible to block a chemical widely dispersed in farm fields from running off into adjacent streams, lakes, and oceans.

A more desirable upstream solution would be the development of agricultural pesticides that do their job and then quickly degrade upon exposure to weather. (An alternative to this is the use of agricultural practices that are more organic and that minimize the need for chemical pest control.) An even more upstream intervention would be to change people's tolerance to (presumably minor and nonharmful) insect damage in food.

Causal models and the identification of upstream solutions. Fischhoff, Hohenemser, and their colleagues urge scientists, government policymakers, and others interested in any given environmental problem to develop a complete causal model of the problem, similar to the two models shown in the figures above. Efforts to develop such a model force the individuals involved to consider the full range of possible solutions to the problem, or points of intervention, especially upstream solutions, that might otherwise not come to mind.

Unfortunately, Fischhoff et al. (1978) note, the use of fully developed causal models and of far-upstream solution strategies is, so far, not common in environmental policymaking. Fischhoff et al. discuss several possible reasons for this, which are beyond the scope of our treatment here. We do, however, discuss in Chapter 11 psychological reasons—not addressed in this chapter—that help explain why humans tend to address the highly visible and downstream symptoms of complex environmental problems, rather than less visible underlying and upstream causes.

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sible for 55 percent of the overall greenhouse effect, CFCs (which do double duty because they also damage the ozone layer) are responsible for 25 percent, methane for 11 percent, and nitrous oxide for 6 percent.

Each *row* of Table 10-4 refers to a particular *human activity* that causes the release of a greenhouse gas or gases. *Human activity* in this table refers to the activity of *all sectors combined,* that is, the individual/household sector plus the industrial sector plus the commercial sector, and so on. Note that "fossil fuel burning" includes the burning of gasoline, fuel oil, other petroleum products, and also coal, in auto engines, boilers in electric plants, industrial furnaces, home heating equipment, and so on. "Biomass burn" refers to the clearing and burning of tropical forests. "Paddy rice" and "fertilization" refer, respectively, to the cultivation of rice in paddies and the use of agricultural fertilizers.

The percentage that each human activity contributes to the overall global greenhouse effect appears at the end of each row (on the right). Note that *fossil fuel burning* causes almost half (46.5 percent) of the global greenhouse effect; it is by far the single human activity most responsible for the effect.

More on Fossil Fuel Consumption

Because fossil fuel burning plays such an important role in the greenhouse effect and global warming, we give it a closer look. Specifically, we examine how much fossil fuel each sector consumes (individual/household, industrial, and commercial/service sectors), and how much each end-use consumes (transportation, space heat, and so on). The only relevant data we have found so far are for the United States. These data appear in Tables 10-5 and 10-6. Please note that U.S. fossil-fuel use is *not* representative of fossil–fuel use in other parts of the world. Thus, the data in the tables do not necessarily generalize to other countries. On the other hand, the United States is responsible for approximately 20 percent of global carbon dioxide.

Table 10-5 shows that the individual/household sector is responsible for only about 35 percent of all fossil fuel consumed in this country. The industrial

TABLE 10-4 Estimated Relative Contributions of Human Activities and Greenhouse Gases to Overall Global Warming (Figures Are from the 1980s)

HUMAN ACTIVITY	GREENHOUSE GAS					
	CARBON DIOXIDE	CFCS	METHANE	NITROUS OXIDE	OTHER	TOTAL
Fossil fuel burning	42%		3%	1.5%		46.5%
CFC use		25%				25%
Biomass burn	13%		1%	1%		15%
Paddy rice			3%			3%
Cattle			3%			3%
Fertilization				2%		2%
Landfills			1%			1%
Other				1.5%	4%	5.5%
TOTAL	55%	25%	11%	6%	4%	101%*

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*Total is greater than 100% due to rounding of individual entries.

and commercial sectors are responsible for the other 65 percent.

Table 10-6 shows that within the U.S. individual/household sector, transportation and space heat are the end-uses that by far consume the most fossil fuel. Therefore, the conservation of fossil fuel used for these two end-uses has the greatest potential to lessen production of carbon dioxide, the main greenhouse gas.

The main findings shown in Tables 10-5 and 10-6 concerning the limited role of the individual/household sector, and the major role of transportation and space heat within that sector, should seem familiar to you. These findings duplicate two main findings from the U.S. energy system analysis we presented earlier in this chapter. Actually, these similarities between the fossil fuel analysis and the energy system analysis are not surprising, given that fossil fuel combustion—rather than solar power or nuclear power—is the main primary energy source in the United States. Specifically, fossil fuels account for approximately 90 percent of all energy consumed in this country each year (Miller, Jr., 1992).

Going a step further, we may infer that those individual/household behaviors identified earlier in the chapter as saving the most *energy* are also the behaviors most effective in reducing *fossil fuel burning* and the release of carbon dioxide. We thus find ourselves, once again, talking about the greater effectiveness of such efficiency-increasing actions as insulating homes and buying fuel-efficient autos, over actions that curtail the use of existing energy equipment. Sound familiar?

The Energy Crisis, Revisited

Though we again find ourselves discussing energy and its conservation, note that we do so in a very

TABLE 10-5 Estimated Percentage of Total Fossil Fuel Use by Economic Sector, for U.S. Only*

SECTOR	%
Household/individual	35
Industrial	43
Commercial/service	22
Total	100

From Congressional Research Service data quoted in the *Washington Post*, 3/10/90, p. A8.

*U.S. data are *not* representative of world fossil fuel use in various ways.

TABLE 10-6 Estimated Percentage of Total Individual/Household Sector Fossil Fuel Used for Different End-Uses, U.S. Only*

END USE	%
Transportation:	
Subtotal	40
In home use:	
Space heat	23
Motors and appliances	14
Water heat	11
Lighting	6
Cooling	6
Subtotal	60

From Congressional Research Service data quoted in the *Washington Post*, 3/10/90, p. A8.

*U.S. data are *not* representative of world fossil fuel use in various ways.

different context from before. The energy crisis of the 1970s discussed at the beginning of the chapter (the Mason and Wilson story) centered on energy supply problems: shortages, embargoes, U.S. dependence on a politically unstable part of the world, and the depletion of nonrenewable fossil fuel reserves. In the 1990s, several of these supply issues are still with us, though they may not be on the public's mind as much.

However, the critical new dimensions of the energy problem in the 1990s involve the gaseous by-products of fossil fuel combustion (Kempton, 1992). As we have just seen, the carbon dioxide produced is the single biggest cause of the greenhouse effect and global warming. Keep in mind that carbon dioxide *is not a "pollutant"* but an inevitable and unavoidable by-product of fossil fuel combustion, as Kempton (1992) points out. It is therefore unlikely that technological fixes, like the antiemission controls in today's autos or the "fluidized bed" combustion methods used in factories, will arise that will eliminate carbon dioxide emissions or keep them from reaching the atmosphere.

Of course, the other by-products of fossil fuel combustion—sulfur oxides, nitrogen oxides, volatile organic compounds, and particulates—cause other serious environmental problems: acid rain, which damages forests and lakes, and urban smog, which poses a health threat to hundreds of thousands of city residents (Miller, Jr., 1990).

To summarize: The use of fossil fuels as a primary energy source is now causing a diverse set of major problems: The gaseous by-products of fossil fuel combustion contribute to global climate change, as well as to local and regional air and water pollution. The dependence of industrial nations on politically unstable petroleum-producing nations adds to global tensions. And humankind is consuming finite and nonrenewable fossil fuel reserves at a rapid rate. Virtually all of these problems can be lessened and ultimately solved by means of energy conservation measures, especially those that increase energy efficiency, and by a switch from fossil fuels to renewable and nonpolluting sources such as solar energy. This is the inevitable future path that global energy use must take, and a path that psychologists can play a role in helping society follow.

CHOOSING TARGET BEHAVIORS: EARTH DAY 1990, AND THE AS-MANY-AS 750 EVERYDAY THINGS YOU CAN DO TO HELP SAVE THE EARTH

Our major theme in this chapter has been the need for psychologists to choose the most important and effective public target behaviors in their efforts to lessen or solve environmental problems. These choices must be based on data and expertise from fields outside of psychology. There is no other way for psychologists to proceed, given the imperfect nature of human behavior and the real world. Humans have limited information-processing capacity (as we discussed in Chapter 9) and limited time and energy, and can therefore engage in only a limited set of behavior changes or new behaviors. Likewise, government programs, media campaigns, evaluation studies, and so on, are of limited size, scope, and budget, and can only try to encourage a limited set of proenvironmental public behaviors. (Of course, as we discussed in Chapters 4 and 5, taxes that increase the prices of gasoline, electricity, etc., can simultaneously encourage a large number of proenvironmental behaviors; but even for these, media campaigns still need to convey information on the behavior changes that conserve the most energy.) We are therefore forced to carefully choose a limited number of target behaviors to encourage—the behaviors that have the greatest proenvironmental impact, that is, that get "the most bangs for the buck."

Although, so far in this chapter, we have critiqued psychologists for failing to choose the most effective public target behaviors, in this last section of the chapter, we critique *ecologists and experts in related fields* and also *environmental groups.* These individuals and groups have the expertise to perform the quantitative analyses needed to choose the most effective target behaviors, but they have sometimes failed to do so, or have failed to make clear to the public the target-behavior priorities suggested by their analyses.

We specifically have in mind the ecologists and the environmental groups that had a role in organizing Earth Day 1990, an event, which—like its predecessor, the original Earth Day in 1970—was one of the largest educational and media events about the environment that ever took place in this country. In hundreds of American schools, colleges, and universities, thousands of people learned more about air pollution, water pollution, toxic chemical wastes, and the depletion of fossil fuels and other nonrenewable natural resources.

Probably the most publicized, often quoted, and widely distributed book published in connection with Earth Day 1990 was one entitled *50 Simple Things You Can Do to Save the Earth,* by the Earth Works Group; (note that an edition of this book was published by the Natural Resources Defense Council). A similar, though less well publicized and distributed, book was *Save Our Planet: 750 Everyday Ways You Can Help Clean Up the Earth,* by Diane MacEachern.

These and several other books attempted to answer a question that millions of environmentally concerned Americans were asking: "What, exactly, can I and my family do to help solve regional and global environmental problems?" Each book featured a long list of specific recommended proenvironmental individual/household actions—in some cases, hundreds of such actions. The recommended actions ranged from the small (e.g., Don't waste water by letting the faucet run while you brush your teeth) to the large (e.g., Start a comprehensive solid waste recycling program in your community). The environmental problems addressed ranged broadly, and included regional air and water pollution, toxic wastes, destruction of tropical rain forests, depletion of energy resources, and global warming.

Although the numerous individual/household actions recommended in these books were clearly valid and constructive, none of the books ranked the listed actions in order of importance—a significant shortcoming. Again, humans can devote only so much information-processing capacity, time, and effort to solving environmental problems (or any other problems). Few individuals can perform fifty, let alone several hundred, specific actions. Readers of these books, therefore, very much need to know which are the most important and effective actions to take so that they can at least take those actions. The issue is, again, the need for ecologists and environmental groups writing books for the general public to identify the most important proenvironmental individual/household actions, that is, the actions that yield the most proenvironmental bangs for the buck.

Given that a ranking of actions is desirable, the question then becomes: How should the quantitative analysis to produce the ranking be carried out? It is much easier to determine which individual and household behaviors will conserve the most energy than it is to determine which behaviors will have the greatest overall proenvironmental impact. An overall ranking is difficult because there are many different global environmental problems to be considered, including the greenhouse effect, ozone layer destruction, water pollution, depletion of resources, and so on.

However, "difficult" needn't mean "impossible." Alan Durning, a senior researcher at the Worldwatch Institute in Washington, D.C., has noted the lack of rankings in the books discussed above and has actually proposed an overall ranking, at least a very general one (Durning, 1990). Durning is a coauthor of the Worldwatch Institute's widely read annual "State of the World" reports. These describe the results of comprehensive environmental "physical exams" of the Earth. The annual exams look at a broad set of global and regional pollution, population, and resource-depletion problems. Durning and the institute are thus in a good position to look broadly at environmental problems and rank their importance as well as the effectiveness of different possible individual and household corrective actions.

Durning chooses as most serious the multiple global and regional problems caused by fossil fuel combustion—the problems we discussed in the section directly above. The major individual/household action he recommends is, not surprisingly, the conservation of energy. Durning writes:

> *The most tenacious and threatening environmental challenges facing industrial countries—things like air pollution, acid rain, and the greenhouse effect—are by-products of burning massive quantities of fossil fuels. . . . Consequently, most people's first priority should be to minimize energy consumption both at home . . . and in transportation. . . [p. 40].*

Durning also notes that individual/household energy conservation is best achieved by increases in energy efficiency, as we stressed earlier in the chapter.

Durning ranks second in priority the "waste disposal crisis and the enormous energy squandered by a throwaway society." His third priority involves water conservation problems. (He goes on in his article to list problems of lower priority.)

We've discussed above the lack of a rank order of environmental problems or recommended actions in the several books published for Earth Day 1990. We'd like to go a step further and suggest that the *order of appearance* of actions recommended in each book provides an implicit rank ordering for the reader: Those actions discussed early in the book are more likely to be read and attempted by readers than actions that come later in the book. Further, the order of appearance of the actions in the books may not be optimal terms of overall proenvironmental impact.

As an example, let's consider briefly the *50 Simple Things You Can Do* book and focus on Durning's first priority of conserving individual/household energy. Twelve of the fifty "things" in the book concern energy and its conservation; approximately nine of the twelve involve increasing efficiency rather than curtailment, which, as we have argued in this chapter, is good. However, consider the order of some of the energy efficiency things as they appear in the book: Increasing hot-water-heater efficiency is the *sixth* "thing"; proper auto tire purchases and maintenance is *ninth*; buying an energy-efficient car and keeping it in tune is *fourteenth*; and insulating and weatherizing one's house is *thirty-eighth.* A comparison of these implicit rankings with the data in Table 10-3 on the effectiveness of different individual/household conservation actions suggests that the ordering of actions in *50 Things* is not an optimal one.

However, we should also point out that the more effective energy efficiency actions just mentioned, like buying a fuel-efficient car, and insulating and weatherizing your home, are not "simple" actions and are thus not the main focus of a book called *50 Simple Things. . .* ! In fact, the book is divided into three sections: twenty-eight simple things, fourteen "takes some effort" things, and eight things "for the committed." Finally, consider the discussion in Chapter 4 of commitment and of overcoming behavioral inertia. These psychological phenomena justify putting very small and simple actions at the beginning of a book, though such actions may not have great direct proenvironmental impact.

But, on the other hand, and holding all other things equal, a simple but important principle remains: Given that people can take only a limited number of proenvironmental actions, it's vital to identify and emphasize the most important and effective actions.

NOTES

1. Data for 1992 from the Energy Information Administration are broken down in slightly different categories than the data in Table 1. Based on some extrapolating and recombining, we arrived at the following approximate figures: Household/individual: 34 percent; Industrial: 37 percent; Commercial/service: 22 percent; Other, 7 percent.

2. The only more recent data relevant to Table 2 that we could locate—from the U.S. Department of Energy for 1984 (source is Miller, Jr., 1990, p. 416)—are broken down in different ways than are the data in the Table. Based on some extrapolating and recombining, we arrived at the following approximate figures: Transportation: a subtotal of 42 percent, consisting of Auto, 37 percent; and Other 5 percent. In Home Use: a subtotal of 58 percent, consisting of Space Heat, 29 percent; Water Heat, 8 percent; Refrigeration, 5 percent; Lighting, 5 percent, Air-Conditioning, 5 percent; and All Other, 6 percent.

3. For a more complete discussion of "net energy" analyses, see, for example, Odum and Odum (1976). Note also that interactive effects among actions are not considered in the table; the total savings from a series of actions is generally less than the sum of the percentages saved by each action alone.

4. *Visibility* may seem like the *availability* concept we discussed in Chapter 9. However, cognitive psychologists define *availability* in a specific way and use the concept mainly to explain people's judgments of the *probability of future events.* People use the availability heuristic when they judge the probability of an event in direct proportion to the ease with which they can recall and/or imagine instances of the event. Psychologists use the availability concept to explain, for example, why people underestimate the likelihood of hazards that they have not personally experienced: People find it difficult to imagine or recall instances of such hazards.