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In. R.S. Chen, E. Boulding & S.H. Schneider (Eds.), Social science research and climate change: An interdisciplinary perspective. Dordrecht, Holland: D. Reidel (1983).

PSYCHOLOGICAL DIMENSIONS OF CLIMATIC CHANGE

1. Coping with Climatic Change: A Decision Problem

The prospect of CO_2-induced climate change poses a series of interlocking decisions to be made by individuals and groups, national and international bodies. At each level, people must decide whether the problem is worth attending to and if so, should efforts be made to prevent the build-up from happening (e.g., by drastically restricting the consumption of fossil fuels), to implement curative schemes (e.g., massive reforestation programs), to adapt to the new world we are creating (e.g., by developing new crops or moving large populations) or to promote the build-up (for those who hope to benefit from the change). Each decision requires an assessment of what is happening, what the possible effects are and how well one likes them. The quality of these assessments at one level constrains the wisdom of the decisions made at others. Failure of the U.S. to adopt a coherent policy is likely to thwart any international effort. Absence of international cooperation may lead U.S. consumers to ask "why should we drive less when the Brazilians provide tax incentives for logging out the Amazon?" We are all in trouble if the climatologists seriously understate or overstate how much they know. How such assessments are made, by consumers, legislators, diplomats or scientists, would seem to be eminently psychological questions.

Like other decision problems, CO_2-related questions require a choice between alternatives. What distinguishes them is the magnitude of the stakes involved and the very difficult choices posed by the various decision options.

Whether done formally or informally, examination of the alternatives in a decision problem involves the following five interdependent steps:

(1) Specifying the objectives (i.e., what one wants),

(2) Defining the possible alternatives (including "do nothing"),

(3) Identifying the possible consequences of each alternative (including, but not restricted to, risks),

(4) Specifying the desirability of the various consequences and the likelihood of their being achieved, and

(5) Comparing the alternatives and selecting the best one.

The initial steps describe the problem as it is perceived by the decision maker, whereas the final step is prescriptive, in the sense of prescribing the option that should be selected (given the logic of the analysis).

Cost-benefit analysts, decision analysts, operations researchers, management scientists and others have devoted their careers to implementing this simple scheme in complex situations. Although based on an appealing premise and supported by a sophisticated methodology, these procedures have a number of characteristic limits on their usefulness as management tools. These limits arise when the mathematical formalisms confront the

R. S. Chen, E. Boulding, and S. H. Schneider (eds.), Social Science Research and Climate Change: An Interdisciplinary Appraisal, 180–203.

fallible individuals who must conduct, accept, or implement them. Be they technical experts, lay interveners or government regulators, these individuals all have, to some extent, limited capacity to process technical information, restricted resources to devote to the project at hand, irrational apprehensions about its consequences, intransigent prejudices about the facts of the matter, ulterior motives, and incoherent and unstable values on critical issues. Deliberately or inadvertently, these human properties tend to foil the best-laid plans of the purveyors of decision-making schemes (Fischhoff, 1979).

If such schemes are hard to implement when one tries to do so, it seems unlikely that they would be a very good description of unaided decision making (Fischhoff *et al.*, 1982). Predicting the decisions of others is nonetheless a crucial aspect of coping with the possibility of climatic change. The policy maker must anticipate the answers to questions like: will the public perceive this change as a possibility? Will they choose to adapt a conservation ethic? What economic incentives are available or efficacious? Will people respond to the international and intranational conflicts resulting from climate change cooperatively or belligerently? What will various groups perceive as their own best interests? Are people willing to make sacrifices for the common weal?

The following pages describe five major research projects designed to improve our ability to cope with possible CO_2-induced climatic change. Each promises to improve our ability to make deliberative decisions and to understand intuitive decisions. Understanding how various kinds of people make decisions naturally is a precondition for providing them with the information and aids needed to make better decisions. Although a decision-making framework is used as an expository device, these projects draw on the talents of individuals from a variety of areas in psychology (in addition to decision making). Moreover, each contains a description of the other disciplines that could most usefully be involved. A concluding section describes the interdisciplinary and international perspective we believe to be necessary to the success of the entire CO_2 research enterprise. The exposition draws examples from other contemporary problems, both because there is no corpus of research on these topics directed explicity at CO_2 issues and because the results of the proposed CO_2 research would have relevance for coping with those other problems.

The five projects are:

(1) Identifying and characterizing subjective aspects of the "facts" of CO_2-induced climatic change. Where does judgment enter into the work of experts and their communication of that work? Where do questions of fact and of value intermix? How good is expert judgment? How well are experts able to assess the definitiveness of their own work?

(2) Understanding and improving lay decision makers' understanding of the facts of CO_2-induced climatic change. How do they interpret (often conflicting) expert testimony? Is such testimony about climate consistent with their direct sensory experience with weather; if not, how are conflicts resolved? What kinds of information pose particular conceptual problems (e.g., very low probabilities, interaction of long-range cycles with varying periodicity)? How can such problems be remedied, so that best use is made of available scientific evidence?

(3) Clarifying and enriching the space of possible action options. What options naturally occur to (different groups of) people? How is feasibility judged? How can the set

be enlarged? What consequences (or side effects) tend to be overlooked? In what ways are decision makers prisoners of their own experience?

(4) Understanding how the alternative responses to climatic change are evaluated. How do people combine multiple and conflicting costs and benefits, on different dimensions with varying degrees of risk, and arrive at a single decision? How can people's values be elicited, so as to inform government officials (e.g., are traditional surveys adequate)? How can elicitation methods (e.g., survey techniques) distort the values expressed through them?

(5) Anticipating conflicts and developing means for their resolution. How will climate change pit nation against nation, group against group? What commons dilemmas exist today and will be created in the future? Can frameworks be developed to aid their resolution? What sorts of mistrust and misunderstanding might emerge and might be avoided?

2. Project 1. Identifying and Characterizing Subjective Aspects of the "Facts" of CO_2-Induced Climatic Change

2.1. Primary Research Questions

(1) Where do subjective judgments enter into scientific analyses?
(2) How valid are those judgments?
(3) How well are experts able to identify and assess such judgments?
(4) How can we make better use of our experts by having a better appreciation of the limits of their abilities?

2.2 Background

For the threat of climatic change to assume a respected place among the constellation of problems about which people are concerned, they must be convinced that it is a reasonably likely occurence. Unfortunately, assessing the probability of such extreme events can be a very difficult business. At times, it is possible to identify a population of events from which a sample may be drawn as a step toward assessing the probability of the event in question. The copious records of ice pack movements maintained in Iceland over the last millenium provide a clue to the probability of an extremely cold year in given future periods. The apparent absence of a full-scale meltdown in the 1000 or so years of nuclear reactor operation may allow setting some bounds on the probability of future meltdowns. Of course, extrapolation from any of these historical records is a matter of judgment. Changes in design, public scrutiny and federal regulation may render the next 1000 reactor years appreciably different from their predecessors. The new conditions created by increased CO_2 concentrations may change climatic variability in a way that amplifies or dampens yearly or daily fluctuations.

Even if experts were to agree on the relevance of these records, a sample of one thousand reactor- or calendar-years may be insufficient. Given the magnitude of possible consequences, a 0.0001 chance of a meltdown might be deemed unconscionable, but we will be well into the next century and irrevocably committed to nuclear power and its consequences before we will have enough hands-on experience to assess the probability of a meltdown to the desired accuracy. We know that meltdowns are unlikely (in the

present sense), but whether they are unlikely enough may not be known until it is too late or may not be known at all.

When no historical record is available upon which to base conjectures, one is left with conjecture alone. In the scientific community, the more sophisticated conjectures are based upon models. General circulation models (GCM's) represent one such genre; the fault trees analyses of a loss-of-coolant accident upon which the "Rasmussen" Reactor Safety Study was based (NRC, 1975) represent another. Both focus on component processes and the interactions between them, instead of the problem in its full complexity.

The fault tree involves a logical structuring of what would have to happen for a core to melt down. If sufficiently detailed, it will reach a level of specificity for which we have relevant experience (e.g., the operation of individual valves). An overall probability of failure for the system is determined by combining the needed component failures. Unfortunately, some components are entirely novel or have never been used in these particular conditions; their performance parameters must be guessed. Furthermore, the logical structure and completeness of the tree are more or less matter of opinion.

GCM's share the same strengths and weaknesses as fault trees. They attempt to predict the unknown world of heightened CO_2 concentrations on the basis of related observables and their hypothesized interconnections. These are, respectively, recorded atmospheric and oceanographic conditions and generally accepted theories of their dynamic interaction. As with fault trees, some of the data are uncertain and some of the logic is disputable.

Thus, facts about climate are often revealed through the filter of formal analyses rather than through direct experience. One's faith in the results so revealed depends on the success of the analysts in identifying all relevant components, assessing their values, and understanding their interrelations. Recent psychological research suggests some likely bounds on their success and our faith. People apparently have limited ability to recognize the assumptions upon which their judgments are based, appraise the completeness of problem representations, or assess the limits of their own knowledge. Typically, their inability encourages overconfidence (Fischhoff *et al.*, 1977, 1978).

One might hope that the results of previous research conducted on lay people could not be generalized to technical experts, that somehow the latter's substantive knowledge and training would lead to improved judgment when forced to go beyond the available data. Unfortunately, a modicum of systematic data and many anecdotal reports suggest that this is not the case. As a case in point, a high level peer review found that the Recactor Safety Study had greatly overstated the precision of its conclusions (NRC, 1978). The unpleasant surprise at Three Mile Island demonstrated that it had not included all pathways to disaster nor even explicitly raised a number of critical and erroneous assumptions (e.g., that trained personnel would always be available). For their part, GCM's necessarily omit some aspects of the environment believed to be relatively unimportant (for the sake of manageability) and incorporate untested assumptions provided by other disciplines (e.g., that the rate of increase in CO_2 production of the last 20 years will continue unabated in the future, in a world that may have more or less nuclear power, war, recession, and environmental awareness than its predecessor). They seem to be poorly suited for even providing guesses at their accuracy.

If one reads such analyses and the rare subsequent evaluations with an eye to the psychology of the analyst, there seem to be generic sources of error and omission. These

include (a) failure to consider the imaginative ways in which human error can mess up a system (e.g., the Browns Ferry fire in which the world's largest nuclear power plant almost melted down due to a technician checking for an air leak with a candle in direct violation of standard operating procedures); (b) insensitivity to the assumptions an analysis makes about constancies in the world in which the system is embedded (e.g., no major changes in government regulatory policy); (c) overconfidence in current scientific and technological knowledge (e.g., assuming that there are no new chemical, physical, biological, or psychological effects to be discovered); (d) failure to see how the system functions as a whole (e.g., a system may fail because a backup component has been removed for routine maintenance).

2.3. Research Plan

For judgments to be evaluated, they must first be identified. Since individuals often have very little insight into the workings of their own intellectual processes, it is not enough to ask someone, "How did you arrive at that answer?" or "What unstated assumptions guided you?" The first step in this project would be a joint effort by substantive experts and judgment experts to answer those questions with respect to scientific analyses of CO_2-induced climate change. The second step would be an analysis of the resultant answers according to the principles of cognitive psychology, and a review of extant literature to see if there is a basis for trusting or doubting such judgments. A moderate amount of additional empirical work will undoubtedly be necessary. The third would be to devise ways to enhance the performance of technical experts who are involved in assessing the CO_2 climate-change prospects.

At the moment, the intellectual processes of the highly trained are rarely studied. There are, however, research methodologies that could readily be extended to this problem. Some critical questions this research should address are: Are experts any different from lay people in their basic cognitive functioning (i.e., can one generalize to experts from research conducted with lay people)? Does professional training encourage or discourage particular misperceptions? Do technical specialists tend to isolate aspects of the CO_2 phenomenon and its impact rather than integrate their results to a system-wide analysis that includes possible compensating, exacerbating or masking effects? How independent can the opinions of two experts be when they have gone through similar training and specialization? How well do experts understand the limits of their own knowledge? Further research questions arise if one considers experts not as dispassionate interpreters of results, but as individuals strongly motivated to confirm pet theories or satisfy employers.

The knowledge possessed by experts may not always be organized in their minds in the form desired by decision makers or the risk analysts paid to help them. For example, an experienced mechanic who sees problems as they come in to the garage may be ill-equipped to estimate break-down rates or the likelihood of malfunctions co-occurring. Theoretically appealing summary measures of complex situations are of little use if no one can produce them, or if none of the relevant decision makers can understand them. Development of ways to elicit from experts what they know about climate or society will have to be a joint effort of substantive experts and experts in information processing.

A variety of behavioral assumptions underlies many climatological, economic,

agronomic and other theories. Examples might be: the public can be viewed as passive impactees, doing little to shape their own world; energy consumption will continue to grow at historical rates; people will not respond to altruistic appeals. Once spotted, such assumptions are subject to empirical tests. Given the large cumulative impact of small changes in, say, energy consumption rates on the conclusions of analyses, such tests and corrections can markedly change the climate picture.

Experts bring with them to any problem an image of its dimensions. This problem definition mixes issues of fact and value. By ignoring some topics and giving little weight to others, it can largely determine the subsequent decision. One would like to know what consequences and strategies they consider (or reject)? Where do they turn for advice on feasibility? What control strategies are they likely to neglect? In what ways are they captive of untested theories or the failure of basic researchers to study potentially useful topics? Studying any of these topics presumes that outsiders can somehow contribute to the wisdom of the recognized experts in a field. The basis for that presumption is the possibility that although experts have a near-monopoly on the best facts, they may not see problems in the full richness that could be obtained by considering the perspectives of a diverse group of others.

2.4. Research Outcomes

The following products can be visualized: (1) Technical papers reporting the results of research on the nature and quality of expert judgment in assessing the facts about CO_2-related issues. (2) Guides translating the conclusions of these technical reports into a form useful for decision makers outside the expert community (i.e., government, the lay public, intervenors, social critics). (3) Practical procedures for better exploiting the educated intuitions of experts. (4) Regular presentations at meetings to disseminate the most useful results to both experts and lay decision makers (and to assess their perceived needs). The research itself should foster better communication between the experts and the public they serve. The participating discipline should include psychology, statistics, cognitive science and relevant substantive professions.

3. Project 2. Understanding and Improving Lay Decision Makers' Perceptions of the Facts of CO_2-Induced Climatic Change

3.1. Primary Research Questions

(1) How do lay decision makers interpret the fact presented to them by experts?
(2) Is this testimony about climate consistent with their direct sensory experience with weather; if not, how are conflicts resolved?
(3) What kinds of information pose particular conceptual problems?
(4) How can such problems be remedied, so that decision makers can make the best use of available scientific knowledge and the wisdom of their own experience?

3.2. Background

The facts of climate change reveal themselves to experts through the filter of various

research methods, formal models, and professional prejudices, each with their strengths and weaknesses. They reveal themselves to non-experts through unsystematic experience and reports from the front by experts, seers, and the news media that traffic in such reports.

To make use of what the experts report, one must understand both the substance of their message and the qualifications that (should) accompany it. An obvious limit on our ability to understand substance is having the report couched in unfamiliar technical terms. These can mislead (say, when technical terms have common language counterparts with different meanings), confuse (perhaps leading us to think that we understand when we really do not) and dissuade us from even attempting to understand.

Obviously, most scientific problems afford opportunities for asserting some sort of elite control. However, even well-meaning attempts to inform the public may go astray. CO_2 issues make a terrific chalk talk, but their impact may be lost if care is not taken to draw causal links between its parts (Tversky and Kahneman, 1980), particularly those links connecting human behavior and climatological consequences. Without such explicit ties, a CO_2 crisis may appear implausible as well as improbable. On some level, it may be hard to believe that global cataclysm might be the result of such innocuous and sensible acts as lighting home fires and burning leaves. The CO_2 problem represents a global commons dilemma in which seemingly inconsequential individual decisions combine to produce universally adverse consequences in the long run. Although moralizing might lead to more prosocial behavior (Dawes, 1980), it is likely to have little effect until recipients are convinced that a dilemma exists.

Even if people are willing to listen, it may be difficult to present low probabilities to them comprehensibly. Is, for example, the difference between 0.001 and 0.0001, so stated, meaningful to people? Scattered evidence suggests that people may ignore or exaggerate probabilities in that range (Slovic *et al.*, 1977; Lichtenstein *et al.*, 1978). One alternative is to provide a concrete referent in the form of a familiar event with an accurately judged probability of similar magnitude. The efficacy of this (or any other) procedure for communicating low probabilities has yet to be demonstrated.

As a guide to action, the uncertainty surrounding the experts' best guess may be as important as the substance of the guess. One wants to know "just how high could it be?" and "do these experts know enough for me to take their best guess seriously?" A good deal of evidence (e.g., Gettys *et al.*, 1973; Kahneman and Tversky, 1973) suggests that were such qualifications provided, they would not be used properly. In particular, people seem to be as confident making inferences from highly unreliable data as from reliable data, rather than less confident, as statistical theory dictates. If, as suggested above, there is also a propensity for experts to exaggerate how much they know, one should expect a gap between the credibility afforded to scientific analyses and that which they merit.

Another form of credibility problem arises when the integrity of the source is threatened. Most people probably have learned to discount what they see on TV because of its tendency to sensationalize. Whether they are aware of the subtle biases that can enter into scientific analyses may be another question. For example, the very raising of CO_2 questions rather than those surrounding other hazards of potentially greater magnitude may reflect a desire to make life easier for one domestic energy industry (nuclear); not raising them may reflect a desire to obscure international energy issues (the fact that the

industrialized countries are enjoying most of the benefits of creating the CO_2 imbalance whose costs will be borne by everyone). As a counterpoint, one might note that despite the enormous destructive potential of earthquakes in the U.S. and the fairly high likelihood of their occurrence, almost no research is going into improving human response. Seismological research designed to develop the capacity for earthquake prediction is, however, well-funded despite some serious suggestion (National Academy of Sciences, 1978) that the expected value of forecasts is negative, once one considers social reactions to them.

Unlike some environmental "problems", climate is directly experienced. That experience may set us wondering about the likelihood of major climatic changes (say, as did the recent West Coast drought and severe Northeastern winters). Once we are interested, that experience may support or contradict what the experts tell us with regard to CO_2 protections. In other cases, personal experience may be all we have to go on.

How good are we at assessing the likelihood of natural events? Lichtenstein *et al.* (1978) asked people to judge the likelihood of a randomly selected individual dying from a variety of recognizable, but not necessarily common, causes (e.g., botulism, tornadoes, cancer). They found that people (a) had a pretty good idea of the relative frequency of most causes of death, (b) substantially underestimated the differences in the likelihoods of the most and least frequent and (c) persistently misjudged the relative likelihood of those causes of death that are unusually visible (e.g., tornadoes) or invisible (e.g., asthma). Slovic, Fischhoff and Lichtenstein (1979) found a similar pattern of results in estimates of the fatalities from various technological hazards, although this work has yet to be extended to judgments of climate change.

Assessing people's knowledge about risks may be far from easy. A recent study asking people about the lethality of some causes of death (i.e., the probability of dying given that one was afflicted) found that formally irrelevant changes in response mode produced appreciable differences in assessed probability (Fischhoff *et al.*, in press). For example, death rates derived from responses to the question "For every 100 000 afflicted, how many die?" were roughly two orders of magnitude greater than those in response to "For every individual who dies, how many are afflicted but survive?" These differences seem due in part to the effect question format has one how people access their knowledge, and in part to variants of the well-known effects that the design of magnitude estimation experiments has on the results of those experiments (Poulton, 1968). Furthermore, even in situations where people have fairly accurate assessments of observable phenomena, their notion of underlying mechanisms may be quite in error. For example, an atypical period of rainy weather following the first agricultural settlements in the High Plains of the U.S. led to the belief (endorsed by the AAAS) that "rain follows the plow". The more normal drought years following the breaking of the sod resulted in tragic disruption of lives and loss of topsoil (Burton *et al.*, 1978; Opie, 1979).

Although many of the climatic fluctuations and meteorological events that may be affected by possible CO_2 changes have some natural, semi-observable frequency, the event itself does not. In fact, one directly sees little or nothing to indicate that some global dislocation may be on the way as a result of commonplace actions taken by all the earth's denizens. Those who have not heard the cry of alarmed climatologists (e.g., Bryson, 1974; Schneider and Mesirow, 1976) are doubtless worrying about other things. While everybody is doing something about the weather, no one is talking about it. Those

who have heard the cry may "overinterpret" short-term climate fluctuations as evidence of long-term climate change.

3.3. Research Plan

To assess people's knowledge of climate change, one must first establish what it is that they need to know, and then characterize that message with regard to the kinds of information it embodies. For example, understanding climate requires a grasp of information that is surrounded by uncertainty, reflects complex interactions between different variables, can be overwhelming in its volume, often deals with time spans much longer than one's lifetime, expresses very low probabilities, and so on. For any kind of information, one should ask a series of questions: (a) What are its formal properties? (b) What are its observable signs? (c) How are those signs revealed to the individual? (d) Are they contradicted, supported or hidden by immediate experience? (e) Do people have an intuitive grasp of such information? (f) To the extent that they do not have such a grasp, what is the nature of their misunderstandings? (g) How great are such misunderstandings and how severe are their consequences? (h) Does natural experience provide feedback highlighting misunderstandings and inducing improvement?

If we hope to improve as well as predict performance, we must also ask: (i) Can understanding be enhanced, for example, by generating better evidence, developing superior presentations or altering basic approaches to knowledge?

These questions ask, in essence, how adequate people's cognitive skills are for coping with the information they receive. As the previous section indicated, there is an extensive body of psychological methods and knowledge about many of these questions. The application of that body to the climate arena must be systematically tested. In addition, we will need to develop more sophisticated techniques to establish what people know and how they think about climate risk. These techniques will reveal not just a snapshot of summary statistical knowledge, but an understanding of people's thought processes and potential for understanding properly presented risk information. Different procedures will be needed for populations differing in verbal and technical literacy (Whyte, 1977).

Once developed, these tools should be applied both to groups representative of the general population and to special-interest groups, each serving a different purpose. Surveys of the general public would show the potential for concern and misinformation; studies of interest groups would show how that concern is realized among people who have thought more about the issues. Each should, in turn, stimulate further elaboration of research instruments designed to find out: What do people know? What information do they want? What sources do they trust? What does climate mean to them?

The nature of the survey will depend in part upon why it is being conducted. At one extreme, it may be designed to establish how much the public already knows, as a guide to determining how far it should be allowed to make decisions in its own behalf. At the other extreme, perceptions would be studied as part of a concerted effort to enhance the public's decision-making ability. In that case, it might be embedded in an attempt to provide meaningful public participation in climate decisions, identifying areas of weakness with an eye to helping the respondents acquire competence, seeking a defensible basis for differences between lay and expert perceptions (Fischhoff *et al.*, in press, b).

This research on lay perceptions of the facts of CO_2-induced climate change must be international in scope if it is to be of maximum utility. People from different cultures often have very different ways of perceiving and understanding a given phenomenon, and a cross-cultural approach to this research will significantly enhance the eventual coordination of responses to CO_2 buildup on a global scale.

3.4. Research Outcome

The following products can be visualized: (1) Scientific papers extending existing judgment work to perception of climate change and opening new research areas. (2) Surveys of public knowledge and opinion on CO_2-induced climate change and its potential impact; results would guide both decision makers and communication specialists. (3) Guides for experts on presenting climate information, and bulletins to experts on what the public wants to know. The participating disciplines should include psychology, sociology, anthropology, plus some technical consulting from climate and survey researchers.

4. Project 3. Clarifying and Enriching the Space of Possible Action Options

4.1. Primary Research Questions

(1) What options naturally occur to people?
(2) How is feasibility judged?
(3) What consequences (or side effects) tend to be overlooked?
(4) In what ways are decision makers prisoners of their own experience?

4.2. Background

As every politician knows, controlling the agenda in a policy debate is part of a winning strategy. The agenda of a formal analysis, like that of any other decision making process, is embodied in its problem statement. Its terms formally foreclose some decision options by not raising them as possibilities. Other options are effectively eliminated by giving little or no weight to the consequences that they best serve. Experienced participants in technology sieges know the power of definitions. They fight hard to have their concerns reflected in the analytical mandate; failing that, they may fight dirty to impeach the resultant analysis. Comprehensiveness is the key not only to political acceptability, but also to conceptual soundness. Many analysts consider only one option (build the plant) or variants on one option (build it here or there or there), or only alternate forms of the same kind of solution (e.g., pesticide X or pesticide Y). Some neglect even the option of foregoing the project (and the risk that that entails). Ignored consequences do not go away; overlooked options may dominate considered ones. For initial analyses designed to enhance our intuitions by framing the overall decision problem, breadth is more important than depth. Guaranteeing minimal representation to all topics should precede elaborating any one topic with costly numerical or modeling exercises.

There is very little previous research on how individuals or groups formulate alternative action plans when faced with a problem to solve. What we do know from previous

work is that the most successful and creative problem solvers are those who are not burdened by unnecessary assumptions, i.e., those who are able to break out of habitual patterns of thinking and see things from unusual perspectives. What we do *not* know is exactly what facilitates and what impedes creative option generation. Any attempt to predict, prevent, or mitigate the CO_2 effect must necessarily be based on some assumptions regarding human behavior, about what individuals will do (e.g., continue to consume energy at present rates), about what people will value (e.g., efficiency and cost-effectiveness over a clean environment), and about what other regions or nations will do (e.g., switch from fossil fuels to nuclear energy). Unrecognized assumptions are as much a handicap to lay decision makers as to experts, constraining the set of options generated without one's being aware of and able to evaluate that constraint. For example, generation of alternative responses to the predicted CO_2 increase requires some sort of causal interpretation of the phenomenon. If the burning of fossil fuels is considered to be the cause of climate change, then obviously one of the most effective options is to halt the use of fossil fuels. However, research suggests that once one sufficient explanation has been offered for an event, other possible causes are immediately and undeservedly seen to be less likely to have been involved (Shaklee and Fischhoff, 1979). Thus, if both fossil fuel burning and deforestation can cause an increase in CO_2, people may tend to focus on one cause and its management to the exclusion of the other. Witness the greater concentration on modifying the rate of burning fossil fuels than on modifying the rate of deforestation.

Another potential limiting factor on option generation is vested interests. The "logic" of one's own position may make it extremely difficult for Brazilians to conceive of, let alone advocate, halting deforestation; or for anti-nuclear environmental groups to suggest increased reliance on nuclear power; or for Americans to suggest giving up the automobile, as possible courses of action. We need research on what factors exacerbate and minimize the blinders of self-interest. Are people only able to generate action options that have obvious personal value, or are there at least some conditions under which they are likely to think of less self-serving solutions?

An important determinant of generating action options is how one views a change from the status quo. When is a "crisis" perceived as an opportunity or challenge, and when is it viewed as a hardship or disaster? Some agriculturalists see increased CO_2 not as a problem, but as an opportunity, since more CO_2 in the atmosphere increases photosynthesis as well as water use efficiency, and since adaptation to new climatic conditions is considered a stimulus to technological development. Many American settlers who moved west into unknown climate conditions also apparently viewed adaptation to the unknown as a challenge. Yet we know very little about (a) why some individuals and some cultures view change from the status quo as undesirable, while others view it as desirable, (b) why a given individual views certain "crises" negatively, but others positively, and (c) how these differing perceptions affect the way people generate action options.

4.3. Research Plans

Since the set of options is constrained by reality and imagination, a combination of projects is needed. One is a study of how individuals generate a set of possible and reasonable

options. Particular attention should be given to cultural differences, showing how the conceptual space of different groups is limited. The eventual international cooperative effort in dealing with the CO_2 issue will require an understanding of the mental world within which others live. The second project is to exploit this understanding to produce the broadest range of possible responses to the CO_2 phenomenon. It should involve a vareity of disciplines and non-academics, poets, workers, clergy and so on, in hopes that their life experiences will reveal hitherto unconsidered possibilities.

4.4. Research Outcomes

The following products can be visualized: (1) Technical papers on the psychological and social processes governing the generation and evaluation of alternative solutions in problem situations in general and climate change problems in particular. (2) A broad set of possible responses to the CO_2 phenomenon for the consideration of policy and lay decision makers, along with an analysis of their feasibility and value assumption (i.e., the world outlooks they represent, the interests they favor). (3) Active participation of research in scientific and policy-making forums devoted to climate change. Such participation will facilitate accommodating research and scientific and political realities as well as changing those realities by expanding and clarifying the range of possible options. Research on options will be multidisciplinary. Psychologists will study individual and group processes in option generation; anthropologists and historians will examine cultural influences and historical examples of how people have viewed pending changes from the status quo, and how they generate action options under those conditions. Philosophers can help offer perspectives on cultural and historical assumptions influencing the generation of alternative responses, one of the most important assumptions being how we view our relationship to nature and the environment.

5. Project 4. Understanding How Alternative Responses to Climatic Change Are Evaluated

5.1. Primary Research Question

(1) How do people combine multiple and conflicting risks and benefits of various options into a single decision?
(2) How can people's opinions on these issues be accurately elicited so as to inform government officials?
(3) How can faulty elicitation methods distort the values expressed through them?

5.2. Background

The generation of creative responses to the CO_2 phenomenon does not assure their implementation. The strategy that is adopted depends upon how the various options are evaluated. This process is sometimes implicit, occurring right at the time of option generation (e.g., the possibility of moving the soil of Iowa to Minnesota may be discarded as unfeasible as soon as it is formulated), and sometimes it is explicit (involving the assignment of probabilities and values to various alternative outcomes). Our knowledge of the evaluation process is only rudimentary. We know little about how people combine

multiple and conflicting costs and benefits, on different dimensions with varying degree of risk, and arrive at a single decision. For example, replacing fossil fuels with nuclear power increases the risk of radioactive contamination, but lowers the risk of climate change. Contamination is a low probability, catastrophic possibility. Climate change is a higher probability, less calamitous eventuality. How do people put these kinds of information together and weight the various options? Are these systematic biases in the evaluative strategies that people use (such as overestimating the likelihood of the most "available" scenarios), leading them to select alternatives that they don't "really" prefer? If so, are there ways of eliminating, or at least minimizing, these biases?

Since climate is part of our lives, we should, it would seem, have no trouble comperhending what the outcomes of CO_2-induced changes are and how much we would like them (e.g., what it means to have an average increase of 2 °C). There are, however, a number of reasons to doubt this presumption, all of which have analogs in the reasons for doubting the assumption that because we all live in society, we would be able to understand the meaning of a projected shift in one of its parameters (e.g., an increase in the median age or percentage of handicapped or price of fuel). One is that we do not experience our environment directly; rather, we have about us a series of defenses that regulate contacts so as to make them more pleasant and less demanding. Air conditioning and social norms are two obvious examples. We may have little idea of what life would be like if the conditions to which that veneer of civilization were adapted were changed.

A related reason for doubt is that we experience weather not climate, people not society. As a result, we seldom have to confront the complexity of the natural and social ecologies within which we live. We may not realize that an older world threatens the bankruptcy of the social security system or that a warmer world will eliminate the hard freezes that keep pests from destroying susceptible crops in some regions. Although the connections are straightforward and comprehensible when drawn, one should not expect either experts or lay people to recognize spontaneously the secondary or tertiary effects of projected changes.

Finally, no one knows how well people are able to imagine dramatic changes or, conversely, to what extent they are prisoners of their own experience. Do any of us who have not suffered that unmaskable pain of cancer know what it means? (If we did, would any of us be smoking?) What presumptions about unalterable aspects of human nature constrain our imaginations regarding, say, what awaits us in foreign countries or prison? Can we flesh out projections of climatic conditions outside of our species' experience? Can we really know what it will be like to live in the greenhouse? Without that experiential understanding, can we act appropriately to the possiblity? A related argument is used by some foes of nuclear power, who say that since we can't grasp the time span during which some radioactive wastes must be stored, we should avoid the whole business; without basic comprehension, wise decision making is infeasible.

Understanding effects requires not only factual knowledge, but also an evaluative assessment. Do we want this to happen? How badly? Such questions would seem to be the last redoubt of unaided intuition. Who knows better than an individual what he or she prefers? When one is considering simple, familiar events with which people have hands-on experience, it may be reasonable to assume that they have well-articulated opinions. Regarding the novel, global consequences potentially associated with CO_2-induced climatic change or nuclear meltdowns, that may not be the case. Our

values may be incoherent, not thought through. In thinking about what are acceptable levels of risk, for example, we may be unfamiliar with the terms in which issues are formulated (e.g., social discount rates, miniscule probabilities, or megadeaths). We may have contradictory values (e.g., a strong aversion to catastrophic losses of life and a realization that we're not more moved by a plane crash with 500 fatalities than one with 300). We may occupy different roles in life (parents, workers, children) which produce clear-cut but inconsistent values. We may vacillate between incompatible, but strongly held, positions (e.g., freedom of speech is inviolate, but should be denied to authoritarian movements). We may not even know how to begin thinking about some issues (e.g., the appropriate tradeoff between the opportunity to dye one's hair and a vague, minute increase in the probability of cancer 20 years from now). Our views may undergo changes over time (say, as we near the hour of decision or the consequence itself) and we may not know which view should form the basis of our decision (Fischhoff *et al.*, in press, a).

The low rates of "no opinion" responses encountered by surveys addressing diverse and obscure topics suggest that most people are capable of providing some answer to whatever question is put to them. Where values are labile or absent, however, these responses may reflect a desire to be counted, rather than deeply-held opinions. The recently-commissioned National Academy of Sciences panel on "Survey Measurement of Subjective Phenomena" is one sign of the growing realization that existing procedures are not up to the tasks put to them. Just as decision makers confronted with climate-related problems cannot assume that an acceptable decision-making tool is available for the asking, they cannot assume that someone is able to find out what the public thinks about any and every question that comes to mind.

5.3. Research Plan

Two types of research projects will be needed. One will study the ways people make complex evaluative judgments, and how they decide to act or to continue to wait in situations of uncertainty. There are undoubtedly cultural differences in option evaluation and in the conditions under which preventive or corrective action will be undertaken. One of the most important determinants of cultural differences in evaluating the pros and cons of taking action is likely to be the degree of control over nature people perceive as possible and/or appropriate. Perceived control is known to be a major determinant of individual differences in many aspects of behavior within American culture. We need to know more about cultural differences on this and related dimensions if we expect to understand how various regions and countries around the globe will respond to information about the possibility of CO_2-induced climate change. In addition, we must examine whether people can be taught or influenced to evaluate response strategies in different (and more adaptive) ways. If so, what are the political and ethical implications of altering the evaluation process? For example, simply discussing low probability events (such as a nuclear plant meltdown) may increase their perceived probability and thereby affect the evaluation of response options involving those events. Research must assess such effects in the evaluation process and their policy implications. It must also address what parameters policy makers use in evaluating a set of alternative options. Are they likely to overemphasize certain aspects of a given course of action (e.g., the technical

feasibility) and to neglect others (e.g., fears, attitudes, rivalries, etc , that may render a technically sound plan impossible to implement)?

A second program of research is needed to develop improved methods for surveying attitudes toward the issues raised by climatic change. Unlike the traditional survey with its philosophy of having impassive interviewers bounce stimulus questions off objectified respondents, these new methods may include structured interactions, designed to illuminate issues by presenting alternative perspectives for the respondents' consideration; they may use a variety of convergent methods; they may involve iterative procedures, in which the respondent goes through the issues several times until a feeling of closure is reached (or rejected, because no resolution seems possible). Formulating items would require the services not only of communications specialists, expert in expressing clearly the question that interests the sponsor of the study, but also substantive experts (e.g., philosophers, climatologists) able to tell whether the question itself was well conceived.

Many of the disparaging remarks one hears about the irrationality shown by "the public" in its responses to attitude surveys may reflect the inadequacy of survey design for the reasons just discussed. "Garbage in-garbage out" holds when addressing people as well as computers. Once developed, these newer, more sophisticated survey methods should be applied to find out what people want from their leaders in response to climate change and how they themselves intend to deal with the issues under their own control. "The people" is usually defined as those individuals represented by a probability sample of adults who can be found and will respond. For some novel issues, even the most sensitive interactive interview may not be able to generate enough understanding to make the results useful. In such cases, the public weal may be better served by questioning intact groups with some interest in the topic, or paying a representative group of citizens to follow the issues over a period of time, developing expertise.

When people do not have articulated opinions on specific risk issues, it may be the job of the responsible interviewer to help them develop positions consistent with their underlying values. One aspect of this aid is offering ways to think about a problem; a second aspect is working out together the implications of various policies that people might consider advocating.

Such analyses are not pulled from one's sleeve. A team of philosophers, economists, psychologists, sociologists, and others is needed to (a) articulate or speculate about the concerns motivating people's attitudes; (b) examine the implications of these positions; (c) offer alternative perspectives, e.g., how *might* people think about intergenerational equity issues or relations between people and other species? An unexploited source of potential insight would be working out the implications of various philosophies of life. Although only a minority of society might subscribe to these philosophies, all might learn something from exploring what a coherent libertarian, Marxist, Hindu, Christian, or Dadaist approach to nature and its challenges would be.

5.4. Research Outcomes

The following products can be visualized: (1) Basic methods for survey research into attitudes regarding the consequences of climate change and options for dealing with them. (2) Reports of empirical studies into how various population groups evaluate the research options generated in project 3. (3) Analyses interpreting what the public wants,

what it might want if "better informed" and what would be the consequences of adopting policies consistent with those desires. The participating disciplines should include psychology, sociology, philosophy, anthropology, and economics.

6. Project 5. Anticipating and Clarifying Conflicts Created by the Inequitable Effects of CO_2-Induced Climate Change; Offering Paths of Resolution

6.1. Primary Research Questions

(1) How will climate change pit nation against nation, group against group?
(2) What commons dilemmas will be created (or exist already)?
(3) What sorts of mistrust and misunderstanding will emerge and can be avoided?
(4) Can frameworks or options be devised for conflict resolution?

6.2. Background

One of the major consequences of a CO_2-induced climate change is likely to be a significant change in distribution of resources. Intraregional, intranational, and international redistributions are likely to occur. However, nobody knows in advance exactly what those redistributions will look like. Local, national, and international communities will be deciding what to do, if anything, about possible redistributions. To anticipate and inform their decisions, we need to know how people make judgments about resource distribution, and what conditions might foster the most harmonious outcomes. How do people solve distribution problems, and how satisfied are they with their solutions? Which procedures and outcomes are considered fair or just; which promote cooperation and goodwill rather than conflict and resentment?

Perception of distributive justice is currently an active area of study in psychology. Extending this work to the topics raised by climatic change will require asking the following questions:

(a) Are distributional evaluations situation-specific, or do people apply general principles? For example, do people conceive of balancing inequities in different situations? If agriculture in certain regions or countries is hurt by the CO_2-induced climate changes, should they be given advantages in other areas (e.g., fewer trading restrictions)? Will they demand such advantages?

(b) What are the consequences of creating distributions that are judged as unjust? How do people react cognitively, emotionally, and behaviorally? Are over-reward and under-reward reacted to differently? Are unjust distributions less distressing when they are expected? How will regions and countries act if they feel the CO_2 issue is not dealt with equitably by local, national, and world decision-making bodies?

(c) How is anti-social behavior leading to inequities perceived and handled? If a country continues to burn a large amount of fossil fuel and that is perceived as contributing to the CO_2 problem, how does that influence the way other countries are willing to share resources with that country? Will CO_2 issues be seen in isolation or lost in the broader context of relations?

(d) What characteristics of the interaction between parties affect distributional behavior; e.g., do the parties presently in control of distributing certain resources do so

differently depending on whether or not they expect other parties to be distributing them in the future? Would they, if long-term dependency were clarified?

(e) How do people judge the relative importance of equality of *opportunity* and equality of *outcome*? Is it enough to give different regions an equal "opportunity" to develop energy sources other than fossil fuels, or should they be assured equal amounts of future energy? Brickman (1977) argues that people will accept inequality in opportunity in order to achieve equality of outcome and that this preference for equality of outcome is greater when people are in Rawls' (1971) "original position" and don't know whether they will be advantaged or disadvantaged by the inequality in opportunity (see below).

(f) Is there a different in *satisfaction* versus *fairness* judgments of different-shaped distributions? Brickman (1975) has argued that positively skewed distributions are preferred to equal or negatively skewed ones, but that equal distributions are judged fairest. If satisfaction and fairness judgments are somewhat independent, the presumption that they are not needs to be challenged in the interests of generating more accepted solutions.

(g) Do *procedures* for distributing resources affect justice evaluations independent of the *outcomes* themselves? In solving this global problem, how important is widespread regional and international participation in the research and the decision process? Folger (1977) argues that procedures and outcomes interact in determining justice evaluations. We need to know more about how they interact.

(h) Do *public* judgments of fairness differ from *private* ones? Rivera and Tedeschi (1976) argue that people express much more satisfaction with being over-rewarded when their opinions are expressed privately than when they are in an experimental situation. Is this true for nations as well? If so, what effect does it have on worldwide cooperation and the structuring of negotiations?

To date, these kinds of issues have almost invariably been studied in a laboratory setting with tasks, rewards, and situational context determined by the investigator. Another major shortcoming of past research is that it has essentially imposed a simple-minded formulation of equity, according to which outcomes should be proportional to inputs. As a result, the typical study provides relative input information and asks for judgments of what are just distributions of outcomes, clearly implying that respondents should base their judgments on the relative input information. We need research examining the relevance of equity theory to CO_2-induced redistributions of resources. What are the "inputs" in this situation (e.g., proportional contribution to the CO_2 buildup over the past 100 years or over the next 10 years)? Are relative inputs of different regions and nations considered relevant to a global strategy to reduce suffering from redistributions? To what extent do the attitudes in existing studies simply reflect the particular historical, cultural, and economic conditions of Americans who participate in psychological experiments, rather than some fundamental characteristic of human nature? Sampson (1975) has argued that the desire for "equity" reflects the emphasis on agency and competition which presently dominates Western civilization, whereas "equality" reflects an emphasis on communion and cooperation, which is characteristic of other cultural and economic systems, both present and past.

Although the study of distributional justice is clearly relevant to understanding how people can and will handle the CO_2 issue, a number of innovations and modifications

to current research paradigms will be necessary. An important lacuna in existing research is the study of judgments about changes in existing resource levels. Climate changes will necessarily involve both goods and bads, i.e., benefits for some, but costs for others. Previous research has generally been limited to the study of positive goods, or "rewards". One exception is Brickman and Bryan's (1975, 1976) studies of *transfers* of goods between two parties Their approach could profitably be applied to the study of regional and national changes in resource distribution. Attention will also have to be given to who is the initiating agency of such transfers. Some people might believe that equity, like effective public participation in decision making, cannot be given, but must be taken. A very special kind of agency is nature. When are inequities viewed as naturally caused? What redress is asked for such inequities?

6.3. Research Plan

In planning relevant research on resource distribution, it must be recognized that the CO_2 phenomenon presents an unusually complex distribution problem requiring new methods and conceptualizations. First, there is not simply a single resource to be allocated among everyone, but rather different resources go to different people: for some people it is energy (by burning fossil fuels), for others it is fish supply (possibly affected by changes in ocean temperature and currents), and for still others it is crops (affected by changes in precipitation). In addition, each resource may have different values to different people. Previous research has dealt exclusively with the same resource being distributed to all.

Second, the potential climate changes are global in nature. People of all nationalities and cultures could be affected. Previous studies have focused almost exclusively on Americans' judgments of distribution fairness.

Third, given the uncertainties of the CO_2-induced climate changes (if they happen at all, what form will they take in any given locality, and how will they sum up across any given nation?), a collectivity of individuals, regions, and/or nations, must decide on a subsequent distribution of goods *without* knowing where any given individual (region or nation) will fall on that distribution. Previous research has generally been limited to resource allocation where each individual knows where he or she will stand in the various outcome distributions under consideration.

In this respect, making decisions about the most just way to handle CO_2-induced redistribution of resources presents us with a real-world analogue of John Rawls' "original position". One aspect of the present project would be a programmatic effort examining the empirical validity of Rawls' theory, expanding on Brickman's (1977) demonstration of the applicability of psychological research methods. His theory suggests that a consideration of the CO_2 buildup by people who find themselves under a "veil of ignorance" as to their future situation can result in just decisions that are recognized as such by all concerned. Knowledge of the empirical validity of Rawls' formulation, and the degree to which it applies to international cooperation on the CO_2 issue, would obviously be invaluable. One further question would be the effect of variations in degrees of risk and of uncertainty; although no one knows exactly how they will be affected by possible climate changes, some people will face much more uncertainty than others, and even among those confronted with the same level of uncertainty, some stand a chance to gain or lose much more than others.

A second subproject would involve applying Rawls' theory to groups (or their representatives) negotiating from an original position. To date, research has been limited to *individual* negotiators representing only themselves. Yet international cooperative decisions on how to handle the CO_2 issue will undoubtedly be made by a handful of people representing regions or entire nations. We know little about how such representatives make distributional decisions and resolve conflicts between their own interests and those of their group.

Research on *judgments* about the most just way to deal with CO_2-induced climate changes must be complemented by research on *behavior* of people facing various degrees of risk and uncertainty, and voicing conflicting claims. In many cases, the CO_2 situation qualifies as a "commons dilemma" or "social trap" (Dawes, 1980). In these situations, a group of individuals, each acting in a way apparently best personally, produce an effect that is bad for all of them. Since the effect of each individual's action is relatively small, it cannot be seen as either causing or potentially alleviating the problem. Rather, it is the sum of individuals' actions that creates the problem, and only their collective action can alleviate it. Referring to the CO_2 context, the energy and/or forestry policy of any given region or country may not discernibly affect the CO_2 levels, and thus it may be difficult for individual regions or countries to decide to curtail fossil fuel consumption or deforestation when their own impact on the problem seems negligible.

Both theoretical and empirical work on behavior in commons dilemma situations is in its infancy. We know very little about circumstances under which cooperative solutions are fostered. Early work has focused on such variables as group size, degree of discussion and communication among members, relative amounts to be gained and lost, etc. It needs to be expanded, with a greater emphasis on group behavior at the level of regions and nations, and address cognitive issues more directly, i.e., what determines when a situation is interpreted as a commons dilemma?

6.4. Research Outcomes

The following products can be visualized: (1) Innovative methodologies for studying resource distribution decisions; (2) Empirical studies of distributional judgments and behavior; (3) A comprehensive delineation of the alternative ways these issues are addressed in different cultures and different historical periods. The participating disciplines should include psychology, political science, sociology, economics, philosophy and history.

7. Guiding Principles

Several principles are fundamental to the success of the above-proposed research projects and to their utilization in dealing with possible CO_2-induced climate changes.

7.1. Interdisciplinary Focus

Psychological issues cannot be studied in a vacuum. When we ask how people perceive the world, how they make judgments and decisions, and how they behave as members of groups and/or nations, we are asking questions which can only be answered meaningfully

by a multidisciplinary team including sociologists, anthropologists, historians, political scientists, and philosophers, with backup from climatologists and other technical specialists. In this perspective, we are echoing the sentiments of the World Climate Conference: "Efforts should be made to ensure that the environment in the institutions in which the projects will be carried out is favorable to interdisciplinary research which is a necessary condition for progress in such a complex field of investigation" (1979).

If interdisciplinary research is so good, why is there so little of it?

One reason is that no one is trained to do it. Rather, the interested parties are trained in their respective professions and are drawn to interaction via involvement in some substantive problem. The nascent fields that result tend to be strong on commitment and on the sort of fresh ideas produced by rubbing strange disciplines together. Weaknesses lie in decreasing quality control and conceptual clarity as one leaves traditional fields, with their strongly developed sense of "what good is" in the way of research. Thus, although the potential payoffs are large in interdisciplinary research, so are the problems and pitfalls.

A second reason why so few people take the interdisciplinary plunge is that there are often rather meager rewards for doing so. University departments like people who can teach the traditional courses and be evaluated by the usual criteria. Real-life problems calling for many perspectives are often in the lock of one discipline (i.e., economics, engineering), which is unwilling to give more than lip service to sharing attention or resources.

A final problem is the lack of persuasive models for how interdisciplinary research might be conducted.

The simplest mode of interaction would be to compare terminology to reveal the hidden assumptions in our frames of reference. If we do not clarify such assumptions, we risk ethnocentric misconceptualizations and the attendant dangers of (a) not realizing that the terms we used have different interpretations in the populations we are studying (and with whom we must communicate), (b) deluding ourselves into thinking that the focus of our research life is also the focus of our respondents' lives, (c) misinterpreting our subjects' lives by failing to see their internal logic. Clarifying the assumptions our psychological work makes about the world in which behavior is embedded is a first step toward establishing the generalizability of our results and developing a theory of context to complement our more evolved theories of the individual.

A higher level of contact can be seen in sorties across disciplinary boundaries, returning with bounty in the form of stolen methodologies. Many major advances have been the result of such appropriation. Kates (1962) and others changed geography by introducing attitude measurement, thereby freeing the field from reliance on purely physical measures.

A dangerous limitation to such contact is borrowing tools from another domain without the full appreciation of their limitations that comes from extended professional socialization in that domain. Hexter (1971) characterized historians borrowing notions from the analytic philosophy of science, just as philosophers were becoming disillusioned with analytic methods, as "rats jumping aboard intellectually sinking ships." Similar criticisms might be leveled against psychohistorians embracing psychoanalysis as an analytic tool just as psychologists were giving up on it as a research methodology, or cliometricians applying economic analysis to historical settings just as economists are questioning the validity of their measures.

The highest form of interdisciplinary work is actually working together with people from other disciplines. Although full collaboration is rare, its salutary effects are widely enough acknowledged for working together to be regarded as virtuous. Only by extended interaction can we learn to incorporate other disciplinary perspectives in our own work. Since most collaborative works are unique products of the interactions between the perspectives and personalities brought to bear on a particular problem, there are no firm standards or systematic means to ensure quality control. Disciplines progress by trial and error. Active collaborations attempt to create new, integrative disciplines in whole cloth at first crack. They can't always do it, and may not always be able to assess the validity of their attempt.

An alternative goal for collaboration is not to create a new discipline, with the capacity for getting the right answers to a newly, but narrowly, defined set of questions. Rather, one can acknowledge that there are no "right" answers (or at least no way to be certain that we have come across them) to questions rich enough to draw talents from a variety of fields. What one can hope for is to avoid getting the wrong answers, with each discipline helping to avoid particular kinds of errors.

7.2. *Cross-Cultural Emphasis in the Context of an International Research Effort*

Just as research on the psychological dimensions of possible CO_2-induced climate change must be cross-disciplinary, it must also be cross-cultural. The problems of ethnocentric research programs are nowhere more evident than in the current crisis in social psychology. As Triandis (1975) has argued, the study of human behavior in a single culture, by researchers from a single culture, results in "knowledge" with very limited replicability and generality. The resulting theories do not account for the complex interactions between person and context. Instead, we need cross-cultural studies in the tradition of Whiting (1964), or along the lines of the more recent "ecological functionalism" approach (Berry and Dasen, 1974). These cross-cultural research programs attempt to tie the nature of the physical environment to the nature of the social environment and to particular psychological phenomena. They often focus on new higher-order variables that account for much of the variance in social behavior, and that can be systematically related to culture-specific behavior (Whiting, 1968).

Since CO_2-induced climate changes will be worldwide, it is clear that the psychological studies proposed above must be carried out in the full range of impacted cultures if we are to understand and improve global response to this issue. In order to implement such a research program, an international effort is needed. Effective cross-cultural work cannot be achieved by United States researchers alone. Research design, data collection, analysis, and interpretation will all suffer if we do not achieve international collaboration from the very beginning. As a starter, the present proposal has been critiqued by well-known psychologists with different cultural perspectives. Later, selection of investigators and research centers to conduct the proposed projects should ensure that a variety of nations and cultures will be involved in planning and conducting the basic research.

It should be emphasized that the participation of the international research community is important not only for the quality of the studies themselves, but also for their acceptance and utilization by the international community of policy makers. If, for example, the Third World has not participated in a cooperative effort to research the

societal impacts of possible climate change, the likelihood of their participation in any eventual cooperative response is greatly diminished. As Rep. George Brown has argued,

> It is a matter of efficiency in the sense of using the vast observation methods and data resources around the world. It's also a matter of political education in the sense that whatever joint world efforts might be required in climate – such as related to CO_2 – will inevitably only be viable if the world has jointly obtained and studied the data. Lip service to this concept and recitation of previously formulated joint scientific efforts is not sufficient to fill the mandate intended here (1979, p. 3).

The National Climate Program Act has already recognized the importance of a coordinated international effort by stipulating that "measures for increasing international cooperation in climate research, monitoring, analysis, and data dissemination must be included as a basic element of the National Program" (National Climate Program, Preliminary 5-Year Plan, July, 1979, p. 68).

7.3. Combination of Basic and Applied Research

A third guiding principle is that one needs a mix of basic and applied research. Experience has shown that leaping into highly specific problems without a theoretical framework or carefully developed methodology tends to be unproductive. "As soon as you break a practical problem into its more basic elements you are faced with numerous fundamental questions, requiring basic research. You can *not* make progress in the solution of the practical problem unless you solve the *basic* problems" (Triandis, 1978, p. 385). For some topics, the basic research background already exists; for others, it will have to be developed. On the other hand, without a constant reminder of the applied focus, academics do tend to pursue their own agendas. With attention to this problem, we feel that on many topics, the path from basic research to application may be fairly short. Although it may be difficult for a mission-oriented agency to envision itself conducting basic research in the social sciences, a similar attitude by all agencies would mean that the basic infrastructure for solving applied problems would never be built.

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