

Testimony to the Subcommittee on Research and Science Education,
House Committee on Science and Technology

At the hearing on:

*The Contribution of the
Social Sciences to the Energy Challenge*

September 25, 2007

Duane T. Wegener

Abstract

The energy challenge is characterized by (a) a great need for development of new technology, and (b) a need for unprecedented changes in energy-related behavior. These behavior changes must occur at many levels, including investors, energy producers (including those in the supply chain), and individual consumers. At Purdue University, I address behavior change through basic research on attitudes, persuasion, and behavior. I also help to lead an initiative in the Purdue Energy Center that focuses on social, economic, and political/policy factors that will influence the behavioral pathways to a new energy economy. By interacting directly with technology development teams, my colleagues and I seek to identify and influence the barriers that new energy technologies will face. By integrating social science with technology development, we believe that new technologies can come on-line faster and more smoothly. The challenge for completing this work is that current federal funding provides strong support for technology pathways but provides insufficient support for research addressing the behavioral pathways. In the various sections of my written testimony, I describe my activities in the Purdue Energy Center, the available funding for our research, the existing research on attitude formation and change (including examples of recent research from my lab on attitudes toward nuclear power), and examples of relevant research questions that remain unanswered.

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Duane T. Wegener

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and

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Energy Center at Discovery Park

Purdue University

Chairman Baird, Ranking Member Ehlers, and Members of the Subcommittee, thank you for the opportunity to testify on the Contribution of the Social Sciences to the Energy Challenge. I believe that the social sciences will play a crucial role in understanding and facilitating the behavioral pathways to a new, sustainable energy economy.

I was asked to address four sets of questions. They are listed, along with my written testimony, in the following sections. In order to facilitate the identification of responses to specific questions, I have included headings to correspond with each question in the question set.

1. Please describe your involvement in the Purdue Energy Center, and in particular the mission and goals of the Social, Economic, and Political Aspects of Energy Use and Policy team of the Center. How and to what degree does your team interact and collaborate with the technology teams at the Center?

Involvement in the Center

I serve as one of three Initiative Leaders for the area of Social, Economic, and Political Aspects of Energy Use and Policy (SEPAE). The other two initiative leaders are Wallace Tyner (a Professor of Agricultural Economics) and Glenn Parker (a Distinguished Professor of Political Science). Included in the initiative leader role, we each also serve as a member of the Executive Board of the Energy Center (a decision-making body that meets quarterly). Our work as initiative leaders is multi-faceted. Because a primary goal for the Energy Center in general is to build new transdisciplinary research teams, we have been working to inform one another about the research we do in each of our respective disciplines. We have also been working to build connections to the various technology-development initiatives within the Center. Finally, as

initiative leaders, we work to organize responses to calls for research proposals. Much of the early effort has been aimed at Federal research dollars, but we have also attempted to make connections with State government, utilities that operate in the state, and, to a lesser degree, with private foundations (more on this in response to Question #2 from the committee).

The Mission of the SEPAE Group within the Energy Center

The mission of the SEPAE group is directly related to the topic of today's hearing. We seek to extend research and theory from the social sciences to the topics of energy technology, energy use, and policy. In other words, SEPAE faculty work to address drivers and obstacles faced by new energy technologies (especially those studied within the other Energy Center research initiatives). The purpose of the SEPAE research is to increase the ultimate effectiveness of technology development by performing simultaneous analyses of economics, policy alternatives, public/political technology acceptance, and energy-related decision making. Each of these factors should feed into energy-related behaviors, including investment by companies or individuals, use of new energy-related products, and support for policy-makers who champion particular energy policies.

We believe that these efforts are crucial in managing the necessary transition away from previous technologies that are ultimately unsustainable (and, in many forms, polluting) and to the use of new, sustainable energy technologies. The reality is that any new energy technology is likely to start with a variety of competitive disadvantages. Potential long term sources of clean energy, such as the promised hydrogen economy, will require new infrastructure for storage, transportation, and fuel delivery. Even energy sources that potentially piggyback on existing infrastructure (such as generation of liquid fuels via clean coal technologies or biomass) require

new processing facilities and pose new logistical challenges as they seek to compete economically with currently dominant energy sources (i.e., fossil fuels).

Every step in the process will depend on a combination of social, economic, and political forces. Uninformed (and perhaps even informed) citizens may continue to favor cheap and familiar sources of energy. Suppliers of that energy may also attempt to forestall widespread adoption of alternative energy sources. Yet, citizens concerned about issues such as security, environmental preservation, and support for local economic development may be willing to pay the premium necessary to fully develop new energy sources that can ultimately compete with fossil fuels. For many new energy technologies, new regulatory statutes and bodies will be necessary, and policies governing the economic risks for investors will have direct effects on whether private investment occurs and to what extent. As the next generation of energy sources comes online, customer acceptance may also determine the extent to which policy-makers and industry support the widespread development, and ultimately the economic feasibility, of the new technologies.

Unfortunately, in many cases, simply waiting for the development of a commercially viable product may be too late. For example, some promising technologies are being developed for use of plants that are genetically modified to increase their efficiency (and environmental friendliness) in production of biofuels. However, no regulatory system exists for the commercial use of those plants for production of biofuel. If the technology progresses to the point of becoming economically viable, but no regulatory process is put in place, it could create years worth of delays before the new plants can be productively used in the marketplace. Of course, this anticipated delay and the associated uncertainty could deter private investment in the technology. And the building of a regulatory system is likely to depend on both public and

political perceptions of the new technology (e.g., in terms of its impact on the surrounding community and on the environment more generally).

Research addressing the social, economic, and political factors that influence development and adoption of new technologies will help the technology researcher to create technologies that face fewer obstacles. For example, public or political opposition to use of a genetically-modified plant in biofuel production might be based primarily in the concern that the modified gene will spread to native species (see Goy & Duesing, 1996; Meilan, 2004). If so, then creation of sterile versions of the plant might face less public and political opposition. In this type of situation, therefore, attention to social and political factors might identify issues that can be addressed in advance by technology developers, and the new technology can avoid an obstacle that would threaten the economic viability of the technology.

In other settings, identification of obstacles or drivers for adoption might identify effective means of educating or persuading the public or policy-makers about the benefits of the new technology. This could ease the creation of regulatory systems friendly to the new technology or could ease the zoning and approval of new plants using the technology. Therefore, in a variety of situations, the economic viability of the new technology might be enhanced by early attention to social, economic, and political/policy matters.

Interaction with Technology Teams

The integration of SEPAE topics with the technology development teams differentiates Purdue University's Energy Center from many others across the country. Ideally, the SEPAE topics will eventually be pursued across each of the other research areas within the center

(including initiatives in Clean Coal, Solar, Bio-, Wind, Electrochemical, Power Electronics, Hydrogen, and Nuclear areas of energy technology).

These integrative efforts have yielded a number of successes in the brief time since the Energy Center's inception. For example, a team of researchers investigating production of biofuels from trees recently received a \$1.4 million grant from the Feedstock Genomics program at the Department of Energy (DOE Grant # DE-FG02-06ER64301; through the Office of Science, Office of Biological and Environmental Research). In the grant proposal, the Principal Investigators noted the connections between SEPAE research in the Center and their research on biofuel production, and these connections were noted as a strong feature of the proposal in panel reviews of the biofuel grant. The SEPAE activities were not funded in the DOE grant, but other recent efforts are beginning to produce funding for the SEPAE activities.

Recently, a team of SEPAE researchers submitted a grant application to the National Science Foundation program on Human Social Dynamics, and this grant has been recommended for funding (for \$750,000 over three years, beginning in January 2008). The grant addresses social, economic, and political aspects of US Ethanol Policy. In particular, the research supported by the grant will examine (a) the economics of the seven most likely ethanol policy options, (b) public and political perceptions of the ethanol policies (including comparisons between public perceptions and those of policy-makers in states that ban use of genetically-modified plants for biofuel production or not), and (c) the influences of attitudes and values on individuals' energy-related decision making.

I am the Principal Investigator for that grant, along with Wallace Tyner (in Agricultural Economics) and Leigh Raymond (in Political Science) as Co-Investigators. In addition, however, the research team includes consultants in Psychological Sciences (Professor Janice Kelly), Biochemistry (Distinguished Professor Clinton Chapple), Forestry and Natural Resources (Associate

Professor Richard Meilan), and Economics (Professor Timothy Cason). Therefore, the research team for this project includes researchers from across the areas of SEPAE, as well as Principal Investigators (Chapple and Meilan) from the DOE grant on biofuel production mentioned earlier.

As these two grants would imply, our interactions thus far have been closest between SEPAE and the BioEnergy initiative. We have also made some initial connections with the Hydrogen and Clean Coal initiatives, though not to the same extent. Other than these three areas, most of the interaction among areas of the Center has taken place in the Executive Board meetings, where each initiative leader describes the current efforts for their initiative. It is clear from our initial efforts that the creation of transdisciplinary teams involves a good deal of “start up” costs. It takes time and effort, not only in developing potential research questions of common interest, but then also attempting to find sources of funding that would be interested in supporting research on those questions.

Researchers in the energy technology areas are naturally focused on the work required to develop those technologies, and only some express interest in integration of SEPAE topics with technology development. In some cases, the researchers believe that public acceptance of the new technology must simply consist of making them aware of the benefits of the technology (whether the benefits be related to cost, environmental preservation, or security). However, as many of the committee members may routinely experience in their role as policy-makers, public acceptance is often influenced by a variety of factors that may, on the face of it, appear less than rational. In the energy domain, many new technologies that appear to have advantages over older technologies (e.g., in decreased pollution), are nonetheless opposed by nearby residents (the prevalent “not-in-my-back-yard” problem). This is certainly true for nuclear energy (Rankin, Nealy, & Melber, 1984; Rosa & Dunlap, 1994). A local example in Southern Indiana provided a similar situation when community members opposed a new coal-based power plant using updated technology capable of cutting pollution to a small fraction of that emitted by the coal-based plant to be replaced (despite the fact that the new plant would create more than ten times the amount of energy of the old plant).

Therefore, it seems crucial to understand the human aspects of energy-related behavior and to take those aspects into account in the technology development process. In order to do this, it may require directed investment on the part of funding agencies or energy centers to build and maintain these transdisciplinary collaborations.

2. How much support do you and your colleagues in this area get from federal funding agencies? Have you sought any support from or partnerships with public or private utilities or other non-governmental entities?

Support from Federal Funding Agencies

A number of SEPAE faculty have been successful in recent competitions for federal research support. However, this success comes despite a relative lack of available funds for SEPAE research.

There are at least a couple of standpoints from which to answer this question. One is from the point of view of energy researchers per se.

For Energy Research

As noted earlier, the SEPAE group has been successful of late in obtaining funding from the Human Social Dynamics (HSD) program of the National Science Foundation (NSF). However, this program is, by no means, focused on problems related to energy per se. Therefore, it is not a surprise that relatively little of the funding through this program supports energy-related research. Over the four years of the HSD program, a number of the awards

support projects focused on influences of climate change, but very few deal directly with energy or new energy technologies.

In addition to the NSF funding, SEPAE member Wallace Tyner was also successful in a recent Department of Energy (DOE) competition for research proposals in Ethical, Legal, and Societal Implications (ELSI) of Research on Alternative Bioenergy Technologies, Synthetic Genomics, or Nonotechnologies. This grant, set to receive \$660,000 over three years, seeks to “develop realistic assessments of the economic and environmental impacts of regional and global policies designed to stimulate bioenergy production and use.” Professor Tyner, who led the proposal, was joined by Tom Hertel, Distinguished Professor of Agricultural Economics, and Quinlai Zhuang, Professor of Earth and Atmospheric Sciences and Agronomy. This was a new program for the DOE, and it funded proposals for a total of \$1 million during fiscal year 2007 (approximately 5 total grants of the size of the Tyner, Hertel, & Zhuang proposal). Therefore, unless this program or something like it is expanded quite a lot, the federal funding aimed specifically at social, economic, and political aspects of energy use or policy seems quite limited.

It is also true that none of the current National Energy Laboratories involve the study of social, economic, or political/policy dimensions of energy technology. Thus, if Congress sees potential benefits in specifically funding energy-related research addressing social, economic, and political/policy factors, this may require changes in the structure or priorities of federal funding sources. One model would be to set up a national center (a national lab) for the social-scientific study of energy. If benefits are seen in the direct integration of this research with technology development, it would be important for this center to be closely associated with either a technology-oriented national lab or energy center. Yet another model would be to provide funding for competitions within existing funding structures (e.g., through the DOE or

even NSF) that focus on the social-scientific influences on energy use, policy, and technology. Again, if benefits are seen in integration of this research with technology development, specific calls could be made for transdisciplinary work on the topic (within either the current DOE focus on technology development or NSF interdisciplinary programs).

For Basic Science

A second standpoint for answering this question comes from my work as a basic (laboratory-based) researcher on processes involved in attitude formation and change. As discussed in more detail in response to Question #3, basic research on attitudes and attitude change seeks to identify psychological processes that generalize across many specific content domains (including, but by no means limited to energy-related topics). Because attitudes have potent influences on behavior, attitude change provides one of the best mechanisms for influencing energy-use behavior (and behaviors in a variety of other domains, such as health, civic engagement, environmental preservation, etc.).

In energy and other domains, it would make little sense to fund research on applications (such as chemical processes involved in making liquid fuels from coal) without continuing to fund basic research (such as the actions of a catalyst on reactions that occur with controlled concentrations of certain chemicals). Yet, whether intended or not, this is what has happened at the National Institutes of Health (NIH) for research on attitudes and attitude change (and for Social Psychology generally -- the discipline in which most psychological research on attitudes occurs).

Indeed, over the years, the National Institute of Mental Health (NIMH) has been the single largest funding source for basic research in social psychology (and attitude change). This

continued to be true until a few years ago. Since that time, NIMH funding for social psychological research has virtually dried up, because NIMH has decided that basic research in all areas of social psychology (not only attitudes and attitude change) is not sufficiently related to severe mental illnesses. Although NIH continues to fund applied research into specific conditions or diseases (e.g., cancer, drug abuse), there is concern from the scientific community that funding for basic (cross-content) research on the relevant behavioral processes is insufficient. This has occurred despite the fact that Congress has repeatedly requested that NIH increase its support for basic behavioral research.

The reader might wonder how this decrease in funding is related to research on energy per se. When basic research is not funded, this reduces advances in theory and research relevant to many applied domains. For example, as I describe in more detail later, my colleagues and I recently conducted research on implications of attitudinal ambivalence for attitude change. In that research, we found the same pattern of results for a health-related topic (proposed taxing of junk food) and an energy-related topic (proposed building of nuclear power plants). Thus, decreases in funding for basic research decreases knowledge that can benefit many (seemingly unrelated) areas of applied interest.

It is true that NSF continues to fund basic research in social psychology generally (and attitude change in particular). Unfortunately, because the NSF budget has not increased, overall support for basic research on attitudes and attitude change (and for research on social and cognitive processes in general) has markedly decreased and remains severely under-funded.

Support from Non-Governmental Entities

In the first two years of the Energy Center, SEPAE efforts at seeking funding for our research have focused on federal funding sources (though, as discussed earlier, relatively few federal dollars are specifically aimed at the types of research we conduct). One reason for this is undoubtedly that most of the researchers gathering as members of SEPAE have had their previous research supported primarily by federal dollars.

We have made some attempts, and are continuing to do so, in other areas, however. Our few contacts with energy utilities thus far have been channeled back to regulatory decisions pending with the Indiana Utility Regulatory Commission. One regulatory settlement occurred recently in the area of natural gas to support analysis of a demand-side (energy conservation) program. Unfortunately, the structure and funding included in that settlement would not support the kinds of research that we conduct in the SEPAE group. Although we are certainly open to direct work with utilities, we have not identified other opportunities for funding our research in this way.

In other areas of the Center, there are close ties with Indiana State Government (especially in supporting research for how to use Indiana coal in environmentally responsible ways). However, we have not yet identified a State government funding mechanism for SEPAE research.

Just in the past couple of weeks, we have also had SEPAE members (Tyner and Wegener) meeting with a broad group of Purdue University researchers to discuss a proposal to a private foundation. This foundation is consulting with various Universities on possible projects that address agriculture and the environment (a Purdue proposal would likely address the environmental impact of biofuels, with a heavy emphasis on changing land use behaviors). These foundation connections are new for us and may take some time to cultivate. The

exploration of new funding sources is certainly one type of “start up” cost involved in the building of transdisciplinary research teams to address important societal problems.

3. What has social science research revealed about factors that influence how Americans form attitudes relevant to energy use and policy? How can this research be used more effectively to inform policy?

Influencing Attitudes

I have to answer this question from the standpoint of a social psychologist, without claiming to be an expert in all areas of social science relevant to attitude formation and change. One interesting aspect of the social psychological literature on attitudes and persuasion is that it is designed to be basic science, identifying general psychological properties that are applicable to attitudes about different people, objects, or policies. Therefore, in most social psychological research on attitude change, the same effects and processes are shown to occur for two or more topics. In many cases, these topics are not directly energy-related, but there is little reason to expect that the processes identified would not also occur when the attitudes are about energy use or energy policy.

Research on attitudes and attitude change has been a core part of social psychology since the 1930s. G. W. Allport (1935) first called *attitude* social psychology’s most indispensable construct, but this is arguably still true today. This is because attitudes (one’s overall evaluations of people, objects, or issues) are pervasive and functional (see Maio & Olson, 2000b; Pratkanis, Breckler, & Greenwald, 1989). For example, attitudes predict behavior when controlling for other psychological constructs, such as values (Homer & Kahle, 1988) and subjective norms

(Ajzen & Fishbein, 1970, 2005). Indeed, it is partly because attitudes are capable of influencing behaviors that researchers became interested in techniques used to change attitudes.

It is beyond the scope of the current testimony to provide a comprehensive review of the last 80 years of research and theory in this area. Therefore, I will provide only a brief summary to provide examples of common variables and processes that have been studied. The reader can see Petty and Cacioppo (1981/1996) for an accessible (undergraduate level) overview of attitudes and persuasion. Petty and Wegener (1998) and Wegener and Carlston (2005) provide more recent reviews.

I divide my current summary into sections on classes of variables studied, common processes in message-based persuasion, and examples of research from my lab that has addressed attitudes toward nuclear power.

Classes of Variables that Influence Attitudes

Factors involved in message-based attitude change (of the type involved in mass communications, such as advertising) have included characteristics of the source of the message, characteristics of the message itself, characteristics of the recipient of the message, and characteristics of the context in which people receive the message (see Petty & Wegener, 1998). Prevalent source characteristics include the credibility (expertise and trustworthiness), attractiveness (likeability), and power of the source. Prevalent message characteristics include the position of the message (i.e., relatively agreeable or disagreeable to the message recipient) and the quality and quantity of arguments used in the message. Other message features include framing of the message (e.g., stating the message in positive terms, such as “if you stop smoking, you’ll live longer,” or negative terms, such as “if you smoke, you will die sooner”) or the order

in which opposing messages are encountered. Recipient characteristics include characteristics of the attitudes message recipients already hold, demographic characteristics, and personality of the person receiving the message. Finally, context variables include the level of distraction created by competing activities, the modality (e.g., written, audio) through which the message is received, and the uplifting or depressing setting surrounding the persuasive message (which could also be considered as creating differences in the mood state of message recipients).

Persuasion Processes

In addition to the many individual variables that have been studied, a variety of psychological processes have been identified to determine when and how the variables influence attitudes. Many of the persuasion processes can be organized using the Elaboration Likelihood Model (ELM; Petty & Cacioppo, 1986b; Petty & Wegener, 1999). The ELM organizes persuasion processes according to how much people are thinking about (elaborating on) the available information about the person, object, or topic of interest.

High-elaboration (thoughtful) processes. The message recipient is likely to think more about available information when highly motivated (e.g., because the message topic is important or personally relevant to the recipient) and able to do so (e.g., because environmental distractions are minimal; see Petty & Wegener, 1998). When elaboration (thinking) is high, message recipients are likely to generate many evaluative thoughts about the information, and these thoughts are responsible for influences of the available information on attitudes (see Wegener, Downing, Krosnick, & Petty, 1995). In these types of situations, argument quality is likely to be an important determinant of attitude change. If arguments are compelling, attitudes become more favorable, but if arguments are weak, then little attitude change occurs. In contrast, if

motivation or ability to think is lacking, argument quality has little effect on attitudes (e.g., Petty, Cacioppo, & Goldman, 1981).

When thinking carefully about available information, message recipients are also likely to actively assess the evaluative implications of available information by “calculating” the likelihood and desirability of presented information. For example, a statement in a message might say that a particular political candidate favors higher subsidies for producers of ethanol that use cellulosic feedstocks (e.g., grasses or trees) than for producers that use corn. When thinking carefully about the information, message recipients assess the likelihood that the candidate strongly favors the policy and their own perceived desirability of the policy (and attitudes are calculated by multiplying likelihood perceptions and desirability perceptions; Fishbein & Ajzen, 1975). Thus, differences in the quality of arguments can be created by changing the likelihood or desirability components of the statements (Petty & Wegener, 1991).

Low-elaboration (non-thoughtful) processes. As noted earlier, effortful elaboration (thinking) is less likely when motivation or ability to think is lacking (e.g., because the attitude issue is not likely to affect the message recipient or the message is encountered when the person must also pay attention to competing activities). When this occurs, attitudes can still be formed or can change, but by using “short cut” (heuristic) strategies that take less cognitive effort.

For example, attitudes can be influenced by classical conditioning, in which positive or negative stimuli are simply associated with the attitude object. In fact, many advertisements use this type of strategy by associating pleasant music or scenery with a product, even when the music or scenery is utterly irrelevant to the qualities of the product. On a related note, people might also use a “How do I feel about it?” heuristic, in which they mistake feelings created by an

unrelated activity (such as the weather outside or watching a happy or sad movie) as being reactions to the attitude object or issue (see Clore & Schnall, 2005).

Other relatively simple processes include familiarity-based liking of objects that one has seen often (even if seen so briefly that one cannot report whether one has previously seen the object or not; Kunst-Wilson & Zajonc, 1980). One reason for this *mere exposure* effect may be that ease in perceiving the object (because it has been seen before) is experienced positively (Winkielman & Cacioppo, 2001).

When *heuristics* are used to quickly and easily determine what one's attitude should be, source characteristics ("I should agree with people I like") that are irrelevant to the primary features of the object may, nonetheless, influence people's attitudes (see Petty & Wegener, 1998). The impact of these *peripheral* aspects of the communication is likely to be different, however, when thinking a lot about available information. In such circumstances (when people are paying close attention to the qualities of information about the object), the influence of peripheral aspects of the persuasive attempt should be minimized (Petty & Cacioppo, 1986b; Petty & Wegener, 1999).

General ELM principles. Therefore, the ELM framework explains when communicators would expect peripheral aspects of a communication to influence attitudes (when motivation or ability to think is low) and when they should not (when motivation and ability are high). This would explain why some relatively peripheral features, like the physical attractiveness of the message source, influences attitudes in some situations (low motivation or ability), but not in others (high motivation and ability; Puckett, Petty, Cacioppo, & Fisher, 1983). In contrast, when motivation and ability to think are high, the quality of arguments provided in the message should

have strong effects on recipient thoughts and attitudes. But when motivation or ability is lacking, the quality of arguments should have little effect (Petty & Cacioppo, 1986b).

Persuasion is not so simple as to say that any one variable can only influence persuasion when people are thinking a lot or a little, however. For example, consider a communication given by an expert source (e.g., a Princeton Professor of Education advocating a new educational policy; Petty et al., 1981). The expertise of the source can be used as a relatively simple “peripheral cue” when thinking is minimal (“I should agree with experts”). However, source expertise can also influence attitudes when people are thinking carefully, if the right conditions exist. For example, if the available information is somewhat ambiguous (open to interpretation), then, as people think carefully about the information, it may be interpreted more positively if provided by an expert rather than a non-expert (Chaiken & Maheswaran, 1994). The idea that the same persuasion variable can influence attitudes for different reasons as the level of elaboration (thinking) increases from low to high levels is referred to as the variable serving “multiple roles” in persuasion (see Petty & Wegener, 1998, 1999).

Perhaps the key reason that researchers pay close attention to the level of thinking by research participants is that the level of thinking determines how consequential the resulting attitude will be. When attitudes are formed or changed in more thoughtful ways, they last longer over time, they better resist future attempts at change, and they serve as stronger guides for future thoughts and behaviors (Petty, Haugtvedt, & Smith, 1995; Wegener, Petty, Smoak, & Fabrigar, 2004). Of course, when seeking to influence the use of energy by consumers or the purchase of energy-efficient products, it would be important not only to create attitudes favorable toward those behaviors, but to create attitudes strong enough to influence those behaviors.

Examples of Attitudes toward Nuclear Power

Consistent with my basic science orientation, over the years, I and my colleagues have used a variety of message topics in studying attitude change. In a number of cases, however, we have used messages that propose the building of new nuclear power plants. Let me give some examples of specific research questions that have guided portions of this work.

Values and information processing. For many years, attitudes researchers have associated “strong” attitudes (i.e., those that resist change and influence behavior) with attitudes that express or connect directly to one’s cherished values (e.g., Sherif & Cantril, 1947; Maio & Olson, 2000a). For example, in one early program of research, Ostrom and Brock (1969) asked message recipients to consider a message in relation to values the recipients viewed as personally important or unimportant. After measuring attitudes, Ostrom and Brock presented an opposing message attempting to change the newly formed attitudes and found that attitudes initially formed while considering important values were more resistant to change than attitudes formed while considering unimportant values. This result was viewed as consistent with “value expressive” or “value linked” attitudes being stronger if the values are important to people.

However, this “structural” view of value effects on attitude strength is not the only possibility. As mentioned earlier, from an ELM point of view, increases in thinking about the issue can also result in strong attitudes (Wegener et al., 2004). Therefore, it seemed plausible that thinking about important rather than unimportant values might make the issue seem more important or interesting, and this increased thinking might be responsible for the creation of stronger attitudes. Indeed, in a series of studies, consideration of important values led to higher levels of information processing than consideration of unimportant values, and this amount of thinking was responsible for the strength (resistance to change) of the resulting attitudes

(Blankenship & Wegener, in press). Measures designed to tap “value expression” showed that the increases in thinking per se did not create attitudes that “expressed” the values, as assumed by Ostrom and Brock (1969) and Sherif and Cantril (1947).

One important feature of the values and processing work is that consideration of important values increases processing of information about topics viewed as utterly irrelevant to message recipients. For example, a number of the studies addressed proposed admission of an Eastern-European country into the European Union (a topic participants viewed as quite irrelevant to them), and one of the studies proposed the building of nuclear power plants in Canada (another topic of relatively little relevance to our message recipients).

As described in the ELM sections earlier, topics of low personal relevance typically receive little thinking, and attitudes produced (by mostly peripheral means) are not very consequential. However, in many domains (such as health, where people often view consequences of negative health behaviors as unlikely to occur for them), practitioners would want people to think about and form consequential attitudes on those topics. Asking people to consider important values (or even briefly presenting the values prior to message presentation, Blankenship, 2006) may be one easy way to get people to think about topics they would otherwise ignore (often to their own peril).

Another applied implication is that persuasive messages about nonthreatening, personally irrelevant topics might be useful in creating attitudes that impact perceptions and behavior on more relevant topics. For example, people start out as less favorable toward the building of a nuclear power plant in their community than they are toward nuclear power in general (Rankin, Nealy, & Melber, 1984; Rosa & Dunlap, 1994). But messages about nuclear power in general or in distant places (where less inherent resistance exists) may be viewed by message recipients as

irrelevant to them and unworthy of their attention. A technique such as consideration of important values might prove helpful. It can use the low-relevance topic, where initial resistance to the message is relatively low, but because the technique can produce high levels of processing, the attitudes produced are then harder to change and more likely to guide later decisions and behavior. It may be, therefore, that thoughtful persuasion of the benefits of nuclear power in Canada could be useful in lessening the public resistance to widespread development of nuclear power closer to home.

Message order effects. The ordering of different messages has also been of interest for many years (e.g., Lund, 1925; Hovland & Mandell, 1957), but results have been mixed. Sometimes the first message encountered is more persuasive (a primacy effect, e.g., Lund, 1925), and sometimes the second/last message received is more persuasive (a recency effect, e.g., Hovland & Mandell, 1957). Summarizing the work to date, Hovland (1957) speculated that primacy might be most likely when presenting information on an unfamiliar/novel topic. Although research on message order flourished in the early 1960s, results continued to be mixed, with a number of results inconsistent with Hovland's (1957) contentions (see Lana, 1961; Rosnow & Robinson, 1967). As recently as 1993, a prominent attitudes text (Eagly & Chaiken, 1993) expressed pessimism that consistent message order effects would be discovered anytime soon.

However, consistent predictions could be made using the ELM notion that higher levels of information processing should lead to stronger attitudes that are more resistant to change. In a pair of studies reported by Haugtvedt and Wegener (1994), we showed that high levels of personal relevance consistently lead to primacy effects (greater impact of the first message), and low levels of personal relevance lead to recency effects (greater impact of the second/last

message). Consistent with the ELM theorizing, greater processing of the first message should create stronger attitudes prior to receiving the second message. With stronger attitudes (when processing of the first message is high rather than low), the message recipient is able to resist the second message, resulting in primacy. In contrast, when attitudes following the first message are weak, the second message is able to exert more persuasive impact (for additional discussion, see Haugtvedt & Wegener, 1994).

These effects were found when the two messages favored and opposed the building of nuclear power plants (when high relevance conditions suggested that the plants be built in the message recipients' own and nearby states, and low relevance conditions suggested that the plants be built in distant states). Consistent with the basic science approach of generalizing the effects across different types of topics, the same effects were also found using a proposal for an educational policy (i.e., institution of senior comprehensive exams for graduating seniors, Petty & Cacioppo, 1986a).

Ambivalence and processing. Finally, a recent set of research studies has examined the effects of attitude ambivalence on information processing. Ambivalence occurs when people realize that there are both positive and negative aspects of an attitude object or policy. For example, people might believe that nuclear power is good because of the lack of greenhouse gas emissions, but is bad because of the radioactive waste.

Research on persuasion has shown that people tend to think carefully about information on topics about which they are ambivalent (Maio, Bell, & Esses, 1996). One way to understand this effect would be to say that people are unsure as to what their attitudes should be when they are ambivalent, and they actively process available information in an attempt to determine what their attitude should be (see Chaiken, Liberman, & Eagly, 1989).

However, another prominent feature of ambivalence is that it is uncomfortable for people to be ambivalent. Because of this, they may be motivated to use information processing to reduce the ambivalence. Note, however, that not all information should be equally capable of reducing ambivalence. Consider a person who is moderately favorable toward nuclear power, for example, because s/he sees more positive than negative features. This person would be more likely to overcome the ambivalence by learning about additional positive features (because the larger number of positive features will “dwarf” the negative features and reduce the feeling of conflict). If the person learns about new negative features of nuclear power, this would only increase the ambivalence (because there would be more negative perceptions to counter the positive, and the feeling of conflict would increase).

This suggests that effects of attitude ambivalence should not be a general increase in information processing (as suggested by past research). Instead, ambivalent people should want to process information that adds new information supporting their existing position (because it could help to decrease the ambivalence). In contrast, people experiencing ambivalence should want to avoid processing of information that opposes their existing attitude (because the information threatens to increase their ambivalence).

Clark, Wegener, and Fabrigar (under review) reported evidence consistent with the proposal in a series of three studies (one addressing attitudes toward nuclear power, and two addressing attitudes toward the taxing of junk food). When people were relatively ambivalent before they received the persuasive message, they processed the message to a greater extent when the message was relatively agreeable (i.e., focusing on features of the proposal that further supported the message recipients’ views before they received the message). When the message disagreed with the ambivalent person’s pre-message assessments, message recipients did not

think carefully about the information. In addition, ambivalent participants perceived the agreeable messages as more likely than the disagreeable messages to reduce ambivalence, and these perceptions of potential for ambivalence reduction led to the processing differences across messages that were relatively agreeable or disagreeable.

However, when participants were relatively unambivalent, they showed a very different pattern of message processing. Unambivalent people processed messages more when the messages were disagreeable rather than agreeable. These results were consistent with past research that did not address ambivalence, but likely examined situations where ambivalence was relatively low. In that past research, disagreeable messages were thought to receive more scrutiny because they threaten the person's attitude or self confidence (e.g., Cacioppo & Petty, 1979; Edwards & Smith, 1996). Although this may be for people experiencing low levels of ambivalence, it appears that motives to reduce ambivalence overpower any attitude-threat effects and entirely reverse the traditional effects of message position on amount of message processing.

When one reorganizes these studies to examine effects of ambivalence on message processing, the Maio et al. (1996) effects are limited to the processing of relatively agreeable messages. When the person already agrees with the point of view in the message, s/he is more likely to process the message when feeling high rather than low levels of ambivalence. In contrast, with disagreeable messages, people experiencing high levels of ambivalence are less likely to think carefully about that message than people experiencing little or no ambivalence.

Therefore, if applied researchers had assumed (as previous research had suggested) that ambivalence would generally lead to careful thinking (and careful thinking would lead to strong attitudes, as discussed in the ELM), these researchers would have been sorely mistaken. In fact, if using a disagreeable message (which is the typical kind of message when changes in attitudes

are sought), the ambivalent people are significantly less likely to process information carefully (and, therefore, their attitudes would remain weak and unlikely to guide future behavior).

Using the Research to Inform Policy

I am not sure if informing policy is the primary role of research on attitudes and attitude change. It is true that the need for policies like government subsidies (e.g., to make environmentally friendly forms of energy more affordable) might be more necessary when consumers do not strongly favor use of those new technologies. It may also be true that government policies influence how much public support a new energy source receives. For example, it may be that support for use of ethanol may stem, in part, from people wanting to support farmers and rural communities (which also implies support for subsidies that go to support farmers or ethanol producers).

It seems to me, however, that research on attitudes and attitude change may be more useful in helping to support and implement government policies pertaining to energy use. For example, it may be deemed as useful or even necessary for our country to transition away from use of fossil fuels (which are polluting and come largely from beyond our borders, producing a security premium for obtaining a steady supply of these fuels). But, as noted earlier, an effective transition from cheap fossil fuels to more costly (and perhaps less convenient) new technologies will take more than technology development alone.

Public attitudes, values, and norms supporting the transition will go a long way toward paving the way for new technologies to take hold and become commonplace. For example, our local municipality recently implemented a city ordinance restricting smoking in public places. Both before and after this policy decision was made, there was a flurry of advertising supporting

this decision prior to implementation of the ordinance. These efforts were clearly not intended to influence the members of the City Council, who had already decided how they were going to vote. The advertising was there to prepare the public for the change and to persuade them that it makes good health sense for employees and patrons. If successful, such efforts increase the likelihood that the ordinance will receive little opposition in the future, and the restrictions will become an accepted norm.

If federal, state, or local government views particular energy sources or technologies as economically or politically desirable, these entities (or policy-makers within them) may want to persuade the public that these energy sources or technologies are desirable. Indeed, such persuasion may be necessary for the public to accept use of the new technologies in their communities. The relevance of these ideas becomes apparent when considering that, in many places around the country, our energy-producing infrastructure is aging and new power plants will be necessary. Yet, the process of building a new plant is often held up, in part, by company officials trying (unsuccessfully) to convince local residents that the plant will not create negative consequences for their community.

Part of this likely stems from incomplete understanding of the principles studied in attitudes and persuasion. For example, utility officials presenting information about the environmental impact of their proposed plants are not likely to be viewed as credible communicators. They have a clear self-interest, and might often be viewed as untrustworthy. In many of these instances, a better grasp of persuasion principles might suggest use of an independent third-party communicator who can provide information without being perceived as having ulterior motives. Assuming that strong (persuasive) arguments are available (e.g., new power plants can often produce many times the power of old plants with far less pollution than

the old, smaller plants), this information may be processed in a more objective manner if presented by a trusted and expert source.

It is also true that initial concerns may not be the same as long-term concerns. For example, although people oppose the building of a nuclear power plant more when it is proposed to be near rather than far away from them, the same is not true for opposition of plants that are already built. That is, people are not more negative toward nuclear power (or oil development) when they live near to it rather than far away (Smith, 2002). Similarly, people who live near a nuclear power plant tend to become more favorable toward it over time – a long-term adaptation effect (van der Pligt, Eiser, & Spears, 1986, 1987). Therefore, for energy sources that promise long-term benefits (and that operate in safe, and environmentally friendly ways), it may be that the primary public perception obstacles are incurred early in the process – when obtaining zoning and permits to build the plant.

Stepping outside my own area of attitudes and persuasion research, I should also mention that other work in the SEPAE area of the Purdue Energy Center is very explicitly aimed at assessing policy alternatives per se. For example, Dr. Tyner's economic analyses specifically address the influences of policy alternatives on whether the technology is likely to draw private investment or not. Perhaps other panel members will also address the links between other social science areas and policy.

4. What basic social psychology research questions relevant to the energy challenge remain unanswered? Do social scientists have all of the tools they need to answer these questions and adequate resources to pursue promising research directions? Are there of yet

undeveloped or underdeveloped technologies or methodologies that would help advance this research?

Unanswered Questions

In over 80 years of empirical social psychology research, much has been learned about how people form and change their attitudes. But for virtually every variable in the persuasion setting, and for each process that has been identified, there exists additional questions that have not yet been examined. Let me provide examples of three types of research questions that seem worth pursuing – one dealing with specific predictors of attitude strength, a second dealing with weak attitudes influencing later information processing in ways that make them stronger over time, and a third addressing the specific cognitive mechanisms that connect attitudes and other psychological variables to behavior. By focusing on attitude strength and behavior, I do not mean to imply that we know everything about attitude change. We certainly do not. However, because the ultimate goal of most attempts at attitude change is to change behavior, a focus on behavior in future research seems as likely as any other focus. I want to be clear, however, that I write this section with the caveat in mind that every year seems to produce new questions that simply were not in the collective consciousness of researchers, sometimes even months before.

Necessary and Sufficient Strength-Related Features of Attitudes

I have mentioned at various points in this testimony that the goal of persuasion is not simply to produce positive attitudes toward one's desired product or policy. The goal is to produce a favorable attitude that is also strong enough to last over time, to resist future attempts at change, and to guide future thinking and behavior (Petty & Krosnick, 1995). This basic idea

has been in the literature for some time, but which properties of the attitude are sufficient or necessary for the attitude to produce these desired consequences? Many properties have been studied (e.g., accessibility, ambivalence, certainty, direct experience, knowledge, elaboration; Wegener et al., 1995). However, these properties of attitudes have often been studied in isolation, so the relative contribution of each attitudinal property remains unclear. Also, many of the attitudinal properties are only weakly or moderately correlated with each other, so there is not a single unified “strength” property of attitudes (Krosnick, Boninger, Chuang, Berent, & Carnot, 1993).

This leaves open the real possibility that the contribution of different strength-related attitudinal properties might differ across the types of attitude consequences of interest. For example, consider a context in which the attitude object is relatively novel (as many new energy technologies would be) and the primary question is whether one’s attitude will persist long enough to guide future behavior. In this situation, it may be that relatively “passive” attitude properties such as accessibility in memory or certainty might be especially important (it turns out that accessibility and certainty are empirically linked, in that both can be increased by simple repeated expression of one’s attitude; Holland, Verplanken, & van Knippenberg, 2003).

On the other hand, when the attitude is controversial and the person is likely to encounter many diverging opinions, the ability of the attitude to resist change may be the key. In such settings, the most important strength-related properties of attitudes may be more “active” qualities that give the person greater ability to counterargue “attacking” messages. If so, then attitudes based on large amounts of knowledge or on high levels of elaboration might be the attitudes best able to hold fast in the face of the diverging opinions. These questions have simply not been addressed in existing attitude strength research.

Initially Weak Attitudes Becoming Stronger over Time

Another interesting set of research questions may address the possible impact of initially weak attitudes. In existing attitude strength research, the weak attitudes are simply treated as relatively nonconsequential (i.e., unlikely to last over time, influence behaviors, etc.). However, there may be at least some “weak” qualities of attitudes that create the potential for the attitudes to “snowball” into becoming strong. For example, as described earlier, recent research in our lab shows that ambivalence and message position combine to influence information processing (Clark et al., under review). That is, ambivalent people think carefully about information that agrees with their pre-message attitudes but avoid thinking about information that disagrees with their pre-message attitudes.

In our initial studies, participants were given the persuasive message rather than choosing to view it on their own. However, these results from our initial research would also have direct implications for what ambivalent and unambivalent people would choose to receive if given the choice. A result parallel to our information processing studies would be for people experiencing ambivalence to be more likely to expose themselves to agreeable rather than disagreeable information. People experiencing little ambivalence may be more balanced in their choices or might even expose themselves to more disagreeable rather than agreeable information.

But notice what the effects of this exposure are likely to be. When ambivalent people expose themselves to agreeable information, this should make them less ambivalent and should, therefore, make their attitude stronger. In contrast, exposure to balanced or more disagreeable information would make people’s attitudes more ambivalent and, therefore, weaker. One interesting aspect of this possible pattern of results is that exposure to attitude-consistent

information is one of the results that has been discussed in past research as indicative of attitude strength (i.e., as “impact on thoughts and behavior”). Because of this, past researchers have expected (and some have recently found; Brannon, Tagler, & Eagly, 2007) that people with stronger attitudes are more likely to seek attitude-consistent rather than attitude-inconsistent attitudes. These effects are rather small in magnitude, however, and we suspect (but have not yet tested) that this overall pattern masks the effects of some specific types of weak attitudes (especially those that are ambivalent).

More generally, it would change the attitude strength literature in important ways if specific forms of “weak” attitudes actually create stronger preferences for attitude-consistent information or create stronger influences on other types of thinking and behavior.

More Specific Mechanisms to Connect Attitudes and Behavior

In many respects, the study of attitude change is predicated on the ability of attitudes to influence future behavior. Indeed, much research over the years has studied when attitudes predict future behavior and when they do not (and other psychological constructs, such as norms, influence behavior instead; see Ajzen & Fishbein, 2005). This emphasis seems justified, both for the study of attitudes in general, and for studies of attitudes in relation to energy.

There are a number of respects in which we can increase our understanding of exactly how attitudes or other psychological constructs influence behaviors, however. For instance, much research on attitude-behavior consistency speaks of “prediction” of behavior, but there is an important distinction to be made between prediction of behavior and influence on behavior (Fabrigar, MacDonald, & Wegener, 2005). For example, consider a person who forms a positive

attitude toward hybrid automobiles after riding in a friend's hybrid automobile. Suppose that this person goes to buy a new car a few months later, but the person does not buy a hybrid car.

This could happen for many reasons, but consider two distinct explanations for this lack of attitude-behavior consistency that have not been systematically differentiated in the attitudes literature to date. One possibility is that the person's positive attitude toward hybrid cars persisted unchanged right up until the purchase decision, but the attitude did not prove strong enough to guide the behavior when the purchase was made. However, there is another possibility -- one that produces the same lack of attitude-behavior consistency (at least when using the initial positive attitude to predict the later behavior). That is, the person may use his or her current attitude when deciding to purchase a new automobile, but the attitude may have changed in the months since the original positive attitude was formed. This latter situation is not really a case of attitude-behavior inconsistency at all, but the change in attitude means that the earlier positive attitude did not carry through to guide the purchase behavior.

In fact, the social psychology program at Purdue University will be holding a conference during May of 2008 with the explicit theme of motivating work to develop more complete theory connecting psychological antecedents with behavior.

We Cannot Forget about Applied Energy Research

The question posed to me by the committee was framed in terms of basic social psychology research, and I am entirely comfortable with that, because I am first and foremost a basic scientist. I should also note, however, that technology-focused researchers do not always appreciate the fact that we are working to identify generalizable persuasion principles that operate across topic domains. Quite naturally, practitioners focusing on a particular topic will

view our research as more relevant and informative to them if it deals specifically with their domain of interest (be it a specific form of energy, a particular health condition, or some other specific topic).

Because of this, there may be benefits of applied research that addresses psychological processes that have been identified in unrelated domains but would have clear relevance to influencing attitudes related to energy. At a minimum, if it is important to direct attention in the energy domain toward the psychological principles we discover, it may be helpful to fund some portion of the basic research (e.g., that funded through NSF) in ways that explicitly incorporate energy-related topics. Doing so would ensure that energy researchers and practitioners identify the persuasion (and other social psychology) principles discovered as relevant to the energy domain.

Even in areas where the basic research has not used energy-related topics, telephone surveys and other tools for attitude measurement can be used to determine the current attitudes, beliefs, and knowledge that people hold about energy topics. When the characteristics of current attitudes are documented, for example, this would tell energy researchers which basic persuasion principles are relevant to attitudes in that energy domain. For example, if surveys show high levels of ambivalence for people's attitudes toward clean coal technologies, this would suggest that the research on attitude ambivalence described earlier (e.g., Clark et al., under review) is quite relevant.

Tools and Resources

One of the benefits of social science research in general, and social psychological research in particular, is that it is very efficient from a cost standpoint. With some sub-

disciplines excepted (such as social, affective, or cognitive neuroscience, which use Functional Magnetic Resonance Imaging, fMRI, techniques), most research laboratories can be constructed with \$100,000 or less. Once a lab is established, the primary costs are those of personnel (i.e., faculty time, graduate students, post-doctoral fellows, research assistants) and research participants (especially if recruiting research participants from the surrounding community).

Because of this efficiency, it seems likely that one might often gain more “bang for the buck” from research on behavior change than on higher-cost funding of new (as yet untried, and often economically unfeasible) energy-production technologies. This is not an argument to reduce funding to develop new technologies. But the research on basic persuasion principles will be relevant across many such technologies, and the transition away from fossil fuels will absolutely require changes in behavior that involve energy conservation (using current technologies) as well as adoption of new energy sources, policies, and products. More generally, this transition will require policies to encourage investment, persuasion of potential consumers, changing norms to encourage adoption, and other social, economic, or governmental interventions to facilitate shifts in energy use.

Unfortunately, despite the relative efficiency of social science research, there is much less federal funding available to fund this research (at least within social psychology) than there used to be. As I described earlier, this is largely a function of the shift in funding priorities for the National Institute of Mental Health. This shift may have made sense for that institute if its primary mission is, indeed, severe mental illness. However, this shift in priorities has left a sizeable gap in funding for basic science whose results and theory cut across many basic and applied disciplines. It is extremely important to find a new home for federal funding of basic research in social psychology in general and of research in attitude change in particular.

New Technologies or Methods

Most social psychological research uses existing computer technology in creative and useful ways. Therefore, many of the new research methods come from the creativity of researchers, rather than the development of new research technology per se. This is not true of all social psychology research, however. As I mentioned earlier, my colleagues in social, cognitive, or affective neuroscience use a variety of techniques that I do not (including fMRI and other versions of brain imaging or scanning).

There are also a variety of new “implicit” measures of attitudes that have been developed recently to tap into attitudes and perceptions that people are reluctant to share or of which people might not even be aware. These typically use existing computer technology, but they represent some very interesting methods that are just beginning to pay big theoretical dividends. For example, implicit measures of attitudes have been shown to improve prediction of behavior in some contexts and for some behaviors, even when traditional direct measures of attitudes are also used (see Ajzen & Fishbein, 2005; Fazio & Olson, 2003). There are many unexplored questions using these techniques.

The long-term impact of these methods for theories of attitudes and attitude change are still unclear. It is also important to note, however, that there is still much to learn using more “conventional” methods to ask people about their attitudes and thereby examine how factors in a persuasive message or in the environment influence the attitude.

Finally, it is also important to note that social psychologists’ focus on cognitive and motivational processes requires sophisticated statistical techniques and research methods (see Reis & Judd, 2000; Sansone, Morf, & Panter, 2004). These developments help to build stronger

evidence in tests of psychological theories, and parallel analyses then receive use in related academic and applied disciplines (for a recent example advance in this area, see Muller, Judd, & Yzerbyt, 2005).

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Biography of

Duane T. Wegener, Ph. D.

Dr. Wegener received his PhD in Social Psychology from Ohio State University in 1994. After serving as an Assistant Professor of Psychology at Yale University for three years, he joined Purdue University in 1997 as an Associate Professor and was promoted to Professor in 2003. Dr. Wegener serves as one of three Initiative Leaders for the Social, Economic, and Political Aspects of Energy Use and Policy, a research initiative within the Energy Center at Discovery Park – an interdisciplinary research hub at Purdue University.

Dr. Wegener's research focuses on attitudes and persuasion, especially influences on the amount and nature of information processing and the consequences of the resulting attitudes for later thinking and behavior. Dr. Wegener has been PI or Co-PI on grants in social psychology (National Science Foundation), health (focusing on processing of health communications; Canadian Institute for Health Research), and energy (focusing on energy-related attitudes and decision making; National Science Foundation – Human Social Dynamics Program).

In 2001, he received the American Psychological Association (APA) Early Career Award for distinguished contributions to the science of social psychology. Dr. Wegener's research has resulted in over 50 publications in journal articles and book chapters. He is currently a Section Co-Editor for the *Social and Personality Psychology Compass*, and he served as Associate Editor for *Basic and Applied Social Psychology* and the *Personality and Social Psychology Bulletin*. He has also served as an editorial board member for the *Journal of Personality and Social Psychology*, the *Journal of Experimental Social Psychology*, and *Personality and Social Psychology Bulletin*, and as an ad hoc reviewer for over 30 academic journals.