NUCLEAR ENERGY: THE ACCURACY OF POLICY MAKERS' PERCEPTIONS OF PUBLIC BELIEFS

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SUMMARY

In many areas of technological policy formulation, the decisions of policy makers are increasingly influenced by the question of public acceptance. However, if a broad base of support is to be found for controversial issues, a simple head-count of those in favor of and those against a given issue is not sufficient. It is only through an appreciation of the beliefs and values which underlie public attitudes that policy makers can formulate solutions which are responsive to the real concerns of the public. This study is intended to further such understanding by examining the extent to which policy makers can accurately assess not only the overall attitudes of public groups but also the belief systems that give rise to those attitudes.

The policy issue addressed is that of the use of nuclear energy. An earlier study had already established the belief structures of members of the Austrian public who were particularly favorable, or unfavorable, toward nuclear energy. These findings were used as the baseline against which to compare the policy makers' perceptions of public positions. The policy makers -- a group of senior Austrian civil servants responsible for energy matters ($N = 40$) – responded to a questionnaire that had already been used for the sample of the Austrian public. This questionnaire measured overall attitude, but was mainly concerned with the measurement of belief systems, that is beliefs about the qualities, attributes, and possible consequences of the use of nuclear energy. A set of 39 attributes were expressed in propositional form (for example, "the use of nuclear energy leads to an increase in the standard of living"), and the policy makers were asked to rate their degree of belief or disbelief in each statement. In this way their own beliefs were measured. They also completed the same questionnaire on a second occasion, this time in the role of an average member of the Austrian public who was in favor of (or against) the use of nuclear energy. This experimental design permitted the following comparisons to be made: (1) between the policy makers' own personal positions and those of the general public, and (2) between the policy makers' in-role responses and those of the appropriate subgroups of the public.

In the earlier study it had been shown that public attitudes toward nuclear energy were based on four underlying belief dimensions: psychological (anxiety-inducing) risks; economic/technical benefits; sociopolitical risks; and environmental/physical risks. These same dimensions were used in the present study to analyze the policy makers' responses. It was found that the policy makers were significantly more in favor of nuclear energy than were the sample of the public, and this was primarily due to differences in their beliefs about psychological risks and environmental/physical risks. The policy makers, as compared to the public, had considerably less strong beliefs relating nuclear energy with psychological risk, and greater disbelief in nuclear energy as a source of environmental risk.

When the policy makers responded in-role to the questionnaire they were able to shift their original (personal) responses in the directions indicated by their role-play assignments and they could quite adequately reproduce the overall attitudes toward the use of nuclear energy of the appropriate public subgroups. There was, however, a tendency to overestimate the positive attitudes of the subgroup in favor of the use of nuclear energy. When the policy makers' perceptions of the public's underlying belief dimensions were examined, it was found that, despite a high degree of accuracy, there was a significant underestimation of the extent to which issues of psychological significance contributed negatively toward public attitudes. This was the case irrespective of whether the public subgroups were in favor or against the use of nuclear energy.

PREFACE

The risks associated with alternative energy systems, and public perceptions of these risks, have become important considerations in the formulation of energy policies. An earlier research memorandum (Otway and Fishbein 1977) reported a study of the attitudes and beliefs held by a sample of the Austrian public with respect to nuclear energy; an extension of the study to compare the beliefs held about five alternative energy sources has also been described (Thomas *et al.* 1980). The present research report analyzes the attitudes and underlying beliefs, with respect to nuclear energy, of senior Austrian civil servants in the Ministry responsible for energy matters, who were in a position to influence energy policies. It also reports on the accuracy of their perceptions of the attitudes and beliefs of those subgroups of the public sample most in favor of and most against the use of nuclear energy.

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1 INTRODUCTION

Issues of technological policy are increasingly attracting public attention, a good example being plans for nuclear energy programs. Experts responsible for making policy recommendations, and government itself, have been forced by events to take notice of public attitudes and opinions. The motivations for wishing to take public attitudes into account in policy decisions will depend very much upon the particular political system involved; such a discussion is beyond the scope of this report. For our purpose we will assume that the aim is to formulate socially viable technological policies, where viability refers not only to an ethically acceptable level of public risk, but also to social acceptability. This requires knowledge of what the relevant public attitudes are as well as an understanding of the belief and value systems which underlie these attitudes. A simple "head-count" of those in favor of (PRO) and those against (CON) a particular technological issue is not sufficient; the policies selected, and even the processes by which they are evolved, must be responsive to the real concerns of the public if a broad base of support is to be found.

The particular aspect of policy we have addressed in this report is the role of nuclear energy in the Austrian economy. During the course of this research the Austrian nuclear energy program became an issue of considerable importance. As Austria's first nuclear power plant (at Zwentendorf, near Vienna) approached completion, the government organized a series of public debates aimed at opening up discussions on energy issues. These debates, held during late 1976 and early 1977, had the effect of polarizing opinions, and clarified the aims of the anti-nuclear lobby, namely to prevent completion and operation of the Zwentendorf plant (Hirsch 1977). At a national referendum held in November 1978, the Austrian electorate decided that the Zwentendorf plant should not be brought into operation. The study reported here was carried out in the period between the public debates and the referendum (late 1977 and early 1978), although the data reported for the public sample were collected before the information campaign.

The aims of the present research were as follows: first, to examine the beliefs and attitudes toward the use of nuclear energy held by a group of senior government officials in Austria (referred to throughout this report as "policy makers") who were in a position to make policy recommendations to decision makers at ministerial level, and to compare these beliefs and attitudes with those of a sample of the general public. Second, to examine the degree of accuracy with which the policy makers perceived the public's beliefs and attitudes on the topic of nuclear energy. The policy makers and the members of the general public responded to the same questionnaire, allowing direct comparisons to be made.[1] The policy makers' perceptions of the viewpoints of the general public were examined by having the policy makers respond to the questionnaire on a second occasion, this time in the role of a typical (i.e., not an active extremist) member of the public in favor of (or against) the use of nuclear energy. Half of the policy makers responded in each role condition. A comparison of the in-role responses with those of the public sample gave an indication of how accurately public beliefs were reproduced. The in-role responses also provided a basis for assessing the policy makers' perceptions of the issues underlying the public response to nuclear energy.

2 THE ATTITUDE APPROACH

The particular attitude model used in this study is that developed by Fishbein and his associates (for a summary, see Fishbein and Ajzen 1975). Since this model has been described in some detail in the references cited in Note 1, we will only summarize the main points that are relevant to the procedures and findings described in this report.

1 Attitude is defined as the overall judgment about an object in terms of favorableness or unfavorableness, where "object" refers to any discriminable aspect of the individual's world
2 Attitude is based on the beliefs an individual holds about an attitude object. The strength of each such belief is treated as a subjective probability judgment that the attitude object is associated with some characteristic or attribute
3 At any given time an attitude is determined by the sum, over the salient beliefs, of evaluations of the attributes, each evaluation being weighted by the strength of the belief (i.e., the subjective probability that the attitude object is characterized by that attribute)
4 The way in which evaluations and belief strengths are combined to estimate attitude can be stated formally:

$$A_o \approx \sum_{i}^{n} b_i e_i$$

where

A_o = the attitude toward the object o
b_i = the strength of the belief which links the attitude object to attribute i
e_i = the evaluation of attribute i
n = the number of salient beliefs, i.e., those currently within the span of attention

Two methods were used to measure attitude: a direct method using the semantic differential technique of Osgood *et al.* (1957), and an indirect method based on respondents' beliefs and attribute evaluations (using the formula of point 4 above). The semantic differential measure of attitude was used as the criterion to validate the set of beliefs by correlating the direct and indirect (i.e., belief-based) measures of attitude.

The beliefs used in the present study were selected on the basis of previous research (Otway and Fishbein 1976), a literature survey, and open-ended elicitations. The 39 belief items relating the use of nuclear energy to a series of possible attributes and consequences are listed in Table 1.

TABLE 1 The original set of beliefs about the use of nuclear energy and the four belief dimensions derived from factor analysis.

Belief dimension	Belief item
Factor I: Psychological risks	*Means exposing myself to risk without my consent
	*Leads to accidents which affect large numbers of people at the same time
	*Means exposing myself to a risk which I cannot control
	*Is a threat to mankind
	*Is risky
	Leads to hazards caused by material failure; has a delayed effect on health; increases the rate of mortality; leads to change in man's genetic make-up; leads to hazards by human failure
Factor II: Economic and technical benefits	*Increases the standard of living
	*Increases Austrian economic development
	*Provides good economic value
	*Increases my nation's prestige
	*Leads to new forms of industrial development
	Leads to technical "spin-offs"; increases employment; increases the development of methodologies for medical treatment; reduces the need to conserve energy; symbolizes the industrial way of life; satisfies the energy need in the decades ahead; decreases dependence on fossil fuels; increases the extent to which society is consumer-oriented
Factor III: Sociopolitical risks	*Leads to rigorous physical security measures
	*Produces noxious waste products
	*Leads to the diffusion of knowledge that facilitates the construction of weapons by additional countries
	*Leads to dependence on small groups of highly specialized experts
	*Leads to transporting dangerous substances
	Increases the likelihood that a technology is misused in a destructive way by terrorist groups; gives political power to big industrial enterprises

TABLE 1 *Continued.*

Belief dimension	Belief item
Factor IV: Environmental and physical risks	*Does exhaust our natural resources
	*Increases occupational accidents
	*Leads to water pollution
	*Leads to air pollution
	*Makes Austria economically dependent upon other countries
	Leads to a long-term modification of the climate
Miscellaneous: Beliefs not loading on any factor	Involves a technology that I can understand; leads to the formation of groups advocating extreme political positions; leads to a police state

*Beliefs used to represent the factor.

3 METHOD

SAMPLES

The sample of policy makers consisted of 40 senior civil servants specializing in energy matters; 34 of the respondents were male, 6 were female. This group of 40 people represented virtually all of the ministry staff in this category who were in duty at the time of the survey; only one person refused to participate. About five weeks after the respondents had completed the questionnaire for the first time, expressing their personal points of view, they were randomly assigned to one of the two role-play subgroups (i.e., playing the role of a typical Austrian citizen in favor of or against the use of nuclear energy) to obtain estimates of the policy makers' perceptions of the beliefs and attitudes of members of the public. Only 35 of the original group of 40 were available for the role-play part of the study ($N = 17$ for the PRO-role, and $N = 18$ for the CON-role).

The sample of the Austrian general public with which the policy makers were compared was a stratified sample controlled for geographic location (Vienna, provincial capital, and rural), sex, age, and education. The number of usable interviews was 224. Details of the sample can be found in Thomas *et al.* (1980). Two subgroups, in favor of or against the use of nuclear energy, were selected from the public sample using the semantic differential measure of attitude as the criterion; the 48 respondents most favorable to the use of nuclear energy were termed the PUBPRO group, and the 47 least favorable the PUBCON group (see Figure 1).

QUESTIONNAIRE

The questionnaire used to measure the policy makers' responses (personal and in-role) consisted of the same items employed in the study of the Austrian public (Otway and Fishbein 1977). The questionnaire was originally designed in English, and then translated into German by the experimenters prior to use.

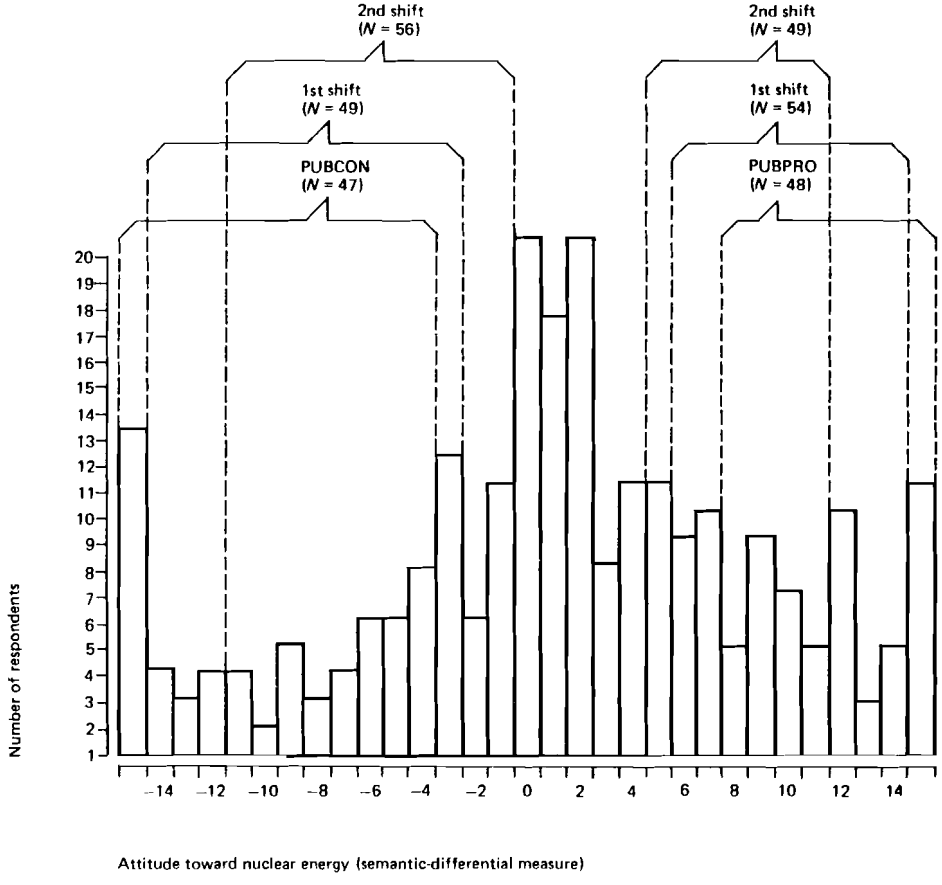

FIGURE 1 Public subgroups selected for comparison with in-role responses of the policy makers.

Apart from the demographic information, the questionnaire measured the following variables:

Attribute Evaluation

For each of the 39 beliefs the evaluation of the attribute was measured using a 7-point (+3 to −3) scale with the end-points labeled with the adjective pair good/bad. For example,

Increasing the standard of living

GOOD :−:−:−:−:−:−:−: BAD

Belief Strength

Belief statements were presented in propositional form (as shown below) and the respondents were asked to judge the "truth" of each statement on a 7-point (+3 to −3) scale, where the end points were labeled likely/unlikely. For example,

The use of nuclear energy leads to an increase in the standard of living

LIKELY :−:−:−:−:−:−:−: UNLIKELY

Although belief strength is conceptualized here as a subjective probability, the measurement procedure described above does not meet certain strict requirements of probability theory. In keeping with most earlier research using Fishbein's attitude model, the beliefs are *not* treated as a partitioned event space, in which the probabilities assigned to each attribute would have to sum to 1; furthermore, in order to permit measurement of belief and disbelief, a bipolar scale is used which makes it possible to encompass the probability that nuclear energy *is* or *is not* associated with the attribute in question.

Direct Measure of Attitude Toward the "Use of Nuclear Energy"

This was measured using the semantic differential technique (Osgood *et al.* 1957). The attitude object ("use of nuclear energy") was rated on a series of 7-point (+3 to −3) scales with the end points labeled with adjective pairs such as good/bad, harmful/beneficial.

4 PREDICTION OF ATTITUDE FROM BELIEFS AND ATTRIBUTE EVALUATIONS

In the earlier study of the Austrian public it was found that respondents' attitudes toward nuclear energy could be accurately estimated from a consideration of beliefs linking the use of nuclear energy with each of the 39 attributes and the evaluations of these attributes. The correlation between estimated attitudes and the same attitudes as measured by the semantic differential was 0.63. Given the validity of the attitude model in that application, a factor analysis[2] of belief-strength scores was used to explore the underlying dimensions which characterized the thinking of the public with respect to the use of nuclear energy. This factor analysis produced a clear factor structure relating the use of nuclear energy to four clusters of belief dimensions (see Table 1)

- Psychological risks
- Economic/technical benefits
- Sociopolitical risks
- Environmental/physical risks

PREDICTION OF PUBLIC ATTITUDES FROM UNDERLYING BELIEF DIMENSIONS

The factor analysis suggested that four major issues underlie public attitudes toward nuclear energy. Therefore, the five attributes which loaded highest on each belief dimension were used to calculate "factor-summaries" representative of each dimension. In each case the five belief strengths were summed ($\Sigma_{i=1}^{5}\ b_i$), as were the corresponding attribute evaluations ($\Sigma_{i=1}^{5}\ e_i$). These two sums were then multiplied in line with the attitude model used, to give an index of the contribution of that belief to overall attitude $[(\Sigma_{i=1}^{5}\ b_i) \times (\Sigma_{i=1}^{5}\ e_i)]$. To test the validity of reducing the 39 original attributes to 20 attributes (5 per dimension) an estimate of attitude based on a sum of these four factor-summary products was correlated with the direct (semantic differential) measure of attitude.

The correlation coefficient was $r = 0.66$, as compared with $r = 0.63$ when all 39 attributes were used.

PREDICTION OF POLICY MAKERS' OWN ATTITUDES

In the case of the policy makers' own attitudes it was found that the correlation between the semantic differential measure of attitude and the attitude estimates based upon all 39 attributes was 0.89. Although it is possible that the higher correlation for this particular sample, as compared with the sample of the general public, could indicate the policy makers' higher level of education and familiarity with the topic, it is more likely that the difference in correlation merely reflects the fact that on the semantic differential the policy makers were asked to indicate their attitudes toward "the *use of* nuclear energy" while the public, due to an error in the wording of the questionnaire, were asked to indicate their attitudes toward "nuclear energy." Since the wording of the belief statements referred to "the *use of* nuclear energy", the semantic differential attitude of the public sample did not correspond precisely to the beliefs measured.

While it would have been desirable to perform a factor analysis of the policy makers' belief scores, the number of respondents ($N = 40$) was too small to obtain meaningful results for a set of 39 beliefs. Therefore, the factor structure obtained from the public sample was also used to summarize the policy makers' data. On calculating "factor-summaries" (as described above) for the policy makers, a correlation of 0.85 between this estimated attitude measure and the direct (semantic-differential) measure was found. This indicated the validity of using the reduced belief set; in the remainder of this report only the factor-summary indices will be considered.

5 COMPARISON OF POLICY MAKERS AND THE AUSTRIAN GENERAL PUBLIC

The first question of interest was the extent to which the policy makers' own beliefs and attitudes correspond with those of the general public. As expected, the attitudes of the policy makers toward the use of nuclear energy were significantly more favorable than those of the total public sample. This was true for both the direct (semantic differential) measure of attitude and the estimates based on the model.[3]

To investigate what underlay these differences, an analysis of variance (ANOVA) was calculated. The ANOVA design contrasted the policy makers and the public with respect to all four belief dimensions using the three factor-summary indices: belief strength, attribute evaluation, and their product (i.e., contribution to attitude, $[(\Sigma_{i=1}^{5} b_i) \times (\Sigma_{i=1}^{5} e_i)]$) as dependent variables. The two main effects (comparisons between the policy makers and the public, and comparisons between the four belief dimensions) and the 2-way interactions were statistically significant for all three dependent variables, with the single exception of the main-effect comparison between the attribute evaluations of the policy makers and the public. (Summary Tables for all ANOVA calculations mentioned in this report are shown in the Appendix.)

Table 2 shows the mean values of the factor-summary indices for the policy makers and for the total public sample. It can be seen that the main differences in overall attitudes were due to different contributions from the psychological-risk and environmental/physical-risk dimensions. The former dimension made an appreciable negative contribution to the public's attitudes but only a small negative contribution to the policy makers' attitudes. In contrast, environmental-risk issues made a large positive contribution to the policy makers' attitudes.[4] The policy makers and the public were in general agreement concerning economic/technical benefits and sociopolitical risks.

When these differences in contributions to overall attitude were analyzed in terms of the underlying beliefs and attribute evaluations they were found to be more closely related to differences in belief strengths than to differences in

TABLE 2 Mean values of attribute evaluations and belief strengths: policy makers and total public sample.

	Mean attribute evaluation (range = ±15)		Mean belief strength (range = ±15)		Mean contribution to attitude (range = ±225)	
Belief dimension	Policy makers	Public	Policy makers	Public	Policy makers	Public
Psychological risks	−8.4	−10.1*	0.7	8.6**	−9.9	−94.7**
Economic/technological benefits	5.7	7.4*	4.2	5.5	39.7	45.7
Sociopolitical risks	−4.3	−5.0	9.8	10.9	−45.0	−56.8
Environmental/physical risks	−8.8	−9.9	−4.9	−1.0**	45.8	8.0**

* Difference significant, $p < 0.05$.
**Difference significant, $p < 0.01$.

attribute evaluations. There were significant differences in the policy makers' and the public's beliefs about psychological risks and environmental/physical risks, although both agreed that the use of nuclear energy would lead to economic/technical benefits and to sociopolitical risks. It is interesting to note that the policy makers and the public agreed in their negative evaluations of sociopolitical risks and environmental/physical risks, but that the policy makers made less unfavorable evaluations of psychological risks and less favorable evaluations of economic/technical benefits.

In summary, the policy makers were significantly more favorable toward the use of nuclear energy than were the general public. This was primarily because the policy makers did not associate the use of nuclear energy with psychological risks, and believed that the use of nuclear energy would not lead to environmental/physical risks; in contrast, the public strongly believed that the use of nuclear energy would lead to psychological risks, and were less certain that it would not cause environmental damage.

6 COMPARISON OF POLICY MAKERS' OWN AND ROLE-PLAY RESPONSES

The ultimate goal of this study was to examine the profiles of attribute evaluations and beliefs which the policy makers perceived as being typical of members of the general public who were in favor of or against the use of nuclear energy. However, before making a direct comparison between these perceptions (the role-play responses) and the actual findings for the general public, it is instructive to examine these role-play responses in relation to the policy makers' own personal positions.

The overall effects of playing ROLEPRO and ROLECON are reflected in measures of attitude estimated from the sum of the evaluation X belief-strength products over the four belief dimensions. Analysis of variance showed that both group membership (ROLEPRO/ROLECON) and role-play (SELF/ROLE) had a significant main effect on this measure of attitude, and the interaction between these variables was also significant. Examination of the mean values of attitude in the four cells of Table 3 clarifies the interaction effect. It can be seen that in the SELF condition there was no significant difference in attitude between the two groups. This is evidence that the policy makers were randomly assigned to ROLEPRO and ROLECON groups.[5] When responding in-role, the differences in attitude between those playing PRO and CON were significant. Further, since the policy makers' own attitudes were more favorable than those of the public, the change in attitude from personal position to role response was greater for the ROLECON group than for the ROLEPRO group.

Analysis of variance was also used to make a detailed comparison between the policy makers' own responses and those they made in-role. The ANOVA design was 2 X 2 X 4 (ROLEPRO/ROLECON X SELF/ROLE X 4 BELIEF DIMENSIONS) using the same three dependent variables as before. All the main effects were statistically significant with the exception of the comparison between attribute evaluations in the SELF and ROLE conditions. More important for this discussion, however, were the significant two-way interactions between ROLEPRO/ROLECON and SELF/ROLE for all three dependent

TABLE 3 Mean values[a] of belief-based attitude of policy makers in SELF and ROLE conditions.

	SELF ($N = 35$)	ROLE ($N = 35$)
ROLEPRO ($N = 17$)	52.6	163.9*
ROLECON ($N = 18$)	9.8	−259.4**
	NS	**

* Difference significant, $p < 0.05$.
**Difference significant, $p < 0.01$.
NS, Difference non-significant.
[a]Range of values = ±900.

variables, and a significant three-way interaction (ROLEPRO/ROLECON X SELF/ROLE X 4 BELIEF DIMENSIONS) for the belief-strength measure. The statistical significance of these interactions permits a detailed *a posteriori* comparison of the mean values of the dependent variables in all the cells of the ANOVA design. These mean values are shown in Table 4.

Looking first at the contribution to overall attitude of each belief dimension, it can be seen that there are no significant differences in the SELF responses of the ROLEPRO and ROLECON groups. When responding in-role, the ROLEPRO group tended to shift in a positive direction on all belief dimensions, but not significantly so. However, the net effect of these non-significant shifts on each of the four belief dimensions had a significant cumulative effect on overall attitude. For the ROLECON group, the shift from SELF to ROLE response was in the negative direction, and was significant on all four belief dimensions.

Although both the ROLEPRO and ROLECON groups shifted their evaluations of risks and benefits in the direction appropriate to their assigned roles, none of these changes were significant. Therefore the different contributions to attitude in the SELF and ROLE conditions were primarily due to in-role shifts in belief strengths as opposed to attribute evaluations. In the ROLEPRO group the SELF to ROLE response shifts were small and nonsignificant, but in the ROLECON group the shifts on three of the belief dimensions were statistically significant. The policy makers assigned to play the CON role shifted their own beliefs with respect to psychological risks, environmental risks, and economic/technical benefits; however, there was no significant shift in their beliefs about sociopolitical risks.

BASIS FOR ROLE-PLAY RESPONSE SHIFTS

The results discussed above show that the policy makers were able to take a PRO or CON role and to shift their own responses in directions appropriate to

TABLE 4 Mean values of attribute evaluations and belief strengths: policy makers in SELF and ROLE conditions.

Belief dimension		Mean attribute evaluation (range = ±15)		Mean belief strength (range = ±15)		Mean contribution to attitude (range = ±225)	
		SELF	ROLE	SELF	ROLE	SELF	ROLE
Psychological risk	ROLEPRO	−8.7	7.4 NS	−0.1	−1.7 NS	4.2	32.1 NS
	ROLECON	−8.2	−10.1 NS	1.3	11.5**	−23.1	−130.8*
		NS	*	NS	**	NS	**
Economic/technical benefits	ROLEPRO	5.5	9.7 NS	3.7	6.2 NS	39.1	83.4 NS
	ROLECON	5.8	2.6 NS	4.7	−1.8**	40.1	−5.6*
		NS	*	NS	**	NS	**
Sociopolitical risk	ROLEPRO	−3.8	−2.0 NS	8.9	8.6 NS	−38.9	−7.7 NS
	ROLECON	−4.7	−6.7 NS	10.6	11.9 NS	−50.8	−80.6*
		NS	*	NS	NS	NS	**
Environmental/physical risk	ROLEPRO	−8.5	−6.3 NS	−4.7	−4.8 NS	48.3	56.1 NS
	ROLECON	−9.2	−8.6 NS	−5.1	4.1**	43.5	−42.4*
		NS	*	NS	**	NS	**

* Difference significant, $p < 0.05$.
**Difference significant, $p < 0.01$.
NS, Difference non-significant.

the roles they were assigned. In virtually every case (the only exception being beliefs about sociopolitical implications) there were significant differences between responses in the PRO and CON roles. However, for the PRO role, these responses were not significantly different from the policy makers' own personal positions. In the CON role the differences between SELF and ROLE responses were significant for three of the belief dimensions.

Given these differences in response shift in PRO and CON role conditions, it is worth exploring whether the policy makers made their in-role responses essentially in terms of their own positions or independently of these positions. If the policy makers made in-role responses which were anchored in their own positions, i.e., a more or less constant shift from SELF to ROLE, then one would expect an appreciable correlation between SELF and ROLE responses. If, on the other hand, they made their role responses independently of their own positions, then only low correlations between SELF and ROLE responses would be expected.

In order to test these hypotheses, two correlations were computed for each respondent: the correlation between SELF and ROLE belief-strength responses over the 20 attributes used to construct the four factor-summary indices; and the correlation between SELF and ROLE attribute evaluations over the same 20 items. These correlations (after conversion to z' scores) were examined using a 2 X 2 (ROLEPRO/ROLECON X ATTRIBUTE EVALUATION/BELIEF STRENGTH) ANOVA. The main effect of role group (ROLEPRO *vs.* ROLECON) on the correlation between personal and in-role responses was not statistically significant; the main effect of ATTRIBUTE EVALUATION *vs.* BELIEF STRENGTH was significant ($p < 0.05$). The interaction between these two main effects was non-significant. The mean values of the correlation coefficients are shown in Table 5. Note first that, on average, the policy makers relied significantly on their own positions in playing the role of the public ($\bar{r} = 0.53$). It is interesting, however, that the policy makers were more likely to use their own positions as a basis for estimating the attribute evaluations of the public than for estimating the belief strengths of the public. This is demonstrated by the higher correlation for evaluation ($\bar{r} = 0.61$) than for belief strengths ($\bar{r} = 0.44$) between the SELF and ROLE responses.

For beliefs and evaluations considered together, the role-play shift was quite similar for the ROLEPRO ($\bar{r} = 0.56$) and ROLECON ($\bar{r} = 0.50$) groups. The correlations between SELF and ROLE in both conditions were also approximately the same for attribute evaluations ($\bar{r} = 0.60$ and 0.62, for ROLEPRO and ROLECON respectively). However, in estimating public beliefs there was a tendency for those in the ROLECON group to rely less on their own positions ($\bar{r} = 0.36$) than did those in the ROLEPRO group ($\bar{r} = 0.51$).

To summarize, when playing the role of public subgroups, the policy makers essentially used their own positions as anchors for estimating the positions of the public. They did so to a greater extent for attribute evaluations (perhaps reflecting a perceived commonality of values within society) than for

TABLE 5 Mean values of correlation coefficients[a] for SELF with ROLE responses.

	Attribute evaluation	Belief strength	Overall SELF/ROLE
ROLEPRO ($N = 17$)	0.60	0.51	0.56
ROLECON ($N = 18$)	0.62	0.36	0.50
Total ($N = 35$)	0.61	0.44	0.53

[a]All correlations statistically significant at $p < 0.05$.

beliefs. It was shown earlier that in the ROLECON condition the policy makers changed their beliefs to a greater extent than in the ROLEPRO condition. It can now be seen that, although not statistically significant, those assigned to the ROLECON group also tended to make more qualitative changes in their beliefs (as opposed to anchored shifts) than did those assigned to the ROLEPRO group. In other words, the policy makers tended to see their own views and feelings with respect to using nuclear energy as being more similar to those of members of the public who are in favor of nuclear energy rather than of those who are opposed to its use.

7 POLICY MAKERS' REPRODUCTION OF PUBLIC PRO AND CON ATTITUDES

The public subgroups whose beliefs and attitudes the policy makers were asked to reproduce were defined by the following instructions (translated from the German-language questionnaire):

> ". . . your answers should reproduce the opinions of a hypothetical person . . . please imagine that you are an average Austrian citizen who does not have any specific knowledge about energy matters. Your only sources of information are the mass media such as newspapers and television, and discussions with friends. Moreover, you are a definite proponent (opponent) of nuclear energy."

While the role-playing of militant extremists was discouraged by these instructions, it is clear that the ROLEPRO and ROLECON responses made by the policy makers refer to loosely defined public groups. Nevertheless, because a detailed examination had already been made of the beliefs and attitudes of the fifty or so members of the public with the most favorable (most unfavorable) attitudes toward the use of nuclear energy, these two subgroups, PUBPRO and PUBCON, were used as a base-line by which to judge the policy makers' in-role responses. Since there is a sense in which the initial definition of the PUBPRO and PUBCON subgroups is arbitrary, additional comparisons were made between the two role-play conditions and increasingly "moderate" subgroups in the public sample, using the overall attitudes, belief strengths, and attribute evaluations. These additional subgroups are described in Figure 1. However, the main analyses reported here are based on comparisons with the original PUBPRO and PUBCON subgroups of the public sample; but comparisons with the additional subgroups are also reported as illustrative of trends, as opposed to absolute accuracy, in the policy makers' perceptions.

The first comparison between the policy makers' in-role responses and those of the public was made, using analysis of variance, on the belief-based

(overall) attitude toward the use of nuclear energy. Only the PRO/CON main effect was statistically significant ($p < 0.01$).

Table 6 shows that the mean values of these belief-based attitudes were remarkably similar in the PUBCON and ROLECON groups, but that there was rather less correspondence between the PUBPRO and ROLEPRO groups. The implication of this is that the policy makers' role-play responses more closely matched those of the public subgroup opposed to, rather than in favor of, nuclear energy. These findings were essentially unchanged when the role-play responses were compared with those of less extreme subgroups. The first and second shifts (see Figure 1) in the CON group of the public sample resulted in mean values for belief-based attitude of −218.7 and −179.4 respectively, neither of which were significantly different from the policy makers' ROLECON responses. But, in the case of those in favor of nuclear energy, comparisons with less extreme PRO subgroups further widened the gap between the policy makers' perceptions and the reality of the public's overall attitudes (32.7 and −1.1, respectively, for the first- and second-shift subgroups). This tendency is interesting since it indicates that, despite the fact that the policy makers in the ROLEPRO condition shifted their own responses less than those in the ROLECON condition, these relatively small shifts led to overestimation of the PUBPRO attitudes. In contrast, the large shifts that the policy makers made from their own positions when in the ROLECON condition resulted in accurate estimates of PUBCON attitudes.

Our main concern, however, was not so much the overall attitudes attributed by the policy makers to the public, particularly since this was an indirect (belief-based) measure, but rather the profile of beliefs and attribute evaluations which the policy makers perceived as contributing to the public's attitudes. The major analysis was therefore a comparison between the public and the policy makers in-role, using the three factor-summary indices, i.e., belief strength, attribute evaluation, and the product of these factors (i.e., the contribution to attitude) for each of the four belief dimensions. A 2 × 2 × 4 ANOVA (PRO/CON × PUBLIC/POLICY MAKERS × 4 BELIEF DIMENSIONS) showed that all possible main effects were significant, with the simple exception of the comparison between the public and the policy makers in-role for the belief-strength × attribute-evaluation product, i.e., the overall attitude. More relevant to this discussion is the finding that there were neither significant PRO/CON × PUBLIC/POLICY MAKERS interactions nor significant three-way interactions for any of the three factor-summary indices. These findings indicate that the policy makers in the two role-play conditions (ROLEPRO and ROLECON) were equally accurate in their perceptions of the public's positions. Once again, however, there was a slight, but nonsignificant, tendency for those in the ROLEPRO group to see the public as being somewhat more positive toward nuclear energy than in fact they were.

As can be seen in Table 7, it was only with respect to the contribution of the psychological-risk dimension to overall attitude that the policy makers

TABLE 6 Mean values[a] of belief-based attitudes of public subgroups and policy makers in-role.

	Public subgroups ($N = 95$)	Policy makers in-role ($N = 35$)
PRO ($N = 65$)	52.3	163.9*
CON ($N = 65$)	−275.5 **	−259.4 NS **

* Difference significant, $p < 0.05$.
**Difference significant, $p < 0.01$.
NS, Difference non-significant.
[a]Range of values = ±900.

were inaccurate to a significant degree. In the ROLEPRO condition they rightly attributed a negative evaluation of psychological risks to the PUBPRO subgroup, but they then assumed a *dis*belief that the use of nuclear energy would actually lead to these risks. The product of these attribute evaluations and belief strengths thus resulted in a positive contribution to overall attitude, indicating that the policy makers in the ROLEPRO condition felt that the Austrian public, being in favor of the use of nuclear energy, would not associate this form of energy generation with psychological risks, while, in fact, the public PRO subgroup were quite aware of these risks. Comparisons between the policy makers' ROLEPRO group and the less extreme public subgroups (see Figure 1) emphazised this mistaken perception: as the public subgroups became less extreme, the discrepancies in these beliefs and their contribution to attitude increased, since the public in these less extreme subgroups believed even more strongly that the use of nuclear energy is associated with psychological risks. In playing the PRO role, the policy makers underestimated the relevance of these risks to such an extent that they attributed a profile which was more positive in its implications than that actually held by *any* systematic subgroup of the sample of the Austrian public.

Inspection of the difference in the policy makers' perception of the public CON groups revealed the following pattern: the former again underestimated the original PUBCON subgroup's negative evaluation of psychological risks and also its belief strength about the association of these risks with the use of nuclear energy. As a consequence, the contribution of psychological risks to overall attitude was underestimated. But when less extreme CON subgroups of the public were used as a baseline for comparisons these differences diminished. This finding indicates that the policy makers in the ROLECON condition demonstrated an understanding of belief strengths and attribute evaluations about the psychological risks associated with the use of nuclear energy which was

TABLE 7 Mean values of attribute evaluations and belief strengths: public subgroups and policy makers in-role.

Belief dimension		Mean attribute evaluation (range = ±15)		Mean belief strength (range = ±15)		Mean contribution to attitude (range = ±225)	
		Public sub-groups	Policy makers in-role	Public sub-groups	Policy makers in-role	Public sub-groups	Policy makers in-role
Psychological risk	PRO	−10.3	−7.4*	3.7	−1.7**	−38.1	32.1**
	CON	−11.9	−10.1*	13.5	11.5**	−162.9	−130.8**
		**	**	**	**	**	**
Economic/technical benefits	PRO	9.0	9.7 NS	9.1	6.2*	80.9	83.4 NS
	CON	5.8	2.6 NS	0.4	−1.8*	1.7	−5.6 NS
		**	**	**	**	**	**
Sociopolitical risk	PRO	−3.6	−2.0 NS	9.2	8.6 NS	−34.8	−7.7 NS
	CON	−6.1	−6.7	12.5	11.9	−79.9	−80.6 NS
		**	**	**	NS	**	**
Environmental/ physical risk	PRO	−8.5	−6.2**	−4.8	−4.8 NS	44.3	56.1 NS
	CON	−11.1	−8.6**	3.0	4.1 NS	−34.5	−42.4 NS
		**	**	**	**	**	**

* Difference significant, $p < 0.05$.
**Difference significant, $p < 0.01$.
NS, Difference non-significant.

appropriate to a less extreme antinuclear subgroup than the original public CON group.

Table 7 also shows some divergent perceptions of the policy makers in-role with regard to two other belief dimensions. Regardless of whether they were in the ROLEPRO or ROLECON conditions, they tended to underestimate the PUBPRO and PUBCON subgroups' negative evaluations of environmental/physical risks and the public's belief strength that the use of nuclear energy would lead to economic/technical benefits. Although both these latter differences were statistically significant, they did not result in significant differences in terms of the contributions of these two dimensions to overall attitude.

When comparisons were made between the policy makers in-role and less extreme public subgroups, the policy makers' underestimation of the public's negative attribute evaluation of environmental/physical risks increased for the PRO subgroups (becoming even less accurate) and decreased for the CON subgroups (becoming more accurate). With regard to belief strength about economic/technical benefits, the policy makers' misperception of the public subgroups was more fundamental. There was very little difference, for any of the three public PRO subgroups examined, in the belief strength that the use of nuclear energy leads to economic benefits, and in all cases this belief was stronger than expected by the policy makers. As less extreme CON subgroups were selected, their belief strength about the economic benefits of nuclear energy actually increased, thus remaining substantially stronger than appreciated by the policy makers.

8 SUMMARY AND CONCLUSIONS

The main objective of this study was to test the accuracy of policy makers' perceptions of the beliefs and attitudes of public groups with respect to the use of nuclear energy. This was done by asking a group of Austrian senior civil servants specializing in energy matters to fill in a questionnaire in the *role* of an average (not extreme) member of the public who was in favor of or opposed to the use of nuclear energy. The same questionnaire had been used earlier to obtain data on the beliefs and attitudes of similar subgroups of the Austrian public, thus allowing direct comparisons to be made. In addition, the policy makers completed the same questionnaire from their own personal points of view, which permitted comparisons between the policy makers' own positions and those of the public. Perhaps not surprisingly, the policy makers tended to have more favorable overall attitudes toward the use of nuclear energy than did the Austrian public in general.

Four major independent dimensions had been found to underlie public attitudes toward the use of nuclear energy: psychological risks; economic/technical benefits; sociopolitical risks; and environmental/physical risks. Analysis in terms of these dimensions indicated that the difference in overall attitudes between policy makers and the public was primarily due to the fact that, for the public, psychological risks were strongly associated with the use of nuclear energy, while environmental risks only made a minimal positive contribution toward their attitude. A similar analysis of the policy makers' own personal responses showed that here psychological risks were associated only to a small extent with the use of nuclear energy, whereas environmental issues were perceived as a substantially positive aspect.

When the policy makers responded to the questionnaire in-role, they were successful in shifting their original responses in the directions indicated by their role-play assignments (ROLEPRO or ROLECON); and they were able to reproduce fairly accurately the general attitudes toward the use of nuclear energy held by the appropriate subgroups of the public. There was, however, a tendency

to overestimate the positive attitudes of the subgroup in favor of the use of nuclear energy.

In terms of the four belief dimensions, the policy makers were also able to satisfactorily reproduce the general attitudes of public subgroups in favor of or against the use of nuclear energy. This was particularly true with respect to the attitudinal contributions made by economic/technical benefits, sociopolitical risks, and environmental/physical risks. The accuracy of the policy makers' perceptions was somewhat diminished, however, by their failure to recognize the extent to which issues of psychological significance contributed negatively to the public's attitudes, irrespective of whether they were in favor of or against the use of nuclear energy. The policy makers underestimated the public's negative evaluation of psychological risks and they also underestimated the public's belief that the use of nuclear energy would lead to such risks.

Although the policy makers had relatively accurate perceptions of the belief and value systems underlying public attitudes for or against the use of nuclear energy, it would be interesting to know the degree to which this understanding is actually reflected in policy recommendations. Furthermore, the degree to which policy makers view public opinion as a legitimate input into the decision-making process remains to be investigated.

NOTES

1 Detailed reports on the beliefs and attitudes, with respect to the use of nuclear energy, of the sample of the Austrian public can be found in Otway and Fishbein (1977), and in Otway *et al.* (1978). An extension of this research to a comparison of beliefs about five different energy sources can be found in Thomas *et al.* (1980). The design of the questionnaire was largely based upon a pilot study reported by Otway and Fishbein (1976).

2 Factor analysis is a generic term for a set of linear, parametric statistical methods which identify the minimum number of independent dimensions needed to account for the variance in a larger set of intercorrelated variables. The method used here was that of principal components analysis, followed by Varimax rotation. This technique produces underlying dimensions which are independent, i.e., orthogonal factors.

3 Semantic differential scores could range from +15 to −15; the policy makers' mean score was 7.9, and the public mean score was 1.3. Recall, however, that policy makers evaluated "the use of nuclear energy" while the public evaluated "nuclear energy." This problem is avoided when estimates based on the model are considered, since all beliefs were about the *use* of nuclear energy. These latter scores could range from +900 to −900; the policy makers' mean score here was 30.6, and that of the public was −97.8.

4 The positive contribution to attitude made by a risk dimension is due to the belief that the use of nuclear energy will *not* lead to negatively valued risks. This double negative results in a positive contribution to attitude.

5 The difference in mean attitude is nevertheless larger than might be expected. It can be attributed to the chance placement of two individuals with initial viewpoints which were strongly CON in the ROLECON group.

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Appendix

SUMMARY TABLES OF ANALYSES OF VARIANCE

TABLE A1 Attribute evaluations and belief strengths: policy makers and total public sample.

Source		*F*	*df*	*MS*	*P*
Main Effects (Attribute Evaluations)					
POLICY MAKERS/PUBLIC	(*A*)	1.06	1	23.92	0.304 NS
BELIEF DIMENSIONS	(*B*)	374.96	3	6,740.32	0.000**
Two-Way Interaction					
A X *B*		3.90	3	70.15	0.009**
ERROR	(*AB*)		747	17.98	
Main Effects (Belief Strengths)					
POLICY MAKERS/PUBLIC	(*A*)	24.19	1	1,515.76	0.000**
BELIEF DIMENSIONS	(*B*)	100.22	3	3,580.72	0.000**
Two-Way Interaction					
A X *B*		8.63	3	308.27	0.000**
ERROR	(*AB*)		759	35.73	
Main Effects (Contribution to Attitude)					
POLICY MAKERS/PUBLIC	(*A*)	13.91	1	123,681.00	0.000**
BELIEF DIMENSIONS	(*B*)	75.16	3	303,876.00	0.000**
Two-Way Interaction					
A X *B*		11.57	3	46,772.66	0.000**
ERROR	(*AB*)		735	4,043.08	

* Difference significant, $p < 0.05$.
**Difference significant, $p < 0.01$.
NS, Difference non-significant.

TABLE A2 Belief-based attitudes of policy makers in SELF and ROLE conditions.

Source		*F*	*df*	*MS*	*P*
Main Effect (Belief-Based Attitude)					
ROLEPRO/ROLECON	(*A*)	23.02	1	950,071.00	0.000**
SELF/ROLE	(*B*)	4.33	1	108,947.50	0.045*
Two-Way Interaction					
A X *B*		25.16	1	633,138.94	0.000**
ERROR	(*AB*)		33	25,164.00	

* Difference significant, $p < 0.05$.
**Difference significant, $p < 0.01$.

TABLE A3 Attribute evaluations and belief strengths: policy makers in SELF and ROLE conditions.

Source		*F*	*df*	*MS*	*P*
Main Effects (Attribute Evaluation)					
ROLEPRO/ROLECON	(*A*)	5.71	1	335.94	0.023*
SELF/ROLE	(*B*)	0.29	1	9.27	0.592 NS
BELIEF DIMENSIONS	(*C*)	115.00	3	3,151.94	0.000**
Two-Way Interactions					
A X *B*		8.76	1	276.69	0.006**
ERROR	(*AB*)		33	31.58	
A X *C*		0.75	3	20.57	0.525 NS
ERROR	(*AC*)		99	27.41	
B X *C*		0.74	3	10.55	0.532 NS
Three-Way Interaction					
A X *B* X *C*		1.79	3	25.64	0.154 NS
ERROR	(*ABC*)		99	14.31	
Main Effects (Belief Strength)					
ROLEPRO/ROLECON	(*A*)	6.63	1	484.05	0.015**
SELF/ROLE	(*B*)	9.37	1	234.25	0.004**
BELIEF DIMENSIONS	(*C*)	58.00	3	1,863.12	0.000**
Two-Way Interactions					
A X *B*		8.07	1	201.59	0.008**
ERROR	(*AB*)		33	24.99	
A X *C*		11.10	3	356.71	0.000**
ERROR	(*AC*)		99	32.12	
B X *C*		4.68	3	174.96	0.004**
Three-Way Interaction					
A X *B* X *C*		10.30	3	385.12	0.000**
ERROR	(*ABC*)		99	37.38	
Main Effects (Contribution to Attitude)					
ROLEPRO/ROLECON	(*A*)	23.02	1	237,519.50	0.000**
SELF/ROLE	(*B*)	4.33	1	27,236.69	0.045*
BELIEF DIMENSIONS	(*C*)	32.51	3	118,157.19	0.000**
Two-Way Interactions					
A X *B*		25.16	1	158,285.94	0.000**
ERROR	(*AB*)		33	6,291.00	
A X *C*		2.98	3	10,819.54	0.035*
ERROR	(*AC*)		99	3,634.47	
B X *C*		3.80	3	9.068.21	0.013*

TABLE A3 *Continued.*

Source		*F*	*df*	*MS*	*P*
Three-Way Interaction					
A X *B* X *C*		1.73	3	4,131.66	0.166 NS
ERROR	(*ABC*)		99	2,388.34	

* Difference significant, $p < 0.05$.
**Difference significant, $p < 0.01$.
NS, Difference non-significant.

TABLE A4 Correlation coefficients for SELF with ROLE responses.

Source		*F*	*df*	*MS*	*P*
Main Effects (Correlation Coefficients)					
ROLEPRO/ROLECON	(*A*)	0.33	1	898.44	0.572 NS
ATTRIBUTE EVALUATION /BELIEF STRENGTH	(*B*)	5.51	1	10,218.90	0.025*
Two-Way Interaction					
A X *B*		1.12	1	2,070.12	0.299 NS
ERROR	(*AB*)		33	1,855.97	

* Difference significant, $p < 0.05$.
**Difference significant, $p < 0.01$.
NS, Difference non-significant.

TABLE A5 Belief-based attitudes of public subgroups and policy makers in-role.

Source		*F*	*df*	*MS*	*P*
Main Effects (Belief-Based Attitude)					
PRO/CON	(*A*)	128.68	1	3,606,463.00	0.000**
PUBLIC/POLICY MAKERS IN-ROLE	(*B*)	3.72	1	104,197.00	0.056 NS
Two-Way Interaction					
A X *B*		2.08	1	58,310.00	0.152 NS
ERROR	(*AB*)		126	28,027.37	

* Difference significant, $p < 0.05$.
**Difference significant, $p < 0.01$.
NS, Difference non-significant.

TABLE A6 *Continued.*

Source		*F*	*df*	*MS*	*P*
Three-Way Interaction					
$A \times B \times C$		0.22	3	919.67	0.883 NS
ERROR	(*ABC*)		378	4,207.62	

* Difference significant, $p < 0.05$.
**Difference significant, $p < 0.01$.
NS, Difference non-significant.

TABLE A6 Attribute evaluations and belief strengths: public subgroups and policy makers in-role.

Source		*F*	*df*	*MS*	*P*
Main Effects (Attribute Evaluations)					
PRO/CON	(*A*)	43.82	1	1,132.40	0.000**
PUBLIC SUBGROUPS/POLICY MAKERS IN-ROLE	(*B*)	3.93	1	101.52	0.050*
BELIEF DIMENSIONS	(*C*)	287.75	3	5,857.28	0.000**
Two-Way Interactions					
A × *B*		2.88	1	74.31	0.092 NS
ERROR	(*AB*)		126	25.84	
A × *C*		2.36	3	48.09	0.071 NS
B × *C*		3.90	3	79.44	0.009**
Three-Way Interaction					
A × *B* × *C*		0.96	3	19.57	0.411 NS
ERROR	(*ABC*)		378	20.36	
Main Effects (Belief Strength)					
PRO/CON	(*A*)	24.21	1	1,389.06	0.000**
PUBLIC SUBGROUPS/POLICY MAKERS IN-ROLE	(*B*)	4.34	1	249.11	0.039*
BELIEF DIMENSIONS	(*C*)	68.98	3	2,294.20	0.000**
Two-Way Interactions					
A × *B*		0.74	1	42.20	0.393 NS
ERROR	(*AB*)		126	57.38	
A × *C*		58.02	3	1,929.48	0.000**
B × *C*		2.81	3	93.35	0.039*
Three-Way Interaction					
A × *B* × *C*		0.42	3	13.87	0.741 NS
ERROR	(*ABC*)		378	33.26	
Main Effects (Contribution to Attitude)					
PRO/CON	(*A*)	128.68	1	901,608.56	0.000**
PUBLIC SUBGROUPS/POLICY MAKERS IN-ROLE	(*B*)	3.72	1	26,049.75	0.056 NS
BELIEF DIMENSIONS	(*C*)	66.81	3	281,122.00	0.000**
Two-Way Interactions					
A × *B*		2.08	1	14,578.19	0.152 NS
ERROR	(*AB*)		126	7,006.82	
A × *C*		7.78	3	32,744.00	0.000**
B × *C*		3.61	3	15,176.33	0.014*

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