Preference Reversals and the Measurement of Environmental Values

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Abstract

Numerous studies have demonstrated that theoretically equivalent measures of preference, such as choices and prices, can lead to systematically different preference orderings, known as preference reversals. Two major causes of preference reversals are the compatibility effect and the prominence effect. The present studies demonstrate that the combined effects of prominence and compatibility lead to predictable preference reversals in settings where improvements in air quality are compared with improvements in consumer commodities by two methods—willingness to pay for each improvement and choice (For which of the two improvements would you pay more?; Which improvement is more valuable to you?). Willingness to pay leads to relatively greater preference for improved commodities; choice leads to relatively greater preference for improved air quality. These results extend the domain of preference reversals and pose a challenge to traditional theories of preference. At the applied level, these findings indicate the need to develop new methods for valuing environmental resources.

Preference Reversals and the Measurement of Environmental Values

The powerful impacts on the natural environment resulting from human actions have stimulated much interest in methods for measuring environmental resources and changes in those resources. The principal approach for assessing environmental values has been the contingent valuation (CV) method, most especially the technique called *Willingness to Pay* (WTP), which posits a hypothetical market for an unpriced good and asks individuals to state the dollar value they are willing to pay for a proposed change in its quantity or quality.

Development of the CV concept has been documented in several recent reviews, including Cummings, Brookshire, and Schulze (1986) and Mitchell and Carson (1989). The approach is now widely used to value a diverse group of goods whose quantity or quality might be affected by the decisions of a public agency or private developer. Recent studies, for example, use WTP to value a wide range of goods such as improved air quality (Irwin, Schenk, McClelland, Schulze, Stewart, & Thayer, 1990), groundwater (Mitchell & Carson, 1989), and forest wildlife resources (Walsh et al., 1990).

Despite its widespread use, much has been written about problems with the contingent valuation approach: it captures attitudinal intentions rather than behavior (Azjen & Peterson, 1988), it is difficult to make CV scenarios comprehensive and meaningful (Fischhoff & Furby, 1988), and its results are susceptible to influence from numerous cognitive and contextual biases (Brown & Slovic, 1988).

Contextual influences have proven to be particularly important in the measurement of personal values. Extensive research in human judgment and decision making indicates that

people often do not hold values that are well-defined in monetary units. Unless the items being valued are simple and familiar-and most environmental goods are neither-individuals will construct values during the elicitation process, based on the context that is provided (see, e.g., Payne, Bettman, & Johnson, in press).

The constructive nature of preference can be appreciated by examining the phenomenon of preference reversal, which has been studied by psychologists and economists for more than 20 years (Slovic & Lichtenstein, 1983; Tversky, Slovic & Kahneman, 1990). Numerous empirical studies have demonstrated that measures of preference systematically violate the fundamental principle of procedure invariance. According to this principle, different (but equivalent) measures for eliciting preferences should lead to the same preference ordering, just as different but equivalent measures of heaviness—e.g., placing two objects on opposite sides of a pan balance to see which is heavier vs. measuring each object separately on a scale—should yield the same ordering of weight. Whereas proper physical measures almost always satisfy procedure invariance, preference measures do not. Object A may be clearly preferred over Object B under one method of measurement while B is clearly preferred under a different but presumably equivalent measurement procedure. This fact, we propose, has significant implications for the valuation of environmental resources.

Failures of procedure invariance have several causes. Two major causes are the compatibility effect (Slovic, Griffin & Tversky, 1990) and the prominence effect (Tversky, Sattath, & Slovic, 1988). The compatibility effect implies that, when dollars are an available (recognizable) attribute of an object, they carry more weight or influence in determining an

evaluative response that is also in dollars (e.g., willingness to pay, cash equivalent, selling price) than they do in determining a response that is not in dollars (e.g., a rating of value or a choice).

The prominence effect causes choice responses to be more dominated by prominent attributes than are pricing responses. This arises from the fact that choices are driven by reasons and arguments to a greater extent than are pricing responses. Prominent attributes tend to form the bases for compelling reasons or arguments.

The most common demonstration of these two effects has occurred in the evaluation of simple gambles such as the following:

Gamble A: .9 win $8

Gamble B: .2 win $30

The evaluator is asked to give minimum selling prices for each gamble and to choose one to play.

Gamble B tends to elicit a higher selling price or cash equivalent than does Gamble A, because the pricing response gives greater weight to payoffs (compatibility effect) on which B is much superior.[1] However, the choice mode invokes reasoning in which probability is prominent ("Gamble A is better because it has such a high probability of winning"). As a result, most people choose to play Gamble A over Gamble B and a high proportion (40-50%) of the total sample assign a higher price to B but assert that they would choose to play Gamble A, thus exhibiting a preference reversal. Reversals in the opposite direction (choose B but place a higher price on A) rarely occur.

Preference reversals due to compatibility and prominence have been demonstrated with many other stimuli besides gambles (Slovic et al., 1990; Tversky et al., 1988). Reversals

induced by changes in response mode have begun to appear in studies of contingent valuation as well. Brown (1984) examined dollar and rating responses of subjects' WTP for environmental amenities (air quality and forest scenic quality) and commodities (cameras, cars, stereos, and bicycles). Most subjects were willing to pay more for the commodities than for the amenities when giving their answers in dollars, but most rated their willingness to pay for the amenities higher than their willingness to pay for the commodities. Magat, Viscusi, and Huber (1988) found that people's values for reducing the risks from chemical products were higher when they were given paired comparisons (i.e., choices) than when they were asked to provide WTP values.

The present studies test the hypothesis that the combined effects of prominence and compatibility will lead to preference reversals in contingent valuation settings where dollar measures of WTP are compared to values obtained by choice responses.

Consider, for example, evaluations of upgrades or improvements in consumer goods, such as a better camera, a better TV set, or a better word processor. Compare these upgrades with improvements in the environment (e.g., cleaner air; prevention of oil spills). We expect WTP responses to make upgrades in consumer goods appear relatively more preferred than upgrades in environmental quality. This is because upgraded commodities are clearly more expensive than the original commodities and this price differential, though not presented and thus not known precisely by the respondents, would be expected (by compatibility) to serve as a cue for the WTP responses. Environmental improvements however, provide no price experience or cues on which to base a monetary WTP response.

On the other hand, we would expect the direct comparison of value by means of a choice response (e.g., "for which upgrade would you be willing to pay more?") to favor an environmental quality improvement because choice invokes arguments and there are many powerful, even noble, arguments in favor of one's placing high personal value on improved environmental quality. Arguments for the value of a better word processor, while meaningful, can hardly compare in importance to the need for a cleaner environment.

In addition to prominence and compatibility effects, there are other reasons to expect that preference orderings for environmental changes might differ according to whether people are giving WTP values or choices. Most environmental commodities are public, meaning that there is a tendency for people to attempt to take a "free ride." In such situations people may give a WTP value that does not match their highest value for the commodity, but rather represents the lowest value that they think they can offer and still receive the good. There are enough examples of this behavior in the market that people may have learned to consider underpaying for public goods; people who underpay taxes still drive on public roads, attend public schools, and so on. Related to "free ride" behavior is "protest" behavior. People often do not understand that environmental improvements may lead to increased prices for goods, they may believe that it is neither their duty nor their responsibility to pay for environmental damage created by others, or they may mistrust organizations in general and not want to give money to someone in charge of cleaning up the environment. To register their anger, they report a zero WTP which does not reflect their actual value for the environmental change. In WTP situations, both "free riders" and "protestors" underrepresent their values for environmental improvements because they believe someone else will or should pay for the improvements. This

underrepresentation means that environmental goods will appear to be less preferred than they actually are, resulting in less relative preference for environmental goods in WTP than in choice.

To test whether preferences for environmental improvements depend on whether people are providing WTP values or choosing, our first two studies presented people with three trades. One of the trades was for a specified improvement in air quality, and the other two trades were for everyday market commodities. Each trade was presented pictorially and described specifically, so that subjects were clear about exactly what they were valuing (Fischhoff & Furby, 1988). About half the subjects provided WTP values for the trades; the others made choices between pairs of trades. In these between-subject studies, in which no one person is presented with both response modes (WTP and choice), preference reversals cannot be shown directly, but must be inferred. Under the assumption of random assignment of subjects to the two response-mode conditions, we will infer the existence of preference reversals from a finding that the choice mode yields a significantly higher proportion of preferences for the air quality trade.

Our third study used a within-subjects design: all subjects provided WTP *and* choice for an air quality improvement and a commodity improvement. Here we can directly observe the frequency of preference reversals as predicted by the prominence and compatibility effects as well as look for preference reversals in the opposition direction (unpredicted reversals).

Study 1

Method

Subjects. Four hundred surveys were mailed (200 of each version) to Denver Metro Area residents randomly selected by a professional survey corporation.[2] There were 61 bad addresses, 36 for the WTP version and 25 for the choice version. Of the remainder, 74 percent (122) of the WTP version and 72 percent (126) of the choice version were returned.

Procedure. All survey booklets started with descriptions and questions about Denver's "Brown Cloud," the air pollution so noticeable over Denver, particularly in winter. Respondents rated photos of various levels of air quality for several Denver area scenes and expressed their concern about the visibility and healthiness of Denver's air. Following this section, all subjects were asked to evaluate three trades: from worse air quality to better, from a worse camera to a better one, and from a worse TV set to a better one. The air quality trade was presented with color photographs of two actual winter days in Denver, taken from the same location. One showed the "Brown Cloud"; the other was clearer. Black and white photographs of two cameras, with lists of their features, and of two TV sets with lists of features, described the commodities trades.

For each trade, respondents in the WTP condition were asked their WTP, starting with the cameras, then the TV sets and finally the air quality. The camera question was worded as follows:

Now suppose you own a new camera like the one shown in Picture 1A. Would

your household be willing to trade it for a new camera as shown in Picture 1B,

if you also had to pay some extra money in the trade?

NO - WHY?

YES - What is the MOST your household would be willing to pay to trade in the camera in picture 1A for the camera in picture 1B? $

The TV set question was the same. The air quality question said,

Now please compare photographs 3A and 3B. They are both pictures of a winter day. One of them shows a greater amount of visible pollution than the other. Suppose 3A depicts the amount of pollution that you live with most days of the winter.

Would you be willing to pay higher prices (for example, gasoline prices) to improve overall air quality-so that your average winter day improves from being like Picture 3A to being like Picture 3B?

NO - WHY?

YES - What is the MOST your household would be willing to pay EACH YEAR, in higher prices, to fund the improvement in average winter-day air quality from that shown in picture 3A to that shown in picture 3B? $

Respondents in the choice condition were first asked to choose between improved air quality and an improved camera. Then they chose between improved air quality and an improved TV set. After the air quality trade and the camera trade were described, the instructions said,

Now suppose you own a new camera like the one shown in Picture 2A. Suppose you could trade it for a new camera as shown in Picture 2B. This improvement would probably cost you money.

In answering the next question, think about the value your household would place on a year's improvement in air quality (both health and visibility) as represented by going from Picture 1A to Picture 1B for the average winter day. DO NOT consider the value such an improvement would have to OTHER PEOPLE. Compare the MOST your household would be willing to pay for this improvement for ONE YEAR, in higher prices, with the MOST your household would be willing to pay to trade in camera 2A for camera 2B.

Which improvement would your household be willing to pay MORE for?

More for one year's improvement in air quality, from Picture 1A

to Picture 1B.

The same.

More for the improvement in cameras, from Picture 2A to Picture

2B.

The question asking for a choice between the air quality trade and the TV set trade was similarly worded.

Results

WTP values were converted into imputed choices based on the ordering of subjects' dollar values. If subjects in the WTP conditions circled "NO" when they were asked if they would pay for the trade, they were assigned a zero for their WTP value for that trade. If they did not provide a value for the WTP question (i.e., they neither circled "NO" nor gave a value) the datum was considered missing and excluded from the analyses. The resulting choice data

are shown in Table 1. Chi-squares were computed using a log-linear regression, so that main effect as well as interaction tests could be performed on the same data.

Insert Table 1 about here

A large majority of respondents preferred the air quality improvement over the commodity improvement; across both response modes (χ^2 (1) = 29.18, n = 153, p < .001 for TV set/air quality and χ^2 (1) = 51.45 , n = 163, p < .001 for camera/air quality). Only 17 percent (excluding ties) preferred the camera trade and 28 percent preferred the TV set trade when each was compared with the air quality improvement. Further evidence for the greater attractiveness of the air quality improvement is seen in the mean WTP values: $164.97 for air quality, $67.06 for the camera trade, and $116.10 for the TV set trade. This predominance of preference for the air quality trade suggests that preference reversals are less likely to be found because preference reversals are most common when the two alternatives are approximately equally attractive.

Nevertheless, response mode did have a significant effect on preference in the predicted direction. Preference for the air quality improvement was significantly more frequent with the choice mode than with the WTP mode: 92 percent versus 71 percent for air quality over camera; 83 percent versus 60 percent for air quality versus TV set (ties excluded; the χ^2 values are given in Table 1). Although these effects are significant, the magnitude of the effects, as measured by Cramer's V statistic,[3] are fairly low (see Table 1). Inclusion of ties in the

analyses did not appreciably change the results. Thus from these data one can infer a statistically significant but modest occurrence of preference reversals.

One way to test for free ride or protest behavior is to look at the number of zero WTP values. If enough people gave zero WTP values for air quality and not for the other commodities, then we would observe data like those in Table 1. In Study 1, 23 (22%) people gave zero values for the air quality trade, 31 (32%) for the camera trade, and 32 (33%) for the TV set trade. Almost half of these zero WTP's came from 11 respondents who reported zero for all three WTP questions. Not surprisingly, this even distribution of zero WTP values did not affect the direction of the preference reversal effect, although the reduction in sample size resulted in a nonsignificant effect for the air quality/TV set comparison. The air quality/camera comparison remained significant when zeros were excluded.

Discussion

Study 1 demonstrates that people's preference orderings depend on response mode. This effect does not appear to be a result of free rides or protests, because it is impervious to the exclusion of zero WTP values. The overall preference for air quality, however, was so pervasive that it is difficult to see to what extent preferences can reverse. In Study 2 we presented people with more enticing market commodities trades in order to achieve a better balance of attractiveness.

Our theoretical bases for predicting preference reversals in the present studies are: (a) The compatibility effect will lead to an elevation of WTP for market commodity trades relative to WTP for the air quality trade and (b) the prominence effect will increase the attractiveness, in choice, of the air quality trade. This theory predicts that no evidence of preference reversal

will be found when the two market commodity trades are paired. To test this prediction, the choice-mode subjects in Study 2 were asked to choose between the two market commodity trades as well as between each market commodity trade and the air quality trade. Also, in Study 1 all subjects in the WTP condition were presented with the two market commodity trades before the air quality trade. In Study 2 this order was varied to test for an order effect.

Study 2 used a different subject population from that used in Study 1. The subjects in Study 1 were Denver area home owners; the subjects in Study 2 were Boulder area students. This change provides a test of the robustness of our results; if Study 2 subjects show the same preference reversals as did subjects in Study 1, we can be more confident that preference reversals of this kind are likely to occur in many valuation situations.

Study 2

Method

Subjects. Forty-seven University of Colorado undergraduates participated in the experiment as part of a class requirement.

Materials. The subjects were presented with the same air quality trade, using the same color photographs as in Study 1. Two new commodity trades were used, a TV set without a VCR traded for the same TV set with a VCR and a computer system without a printer traded for the same system with a printer. These commodities were chosen on the basis of WTP data for commodities presented in another set of experiments (Irwin, 1991). Both the commodity trades were presented via pictures with lists of features.

The instructions were the same as in Study 1, suitably altered for the new commodity trades, but there was no lengthy initial section describing and asking about Denver's "Brown Cloud."

Half of the WTP subjects received the air quality question first; the others received it last.

Results

The bottom half of Table 1 presents the results for Study 2. There was no effect due to order of presentation in the WTP condition; the data from the two orders are combined in Table 1.

There was no strong overall preference for the air quality improvement over the commodity improvements (χ^2 (1) = .52, n = 41, n.s. for printer/air quality; χ^2 (1) =.03, n = 40, n.s. for V.C.R./air quality). Across both response modes, 55% indicated a preference for air quality over the printer; 48% for air quality over the VCR (ties excluded). In the WTP condition the mean responses were $156.74 for the printer trade, $162.70 for the VCR trade, and $92.74 for the air quality trade. A comparison of WTP values for the air quality trade in Study 1 versus Study 2 showed no significant difference in WTP, either when including or excluding zero WTP's (t (143) = .87, n.s. for all WTP, t (102) = 1.67, n.s. for positive WTP).

The data from Study 2 showed a strong response mode effect, indicative of preference reversals. As Table 1 indicates, the magnitude of this effect is roughly double that of Study 1. For the choice mode, air quality improvement was preferred by 81 percent of the subjects over the printer trade and by 74 percent over the VCR trade (ties excluded). In striking contrast, for the WTP mode, the commodities were preferred: 71 percent of the subjects reported a larger

WTP for the printer and 76 percent for the VCR over the air quality improvement (ties excluded). Inclusion of ties in the analysis did not appreciably change the significance or magnitude of these differences.

As the bottom part of Table 1 shows, there was no effect of response mode on preference when the two commodities were compared with each other.

As in Study 1, there was a fairly even distribution of zero WTP values among the trades: four for the printer trade, one for the VCR trade, and two for the air quality trade. Again, exclusion of these zero WTP values did not appreciably change the results.

Discussion

Study 2 successfully replicated the preference reversals of Study 1, but showed an even stronger effect of the response mode manipulation because overall preference for the air quality trade was eliminated. As with Study 1, it is clear that free ride or protest behavior did not produce the results, because elimination of zero WTP's did not change the analyses. As predicted, no preference differences were found in comparisons involving the two market commodity trades.

The switch in respondents from Denver home owners to Boulder students did not seem to affect the results. There was no significant effect of subject population on WTP values for air quality, whether zero WTP's were included or not. There were proportionately fewer zero WTP's in Study 2 than in Study 1, but this difference is understandable given that Study 1 was a mail-in survey.

Study 3

Study 3 was conducted to determine whether preference reversals would occur within the same individual, evaluating commodity and air quality improvements under both WTP and choice response modes.

<u>Method</u>

Subjects. Ninety-two young adults who responded to an ad in the University of Oregon newspaper were paid for their participation in the study.
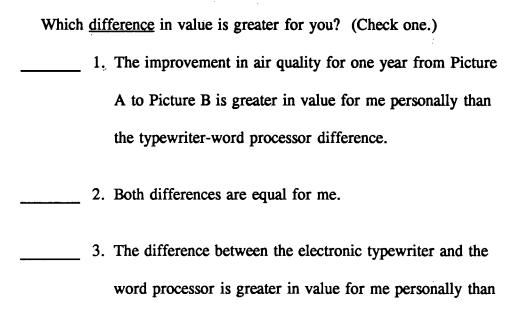
Procedures. The format of Study 3 was the same as that of Studies 1 and 2 with the following changes: First, there was only one pair of commodities, an electronic typewriter to be traded for a laptop personal word-processing system. Pictures of both commodities were shown to the subjects. The electronic typewriter was described as having a 7000 character memory, a 16 character display, and a 50,000 word spell checker. The personal word processor was described as " . . . much more advanced. It has a 16 line by 80 character display, a 50,000 character internal memory, a 100,000 character data disk capacity, a 90,000 word spell checker, a printer, and many other features."

The air quality trade was the same as in Studies 1 and 2, using the same color photographs (but the Denver location was not mentioned). WTP was elicited first for the word-processing system, then for the improved air quality.

The wording of the choice question was changed. In Studies 1 and 2, the subjects were asked, "Which improvement would your household be willing to pay MORE for?" In Study 3 the choice instructions were:

Think about the <u>difference in value to you</u> between the typewriter and the word

processor and the <u>difference in value to you</u> between the two levels of air quality.

Refer to the pictures if you wish.

Which <u>difference</u> in value is greater for you? (Check one.)

_____ 1. The improvement in air quality for one year from Picture

A to Picture B is greater in value for me personally than

the typewriter-word processor difference.

_____ 2. Both differences are equal for me.

_____ 3. The difference between the electronic typewriter and the

word processor is greater in value for me personally than

the air quality difference.

The final difference was that each subject provided both WTP and choice responses. The

two WTP responses always preceded the choice.

<u>Results</u>

Table 2 provides the results from Study 3. The improvement in air quality was valued

more highly in 86% of the direct choices but in only 40% of the choices inferred from WTP

responses (ties excluded). There were 71 subjects who made a choice and two unequal WTP

responses (after excluding subjects with any ties or missing values). Of these, 29 (41%)

reversed their preferences in the predicted direction by choosing the air quality improvement as

having greater value to them personally and indicating a higher WTP value for the better word-

processing system. None of these 71 subjects exhibited an unpredicted reversal (choosing the word-processing system but assigning greater WTP to the air quality improvement).

Insert Table 2 about here

Discussion

With a different sample of subjects, a different pair of commodities, and a slightly different choice question, Study 3 replicated the results of Studies 1 and 2. Most importantly, in Study 3, because of its within-subject design, direct observations of preference reversals could be made. Predicted reversals were common; unpredicted reversals did not occur.

General Discussion

The present study demonstrates a new kind of preference reversal, predictable from the heuristics and choice strategies that have produced reversals in simple gambles, but taking place within a very different domains of preferences. As with other violations of procedure invariance, the reversals of preference between environmental and non-environmental commodities shown here pose a serious challenge to theoretical conceptions of preference and choice. As Tversky et al. (1988) observed:

> In the classical analysis, the relation of preference is inferred from observed responses and is assumed to reflect the decision maker's underlying utility or value. But if different elicitation procedures produce different ordering of options, how can preferences and values be defined? And in what sense do they exist? (p. 383).

This state of theoretical uncertainty coupled with the psychological concept of constructed preferences points to the need for a new approach to eliciting values for environmental resources. If, as preference reversal studies suggest, values are constructed during the elicitation process in a rather unconscious way that is strongly determined by context, why not take a deliberate approach to value construction in a manner designed to rationalize the process? Following this line of thought, Gregory, Lichtenstein, and Slovic (1991) have proposed that explicit value-structuring techniques based on multiattribute utility theory be used as a contingent-valuation method to develop psychologically and morally defensible measures of environmental values. This approach is sensitive to the multidimensionality of environmental goods and the need to help people think about and integrate these values in a coherent manner. It thus views the CV approach as a kind of tutorial, building the monetary value as it elicits it. In this sense a CV survey becomes an active process of value construction, rather than a neutral process of value discovery.

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Footnotes

1. The compatibility effect can be produced by a number of different cognitive mechanisms. One such mechanism is anchoring and adjustment (Schkade & Johnson, 1987; Slovic & Lichtenstein, 1968). Respondents may construct a price by starting with the amount to win and adjusting it downward in light of the less than perfect chance of winning.

2. Study 1 was part of a large contingent valuation survey project, with six other versions besides the two described here. The results from the other six versions have been reported by Irwin et al. (1990).

3. While χ^2 tests the reliability of an effect, Cramer's V provides a measure of the magnitude of that effect. Like most measures of magnitude of effect, Cramer's V ranges from 0 to 1.0, and higher values indicate that more variance has been explained (i.e., that the effect is larger).

Table 1. Response Frequencies in Studies 1 and 2.

	Response Mode		Effect of Response Mode on Preference (Ties Excluded)
	Choice	WTP	

STUDY 1

	Choice	WTP	
Air Quality Preferred	91	45	$\chi 2 = 11.7$, n = 163, p < .0001
Camera Preferred	8	19	Magnitude of Effect (V) = .28
Ties	24	26	
Missing Data	3	32	
Total	126	122	

	Choice	WTP	
Air Quality Preferred	76	38	$\chi 2 = 7.67$, n = 153, p < .005
T.V. Preferred	16	23	Magnitude of Effect (V) = .23
Ties	30	0	
Missing Data	4	61	
Total	126	122	

STUDY 2

	Choice	WTP	
Air Quality Preferred	17	6	$\chi 2 = 11.6$, n = 42, p < .001
Printer Preferred	4	15	Magnitude of Effect (V) = .53
Ties	3	2	
Missing Data	0	0	
Total	24	23	

	Choice	WTP	
Air Quality Preferred	14	5	$\chi 2 = 10.0$, n = 40, p < .002
V.C.R. Preferred	5	16	Magnitude of Effect (V) = .50
Ties	5	2	
Missing Data	0	0	
Total	24	23	

	Choice	WTP	
Printer Preferred	10	9	$\chi 2 = .11$, n = 38, n.s.
V.C.R. Preferred	9	10	
Ties	5	4	
Missing Data	0	0	
Total	24	23	

Table 2

	Choice Favored			
	Air Quality	Computer	Tied	Total
WTP Favored:				
Air Quality	31	0	0	31
Computer	29	11	6	46
Tied	7	1	1	9
Missing Data	6	0	0	6
Total	73	12	7	92

Predicted Reversals: 29/71 = 41%

Unpredicted Reversals: 0/71 = 0%