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The Psychology of Drinking Water Quality: An Exploratory Study

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Perceptions of drinking water quality were measured for residents at four locations in Western Australia. The total dissolved solid levels for the locations varied. Four scales of drinking water satisfaction were measured: acceptability of water quality; water quality risk judgment; perception of neighborhood water quality; and attitudes toward fluoride as an additive. Responses to each of these scales did not appear to be highly related to total dissolved solids. The relationship between attitudes toward water quality and a variety of psychological, attitudinal, experiential, and demographic variables was investigated. It was found that responses to the acceptability of water quality and water quality risk judgment scales related to perceived credibility of societal institutions and feelings of control over water quality and environmental problems. For the remaining two scales few significant correlations were found. The results support those who advocate localized information and involvement campaigns on drinking water quality issues.

1. INTRODUCTION

The derivation of standards of drinking water which are acceptable to the community is becoming an increasingly vexing question. Many consider that the setting of water quality standards is solely the responsibility of experts or planners because of the technical nature of many issues. Others argue that full public information should be given and community input received [e.g., *Cotruvo*, 1989; *Sheat*, 1992; *Syme et al.*, 1991*a*]. "Perception may very well become more important than reality . . . especially when it comes to the quality of drinking water" [*Sheat*, 1992, p. 3].

Generally, water authorities have tended to rely on small consumer panels to derive acceptable sensory standards for water [*Bartels et al.*, 1987]. Those few extensive studies of general community acceptance of drinking water quality have tended to rely on satisfaction with taste as an index and mineral content as a water quality variable [*Bruvold et al.*, 1969; *Bruvold*, 1970].

Bruvold et al. [1969] and *Bruvold* [1968] in a series of attitudinal studies in a variety of communities were able to demonstrate a linear regression relationship between reported taste quality and level of mineral content. A later study [*Bruvold and Mitchell*, 1976] showed that total dissolved solid (TDS) levels of more than 500 mg/L was perceptually unacceptable to Californian consumers.

Dillehay and Siegel [1966] had already suggested that social variables unrelated to mineral content in drinking water would influence attitudes towards its taste. Some of these were investigated in the *Bruvold* [1968, 1970, 1975] studies. Issues such as age of respondent, length of residence, quality of neighborhood, experience with different water supplies, water quality in adjacent towns, socioeconomic level, and general perceived quality of service provided by the water utility were all tested for their relationship with taste satisfaction. Two variables were found to correlate moderately, but significantly, with taste satisfaction. These were perceived quality of neighborhood and of the service provided by the local water utility.

It may be considered that taste is only one aspect of water quality and that the *Bruvold et al.* [1969] findings have limited relevance to other dimensions such as color; however, this may not be the case. *Syme and Salerian* [1987], for example, have shown that attitudes toward all aspects of drinking water quality are highly correlated and that the judgment that water has a poor quality on one dimension may predicate similar judgments on others. The personal characteristics governing taste perception may be similar to those related to color, smell and overall judgment of water quality. For example, "taste" perception is largely influenced by the perception of odor [*World Health Organization*, p. 293, 1984].

Nevertheless, despite the relatively modest relationship shown to date between social or attitudinal variables and water quality judgments, it is obvious that there are significant sections of the community who, for nonsensory reasons, no longer trust the water utility with a healthy supply. The growth in the bottled water community, for example, highlights the health concerns of many [*Williams and Syme*, 1989]. *Curry* [1983] has shown that health concerns are a major factor in governing purchase of bottled water. *Rayner and Cantor* [1987] suggest that culturally, we are becoming more risk aversive. Definitions of "acceptable risk" may become more of a concern in the future. These and other attitudes and psychological characteristics may be important determinants of overall satisfaction with drinking water. Knowledge of these will be vital for successful planning in this area.

The purpose of this study was therefore to investigate more widely the personal attitudinal or dispositional factors which may govern community perceptions of drinking water. Unless these variables are identified, priorities for education and public involvement programs will be difficult to derive. Appropriate socially based evaluation criteria for drinking water standards will also be hard to set. In this case conflict surrounding drinking water quality seems likely to escalate.

A number of well-researched psychological variables thought likely to affect perception of the adequacy of drinking water quality were assessed in this study. Perceived water quality was measured in four scales. These quantified current acceptability of scheme water supply, risk perceptions related to water quality, judgment of localized neigh-

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borhood water quality, and attitudes toward the addition of fluoride to the water supply scheme.

The selection of the first two scales is self-evident. Neighborhood water quality was examined as there were noticeable differences in water quality between suburbs in all four locations of the study. This may have been the subject of some local discussion. Many people also use private bores for irrigation and so would be aware of the quality of their "own" groundwater. The fluoride scale was chosen as in all locations fluoride had been added to water supply as a means of promoting dental health. This additive has attracted considerable community debate from time to time.

Variables chosen to predict scores on these water quality scales included trust in authorities; perceptions of risk; attitudes toward the environment; feelings of personal control (both in terms of life generally and water quality in particular); attitudes toward environmental activism; general contentment with one's neighborhood; past experiences of differing water supply; consumption; and demographic variables. These variables are explained below in full. Specific hypotheses are offered for the predicted relationship between each variable and perceived water quality. These variables were measured in a survey study in four locations of differing drinking water quality in Western Australia.

2. METHOD

Sample

The study population was defined as those consumers receiving water supplied by the Water Authority of Western Australia (WAWA) in the Perth metropolitan area and in two major regional centers (Albany and Geraldton). Bunbury, whose supply was provided by a local water authority, was also included.

The Perth metropolitan sample was stratified by (1) main source of water being delivered to consumers (i.e., hills versus groundwater); (2) the variability in the quality of water supplied during the year (dependent on whether there was a constant supply from one source or a supply from more than one source during the year); and (3) low-, medium-, and high-income levels as indicated by Australian Bureau of Statistics data.

Information concerning criteria 1 and 2 above was obtained from WAWA and formed the basis for defining geographic zones in the metropolitan area. Seven zones were identified, and sampling was undertaken within each. However, as differences in water quality within these zones did not influence attitudinal responses to drinking water quality, they are not reported here in separate analyses. A stratified sampling procedure based on income was used to sample from each of the three regional areas.

Data were collected in July through August 1988. A total of 1006 people were interviewed which represented 72% of those approached. Sample sizes were as follows: Perth, 436; Bunbury, 179; Albany, 199; and Geraldton, 192. The regional centers were chosen because they varied in the levels of TDS in their water supply. TDS had been decided on as the major indicator of drinking water quality in view of its economic significance to WAWA. In addition, *Bruvold* [1975] concludes that until definitive results show otherwise "TDS will continue to be the primary chemical measure of the taste quality of mineralised waters."

TABLE 1. TDS Data

	Mean TDS,* ppm	Annual Range, ppm	Minimum, ppm	Maximum, ppm
Albany	390	114	332	446
Bunbury	357	460	269	720
Perth	281	409	112	521
Geraldton	759	983	209	1192

Data are from Bunbury Water Board, Water Authority of Western Australia.

*As the water supply in these centers is often from more than one source the TDS range is comprised of the mean minimum and the mean maximum. All locations with the exception of Albany have a highest TDS level of above 500 ppm considered by *Bruvold and Mitchell* [1976] to be perceptually unacceptable in the California context. They additionally note that the TDS range tends to increase with the increase of mean TDS, which can be seen to occur here.

Average TDS values for the centers selected are shown in Table 1. While TDS was consciously varied it was also recognized that other chemical characteristics could influence attitudes toward drinking water quality. For example, Bunbury water has much higher levels of iron and manganese than any of the other three centers, and these may interfere with taste evaluations.

Climatic variables such as number of rain days and temperature may also influence the salience of water issues and water quality in particular in each of the locations. In this regard Geraldton is the hottest center (average maximum temperature 1987 = 19) with a mean rainfall of 470 mm. Albany is the coolest location (mean maximum temperature 1987 = 15) with a mean rainfall of 808 mm. Bunbury and Perth have intermediate temperatures and rainfall averages of approximately 870 mm.

Survey Contents and Psychometric Analyses

A questionnaire was developed to elicit responses concerning people's attitudes to drinking water quality. The questionnaire was administered on a door to door basis by trained interviewers. The interview lasted between 40 and 90 min. Some questions also addressed attitudes toward restrictions. The responses to the restrictions questions are not reported here. Questions ranged from open-ended free response format questions to Likert scale and attitudinal questions. A number of attitudinal items were derived to comprise scales.

1. The authors derived attitudes toward water quality [adapted from *Bruvold*, 1968] and risk associated with drinking water quality as well as attitudes toward neighborhood water quality and fluoride as an additive.

2. The authors also measured individual differences in attitudes which could, on past evidence, be related to water quality satisfaction. These included trust in authorities or experts, the individual need for certainty, locus of control [adapted from *Rotter*, 1966], perceived human control of environmental problems, attitudes towards the environment and social desirability. (Is pure drinking water considered as being demanded by society?) These latter questions were adapted from *Crowne and Marlowe* [1960].

Eighty attitudes were presented to respondents who could rate them on a six-point Likert scale. The first five points on the scale varied from (1) strongly agree to (5) strongly

disagree. A sixth point on the scale allowed respondents to state that they "didn't know." This was included to discourage the collection of "nonattitudes" [*Converse*, 1970]. In the event there were so few responses to "don't know" (less than 0.05% for any item), these were combined with the neutral category for analysis.

A principal components analysis was then conducted on each of the items within each of the categories 1 and 2 separately (see *Bartholmew* [1987] for a review of this and other developments of this kind). This was done to establish whether there were any consistent "dimensions" of attitude toward water quality or the attitudes which may be associated with it. This resulted in a 21 factor solution overall. This structure was confirmed by the conduct of a split half analysis which showed two highly comparable solutions.

The factors were then interpreted, and unidimensional attitudinal scales were derived. In all, 18 scales were derived for further analysis. These were ordered into four categories: (1) attitudes toward water quality; (2) attitudes toward natural resources and the environment; (3) attitudes toward societal institutions; and (4) personal psychological attributes. The first four scales in the first category were used as dependent variables for subsequent analyses. The last scale was an experiential one which measured whether in the past people had experienced different levels of water quality.

In the case of these scales and the subsequent scales used as independent variables, Cronbach's alpha was chosen as a statistical indicator of the reliability of the measure [*Nunnally*, 1978]. In general, a value of at least 0.6 is suggested as the minimum reliability for analysis. Nevertheless, while the reliability was more modest for some scales they were included in later analysis in view of the exploratory nature of the study. Low reliability will tend to obscure relationships between some variables. For scales consisting of only two items a simple correlation was used to indicate the relationship between the items.

Drinking Water Quality Attitudes

Acceptability of drinking water quality (ACCWQ) standardized alpha = 0.89). This was a seven-item scale. This scale examined overall aesthetic attitudes toward the respondents' drinking water. Statements such as "I am happy to have to accept our water as our regular drinking water"; "Our water tastes very good"; and "We are fortunate to have such good quality water" were included in this scale.

Water quality risk judgment (WQRJ) (standardized alpha = 0.73). This three-item scale included statements which assessed peoples concerns about the "healthiness" of scheme water supply. The statements included "There are so many chemicals and additives in the water that it must be unhealthy"; "I don't believe there is any possibility of becoming ill from drinking water straight from the tap"; and "Our water will not harm anybody."

Neighborhood drinking water quality (NEIWQ) (standardized alpha = 0.49). As was already indicated, there are localized differences in water supply quality and differences in the consistency of water supply quality. These differences are the subject of community comment from time to time. Therefore specific questions which related to localized water quality were also asked in two items: "I would be surprised if I was told the water in this neighborhood was not as good as other neighborhoods" and "I don't believe the quality of the water in this neighborhood is so bad that it needs improvement."

Attitudes toward fluoride (FL) (standardized alpha = 0.69). All sources of supply for the study locations is fluoridated. In at least one location (Bunbury) there had been recent lively debate as to whether this was desirable or not. For this reason this three-item attitudinal scale was included. Items included "I do not want fluoride added to my water supply"; "The benefit of having fluoride in our water far outweighs any possible risk"; and "Fluoride is of no benefit to adults."

Experiences of past water quality (WATEXPER) (correlation = 0.58). This water quality scale was used as a predictor variable for scores on the above water quality scales. As in earlier studies, it was thought likely that experiences of past water supplies with differing quality may be a determinant of perceptions of current water supply. The two statements in this scale included "I have tasted some terrible water in my time" and "I've experienced what it is like to have a really limited supply of water." It was hypothesized that those people who had experienced limitations on water supply in the past would show greater satisfaction with current water supply on all four of the above scales.

Environmental Concerns

Personal concern for the environment (PERSCON) (standardized alpha = 0.46). This three-item scale measured attitudes toward personal concern for environmental issues. Although having only moderate reliability it was felt that this scale could assist in identifying any nexus between water quality issues and wider environmental concerns. Items in this scale included "Water supply issues are important"; "Individuals should take responsibility for the environment around them" and "I would be willing to pay more for products like flyspray and laundry cleaners that do not harm the environment." It was considered that those with a higher personal concern for the environment would show a lesser satisfaction on all four scales.

Belief in human control of environmental problems (ENVFUT) (standardized alpha = 0.69). This was a four-item scale which measured confidence in our ability to manage future environmental problems and water supply issues. Example statements are "Scientists will find solutions to environmental problems before they get serious" and "Nature has a way to solve water supply problems before they get serious." It was hypothesized that those who felt that humanity was more in control of the environment would be more content with their water supply on all four water satisfaction scales.

Borewater usage and environmental effects (BOREWAT) (standardized alpha = 0.56). This four-item scale assessed attitudes toward the use of borewater and its possible effects on the environment. This issue is an important one in all locations as there has been, for example, public discussion that urban water supply from groundwater sources has affected the state of the wetlands and native vegetation. In addition, there are a significant number of households who have private bores for garden irrigation, the desirability of which has generated public comment in certain areas. A four-item scale including the following statements tested attitudes to this issue. Examples are "overuse of groundwa-

ter can affect the surrounding environment" and "People who put down their own bores should be able to use as much of this water as they like." It was hypothesized that those more concerned about groundwater issues would be less satisfied with their water supply.

Attitudes Toward Societal Institutions

Trust in information from the media (TRUSTMED) (standardized alpha = 0.93). Water and water quality issues are frequently aired in the Western Australian media. Trust in five of these sources was measured. It can be seen from the above alpha that perceived trust was highly correlated for the five measured media. Trust attitudes were therefore summed into a single scale.

Trust in water quality relevant government agencies (TRUSTGOV) (standardized alpha = 0.85). These agencies ranged from the World Health Organization to the Water Authority of Western Australia, who are charged with the delivery of drinking water. Again, there were highly positive correlations in the scores for each of the five nominated agencies. These items were therefore summed and used as a single attitudinal scale. For both trust scales it was hypothesized that the more trust that the individual had in these institutions the happier they would be with their water supply. It was thought that this relationship would be greatest for the WQRJ items.

Personal Psychological Attributes

Neighborhood satisfaction (SATNEIGH) (correlation = 0.49). Water is one of a number of government services which affect quality of life at a local level. Satisfaction with drinking water may therefore be simply a subset of an overall view as to the pleasantness or otherwise of neighborhood conditions. This was assessed in two statements "I would be happy living in this neighborhood in 15 years time" and "If I had the opportunity I'd rather be living in another neighborhood." Those more content with their day to day environment were hypothesized to be happier with their drinking water quality as well. This relationship was found to exist in modest correlations by *Bruvold et al.* [1969].

External locus of control (EXTLC) (standardized alpha = 0.58). Two factors emerged from the analysis of adaptations of *Rotter*'s [1966] locus of control measures. The first was labeled external locus of control and consisted of five items relating to general feelings that the external environment controlled one's destiny. Items included "Sometimes I feel I don't have enough control over the direction my life is taking"; "Many times I feel I have little influence over the things that happen to me"; and "Many times we might as well decide what to do by flipping a coin." The scale resembles the third factor in *Levenson*'s [1972] three-factor model; that of belief in chance. Those scoring higher on this scale were hypothesized to be less happy with their drinking water quality as the issue was largely out of their hands and they would be inclined to think they were taking a "chance" in drinking scheme water.

Internal locus of control (INTLC) (standardized alpha = 0.46). This three-item scale measured the respondent's perception that they had control over their own destiny. Statements included "What happens to me is my own doing" and "In my case getting what I want has little or nothing to do with luck." Those who were more internally located were hypothesized to be likely to be more content with their drinking water quality as it was something that they could control themselves. One presumes that these people would be the first to buy bottled water or insert a tap filter if they felt the quality of scheme water was not satisfactory.

Certainty seeking (CRTSKRS) (correlation = 0.47). This scale consisted of two items designed to assess the respondent's outlook on risk. These items were "If I could afford to, I would always rather being insured than take a chance" and "I would not have any sort of insurance if it wasn't required by law." Those who were more willing to take a chance were hypothesized to be more happy with their water supply, particularly on the risk judgment and fluoride scales.

Perceived control over own water supply (CONWAT) (correlation = 0.50). These were two items which related specifically to control in relation to the respondent's own water supply. Those perceiving more control of their own water supply were hypothesized to be happier with their water supply.

Social desirability (SOCDES) (correlation = 0.42). This consisted of two items taken from the *Crowne and Marlowe* [1960] social desirability scale: "No matter who I'm listening to, I'm always a good listener" and "I always try to practice what I preach."

No specific hypotheses were made in relation to this variable, but it was included to assess whether there were social desirability considerations in relation to attitudes towards water quality. Previous studies [*Kantola et al.*, 1982] had shown that good citizenship figured largely in Perth people's attitudes toward water conservation. If people were wishing to impress the interviewer with their social responsibility therefore may wish to present themselves as "concerned" for clean water and for environmentally responsible bore use.

Environmental activism (ENV) (correlation = 0.41). These two items related to two issues of the day: environmental activism and attitudes towards nuclear powered ships being allowed into Fremantle. Specifically, the items were "Conservationists or "greenies" usually take issues too far" and "We should allow ships which are nuclear powered into Fremantle." It was hypothesized that those who were less happy with environmental activism would be more happy with their water supply.

Demographic Variables

A variety of demographic variables were collected. These included gender (GEN), age, income, and level of education (EDUC). Identification with the local community was asked by enquiring as to how many community groups the respondent belonged to (JOIN). Perceptions of the variability of water quality (FRQCHG) and how much water the respondent drank on a daily basis (DRINKW) were also asked.

Permission was asked to obtain water consumption records from the Water Authority of Western Australia and 75% of people agreed (CONSUM). Finally, respondents were asked whether they would be interested in participating in any future water quality activities. As this variable showed the degree of personal interest in the drinking water topic this was also included in further analysis (INT).

The relationship between these variables and overall sat-

TABLE 2. Correlations Between Each of the Four Water Quality Scales

	ACCWQ	WQRJ	NEIWQ	FL
ACCWQ		0.69	0.55	−0.04
WQRJ			0.65	−0.05
NEIWQ				0.00

ACCWQ, acceptable drinking water quality; WQRJ, water quality risk judgment; NEIWQ, neighborhood water quality; and FL, flouride content of water.

isfaction with drinking water was not specifically predicted in most cases. Nevertheless, we did hypothesize that those who noticed most change during the year in their water quality would be less satisfied on all water quality scales except FL.

Finally, those who drank more water were assumed to be most satisfied with their water quality.

3. RESULTS

The four drinking water quality scales assessing perceptions of current water quality were used as the major dependent variables for the analysis. The correlations between each of the water quality scales are shown in Table 2. While the acceptability of water quality (ACCWQ), water quality risk judgment (WQRJ), and neighborhood water quality (NEIWQ) all correlated significantly and reasonably highly, there seemed to be sufficient unexplained variance for them to be treated separately in analysis. There was a low correlation between the responses to the FL questions and the other three scales.

Perceptions of Water Quality in the Four Locations

The means and standard deviations for the four locations are shown in Table 3. A number of statistical comparisons are presented between the locations to establish whether as in earlier studies differences in attitudes to differing risk attitudes could be related to TDS characteristics.

One-way analyses of variance revealed highly significant differences in responses between locations for all four scales. It can be seen, however, that the differences were small. For the ACCWQ scale Geraldton found their water less acceptable than the other three locations when the ranges of the means were considered. Since a mean of higher than 21 would have been needed to demonstrate any degree of dissatisfaction by the respondents, only Geraldton showed a mild dissatisfaction. Similar differences were found for other scales but no substantial dissatisfaction was observed with the possible exception of Bunbury and Geraldton having mild dissatisfaction with their neighborhood water quality.

TABLE 4. Correlations Between the Responses to the Four Attitudinal Scales for Water Quality and the Attitudinal, Demographic, and Experiential Variables

	ACCWQ	WQRJ	NEIWQ	FL
WATEXPER	−0.09	−0.15	−0.07	0.04
PERSCON	0.03	−0.03	0.00	0.00
ENVFUT	0.26*	0.31*	0.07	0.09
BOREWAT	0.02	0.05	0.05	0.10
TRUSTMED	0.20*	0.21*	0.01	0.04
TRUSTGOV	0.27*	0.33*	0.04	−0.01
SATNEIGH	0.13*	0.11	0.04	0.09
EXTLC	0.10	0.10	0.07	0.15*
INTLC	0.13*	0.14*	0.06	0.04
CRTSKRS	0.01	0.02	0.01	−0.04
SOCDES	0.14*	0.19*	−0.01	0.08
ENV	0.01	0.13*	0.00	0.13*
CONWAT	0.18*	0.26*	0.12*	0.06
GEN	0.01	−0.02	−0.03	0.04
AGE	−0.04	−0.17*	−0.03	−0.23*
INCOME	0.06	0.03	−0.02	0.05
EDUC	0.05	0.17*	−0.06	0.11
JOIN	−0.01	0.07	−0.04	0.07
FRQCHG	−0.17*	−0.12*	−0.06	0.02
DRINKW	0.09	0.01	−0.02	−0.01
INT	−0.09	0.10	−0.05	−0.09
CONSUM	0.07	−0.08	0.07	−0.02

See text for definitions of abbreviations.
*Here $p < 0.001$ one tailed.

Predictors of Perceptions of Water Quality

In this section each of the four water quality attitudinal scales were used as dependent variables in regression analyses in which attitudinal, socioeconomic, and experiential variables were used as independent variables. While it was tempting to consider more sophisticated causal modeling statistical techniques, it was felt that the earlier literature did not provide sufficient background on which to specifically hypothesize such a model. The simple correlations between each of the independent variables and the four water quality scales are shown in Table 4.

Acceptability of water quality. It can be seen that in general the correlations are low to medium. Only two correlations were above 0.20. The highest correlation (r = 0.27) was a positive one between acceptance of water quality and trust in government authorities. The higher the trust in water quality related agencies the greater the tendency to accept one's water quality. The other correlation of note (r = 0.26) was that between belief in human control over environmental problems and ACCWQ. Those who

TABLE 3. Means and Standard Deviations of Responses to the Four Water Quality Scales

	ACCWQ		WQRJ		NEIWQ		FL	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Albany(390)	17.42	7.41	9.66	3.45	5.54	2.02	8.46	2.04
Bunbury(357)	19.28	8.61	10.84	4.03	6.26	2.64	8.65	2.02
Perth(281)	16.81	7.20	9.90	3.82	5.50	2.22	9.05	1.96
Geraldton(759)	22.73	7.87	11.70	3.74	6.77	2.30	8.92	2.08

The mean TDS value for each location is shown in brackets. See table 2 for abbreviations.

TABLE 5. Multiple Regression With Acceptability of Water Quality as a Dependent Variable and Personal and Demographic Variables as Independent Variables

	Coefficient	Standard Error	Partial Correlation
TRUSTGOV	0.395	0.085	0.21
SATNEIGH	0.513	0.140	0.16
ENVFUT	0.270	0.096	0.13
CONWAT	0.400	0.138	0.13
BOREWAT	−0.471	0.165	−0.13
WATEXPER	−0.345	0.143	−0.11
GEN	−1.548	0.649	−0.11
FRQCH	−0.482	0.097	−0.22
DRINKW	1.117	0.274	0.18

See text for definitions of abbreviations. Statistically significant variables ($p < 0.05$) only are shown.

believed people could control environmental problems tended to be more happy to accept their water quality.

There appeared to be locational differences in the correlations for trust in government. Albany ($r = 0.27$), Bunbury ($r = 0.22$) and Perth ($r = 0.40$) all had significant correlations. Geraldton ($r = 0.10$), did not.

For control over environmental problems Bunbury ($r = 0.24$), Perth ($r = 0.22$), and Geraldton ($r = 0.35$) had significant correlations. Albany did not ($r = 0.03$).

A stepwise regression analysis using this scale as a dependent variable gave multiple correlation of 0.46 with an adjusted R^2 of 0.20. Nine variables were shown to be significant contributors to explained variance. These are shown in Table 5.

Those who had greater trust in government authorities tended to rate water quality as more acceptable. Those satisfied with their neighborhood tended to include acceptability with their water quality. Respondents who felt humans had more control over environmental problems also tended to accept their water quality more readily. The theme of control was also repeated with the feeling of personal control over drinking water quality contributing to explaining acceptability.

Those concerned with the environmental effects of use of groundwater were less accepting of water quality. Given that groundwater plays a role in domestic supply for many of the sample this may reflect a general interest and perhaps concern about groundwater issues.

People previously experiencing limits to water supply or quality were happier with quality, those noticing lesser frequency of change were happier and perhaps not surprisingly those who drank more water were happier. The partial correlation indicated that given the other factors males tended to be happier to accept their water quality than females. Nevertheless, given the low overall variance explained these effects were modest for the latter variables.

Water quality risk judgment. The correlations for this scale were also moderate to low although on this occasion there were two correlations above 0.3 and another two above 0.2. The highest correlation overall was that of trust in government ($r = 0.33$) and belief in human control over environmental problems.

It was noticeable, however, that both these correlations varied from location to location. Whereas the correlations for trust in government authorities were moderate to high and statistically significant for Albany ($r = 0.40$), Bunbury ($r = 0.36$), and Perth ($r = 0.47$), it was low and nonsignificant for Geraldton ($r = -0.02$). Similar localised variation was observed for the environmental control variable. In this case Bunbury ($r = 0.47$), Perth ($r = 0.36$), and Geraldton ($r = 0.30$) were all positive and significant. For Albany ($r = -0.11$) there was a low and nonsignificant correlation. These variations in correlation are similar to those for the ACCWQ scale.

The other two correlations worthy of note were the positive association between perceived control over one's own drinking water quality (CONWAT) ($r = 0.26$). Those who felt they had more control tended to be happier about the riskiness of their water. This correlation appeared to be reasonably consistent over the four locations.

Finally, there was a tendency for those who had a greater trust in the media to approve of their water quality on this scale.

A stepwise regression analysis was conducted using WQRJ scores as a dependent variable. A multiple correlation of 0.51 was found with an adjusted R^2 of 0.25.

As can be seen in Table 6, the variables contributing to this explanation were very similar to those for acceptability of drinking water quality. Unlike the ACCWQ scale the reported amount of water drunk and past experiences with water supply did not contribute significantly.

Neighborhood water quality. It can be seen that there were not substantial correlations between perceived neighborhood water quality and any of the predictor variables. This was confirmed in the multiple regression analysis. Here four variables contributed to an adjusted R^2 explanation of only 4.1%.

Attitudes toward fluoride. For this variable there was one correlation above 0.2. Age was negatively correlated with concern about fluoride ($r = -0.23$). Older respondents tended to be more concerned. The multiple regression explained had an adjusted R^2 of 7.9%. Four variables contributed to this explanation, age being the most significant.

4. Discussion

There appeared to be some sort of relationship between responses for all the water quality attitudinal scales and actual TDS. Nevertheless, with large differences in mean TDS the mean changes in satisfaction were quite modest. It must also be noted that there is not an exact correspondence of rank ordering of means of TDS and water quality attitudes for the four locations and the four measures. It must be

TABLE 6. Multiple Regression With Water Quality Risk Judgment as a Dependent Variable and Personal and Demographic Variables as Independent Variables

	Coefficient	Standard Error	Partial Correlation
TRUSTGOV	0.257	0.039	0.28
SATNEIGH	0.234	0.064	0.16
ENVFUT	0.210	0.044	0.21
CONWAT	0.353	0.063	0.24
BOREWAT	−0.195	0.076	−0.11
GEN	−0.868	0.298	−0.13
FRQCHG	−0.152	0.045	−0.15

See text for definitions of abbreviations. Statistically significant variables ($p < 0.05$) only are shown.

noted that as with the *Bruvold and Mitchell* [1976] study the only mean rating which was noticeably less than satisfactory was in Geraldton where the mean TDS was above 500 mg/L. This was the figure suggested by the *Bruvold and Mitchell* [1976] study as being perceptually unsatisfactory.

Furthermore, for none of the four water satisfaction scales were we able to account for more than one quarter of the variation from the regression analyses using attitudinal and other socio-economic variables. This is consistent with the findings of *Bruvold et al.* [1969]. Such a finding may be typical of multivariate attitudinally based domestic water studies [*Syme et al.*, 1991*c*]. and other applied attitudinal studies [*Kenny*, 1979] and do not prevent useful conclusions being derived.

First, correlations between drinking water satisfaction and attitudinal and socioeconomic variables did vary somewhat from location to location, so that those calling for localized and specific information and public involvement [e.g., *Shovlin and Tanaka*, 1990; *Wardlaw and Bruvold*, 1989] can do so with some justification. Second, examination of the simple correlations showed that where they were significant they tended to be in the directions hypothesized. Of the attitudes that predicted water quality judgments, trust in institutions tended to be a recurring theme, at least for attitudes toward acceptability of water quality and water quality risk judgment. This finding tends to quantitatively underscore the concerns of *Stukenberg and Argo* [1991], who emphasized the need for information and public involvement by agencies to maintain trust in setting water quality standards.

In assessing the role of trust in government in drinking water quality issues it is worthwhile considering whether this is a finding that is specific to drinking water quality alone or whether it is a generalized attitude or disposition toward government performance as a whole. *Schmidt and Gifford* [1989], for example, have shown that concern about hazards is a disposition and that attitudes toward drinking water quality and its management may reflect those for a variety of other environmentally related hazards. Similarly, *Syme and Nancarrow* [1992] have shown that the tendency for individuals to consider state governments to be "fair" in their allocation of water tends to correlate across quite disparate allocation situations and agencies. There may therefore be a generalized disposition to be content with government.

Institutional trust has been identified by several political philosophers as an important mechanism by which democracies will have to work in a complex environment [*Luhman*, 1979]. If such a trust is a generalized attitude it may well be that drinking water quality may be one among a number of phenomena for which the resident would have expressed satisfaction. Further research analyzing the effect of trust a variety of natural resource and public services simultaneously would clearly be of considerable theoretical interest.

The other attitudinal themes predicting quality assessments appeared to relate to the general concept of control in relation to acceptability of water quality and water quality risk judgment. For both of these scales those who felt that both humanity in general and they as individuals had more control over their environment (including their neighborhood) tended to be the most satisfied. This finding has been paralleled in earlier work from the work on public involvement in water resources planning [*Syme et al.*, 1991*b*]. The finding that control is an important factor has also been demonstrated in a variety of studies of human perceptions of potential stress from environmental variables such as pollution or crowding [*Evans and Cohen*, 1987]. Care therefore should be taken in involving the public in drinking water quality issues to enhance feelings that the public's views have been heard and responded to at an appropriate level. This care should also be reflected in other policy issues for water agencies in which public involvement has been invited.

Water quality risk judgment showed some association with more general environmental attitudes. Those who were less environmentally concerned tended to be those who were happier about their risk and also were happier about fluoride being added to their supply. Acceptability of water supply on the other hand showed a positive correlation with neighborhood satisfaction which may reflect the community service nature of this scale. Age was somewhat related to risk perception with older respondents tending to be more concerned about the risks associated with their water quality and about fluoride being added.

Finally, as hypothesized, there was a significant negative correlation between perceived frequency of change and acceptability and risk judgments for water supply. The regression analyses did allow some further variables to enter into accounting for water quality acceptability although these contributions were modest. These tended to be related to past experience, gender and concern about groundwater issues generally.

In conclusion, it is evident that the psychological variables predominantly affecting water quality perceptions relate to trust in relevant agencies and personal and environmental perceptions of control. The identification of the significance institutional trust and perceived control in governing satisfaction, combined with the localized differences, provide a strong quantitative basis on which to support current calls for ongoing and localized public involvement on drinking water quality issues.

Future latent variable causal modeling studies [*Bentler and Speckart*, 1979] using the control and trust variables in association with demographic and wider physical indicators are strongly encouraged from the findings of this preliminary research.

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