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Introduction

Risk comparisons have evoked far less empirical study than rhetorical support.[1] Focus groups probing public responses to risk comparisons found citizens dubious about comparisons involving decisions they saw as outside of their control (e.g., facility siting), but open to risk comparisons relevant to household and personal decisions.[2] Some of the public response risk comparisons volunteered by such focus groups were of citizens who compared the quality of bottled water to the quality of tap water delivered by utilities. Two focus groups devoted to drinking water information elicited spontaneous requests for comparisons of a utility's water to bottled water.[3] A later survey of a different utility's customers found that 63% wanted a comparison of their own utility's water quality to that of other utilities.[4]

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1 *See e.g.* Emilie Roth et al., *What Do We Know About Making Risk Comparisons?*, 10 Risk Anal. 375 (1990); Paul Slovic et al., *What Should We Know About Making Risk Comparisons?*, 10 Risk Anal. 389 (1990); William R. Freudenburg & Julie A. Rursch, *The Risks of "Putting the Numbers in Context": A Cautionary Tale*, 14 Risk Anal. 949 (1994); Branden B. Johnson, *Stability and Inoculation of Risk Comparisons' Effects Under Conflict: Replicating and Extending the "Asbestos Jury" Study by Slovic et al.*, Risk Anal. (forthcoming 2002); Branden B. Johnson, *Are Some Risk Comparisons More Effective Under Conflict?: A Replication and Extension of Roth et al.*, manuscript under review (2000).

2 Branden B. Johnson, *Risk Comparisons in a Democratic Society: What People Say They Do and Do Not Want*, 10 Risk: Health, Safety & Environment 221 (1999).

3 Branden B. Johnson, *"Consumer Confidence Report" for Drinking Water Contamination: Initial Studies on Public Response*, presented at the Society for Risk Analysis meeting (Dec. 10, 1997).

4 Branden B. Johnson, *Utility Customers' Views of the "Consumer Confidence Report" of Drinking Water Quality*, 11 Risk: Health, Safety & Environment 309 (2000).

This paper reports the results of two small exploratory experiments testing comparisons of a utility's water quality to that of other utilities and to bottled water quality. These experiments tested whether utility customers: (1) welcomed comparisons in practice; (2) changed their views of their own utility's relative water quality; (3) changed their behavioral intentions to use bottled water or home treatment devices when exposed to a one-time comparison; or (4) preferred a number-only comparison to a more detailed, nuanced contrast. The aim of the two exploratory experiments reported here was to provide the first known empirical study of the impact of comparisons for a specific risk issue of high salience to citizens (i.e., that of drinking water quality for utility customers).

Background

Focus group comments indicated that people desiring comparisons to other utilities' water quality or to bottled water quality wanted to be reassured that their own utility's water was relatively safe.[5] Utility staff also have suggested that such comparisons would reduce customers' concerns. Thus two possible hypotheses are suggested:

- H1. Comparisons will reduce consumers' reports that the quality of their water is worse than other utilities' water or bottled water.
- H2. Comparisons will reduce consumers' reported concern about the safety of their own tap water.

Bottled water consumption has been increasing in the United States.[6] A recent statewide New Jersey poll found 60% of respondents used bottled or filtered water for drinking, while just 14% used only tap water.[7] Reasons given by consumers for shifting from tap water vary by population and time, health concerns, aesthetic criteria (e.g., taste, odor, color), and convenience.[8]

5 Johnson, *supra* n. 2; Johnson, *supra* n. 3.

6 For example, in 1999 bottled water consumption grew by 11%, to seventeen gallons per American, "the fastest growing beverage in the country." *See* Dean E. Murphy, *Tap or Bottle? Old Issue, New Slant*, 41 N.Y. Times (Sept. 17, 2000).

7 *Environmental Attitudes in New Jersey: Treading (Dirty) Water*, Release EP125-4. The Star-Ledger/Eagleton-Rutgers Poll (April 2, 2000) [hereinafter *Environmental Attitudes*].

8 A study in four small water supply systems in Oregon found that a town with a chronic water quality problem had significantly higher bottled water consumption than towns with short-term or no official health-related water quality problem. *See* Edith C. Anadu & Anna K. Harding, *Risk Perception and Bottled Water Use*, 92 J. Amer. Water Works Assn. 82 (2000).

Secondary drinking water standards for factors that can affect aesthetic qualities of water are not enforceable. Water that is "safe" for health might still offend consumers' taste, smell, or vision (as with discolored water). Since many bottled waters come from groundwater sources less prone to some of these aesthetically-offending substances, shifting to bottled water can reduce, or be thought to reduce, aesthetic problems. Because "risk" comparisons based on attributes, such as whether tap water or bottled water has met primary health standards, does not address aesthetic or convenience issues, it is possible that such comparisons to health standards will not shift beliefs about relative water quality. Because visual and olfactory cues (e.g., smelly or dirty-looking water) can seem to indicate unhealthiness, and even trigger somatic changes reinforcing aversion, they might strengthen mental models of bottled water against messages seeking to correct their errors.[9]

By contrast, comparisons to other utilities' water quality might have lower salience than comparisons to bottled water. On average, consumers have less of a chance to actually taste any difference between other utilities' tap water and their own tap water than they do to taste differences with bottled water. Consumers can exploit better water quality at other utilities only by moving their entire household, while bottled water is easily accessible. If consumers' mental model of tap water assumes that tap water is generically bad, a comparison that shows that their own water is as good as other utilities' water is hardly reassuring. In other words, changing one's view of the relative quality of other tap water might occur easily because changing that view has few consequences. Thus, one might hypothesize that:

- H3. Comparisons will have less of an effect on consumers' judgments of the relative quality of bottled water than on their judgments of other utilities' water quality.

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9 Donald G. MacGregor & Raymond Fleming, *Risk Perception and Symptom Reporting*, 16 Risk Anal. 773 (1996); Katherine E. Rowan, *Effective Explanation of Uncertain and Complex Science*, in Communicating Uncertainty: Media Coverage of New and Controversial Science (Sharon M. Friedman et al. eds., 1999).

Because behavioral intentions are affected by factors beyond expressed views about risk or relative quality (e.g., habit, other household members),[10] we should also expect, contrary to opinions of some utility staff, that:

- H4. Comparisons will affect consumers' behavioral intentions on bottled water use or home treatment of water less than they will affect their views or expressed concern about water quality.

Most proposed or tested risk comparisons have been in the form of tables of numbers.[11] Similarly, the federal government requires that utilities' annual water quality reports center around a table of numbers about contaminant levels found in the water and associated health standards and goals.[12] Yet, a table of numbers alone might provide an inadequate comparison. For example, utility staff, drinking-water regulators, and the Natural Resources Defense Council agree that bottled water and tap water meeting the health standards (i.e., maximum contaminant limits, or MCLs), are equally safe or unsafe.[13] The probability that bottled water (at least varieties using only ground water) and tap water suffer (or benefit, in the case of fluoride) from particular kinds of contaminants varies.[14] These are not caveats that can be conveyed by numbers alone, nor do they unequivocally show one source safer or better than the other. However, some analysts have suggested that "balanced" stories about risk can have unintended consequences. For example, Mazur asserted that positive coverage of hazards by the mass media can make risks more salient merely by mentioning that they exist, even if there are large net benefits.[15]

10 *See e.g.* Irwin Deutscher, What We Say/What We Do (Scott Foresman 1973); Irwin Deutscher et al., Sentiments and Acts (Aldine de Gruyter 1993).

11 *See e.g.* Bernard Cohen and I-Sing Lee, *A Catalog of Risks*, 36 Health Physics 707 (1979); Richard Wilson, *Analyzing the Daily Risks of Life*, 81 Tech. Rev. 40 (1979); Roth et al., *supra* n. 1; Slovic et al., *supra* n. 1.

12 Johnson, *supra* n. 4.

13 Erik D. Olson, *Bottled Water: Pure Drink or Pure Hype?*, attachment to the NRDC Citizen Petition to the U.S. Food and Drug Administration for Improvements in FDA's Bottled Water Program (February 1999) (available at <www.nrdc.org/water/drinking/bw/bwinx.asp>).

14 For example, most bottled waters are not fluoridated, so tap water is better at preventing tooth decay. Bacterial levels in bottled water are generally lower than in tap water, but about 20% of bottled waters in one study contained far higher bateria levels than Cleveland tap water. *See Tap Water Has Edge on Fluoride Front,* N.Y. Times F8 (Mar. 21, 2000).

15 *See* Allan Mazur, *The Dynamics of Technical Controversy*, 31 J. Comm. 106 (1981);

"Social amplification of risk" might stem in part from discussions of both advantages and disadvantages, thus making audiences aware and concerned about unknown risks.[16] One study found one-sided messages more persuasive to those initially favorable to the message and to less-educated people, and two-sided messages more persuasive to initial opponents and the better-educated.[17] Thus the null hypothesis may or may not be appropriate:

- H5. Comparisons comprised solely of numbers (e.g., percentage of waters violating standards) will have the same effect on consumers' views of relative water quality, concern, and behavioral intentions as comparisons that provide a more balanced, narrative discussion.

The value of these two experiments is that even the empirical studies of risk comparisons have either not used specific examples of such comparisons, or have concerned comparisons for which citizen demand was unknown (e.g., risks of industry emissions). Such comparisons also appear to violate the principle that a "comparison between two alternatives is (acceptability)-relevant to the extent that one of these alternatives can replace the other."[18] People can and do substitute bottled water for tap water, or the reverse. However, just as the risk of a local factory cannot be replaced by the risk of a factory elsewhere, one cannot easily substitute one utility's water for water from another utility. This case thus offers the first test of how people react to a comparison of true replacement alternatives.

Method

Experimental Treatments

Overall, there were four versions of the experimental text: (1) a one-page report on the utility's tap water quality; (2) a one-page report comparing the utility's water quality to that of other utilities in New Jersey; (3) a one-page report comparing the utility's water quality to

Allan Mazur, *Nuclear Power, Chemical Hazards, and the Quantity of Reporting*, 28 Minerva 294 (1990).

16 Roger E. Kasperson et al., *The Social Amplification of Risk: A Conceptual Framework*, 8 Risk Anal. 177 (1988).

17 C.I. Hovland et al., Experiments on Mass Communication (John Wiley 1965), cited in Katherine A. McComas & Cliff W. Scherer, *Providing Balanced Risk Information in Surveys Used as Citizen Participation Mechanisms*, 12 Society & Nat. Resources 107, 110 (1999).

18 Sven Ove Hansson, *Incomparable Risks*, in Proceedings: New Risk Frontiers 594, 595 (Britt-Marie Drottz-Sjöberg ed., Center for Risk Research 1997).

that of bottled water sold in New Jersey; and (4) a three-page version of the bottled water comparison.[19] Experiment 1 used all four versions. Experiment 2 excluded the inter-utility comparison and used a slightly-abridged version of the long bottled-water comparison. Both utilities' water met health standards, both in fact and in these hypothetical reports.

The hypothetical water quality reports grouped contaminants into five classes (i.e., volatile organic chemicals, inorganic chemicals, synthetic organic chemicals, radioactive substances, total coliform bacteria), and gave the required testing frequencies for each class. Annual reports to customers, required by federal law, must report on each contaminant found in the drinking water. The grouping used here saved space, as did the omission of other information required in annual reports. The fact that the utility did not violate health standards was highlighted for each class and was followed by information on detected levels of individual contaminants in the class, including comparisons to applicable standards.[20] The comparisons to other utilities and bottled water simply added the percentages of all utilities or all regulated bottled waters with violations or detections to the utility-only format. An example of the one-page reports for bottled water appears in Figure 1.

The long comparison to bottled water included all of this information, but in a different format and with added material. See Figure 2 for a list of its elements, including selected excerpts from Experiment 1. Experiment 2's version omitted the section on water supply sources and trimmed the length of other sections slightly, but retained all themes otherwise. Overall, the long version of the bottled-water comparison provided a more balanced and detailed contrast of bottled and tap water than did the short version (i.e., Hypothesis 5). For example, the quotations in Figure 2 add explicit messages to the shorter version's risk numbers that experts (and a well-known

19 Data sources were: utility's water quality (utility's annual report); utilities' water quality statewide (annual report, Bureau of Safe Drinking Water, NJDEP); bottled water quality (annual report, New Jersey Department of Health and Senior Services, which regulates all such water sold in the state).

20 Thus all experimental texts included a comparison of what was found in the water to the relevant standard, as required in all annual water quality reports. The aim here was to test the effect of *additional* comparisons to the quality of water from other sources.

environmentalist critic of risk managers, the Natural Resources Defense Council) believe bottled water and tap water to be equally safe or unsafe. These quotations also pointed out, in general and for particular classes of contaminants, that determining whether tap water or bottled water is cleaner depends upon a variety of factors and that blanket assertions are inappropriate.

The bottled water comparison showed that for four of the five contaminant categories, neither the target utility's water nor the 200 bottled waters certified in the state violated the public health standard. For the fifth category, inorganic chemicals, one bottled water had violated a standard. For two of the five categories, neither the target utility's water nor bottled waters had detected contaminants below the standard. For three categories, both the target utility's water and varying numbers of bottled waters (one, to about 50%) had detected contaminants. As for the utility comparison, four of the five contaminant categories featured at least one utility violating a standard, up to 6% of all utilities in the state, while the target utility had no violations. Synthetic organic chemicals had no difference across utilities. Volatile organic chemicals, inorganic chemicals, and radioactivity were detected in both the target utility's water and in varying percentages (25-100%) of utility water statewide. Thus, one might conclude that: the target utility water was identical both to bottled water and to other utilities' water on detections of contaminants; that it was similar to bottled water on violations of standards; and that it was superior to a few other utilities on violations. In the long version of the bottled water comparison, the assertion that tap water was equally safe (or unsafe) was meant to reinforce these numbers.

Figure 1
Short Bottled-Water Comparison for Utility A Survey*

*A Comparison of UTILITY** Water Quality and Bottled Water Quality*

Because our customers have said they wanted this comparison, we are providing the information below about UTILITY and bottled water quality in the last calendar year.

[NOTE: The following compares UTILITY water to the 200 bottled waters certified to be sold in New Jersey. UTILITY reports its testing results to the New Jersey Department of Environmental Protection. Bottled water sellers report their testing results to the New Jersey Department of Health and Senior Services. NJDHSS is the source of the bottled water information cited below.]

Volatile Organic Chemicals (tested monthly in UTILITY water; tested once per year in bottled water).

- **UTILITY did not violate the public health standard (or MCL) for volatile organic chemicals.**
  Trichloroethylene was detected in the water at a level of 0.46 parts per billion (MCL=1.0 part per billion). Total trihalomethanes (TTHMs) were detected in the water at 38 ppb (MCL=100 ppb).
- No bottled waters sold in New Jersey violated the MCL for VOCs.
  - Four different bottled waters had the following VOCs: xylene, 1.0 part per billion (ppb) and 0.6 ppb (MCL=1,000 ppb); toluene, 7.9 ppb (MCL=1,000 ppb); ethylbenzene, 0.9 ppb (MCL=700 ppb).

Inorganic Chemicals (tested once per year in UTILITY water; tested once per year in bottled water).

- **UTILITY did not violate the MCL for inorganic chemicals.**
  - Six inorganic chemicals were found in the water: barium, 22 parts per billion (MCL=2,000 ppb); copper, 690 ppb (AL=1,300 ppb); fluoride, 100 ppb (MCL=4,000 ppb); lead, 6 ppb (AL=15 ppb); nickel, 7 units (no MCL, but monitoring required; former MCL=100 units); nitrate/nitrite, 1,000 ppb (MCL=10,000 ppb).
- One bottled water violated the MCL for nitrate/nitrite, at 11,700 ppb (MCL=10,000 ppb).
  - Nitrate/nitrite was detected in about half of bottled waters. Levels of other inorganic chemicals detected in bottled waters were too low and too infrequent for DHSS to report.

Synthetic Organic Chemicals (tested once per year in bottled water).

- NJDEP has authorized UTILITY to stop testing for synthetic organic chemicals, since testing shows these pesticides have not occurred in its water, and are not applied to land near UTILITY water sources.
- No bottled waters sold in New Jersey violated the MCL for synthetic organic chemicals.
  - No synthetic organic chemicals were detected in bottled waters.

Radioactive Substances (tested every 4 years in UTILITY water by NJDEP; tested every 4 years in bottled water).

- **UTILITY did not violate the MCL for gross alpha radioactivity** (no other radioactive substances are tested for in any water unless that water exceeds the MCL for gross alpha radioactivity).
- No bottled waters sold in New Jersey violated the MCL for radioactive substances.
  - Radium 226/228 was detected in some bottled waters.

Total Coliform Bacteria (tested twice per week in UTILITY water; tested once per week in bottled water; these bacteria do not themselves cause disease, but may signal that other microorganisms that do cause disease are in the water).

- **UTILITY did not violate the MCL for coliform bacteria.**
  - No coliform bacteria were detected in UTILITY water.
- No bottled waters sold in New Jersey violated the MCL for coliform bacteria.
  - No coliform bacteria were detected in bottled water.

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* This excludes the introductory material (definitions, etc.).
** "UTILITY" replaces actual utility name.

Instrument

The instrument began by asking about attitudes toward respondents' tap water, and the receipt, utility, and evaluation of the required annual report of tap water quality from the utility (latter responses not discussed here). It then presented one of the hypothetical reports on water quality as black-and-white text in a different font than the rest of the instrument, but without color or graphics other than the map of water supply sources. Response measures included: (1) an audience evaluation measure (the desire for such a comparison in respondent's own utility's water quality report); (2) a measure of agreement with claims in the comparison, the concerning safety of the respondent's own utility's water compared to either other utilities (baseline or utility comparison condition) or bottled water (bottled-water conditions); and (3) several measures that might reflect dose-response consistency (i.e., concern, judged risk, trust in "utility to tell me the truth about its water quality," and respondent's intentions to increase use of bottled water or in-home treatment devices in the coming year).[21] Three measures were asked both before and after the comparison in the same instrument. These included the relative water quality, intentions to increase the use of bottled water, and intentions to increase the use of home treatment devices. Missing cases for the pre-post contrasts were 8-10% for water quality questions, and 15-26% for

[21] These were three of the seven evaluation criteria recommended by Neil D. Weinstein & Peter M. Sandman in *Some Criteria for Evaluating Risk Messages*, 13 Risk Anal. 103 (1993). The Weinstein-Sandman discussion of dose-response consistency stressed different levels of risk evoking different reactions. The unmentioned corollary is that identical risks should evoke similar reactions. If different comparisons with identical utility water quality information evoke different beliefs about risk, for instance, this indicates an inconsistency, although these measures do not allow identification of the conditions which prompt more consistent responses.

the intention questions, somewhat due to a failure to answer the question the first than the second time. Socio-demographic questions ended the instrument.

Figure 2
Elements of and Selected Excerpts from the Long Bottled-Water Comparison

Introduction (same as in short versions)
Utility's water sources
Utility and bottled water must meet same standards
Both utility's water and 199 of 200 bottled waters sold in state met standards
Safety of water meeting the standards, criteria for setting standards, and safety implications of differences in contaminant levels when two sources both meet standards

"In short, both UTILITY* and bottled waters meet the public health standards for drinking water. Experts on drinking water quality generally agree that this **makes the two kinds of water equally safe.** (If you are uncertain about whether water of a quality equal to or better than a standard is 'safe,' the experts would say that standards are usually set at a level that will protect human health with a considerable margin of safety. If this does not reassure you, the experts would still say that if both waters meet the standards, as they do, to be consistent you should believe that UTILITY and bottled waters are equally 'unsafe.') . . . . Most experts believe that the level of a substance in water does not affect safety as long as it is below the standard. Bottled waters might or might not have 'less' in them, depending on which bottled waters and which utility waters are being compared for which substances. What substances can be found in various waters depends upon the source(s) used, changing events, and natural variability."

Utility's and bottled waters' detected contaminants by class

"Disinfection byproducts such as total trihalomethanes (TTHMs) result from chemical reactions between organic matter and such disinfectants as chlorine. Chlorine is used widely by utilities but not usually for bottled water. TTHMs tend to occur more in drinking water from surface water sources, and very rarely in spring water or other groundwater sources. However, bottled water can contain TTHMs if the bottler used a municipal source whose water contained TTHMs. . . . While no bottled waters sold in New Jersey violated the [standard] for radioactive substances, radium 226/228 was found in some bottled waters . . . . Finding radioactive substances in bottled water is to be expected, given that most bottled waters use ground water as a source, and the rocks and soils through which this water moves are often sources of naturally-occurring radioactivity. This is most likely for mineral waters, which may have high gross alpha levels but still meet the [standard]."

Other potential contamination problems with bottled water (mold, mineral precipitation, solvent diffusion into nearby stored bottles, improper cleaning of water coolers)
Testing frequencies (more often by purveyor and regulator for utility than bottled water)
Price ($0.89-$3.00+ per gallon for bottled water; $2.57 per 1,000 gallons for the utility)
Quotes from National Defense Council critique of bottled water regulation and quality

"About one third of the bottled waters we tested contained significant contamination . . . in at least one test . . . . Therefore, while much tap water is indeed risky, having compared available data we conclude that there is **no assurance that bottled water is any safer than tap water.**"[22]

* "UTILITY" replaces the actual utility name used in the experimental report.

22 Johnson, *supra* n. 4 (emphasis added).

Data Collection

Both studies used random samples of New Jersey utility customers, and randomly assigned different hypothetical reports to them for a three-wave mailed survey. Experiment 1 randomly sampled 285 residential customers from one utility in January to February 2000. Subtracting undeliverable customers yielded a 60% response rate (158/263). Respondents were 55% male, with a mean age of 54 (range 29-91; s.d. 15). They were well-educated: 17% high school diploma or less; 22% some college; 31% college graduates; and 29% graduate school. Ninety-five percent were white. The median 1999 household income was $80,000-99,999 with 23% at $140,000 or more. Experiment 2 randomly sampled 397 residential customers from a second utility[23] in September to November 2000. Excluding undeliverable customers yielded a 50% response rate (191/382). Respondents were 61% male with a mean age of 54 (s.d.=16; median age 51; range 19-89). Thirty-nine percent high school or less, 34% college or graduate degree, the rest "some college;" 82% white; 32% household income under $40,000, 39% $40,000-79,999.

A *t*-test for independent samples revealed that the Experiment 2 sample was significantly lower ($p<0.05$ or better) on education, income and proportion "white," but did not differ on sex or age. Experiment 1 respondents were more likely to rate aesthetic quality (i.e., taste, odor, clarity, or color) of their drinking water as "good," and less likely to answer "don't know," and they differed also on three reactions to the comparisons. The latter differences endured when the "utility comparison" group in Experiment 1, a treatment not used in Experiment 2, was removed from the analysis. Thus, the two experiments were analyzed separately for comparison effects.

Of the forty-nine *t*-tests reported below, five were statistically significant at $p < 0.05$, twice as many as would be expected by chance.

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23 *Id.* This is the same utility whose customers, in an earlier survey, indicated interest in comparisons with other utilities' water quality.

Results

General Attitudes

Table 1 shows responses to baseline questions (i.e., before respondents read hypothetical water quality reports). About half of the respondents rated their water quality as "fair" or "poor." Half could not compare the safety of their utility's water to that of other utilities, but those who did mostly rated it at least as good. A third were unable to compare it with bottled water, but nearly one-half of the total thought the utility's water was worse than bottled water. The importance of knowing about water quality was rated as high; only one-quarter reported that they were more than "somewhat" trusting of their utility, and over half rated its provision of water quality information as only "fair" or "poor."[24] About half of the combined samples used bottled water for half or more of their consumption, and about half used some home treatment or purification device for their tap water. Overall, 56% did one or both, consistent with the New Jersey statewide results cited earlier.[25]

After reading the provided information (baseline or comparison), across all conditions, 47% of the respondents were concerned about the effects of drinking "this water"; 33% felt it presented "a serious health risk"; and 43% did not trust the utility to be honest about the water quality. About 84% of those in the baseline and utility conditions wanted a comparison to other utilities in future water quality reports; 81% of those in the bottled-water conditions wanted a bottled-water comparison.

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24 The two utilities did not differ significantly on this measure, although one had mailed annual water quality reports to every customer for years on its own initiative, while the other gave such reports to customers only upon request until required to do so by federal regulations.

25 *Environmental Attitudes*, *supra* n. 7.

Table 1
General Attitudes Toward Drinking Water and Utility

Item (N)	*Combined Utilities*
Overall quality of utility's drinking water (330)	
Excellent	9%
Good	42%
Fair	29%
Poor	12%
Don't know	8%
Safety of utility's drinking water (327)	
Excellent	10%
Good	36%
Fair	20%
Poor	9%
Don't know	24%
Safety of utility's water relative to other utilities (343)	
Better	13%
Same	29%
Worse	9%
Don't know	49%
Safety of utility's water relative to bottled water (343)	
Better	3%
Same	25%
Worse	43%
Don't know	29%
Trust of water utility (345)	
Very much	26%
Somewhat	48%
Not very much	16%
None at all	2%
Don't know	8%
Personal importance of knowing more about one's water quality (347)	
Very important	56%
Important	35%
Not very important	6%
Not at all important	1%
Don't know	1%
Utility's provision of water quality information (346)	
Excellent	7%
Good	23%
Fair	24%
Poor	31%
Don't know	16%

Sources of water for drinking (including hot drinks (e.g., coffee, tea) and cooking) (343)	
Drink only tap water	26%
More than half is tap water	23%
Bottled and tap water equally	15%
More than half is bottled water	20%
Drink only bottled water	16%
Will increase bottled water use in coming year[a] (288)	
Yes	23%
No	59%
Don't know	18%
Use home treatment/purification devices[a] (297)	
Yes	46%
No	54%
Don't know	0%
Will increase use of devices in coming year[a] (298)	
Yes	23%
No	53%
Don't know	24%

[a] Those who drink only bottled water did not answer these questions.
Note: Results are combined for both utility samples since *t*-tests for independent samples found no significant differences.

Utility Comparison

This test occurred in Experiment 1 only. Of seven post-test measures, only one had significantly different responses (by *t*-test of independent samples) between those who read only about the utility's water quality and those who had information about water quality for utilities statewide. Of those respondents with only their own data (N~35), 17% said their utility's water was better than that of other utilities; of respondents with the comparison (N~47), 38% made this claim (t=2.2, df=81, $p<0.05$).

A *t*-test of dependent samples was conducted for the three questions asked both before and after exposure to the water quality information. The baseline condition shifted respondents' intentions to increase the use of in-home treatment devices in the next year from 11% to 22% (t=2.9, df=34, $p<0.01$). The utility comparison improved the proportion of respondents rating their own water better than that of other utilities from 6% to 38% (t=4.1, df=46, $p<0.001$), but did not affect their intentions to increase the use of bottled water or home treatment devices.

Bottled-Water Comparisons

Experiment 1 found just one significant difference on seven post-information questions between readers of the short and long bottled-water comparisons (Ns~55 in both groups). Readers of the long version were less likely (25% verses 41%) to say that they would increase use of bottled water in the coming year (t=2.2, df=63, p<0.05); however, this intention did not shift significantly before or after exposure to the comparison. No within-group shifts for the two comparisons (separately or jointly) were significantly different from the baseline condition, either on relative ratings of water quality or on intentions for use of in-home treatment devices.

Experiment 2 found no significant differences on post-information questions between readers of the short and long bottled-water comparisons (Ns~55 in both groups). There was a significant difference relative to the baseline (no comparison) condition in how readers of the comparisons (separately or combined) rated the quality of their water relative to bottled water (t=3.5, df=173, p<0.001; Ns=66 and 109, respectively, for the combined analysis). Unlike the results for the utility comparison, the difference did not stem from ratings of the utility water as "better" (7% comparisons verses 6% baseline). Rather, "don't know" responses were greatly reduced (29% verses 58%), resulting in both more "same" ratings (38% verses 29%) and more "worse" ratings (26% verses 8%). There was less concern but more judged risk and desire for a bottled-water comparison in future water quality reports among those seeing the comparison, but neither of these differences, nor within-group shifts, were statistically significant.

Patterns of Response

Six of seven post-information measures were recoded to ensure all reflected, for instance, a high-concern or a high-judged-risk stance, and subjected to principal component factor analysis. Extraction of factors with eigenvalues above 1.0 and varimax normalized rotation identified measures loading high on the same factor. Reliability analysis examined whether an additive scale compiled from these high-loading measures was reliable. The aim was to identify a scale that could be the dependent variable in a multiple regression analysis.

Table 2 shows the results of the factor analyses. In Experiment 1, concern, risk, and two behavioral intention measures loading high on the first factor extracted created a reliable additive Concern scale (standardized Cronbach's alpha=0.73). The second factor showed that people distrusting the utility's information about its water quality were more interested in the comparison.

Experiment 2 had risk, distrust, and behavioral intentions to use bottled water or home treatment loading high on the first factor extracted. These items created a modestly reliable additive Risk scale (standardized Cronbach's alpha=0.60; deleting any item reduced alpha). Concern loaded high with desire for the comparison on the second extracted factor, in contrast to Experiment 1, where distrust loaded with desire for the comparison.[26]

One-Sided versus Balanced Comparisons

ANOVA and post-hoc comparisons (with the Tukey test of honest significant differences) tested whether the difference found in the literature applied here (i.e., one-sided presentations (as in the short bottled-water comparison) were more persuasive to those initially receptive to the message and to the less-educated, and two-sided messages (the more nuanced long comparison) were more persuasive to initial opponents and the better-educated).[27] Dummy independent variables for these factors included initial (pre-experiment) trust of the utility, education, and receipt of the short or long comparison.[28] Dependent variables were the Concern scale and the post-comparison rating of the respondents' own tap water quality to bottled water quality for Experiment 1, and the Risk scale and the contrast to bottled water quality for Experiment 2.

26 Multiple regression analyses (results upon request) had "desire for comparison" as a dependent variable, and as listed in Table 3, pre-experiment attitudes (including overall trust in utility) and demographics as independent variables. Neither attitudes about water quality nor trust were significant factors. In Experiment 1, personal importance of knowing more about one's water quality and being white had significant betas (both $p<0.01$; adjusted R^2=7%). In Experiment 2, the importance of knowing ($p<0.00001$) and low income ($p<0.05$) were significant, and being female and non-white marginally significant at $p<0.10$ (adjusted R^2=21%).

27 Hovland et al., *supra* n. 17.

28 This categorical approach removed some data in the full distributions of trust and education, but ANOVA failed with the latter due to unbalanced designs and many empty cells.

In Experiment 1, two of twelve contrasts were statistically significant. Readers of the short comparison with low trust and less education had higher scores on the Concern scale (mean=9.5) than readers of the short comparison with high trust and more education (mean=4.9, $p<0.05$), or readers of the long comparison with high trust and more education (mean=5.1, $p<0.01$). No significant differences occurred across the various trust-education-comparison trios in ratings relative to bottled water quality, either absolutely or in shifts from pre-comparison judgments.

Table 2
Factor Analyses

	Experiment 1		*Experiment 2*	
Measures	*Factor 1*	*Factor 2*	*Factor 1*	*Factor 2*
"I would be concerned about the effects of drinking this water."	**+0.84**	+0.00	+0.43	**+0.71**
"This water does not seem to pose a serious health risk." [recoded: high values = high perceived risk]	**+0.78**	-0.01	**+0.76**	+0.14
"I trust the utility to tell me the truth about its water quality." [recoded: high values = high distrust]	-0.30	**+0.77**	**+0.68**	-0.39
"I want a comparison of my utility's water quality with [bottled water] in future water quality reports."	+0.26	**+0.71**	+0.02	**+0.80**
Increase bottled water use in coming year (3=yes, 2= don't know, 1=no)	**+0.69**	-0.27	**+0.63**	+0.27
Increase home treatment devices in coming year (3=yes, 2=don't know, 1=no)	**+0.62**	+0.23	**+0.58**	+0.25
Eigenvalues	2.33	1.21	2.24	1.16
Proportion of variance explained	39%	20%	33%	24%

Principal components analysis, eigenvalues > 1.0 and varimax normalized. N=139 and 163, respectively. Higher loadings in boldface.

In Experiment 2, four of twelve contrasts were significant. People with low trust and high education, whichever bottled-water comparison they read, had higher Risk scores (mean=10.8 for long, 9.8 for short comparison) than people with high trust, regardless of the latter's education level or the comparison they had read (means=5.6 to 6.3, all $p<0.01$). Again, absolute and shifted relative ratings of bottled water had no significant differences across conditions.

Reasons for Judgments

Asked to explain why they reacted as they did to the provided information, few comments in either study referred to the comparison or baseline information. Instead, people referred to pre-existing opinions. Either they trusted the utility (e.g., felt the water quality was good) or they thought the quality was terrible (including some who had the water tested independently). The few comments on the comparisons (whether to other utilities or bottled water) were positive.

Multiple regression analysis was done for each study to test for the effect of comparisons while controlling other variables. The Concern and Risk scales were the dependent variables for Experiments 1 and 2, respectively. Independent variables were four pre-information attitudes with few "don't knows," to keep N high; four risk beliefs (Experiment 1 only); six or five demographic measures, respectively; and dummy variables for exposure to a comparison (two dummies, "utility" and "bottled," in Experiment 1; "bottled" only for Experiment 2).

Table 3 shows the results for Experiment 1. Pre-experiment attitudes alone explained one-third of the variance in the Concern scale. People who rated the overall water quality poor distrusted the utility thought it very important to know about water quality and had higher Concern scores (poor aesthetic quality of the water also contributed to Concern, but not significantly). Belief in serious local environmental health problems was the only one of four risk beliefs with a significant beta. The greater this belief, the higher the Concern score. Risk beliefs alone explained 16% of the variance, or half of the power of pre-experiment attitudes. Of six demographic measures, only lower levels of education significantly predicted Concern, and the variance explained was minimal. The comparison dummy variables had negative values, so comparisons did reduce Concern, but by themselves they explained none of the variance in Concern. Putting all four classes of independent variables into a single regression produced an explained variance of 39%, but now only the pre-existing attitude of trust of the utility had a significant beta. Clearly prior attitudes explained far more Concern than other variables. The inclusion of other variables strengthened the contribution of comparisons to reducing Concern, but their effect was still not significant.

Table 4 shows Experiment 2 results. The Risk score was shaped by low aesthetic quality of this utility's water and low trust in the utility. Neither demographics nor exposure to bottled-water comparisons had a significant effect by themselves. When all three categories of independent variables entered the regression, aesthetic water quality and distrust became more important, higher income became marginally significant, and exposure to bottled-water comparisons almost reached marginal significance ($p<0.105$) in reducing Risk scores (versus increasing such scores when entered alone in the analysis). Prior attitudes toward water quality and the utility dominated other independent variables in explaining Concern even more than in Experiment 1. Overall, the results were similar (but not identical) to those in Experiment 1.

Discussion

These two pilot studies, despite the small sample sizes, revealed more statistically significant differences than could be expected by chance. In particular, they suggested that:

- Comparisons of utility-provided drinking water quality to the quality of other utilities' water or bottled water are indeed desired by utility customers. Audience evaluations of actual comparisons, using real data, were positive. Earlier expressions of interest in the abstract were not anomalous. Personal importance of knowing about one's water quality seemed the primary motivation for this desire.[29]

29 *Environmental Attitudes, supra* n. 7.

Table 3
Multiple Regression Analyses for Experiment 1

	Attitudes	*Beliefs*	*Demographics*	*Comparisons*	*All*
Pre-experiment attitudes					
Overall water quality (1=excellent, 4=poor)	+0.24†	-	-	-	+0.03
Water quality, aesthetics (1=excellent, 4=poor)	+0.06	-	-	-	+0.14
Trust in utility (1=very much, 4=none at all)	+0.29**	-	-	-	+0.43***
Important to know about water quality (1=very important, 4=not at all important)	-0.18*	-	-	-	-0.12
Risk beliefs					
"There are serious environmental problems where I live." (1=strongly disagree, 5=strongly agree)	-	+0.42*****	-	-	+0.15
"I have very little control over risks to my health." (1=strongly disagree, 5=strongly agree)	-	+0.01	-	-	+0.02
"Decisions about health risks should be left to the experts." (1=strongly disagree, 5=strongly agree)	-	+0.07	-	-	+0.13
"When the risk is very small, it is OK for society to impose that risk on individuals without their consent." (1=strongly disagree, 5=strongly agree)	-	-0.04	-	-	-0.16
Demographics					
Sex (1=male, 2=female)	-	-	+0.13	-	+0.04
Age	-	-	+0.03	-	+0.14
Education (1≤ high school, 5=graduate school)	-	-	-0.26*	-	-0.14
"White" ethnicity (1=yes, 0=no)	-	-	-0.12	-	+0.00
Children at home (1=yes, 0=no)	-	-	-0.05	-	+0.01
Income	-	-	+0.01	-	-0.04

Table 4
Multiple Regression Analyses for Experiment 2

	Attitudes	*Demographics*	*Comparison*	*All*
Pre-experiment attitudes				
Overall water quality (1=excellent, 4=poor)	-0.15	-	-	-0.27
Water quality, aesthetics (1=excellent, 4=poor)	+0.31*	-	-	+0.36*
Trust in utility (1=very much, 4=none at all)	+0.48*****	-	-	+0.54*****
Important to know about water quality (1=very important, 4=not at all important)	-0.03	-	-	-0.10
Demographics				
Sex (1=male, 2=female)	-	+0.13	-	+0.10
Age	-	-0.04	-	+0.04
Education (1≤ high school, 5=graduate school)	-	-0.02	-	-0.06
"White" ethnicity (1=yes, 0=no)	-	-0.08	-	-0.03
Income	-	+0.09	-	+0.20†
Comparisons				
Bottled Water (1=yes, 0=no)	-	-	+0.06	-0.14
F	14.7	0.7	0.6	5.8
N	119	118	163	84
p	******	< 0.60	< 0.46	*****
Variance explained (adjusted R^2)	31%	0%	0%	34%

Dependent variable is Risk scale. "Don't know" responses were case-wise excluded for pre-experiment attitudes, to make interpretation easier. Significant betas are in boldface.
† p < 0.10
* p < 0.05
***** p < 0.00001
****** p < 0.000001

- Hypothesis 2, about comparisons reducing consumers' reported concern about the safety of their own tap water, was not supported for either type of comparison. Both had negative, but insignificant, effects on Concern scores in a multiple regression analysis of Experiment 1 data, and the same for effects on Risk scores in Experiment 2 data.
- The test of Hypothesis 3, that comparisons will have less effect on consumers' judgments of the relative quality of bottled water than of

Comparisons					
Utility (1=yes, 0=no)	-	-	-	-0.09	-0.10
Bottled Water (1=yes, 0=no)	-	-	-	-0.00	-0.13
F	15.8	7.2	2.0	0.5	4.7
N	118	131	99	138	74
p	*****	****	†	< 0.61	*****
Variance explained (adjusted R^2)	33%	16%	6%	0%	39%

Dependent variable is Concern scale. "Don't know" responses were case-wise excluded for pre-experiment attitudes, to make interpretation easier. Significant betas are in boldface.

† $p < 0.10$
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$
**** $p < 0.0001$
***** $p < 0.00001$

- Hypothesis 1, that comparisons will reduce consumers' reports that the quality of their water is worse than other utilities' or bottled water, was seemingly supported (see caveats below) for utilities but not for bottled water comparisons. The comparison to other utilities' water quality in Experiment 1 significantly improved relative ratings of respondents' own tap water, in contrast both to their own pre-comparison ratings and to ratings of people in the no-comparison condition. Bottled-water comparisons significantly changed relative ratings of respondents' own tap water and bottled water in Experiment 2, but by increasing the "same" and "worse" ratings, not the "better" ratings. The results imply that the comparisons' intended message, that overall the two water sources provide similar quality, was persuasive to some people. However, as the Mazur hypothesis suggests, it might have reminded others of the reasons (especially aesthetic quality) they rated their water quality low.

other utilities' water quality, seemed to be rejected. Both sets of comparisons had significant effects, but in opposite directions.

- Hypothesis 4 was supported. Comparisons had less effect on consumers' behavioral intentions on bottled water use or home treatment of water than on their views or expressed concerns about water quality.
- Hypothesis 5, given divergent data from the relevant literature, suggested that comparisons comprised solely of numbers (e.g., percentage of waters violating standards) would have the same effect on views of relative water quality, concern and behavioral intentions as comparisons that provide a more balanced, narrative discussion. The two bottled-water comparisons differed significantly only in the long version evoking fewer intentions of increased use of bottled water (but not relative to those same respondents' pre-comparison intentions). The relative persuasiveness of one-sided versus balanced messages to people of differing "receptivity" (measured here as prior trust) and education did not occur as hypothesized in the literature. Concern and risk judgments were affected by trust and education, not the type of comparison read.[30]
- Although not subject to a prior hypothesis, general attitudes toward the utility and tap water quality drove people's concerns, while risk beliefs, demographics, and exposure to comparisons played relatively little role, as indicated by both ANOVA and multiple regression analyses. Exposure to comparisons reduced concern, but not significantly.

Some caveats must be raised. First, as noted in Methods section above, the measured quality of target utilities' water was better than the water quality of (some) utilities statewide, while identical in quality to bottled waters sold in the state. Thus, the positive impact of the utilities, comparison on judgments of relative water quality might be due to the particular data provided rather than to exposure to any comparison at all. However, this would be true anyway, unless we assume (as some advocates of risk comparisons appear to do) that all comparisons will show target risks as low. This caveat does not apply to the bottled water results since seemingly identical monitoring results increased judgments that respondents' own water quality was "worse"

30 Hovland et al., *supra* n. 17.

than bottled water quality, and increased "same" judgments. As discussed for Hypothesis 5 (above in the Background section), this may reflect the import of personal experience (e.g., better taste of bottled water) into the judgment process, an import less feasible for other utilities' water.

A second caveat is that these exploratory studies lacked any measure of information processing, except for the open-ended question asking for reasons for respondents' prior reactions to the information given. These reasons did not mention the comparison often, which might imply it did not get a lot of attention. However, it could equally well reflect the dominance of prior views of tap water quality regardless of how closely the comparison was read. Because the utilities comparison and the short bottled-water comparison were of equal length, it is plausible, but not demonstrated, that the mean processing strategy (e.g., systematic versus heuristic) across the two subsamples exposed to these comparisons, did not differ, and thus cannot explain the divergent results. The lack of significant differences in reactions to the short and long bottled-water comparisons could imply similar degrees of information processing, or less processing of the longer one. The recent emergence of survey-relevant measures of information processing may allow resolution of these ambiguities in future research.[31]

Are these results representative of likely utility customer reactions to such comparisons? The pre-comparison ratings of water quality and trust in the utility, for example, are similar to those provided by customers of other New Jersey utilities.[32] To the extent that such reactions are driven more by these views, particularly for bottled water, than by the comparisons themselves, similar results should occur. National data suggests similarities as well. For example, a 1993 survey found similar ratings of tap water quality across national regions. The proportion of the population drinking only bottled water in the Northeast, New Jersey's region, was in the middle of the regional ranges (9%, versus 4-16%), although its residents were less likely than those of other regions to use only tap water for drinking (46%, versus

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31 For example, as-yet-unpublished efforts by Robert Griffin and colleagues, and Craig Trumbo (on file with author).

32 Johnson, *supra* n. 4; *see also* Branden B. Johnson, *Public Reaction to Mandated Language for U.S. Water Quality Reports*, 12 Risk: Health, Safety & Environment 153 (2002); Branden B. Johnson, *Experiments in the Content of Reports on Drinking Water Quality*, manuscript under review (2002).

48-64%). A third expressed "very much" trust in their own utility, with 52% saying they trusted their own utility "somewhat." The national survey asked the general public to rate tap water's generic quality (not that of their own utility) for safety and health relative to bottled water. About half (49%) said they were the same, 37% said bottled water was better, and 10% selected tap water.[33] These limited comparisons suggest, but cannot prove that the results reported here will generalize to other populations. This conclusion is reinforced by focus groups that indicated that meeting or not meeting standards seemed less important in customers' views of their water quality than the broad relationship they had with that utility.[34] However, the differing reactions across the two utilities suggest caution even though the differences seem to have less to do with comparisons than with attitudes toward the utility itself. Overall, replication with larger samples or with frequent similar messages from multiple or more-trusted sources might find that water quality comparisons have a more significant effect. However, their impact relative to other variables, particularly prior attitudes toward the utility and water quality, seems unlikely to change much.

On a more practical point, complying with or improving secondary water quality standards, so fewer aesthetic problems alienate customers, seems utilities' best bet for reducing future shifts to bottled-water sources. However, given varied reasons for using bottled water and the existing high use of bottled water, utilities should not expect to reduce that use in the short run.

Conclusions

Theory on risk comparisons is even less developed than is their empirical testing, which has just begun to examine whether comparisons change beliefs, attitudes, or behavioral intentions.[35] The literature to date shows that people want the risk comparisons they have been shown, but is less clear on their substantive effect. This study is

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33 Robert E. Hurd, *Consumer Attitude Survey on Water Quality Issues*, AWWA Research Foundation and the American Water Works Association 38, 42, 49, 69 (1993).

34 Robert Hurd & Joan Becker, *AWWA Focus Groups to Develop and Test Effective Water Quality Reports: Responding to CCR Requirements in the SDWA* (WITAF Project No. 408, Final Report 1998); *see also* Johnson, *supra* n. 3.

35 *See* Roth et al., *supra* n. 1.

consistent with previous studies.[36] The effect is in the predicted direction, but too small to be significant, and far less important than consumers' prior attitudes (in this case, toward water quality and the utility). Without similar studies, it is too soon to know whether this result is restricted to comparisons concerning risk topics on which people already have definite beliefs and behaviors, or reflects the limited impact of simply providing information, relative to trust and other contextual factors.

36 *See* Slovic et al., *supra* n. 1; Johnson (2002), *supra* n. 1.