DOE/NV/10461--T25

DE90 004734

STATE OF NEVADA

AGENCY FOR NUCLEAR PROJECTS/ NUCLEAR WASTE PROJECT OFFICE

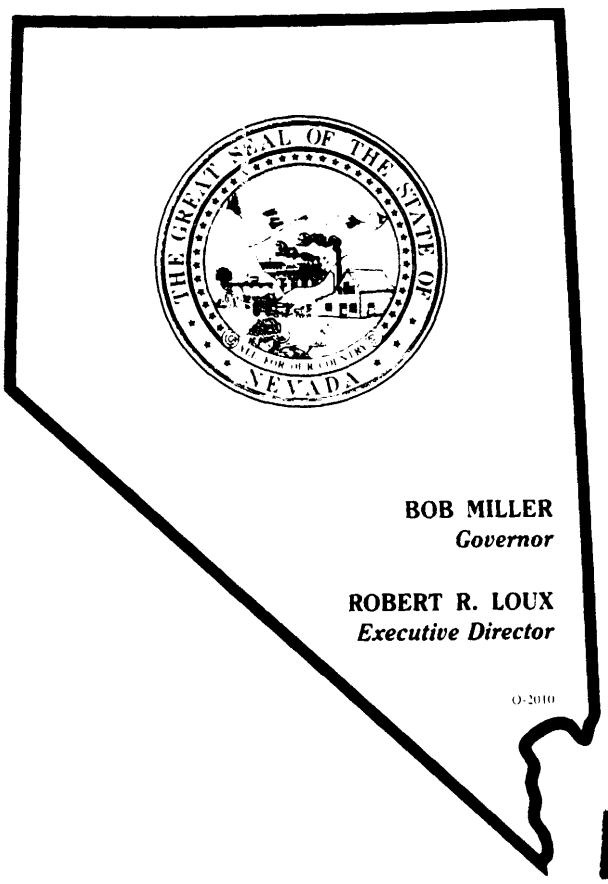
NWPO-SE-023-89

Perceived Risk, Stigma, and Potential Economic Impacts of a High-Level Nuclear Waste Repository in Nevada

by

Paul Slovic, Mark Layman, and Nancy N. Kraus
(Decision Research, Eugene, Oregon)
and
James Chalmers, Gail Gesell, and James Flynn
(Mountain West Research, Las Vegas, Nevada)

July, 1989



STATE OF NEVADA
AGENCY FOR NUCLEAR PROJECTS/
NUCLEAR WASTE PROJECT OFFICE

NWPO-SE-023-89

Perceived Risk, Stigma, and Potential Economic Impacts of a High-Level Nuclear Waste Repository in Nevada

by

Paul Slovic, Mark Layman, and Nancy N. Kraus
(Decision Research, Eugene, Oregon)
and
James Chalmers, Gail Gesell, and James Flynn
(Mountain West Research, Las Vegas, Nevada)

July, 1989

The Nevada Agency for Nuclear Projects/Nuclear Waste Project Office was created by the Nevada Legislature to oversee federal high-level waste activities in the State. Since 1985, it has dealt largely with the U.S. Department of Energy's siting of a high-level nuclear waste repository at Yucca Mountain in southern Nevada. As part of its oversight role, NWPO has contracted for studies designed to assess the socioeconomic implications of a repository and of repository-related activities.

This study was funded by DOE grant number DE-FG08-85-NV10461.

Acknowledgment. This research was supported by a contract with Mountain West Research and the Nuclear Waste Projects Office of the State of Nevada. The work reported here has benefited from the efforts, advice, and criticisms of many individuals. In particular, we wish to thank Roger Kasperson, Howard Kunreuther, David Pijawka, and the Technical Review Committee of the State of Nevada. The survey research reported in this paper was conducted under the direction of Michael J. O'Neil of O'Neil and Associates in Tempe, Arizona. Sarah Lichtenstein provided valuable comments on an early draft of the manuscript.

Perceived Risk, Stigma, and Potential Economic Impacts of a High-level Nuclear Waste Repository in Nevada

Abstract

This paper describes a program of research designed to assess the potential impacts of a high-level nuclear waste repository at Yucca Mountain, Nevada, upon tourism, retirement and job-related migration, and business development in Las Vegas and the state. Adverse economic impacts may be expected to result from two related social processes. One has to do with perceptions of risk and socially amplified reactions to "unfortunate events" associated with the repository (major and minor accidents, discoveries of radiation releases, evidence of mismanagement, attempts to sabotage or disrupt the facility, etc.). The second process that may trigger significant adverse impacts is that of stigmatization. The conceptual underpinnings of risk perception, social amplification, and stigmatization are discussed in this paper and empirical data are presented to demonstrate how nuclear images associated with Las Vegas and the State of Nevada might trigger adverse effects on tourism, migration, and business development.

New Orleans, Louisiana -- This is New Orleans! Air conditioning ... Al Hirt ... Andrew Jackson ... antebellum plantations ... antiques ... Antoine's ... Arnaud's ... Audobon Park ... bananas Foster ... Basin Street ...Battle of New Orleans ... bayous ... Bourbon Street ... breakfast at Brennan's ... Cafe du Monde ... cafe au lait and beignets ... Cajun ... Canal Street ... chicory coffee ... "cities of the dead" ... Commander's Palace ... courtyards ... Creole cuisine ... Dixieland ... Duelling Oaks ... French Market ... French Quarter or "Vieux Carre" ... Galatoire's ... Garden District ... Lafitte ... lace balconies ... Lake Pontchartrain ... levees ... Longue Vue Gardens ... the Longs of Louisiana ... Mardi Gras ... Old Absinthe House ... oysters Rockefeller ... Neville Brothers ... pecan pralines ... Pete Fountain ... Preservation Hall ... Ramos gin fizz ... riverboats ... shrimps ... St. Charles streetcar ... Storyville ... streetcar named Desire ... Sugar Bowl ... Superdome ... Uptown ... voo-doo![1]

In December, 1987, the U.S. Congress amended the Nuclear Waste Policy Act and authorized the Department of Energy to determine whether Yucca Mountain, Nevada, is a geologically sound and technically feasible site for storing high-level nuclear waste. If the site passes a set of prescribed technical criteria, a repository will be constructed there to store nuclear waste from the nation's commercial power plants.

Much effort has been, and will continue to be, devoted to characterizing the physical and biological risks associated with construction and operation of such a facility. Socioeconomic risks, though less studied, are also important. This paper addresses the following question pertaining to social impacts: What is the potential for a high-level nuclear waste repository at Yucca Mountain to have

---

1. Images define places. Introduction to the announcement for the 1989 Annual Meeting of the American Psychological Association in New Orleans, Louisiana. American Psychologist, March, 1989, p. 583.

adverse economic effects on the city of Las Vegas and the State of Nevada?

The economic impacts of concern to us here include reduction in short-term visits to the city and state by vacationers or conventioneers, effects on long-term residents (moving out of the region, reduced in-migration of retirees), and reduced ability to attract new businesses.

Assessment of these impacts is obviously important to citizens and officials of Nevada, who need to know what adverse economic consequences to expect if Yucca Mountain is developed as the repository. Indeed, selection of Yucca Mountain as the prime candidate and attempts to evaluate its qualifications over the next few years may even trigger some of these impacts in advance of the final decision. Information about possible economic impacts may also be relevant to the final decision itself.

Empirical research on this topic faces some major obstacles, however, Foremost among these is the fact that people may not really know how the repository will affect their future preferences and decisions. For example, asking people to project the repository's impacts on vacation decisions to be made many years hence may, in effect, be asking them to "tell more than they can know" (Nisbett & Wilson, 1977). Studies by Baker, Moss, West and Weyant (1977) and West and Baker (1983) indicate that answers to questions about the impact of nuclear facilities on future behavior may not be trustworthy. Despite this difficulty, there are theoretical reasons to expect that the repository will produce adverse economic impacts. In this study we

develop a method for assessing impacts that is not dependent on direct questioning of people who are unfamiliar with the decisions of concern here. We then use this method to assess the potential impacts from a repository at Yucca Mountain.

BACKGROUND AND THEORY

Adverse impacts from the proposed Yucca Mountain repository may be expected to result from two related social processes. One has to do with perceptions of risk and socially amplified reactions to "unfortunate events" associated with the repository (major and minor accidents, discoveries of radiation releases, evidence of mismanagement, attempts to sabotage or disrupt the facility, etc.). The second process that may trigger significant adverse impacts is that of stigmatization.

Perceptions of Risk and Social Amplification of Risk

Nuclear waste has several unique characteristics that strongly suggest the potential for a repository to have adverse effects upon the region in which it is located.

1. The technology of high-level nuclear waste disposal is complex and largely untried. There are genuine hazards associated with such a facility, and the nature of these hazards is only partly understood.
2. From the time that radioactivity was discovered shortly before 1900, nuclear energy has been unique in the power of the imagery and symbolism that has surrounded it. Weart (1988) traces the salience and persistence with which both positive and negative associations have become attached to things nuclear. His analysis demonstrates the strength of nuclear imagery and its broad

penetration into our social and cultural consciousness over the past 90 years.

3. Contemporary evaluations of nuclear power and nuclear waste could hardly be more negative. Nuclear power stands out in studies of risk perception as unknown, uncontrollable, and dreaded, with the perceived potential to produce immense numbers of fatalities, even in future generations (Slovic, 1987; Slovic, Lichtenstein, and Fischhoff, 1979). Nuclear waste tends to be perceived in a similarly negative way (Kunreuther, Desvousges, and Slovic, 1988).

These public perceptions have evoked harsh reactions from experts. One noted psychiatrist wrote that "the irrational fear of nuclear plants is based on a mistaken assessment of the risks" (Dupont, 1981; p. 8). A nuclear physicist and leading advocate of nuclear power contended that "...the public has been driven insane over fear of radiation [from nuclear power]. I use the word 'insane' purposefully since one of its definitions is loss of contact with reality. The public's understanding of radiation dangers has virtually lost all contact with the actual dangers as understood by scientists" (Cohen, 1983).

Risk perception research paints a different picture, demonstrating that people's deep anxieties are linked to numerous realities, including the reality of radiation's unique and powerful qualities, the reality of nuclear power's links to nuclear weapons proliferation and war (despite the term "the peaceful atom"), the reality of many serious examples of mismanagement (e.g., the releases of radioactive material into the environment from military reactor sites), and the reality of extensive

media coverage documenting major and minor problems and controversies involving nuclear technologies. Attempts to "educate" or reassure the public and bring their perceptions in line with those of industry experts face great difficulties because industry and government lack trust and credibility and because evidence of incompetence is much more persuasive than evidence of competence.

Perceptions of risk play a key role in a process labeled "social amplification of risk" (Kasperson, Renn, Slovic, et al., 1988). Social amplification is triggered by the occurrence of an adverse event, which could be a major or minor accident, a discovery of pollution, an incident of sabotage, etc. Risk amplification reflects the fact that the adverse impacts of such an event sometimes extend far beyond the direct damages to victims and property and may result in massive indirect impacts such as litigation against a company or loss of sales, increased regulation of an industry, etc. In some cases, all companies within an industry are affected, regardless of which company was responsible for the mishap. In extreme cases, the indirect costs of a problem event may even extend past industry boundaries, affecting companies, industries, or government agencies whose business is minimally related to the initial event. Thus, the risk event can be thought of as a stone dropped in a pond. The ripples spread outward, encompassing first the directly affected victims, then the responsible company or agency, and, in the extreme, reaching other companies, agencies, or industries. Examples of events resulting in extreme higher-order impacts include the chemical manufacturing accident at Bhopal, India; the pollution of Love Canal, New York and Times Beach,

Missouri; the disastrous launch of the space shuttle Challenger, the nuclear-reactor accidents at Three Mile Island and Chernobyl, and the adverse reactions to the drug Thalidomide. An important feature of social amplification is that the direct impacts need not be large to trigger major indirect impacts (e..g, no one died at Three Mile Island).

It appears likely that multiple mechanisms contribute to the social amplification of risk. First, extensive media coverage of an event can contribute to heightened perceptions of risk, particularly if the information reported is exaggerated or distorted. Second, a particular risk or risk event may enter into the agenda of social groups, or what Mazur (1981) terms the partisans, within the community or nation. This may occur either because a particular group has goals which include this risk issue or because political advantage is to be had for the group by keeping the issue in the public eye. The recent attack on the apple growth-regulator "Alar" by the National Resources Defense Council demonstrates the important impacts that special-interest groups can produce (Moore, 1989).

A third mechanism of amplification arises out of the interpretation of unfortunate events as clues or signals regarding the magnitude of the risk and the adequacy of the risk-management process (Slovic, 1987). The informativeness or signal potential of a mishap, and thus its potential social impact, appears to be systematically related to the perceived characteristics of the hazard. An accident that takes many lives may produce relatively little social disturbance (beyond that caused to the victims' families and friends) if it occurs

as part of a familiar and well-understood system (e.g., a train wreck). However, a small accident in an unfamiliar system (or one perceived as poorly understood), such as a nuclear waste repository or a recombinant DNA laboratory, may have immense social consequences if it is perceived as a harbinger of future and possibly catastrophic mishaps.

The concept of accidents as signals helps explain our society's strong response to mishaps involving nuclear power. Because nuclear power risks are seen as poorly understood and catastrophic, accidents anywhere in the world may be seen as omens of disaster everywhere there are nuclear reactors, thus producing responses (e.g., increased regulation; public opposition) that carry large socioeconomic impacts.

Stigmatization

Substantial socioeconomic impacts may also result from the stigma associated with a nuclear waste repository. The word stigma was used by the ancient Greeks to refer to bodily marks or brands that were designed to signal infamy or disgrace--to show, for example, that the bearer was a slave or a criminal. As used today, the word denotes someone "marked" as deviant, flawed, limited, spoiled, or generally undesirable in the view of some observer. When the stigmatizing characteristic is observed, the person is denigrated or avoided. Prime targets for stigmatization are members of minority groups, the aged, homosexuals, drug addicts, alcoholics, and persons afflicted with physical deformities or mental disabilities.

Although the sociological and psychological treatment of stigma typically pertains to interpersonal contexts far removed from that of radioactive waste disposal, the concept of stigma can clearly be

generalized from persons to environments (Edelstein, 1988). Times Beach, Missouri, and Love Canal, New York, come quickly to mind as examples of stigmatized environments.

A dramatic example of stigmatization involving radiation occurred in September, 1987, in Goiania, Brazil, where two men searching for scrap metal dismantled a cancer therapy device in an abandoned clinic. In doing so, they sawed open a capsule containing 28 grams of cesium chloride. Children and workers nearby were attracted to the glowing material and began playing with it. Before the danger was realized, several hundred people became contaminated and four persons eventually died from acute radiation poisoning. Publicity about the incident led to stigmatization of the region and its residents (Petterson, 1988). Hotels in other parts of the country refused to allow Goiania residents to register; airline pilots refused to fly with Goiania residents on board; automobiles driven by Goianians were stoned; hotel occupancy in the region dropped 60% for six weeks following the incident and virtually all conventions were canceled during this period. The sale prices of clothing and other products manufactured in Goiania dropped by 40% after the first news reports and remained depressed for a period of 30-45 days, despite the fact that none of these items was ever shown to have been contaminated.

RATIONALE AND METHOD

Building on the theoretical concepts and research described above, we designed a series of studies to determine the potential impacts of

the Yucca Mountain Repository on tourism, migration, and business location decisions.

Our first efforts followed the traditional approach of asking people in a national survey to indicate whether a nuclear waste repository located 100 miles from a site would reduce the desirability of that site as a place to attend a convention, vacation, raise a family, retire, or locate a new business (Kunreuther, Desvousges, & Slovic, 1988). Depending upon which of these activities was targeted in the question, between 41% (attend a convention) and 73% (raise a family) said that a repository would reduce the desirability of the region. It appeared that the more time people thought they would be spending in an area, the more likely they were to assert that the repository would make it a less desirable place in which to be.

In response to direct questions, interviewees consistently anticipated that a repository would decrease the attractiveness of a site. However, in light of the aforementioned problems with projecting impacts far into the future on the basis of answers to hypothetical questions, one cannot rely solely on such data. Therefore, the present studies employed an indirect strategy, based on the notion of environmental imagery. The importance of imagery is acknowledged in the Department of Energy (DOE) assessment of the potential impact of Yucca Mountain on Las Vegas tourism:

> "Locating a repository at Yucca Mountain could damage the image or aesthetic appeal of the Las Vegas area. This could result from physical features of a repository (about 100 miles northwest of Las Vegas) or its associated transportation network (whose actual routes are presently unknown). Damage to the Las Vegas image could also be the

> result of events related to the repository, such as a highly visible debate in the national news media" (SAIC,1985).

We concur with DOE in this view. Studies of environmental imagery appear to have the potential to provide a sound and defensible theoretical framework from which to understand and project possible impacts of a nuclear-waste repository on tourism and other important behaviors. The present studies were designed to:

1) demonstrate the concept of environmental imagery and show how it can be measured;

2) assess the relationship between imagery and choice behavior; and

3) describe economic impacts that might occur as a result of altered images and choices.

The concept of imagery is not new to the study of environment and behavior. Geographers, cognitive and environmental psychologists, marketing strategists, and consumer theorists have written at length about the importance of images in our environmental consciousness and our behavior (see, e.g., Boulding, 1956; Kearsley, 1985; MacInnis & Price, 1987; Paivio, 1979; Saarinen & Sell, 1980; Weart, 1988). However, to our knowledge, no one has used a design such as ours to link imagery to the behaviors of concern here.

Our research is designed to test the following three propositions:

1) Images associated with environments have diverse positive and negative affective meanings which influence preferences (e.g., in this case, preferences for sites in which to vacation, retire, find a job, or start a new business).

2) A nuclear-waste repository evokes a wide variety of strongly negative images, consistent with extreme perceptions of risk and stigmatization.

3) The repository at Yucca Mountain and the negative images it evokes will, over time, become increasingly salient in the images of Nevada and of Las Vegas.

If Propositions 1-3 are true, it seems likely that, as the imagery of Las Vegas and of Nevada becomes increasingly associated with the repository and things nuclear, the attractiveness of these places to tourists, job seekers, retirees, and business developers will decrease and their choices of Las Vegas and Nevada within sets of competing sites will decrease.

Support for these three propositions, therefore, would demonsrate the mechanism whereby the repository could adversely affect tourism and migration to Nevada and this demonstration would occur without having to ask people to make introspective judgments about their future behaviors.

Survey Design

In order to test the propositions described above, we conducted three studies of imagery and preference. Studies 1 and 2 surveyed representative samples of residents in Phoenix, Arizona. Study 1 elicited images for four cities and asked people to indicate their preferences among these cities as places to vacation, take a new job, or retire. Study 2 did the same for four states. Study 3 surveyed a national sample of business executives, asking for their images of each of four cities and their preferences among these cities as places to

open a new business or expand an existing business. All three surveys were conducted by telephone. Each survey had a sample size of about 400 persons.

The survey questions in Studies 1 and 2 were nearly identical. The cities questionnaire asked respondents to provide images for San Diego, Las Vegas, Denver, and Los Angeles. The states questionnaire elicited imagery for California, Nevada, Colorado, and New Mexico. These cities and states, in addition to Las Vegas and Nevada, were chosen for the study because they are important vacation destinations for residents of Phoenix.

The images were elicited using a version of the "method of continued associations" (Szalay & Deese, 1978), adapted for use in a telephone interview.[2] Image elicitation was always the first task in the survey. In the cities survey, the elicitation interview proceeded as follows:

> "My first question involves word association. For example, when I mention the word baseball, you might think of the World Series, Reggie Jackson, summertime, or even hotdogs. Today, I am interested in the first SIX thoughts or images that come to mind when you hear the name of a PLACE.

---

2. The study of associations has a long history in psychology, going back to Galton (1880), Wundt (1883), and Freud (1924). Szalay and Deese argue that word-association techniques are easy and efficient ways of determining the contents and representational systems of human minds without requiring those contents to be expressed in the full discussive structure of human language. In fact, they argue, we may reveal ourselves in associations in ways we might find difficult to do if we were required to spell out the full propositions behind these associations through answers to questions.

Think about _____ for a minute. When you think about
[CITY]
_____, what is the first thought or image that comes
[CITY]
to mind?

What is the next thought or image you have when I say
_____?
[CITY]

_____. Your next thought or image?
[CITY]

What is another thought or image you have about

_____?"
[CITY]

This continued until six associations were produced or the respondent drew a blank. Then the procedure was repeated for the next city. The order of the cities was rotated across respondents. The procedure was identical for the states and business location surveys.

Following the elicitation of images, respondents were asked to rate each image they gave on a scale ranging from very positive (+2), somewhat positive (+1), neutral (0), somewhat negative (-1), or very negative (-2).

Respondents in Studies 1 and 2 were then asked to rank the cities/states according to their preference for a vacation site (long weekend vacation for cities; week or longer vacation for states). Subsequent questions asked for a preference ranking among these cities or states as retirement sites or places to move to assuming equally attractive job offers in each place, much in the same manner as vacation preferences were elicited. Additional questions assessed the extent of previous visits or living experiences in each of the cities or states,

and the existence of family or close friends in each of those places.

Next, up to six images were elicited to the stimulus "underground nuclear waste storage facility" and the stimulus "nuclear test site."

The survey also asked "in which state has the federal government proposed to build an underground facility for storing radioactive wastes?" and "in which state is the Nuclear Test Site located?"

The survey of corporate decision makers first elicited images for each of four cities--Phoenix, Las Vegas, Denver, and Albuquerque--and then asked the respondents to evaluate these images on the -2 to +2 rating scale, as in the other surveys. These individuals were then asked to rank these cities in order of preference as a location for opening or expanding a business, assuming that market conditions and cost conditions were about equal.

Survey Samples

Adults 18 years of age and older in Phoenix were surveyed with the cities questionnaire during the period April 13 through May 4, 1988. The Kish method of sample selection was used (Kish, 1949). In this method, profiles of all members living in the household are requested and then one qualified member is randomly selected to be interviewed. Five hundred and fifty-one households were contacted by means of random digit dialing. Of those contacted, 402 (73%) resulted in completed interviews, 27 refused the interview twice, 26 refused three times, and 76 refused the interview four or more times.

The states telephone survey was conducted in metropolitan Phoenix between May 16 and June 8, 1988. Sampling procedures were identical to

those employed in the cities survey. Five hundred and sixty-two (562) household were contacted. Of those contacted, 400 (71%) resulted in completed interviews, 17 gave a partial interview, 59 requested a "callback," but were subsequently unreachable, 37 refused and could not be reached again and 49 refused the interview two or more times.

The survey of corporate decision makers took place between June 9 and July 29, 1988. The sample was selected from the 1988 edition of Who's Who in Corporate Real Estate published by NACORE. Five hundred and sixty-nine (569) business people were contacted. Of those contacted, 400 (70%) resulted in completed interviews, 8 gave a partial interview, 30 were unreachable, 37 refused and could not be reached again, and 10 refused the interview two or more times.

RESULTS

Cities Survey

Respondent characteristics. When asked "who in your household makes the final decision on vacations?", 49% of the respondents in the cities survey said that they did. An additional 33% said they made the decisions jointly with their spouse or partner. For retirement or migration decisions, the corresponding figures were 53% and 27%. Thus about 80% of those surveyed can be considered the main decision makers for the behaviors of interest in this study.

When asked whether they had visited the target cities during the past five years and, if they had, whether they had spent a long weekend

there during the past two years, the results for the entire sample were:

	% visited (5 years)	% long weekend past 2 years (assuming a visit in past 5 years)
San Diego	63	76
Los Angeles	65	74
Las Vegas	55	69
Denver	40	50

These self reports support the choice of Phoenix residents as an appropriate target population for Las Vegas and support the selection of San Diego, Los Angeles, and Denver as competing sites for vacations.

Only 3% of the respondents had ever lived in Las Vegas; 10% had lived in San Diego; 10% in Denver; and 13% in Los Angeles. , The number of respondents having family or close friends in each of these places was:

Los Angeles	41%
San Diego	33%
Denver	27%
Las Vegas	16%

Only 19.6% of the sample knew that Nevada had been selected as the leading candidate for an underground facility for storing radioactive wastes and 46.8% knew that the Nuclear Test Site is in Nevada.

Images. Table 1 presents the hierarchy of images produced in response to the stimulus word "Las Vegas." Images associated with gambling, casinos, hotels, bright lights and entertainment were dominant, followed by imagery pertaining to the climate and physical landscape and money. Crime and immorality formed the seventh category of images. Imagery related to nuclear waste and the nuclear test site was very infrequent (only 2 images out of more than 1500). Table 2

Table 1

Images of Las Vegas
CITIES SURVEY

	Category	Image Frequency
1.	Gambling	365
2.	Casino-Hotels	200
3.	Lights	154
4.	Entertainment	154
5.	Climate/Natural Environment	108
6.	Money	101
7.	Crime and Immorality	99
8.	Fun and Good Times	60
9.	Celebrities	45
10.	Crowds - Types of People/People Watching	42
11.	Food and Drink	39
12.	Geographic Locations	35
13.	Unappealing	35
14.	Night	34
15.	For the Rich	28
16.	Hectic	28
17.	Appealing	28
18.	Friendly, Friends, and Relatives	25
19.	Marriage and Divorce	19
20.	Travel To and Within	17
21.	Sports and Outdoor Activities	16
22.	Losing Money	15
23.	Inexpensive	14

Basis: N = 402 respondents

Table 2

Images Associated with an
"Underground Nuclear Waste Storage Facility"

CITIES SURVEY

	Category	Frequency	Images Included in Category
1.	Dangerous	179	dangerous, danger, hazardous, toxic, unsafe, harmful, disaster
2.	Death/Sickness	107	death, dying, sickness, cancer
3.	Negative	99	negative, wrong, bad, unpleasant, terrible, gross, undesirable, awful, dislike, ugly, horrible
4.	Pollution	97	pollution, contamination, leakage, spills, Love Canal
5.	War	62	war, bombs, nuclear war, holocaust
6.	Radiation	59	radiation, nuclear, radioactive glowing
7.	Scary	55	scary, frightening, concern, worried, fear, horror
8.	Somewhere else	49	wouldn't want to live near one not where I live, far away as possible
9.	Unnecessary	44	unnecessary, bad idea, waste of land
10.	Problems	39	problems, trouble
11.	Desert	37	desert, barren, desolate
12.	Non-Nevada Locations	35	Utah, Arizona, Denver
13.	Nevada/Las Vegas	34	Nevada (25), Las Vegas (9)
14.	Storage Location	32	caverns, underground salt mine
15.	Government/ Industry	23	government, politics, big business

Basis: N = 402 respondents

presents the hierarchy of images elicited by the stimulus phrase "underground nuclear waste storage facility." The imagery was overwhelmingly negative. By far, the most frequent associations were dangerousness and death and their synonyms, followed by pollution, negative concepts, and radiation. Although we did not ask people to score these images, it seems likely that most of them would have been judged "very negative," a -2 on our five-point scale. Although some images pertaining to "necessity" came at the 17th position, they were very few in number (17) and included the phrase "necessary evil" given by two respondents. The words "Nevada" and "Las Vegas" were weakly associated with the repository, which was not surprising, given the low level of awareness of where the site is proposed to be located.

Images of the nuclear test site were similarly negative. Major images included radiation, death, danger, cancer, destruction, and Nevada. More people associated Nevada with the test site (82 mentions) than with the repository.

Predicting preferences from images. To predict preferences among cities from images, we developed a scoring rule, the summation model, which simply sums the ratings for all the images a respondent produced for each city. Preferences among cities are hypothesized to be predictable from these sums.

An example, illustrating the application of the summation model to the data of one respondent, is given in Table 3. For this respondent, the rank order of summation scores matched the preference order exactly.

Table 3

Images, Ratings, and Summation Scores For Respondent 132

CITIES SURVEY

Sample Subject	Image number	Image rating	
SAN DIEGO	1	2	very nice
SAN DIEGO	2	2	good beaches
SAN DIEGO	3	2	zoo
SAN DIEGO	4	1	busy freeway
SAN DIEGO	5	1	easy to find way
SAN DIEGO	6	2	pretty town
		Sum = 10	
LAS VEGAS	1	-2	rowdy town
LAS VEGAS	2	-1	busy town
LAS VEGAS	3	-1	casinos
LAS VEGAS	4	-1	bright lights
LAS VEGAS	5	-2	too much gambling
LAS VEGAS	6	0	out of the way
		Sum = -7	
DENVER	1	2	high
DENVER	2	0	crowded
DENVER	3	2	cool
DENVER	4	1	pretty
DENVER	5	-2	busy airport
DENVER	6	-2	busy streets
		Sum = 1	
LOS ANGELES	1	-2	smoggy
LOS ANGELES	2	-2	crowded
LOS ANGELES	3	-2	dirty
LOS ANGELES	4	-1	foggy
LOS ANGELES	5	0	sunny
LOS ANGELES	6	-2	drug place
		Sum = -9	

Note: This person's stated preference order for a vacation site was: San Diego, Denver, Las Vegas and Los Angeles.

Table 4 gives the overall picture of the association between ranks generated by the summation model and the actual ranks generated by the respondents when they stated their preferences. The model does quite well, correctly predicting 55% of the number 1 ranked vacation cities and 56% of the fourth ranked cities, with somewhat less accuracy in predicting intermediate ranks (if the model lacked predictive validity, we would expect a 25% hit rate by chance). The exact rank order of four cities generated by the summation model matched the exact rank order of the respondent 26.4% of the time (perfect matching of ranks would be expected by chance only 4.2% of the time).

A second set of tests was conducted with the summation model. Each of the four cities was paired with every other city--making six pairs in all. For every respondent and every pair, the image score for city B was subtracted from the image score of city A. The resulting 2,346 A-B scores across all respondents were ordered from extreme negative to extreme positive and this distribution was partitioned into five subsets, as equal in size as possible (range = 419 to 511 comparisons in each subset). Finally, within each subset, the percentage of respondents who ranked city A more favorably than city B as a vacation site was calculated. The plot of the mean A-B difference within each subset against the proportion of people preferring city A is shown for all respondents and all pairs combined in Figure 1. Note the strong relationship between the mean image score difference (based on the summation model) in each subset and the proportion of respondents in that subset choosing city A over city B. When the A-B difference was

Table 4

Association between Predictions from the Summation Model and City Vacation Preferences

		Model's Ranking				
		1	2	3	4	
Respondents' Ranking	1	216	99	50	26	
	2	109	154	86	42	
	3	43	87	156	105	
	4	24	49	99	219	
Hit Rate[a]		.55	.40	.40	.56	overall hit rate = .48

Note: All entries are frequencies. If two or more cities received the same summation score, assignment to a rank for the model was made randomly.

[a] Hit rate is the proportion of model predictions that exactly match the respondents' ranking; e.g., 216 of 391 first choice predictions (55%) were correct.

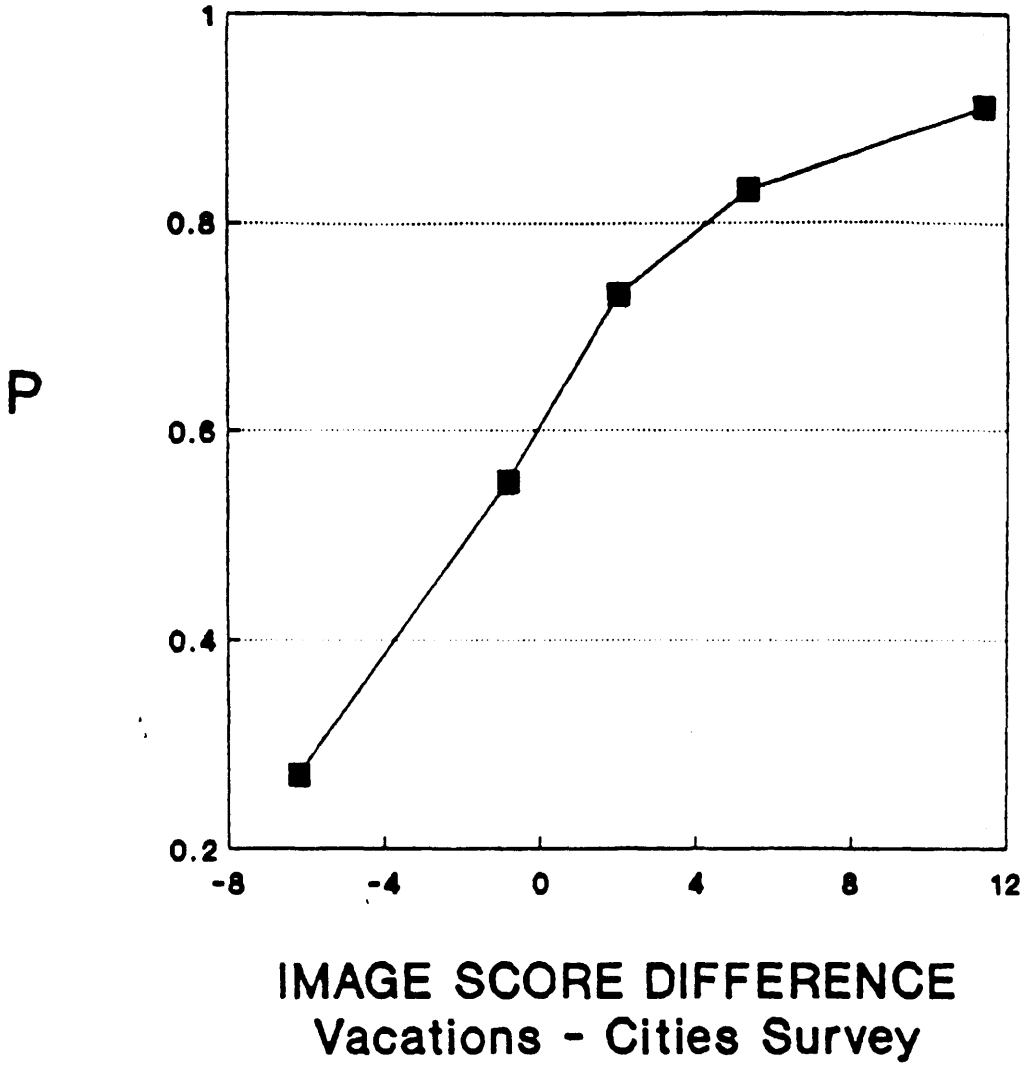


Figure 1
Relationship between mean image score differences (City A-City B) and proportion of times (P) City A was ranked higher than City B in the respondent's preference rankings for vacation sites. All possible pairs of cities are included in this analysis.

most negative (mean = -6.2), A was preferred as a vacation site for only 27.4% of the pairs. For the subset in which the mean difference was most in favor of A (mean = +11.4), 90.7% of the preferences favored A. The best fitting regression line through these five points had a slope of .037, indicating that every 1-point increase in the mean difference score was associated with a 3.7% increase in the percentage of choices favoring city A.

Note, however, that the relationship in Figure 1 is curvilinear, due to a ceiling effect on the scale of choice proportions. The proportion of A choices is already above 80% when the mean A-B difference is only +5.3 and thus has little room to increase when the mean difference rises to 11.4 in the next subset (the choice proportion rises to 90.7%). So the overall slope of .037 is misleading. The effect of image score on choice proportion is greater for small differences than for large differences.

To correct this ceiling effect, a logit transformation was applied to each choice proportion (P). The logit function L is defined as

$$L = \log \frac{P}{1-P}$$

L has a value of 0 when P is .5 and it is symmetric around 0 for values of P equally above or below .5. The transformed data are plotted in Figure 2 and are strikingly linear (r = .98; slope = .082). Figures 1 and 2 illustrate the performance of the summation model across <u>all pairs</u> of cities. The choice proportions for <u>specific pairs</u>

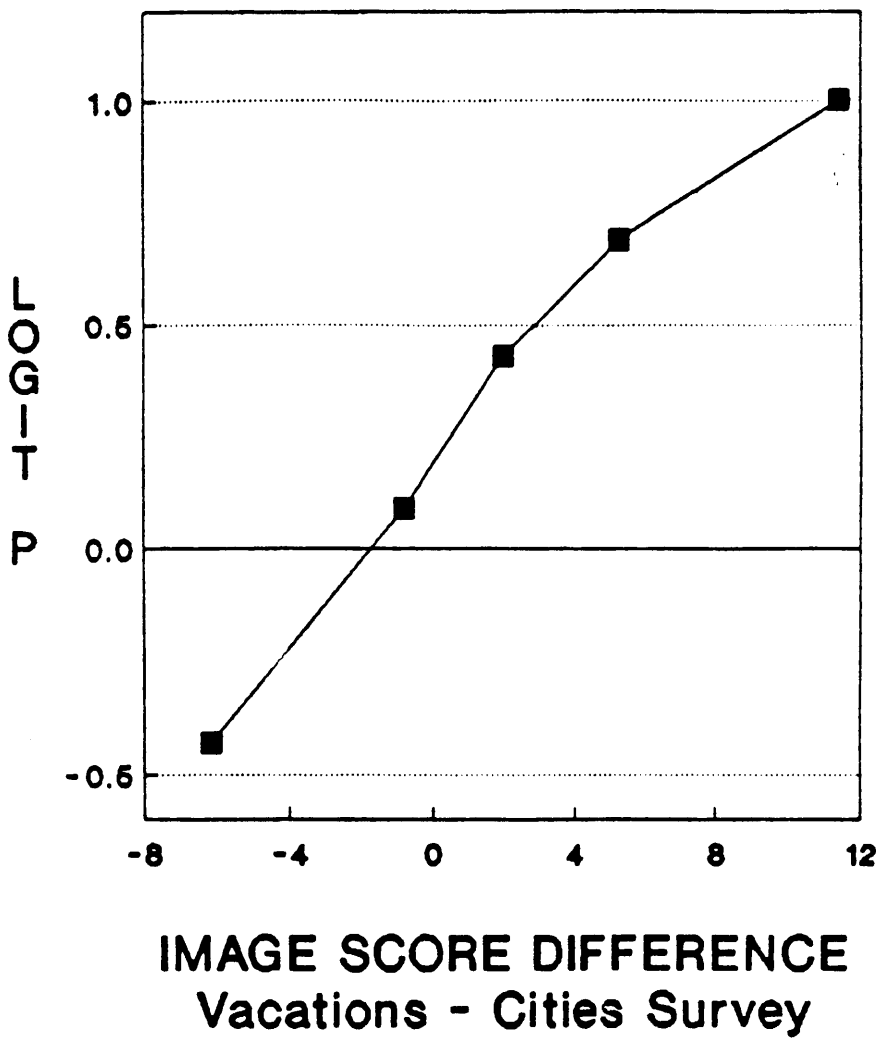


Figure 2
Logit transformation of the vacation choice probabilities shown in Figure 1.

of cities (e.g., Las Vegas vs. Denver), shown in Figure 3, look essentially like the combined plot in Figure 1.

The same pairwise analyses were carried out on a 10 subset partition of the distribution of A-B differences (the number of comparisons within each subset ranged between 174 and 361). This finer partitioning of the data made virtually no difference in the relationships between imagery and preference shown in Figures 1, 2 and 3. Henceforth only results from 5-category partitions will be reported.

The data in Figures 1, 2 and 3 show that imagery and preference for vacation cities are strongly related. If city B has a more positive set of images than city A (as indicated by simply summing the affect ratings across however many images were produced for each city), then city B is more likely to be preferred as a vacation site. If city A has more positive imagery, then city A is more likely to be preferred as a vacation site.

The quantitative implications of the relationships shown in Figures 1, 2 and 3 are noteworthy. For example, assume that city A and city B are equally preferred as a site for a weekend vacation (P = .5 for A, P = .5 for B, and the logit of P = 0).

Assume further that City A has one neutral image in its image set (affect rating = 0) that is replaced by a repository-induced image (for example, "pollution") which has a value of -2. The predicted new logit value for city A would be

$$0 - (.082 \times 2) = - .164$$

based on the drop of 2 points in value of the image set for city A and

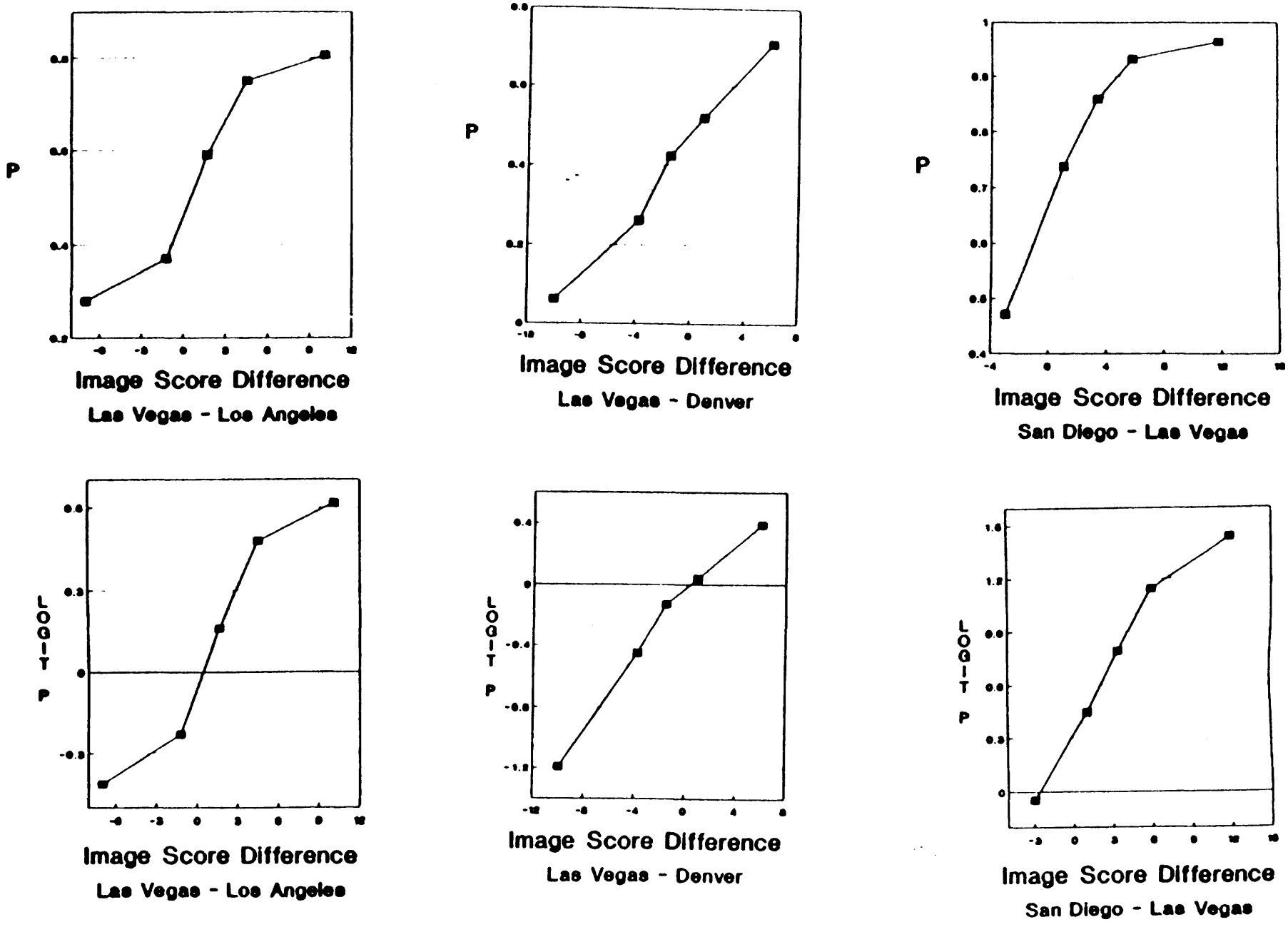


Figure 3
Relationship between mean image score differences and vacation preferences for specific city pairs.

the overall slope of the logit vs. preference relationship shown in Figure 2. The logit value of −.164 corresponds to a choice probability of about .41 for city A. In other words, the present data imply that a 2-point reduction in image score would reduce a .5 choice probability to .41. A 4-point reduction in image score would be predicted to reduce the choice probability for city A from .50 to .32.

Predicting Job and Retirement Preferences

The top three rows of Table 5 present the hit rates for the summation model applied to the prediction of vacation preferences (described in Table 4), job preferences, and retirement preferences for the cities survey. The hit rates were slightly lower for job preferences. Hit rates for retirement preferences were similar to those for job preferences.

The first three rows of Table 6 present the equations relating difference scores to choice probabilities. The equations shown in Figures 1 and 2 for vacation preferences are given in the first row. The equations for job and retirement preferences were extremely similar to the equations for vacation preferences. These linear equations all fit the data well and had quite similar slopes.

Results: States Survey

Tables 5 and 6 also provide hit rates and equations for predicting vacation, job, and retirement preferences among states, using data from the second survey of Phoenix residents. Table 5 shows that the hit rates for state preferences were similar to those for city preferences.

Table 5

Hit Rates for Predicting Preference Rankings from Image Scores

	Proportion of correct predictions				
CITIES SURVEY (N = 402)					
Criterion	First Choice	Second Choice	Third Choice	Fourth Choice	Overall
Vacation preference	.55	.40	.40	.56	.48
Job preference	.47	.33	.37	.50	.42
Retirement preference	.60	.52	.44	.58	.54
Vacation preference[a]	.66	.40	.32	.54	.48
STATES SURVEY (N = 400)					
Criterion					
Vacation preference	.54	.42	.42	.61	.50
Job preference	.47	.34	.37	.54	.43
Retirement preference	.33	.28	.37	.65	.41
BUSINESS DECISIONS SURVEY (N = 400)					
Criterion					
Business location	.47	.32	.34	.48	.40

[a] Study 4, conducted in Oregon; Images evaluated by independent raters.

Table 6

Equations Relating Preference for City/State A over City/State B As a Function of the Difference in Image Scores (A-B)

	Probability equation		Logit Equation	
CITIES SURVEY (N = 402)				
Criterion				
Vacation preference	P = .57 + .037Δ	r = .953	L = .17 + .082Δ	r = .984
Job preference	P = .55 + .033Δ	r = .976	L = .10 + .069Δ	r = .989
Retirement preference	P = .55 + .036Δ	r = .923	L = .10 + .086Δ	r = .970
Vacation preference[a]	P = .54 + .026Δ	r = .976	L = .10 + .060Δ	r = .993
STATES SURVEY (N = 400)				
Criterion				
Vacation preference	P = .62 + .038Δ	r = .951	L = .32 + .099Δ	r = .993
Job preference	P = .54 + .037Δ	r = .980	L = .09 + .080Δ	r = .994
Retirement preference	P = .55 + .037Δ	r = .997	L = .13 + .084Δ	r = .997
BUSINESS DECISIONS SURVEY (N = 400)				
Criterion				
Business location	P = .60 + .041Δ	r = .976	L = .19 + .081Δ	r = .982

[a] Study 4, conducted in Oregon; Images evaluated by independent raters

Notes:

a) Each equation is based on 5 points, determined by partitioning the distribution of difference scores into five subsets of approximately equal size.

b) Vacation preference equations are based on more than 2200 difference scores calculated from all possible pairs of four cities or four states. Job equations are based on about 1800 scores and retirement equations are based on about 300 scores.

c) P represents choice probability; L represents logit transform of P; Δ represents difference score.

Again, the hit rates for job-location preferences were slightly lower than for vacation preferences.

Table 6 shows that the equations for predicting state preferences had almost identical slopes and predictability as the equations in the cities data.

Imagery associated with "a nuclear waste storage facility" and the "nuclear test site" was extremely negative for respondents in the states survey and was almost identical to the imagery obtained in the cities survey. Whereas few people expressed nuclear-related imagery in response to the stimulus words "Las Vegas," about 10% of respondents in the states survey produced nuclear imagery in response to the stimulus "Nevada" (see Table 7). Such images included the terms nuclear testing, nuclear bomb, nukes, explosions, and radiation.[3] The mean image score for Nevada for these persons was 0.18. The mean image score for persons who did not associate Nevada with things nuclear was 2.56 (a statistically significant different; $p < .001$). As expected, persons with nuclear imagery assigned lower (poorer) preference rankings to Nevada than did persons without such images (see Table 8). These findings are important because they suggest that Nevada has already undergone some stigmatization as a nuclear place.

---

3. A small amount of nuclear imagery was also produced in response to the stimulus "New Mexico". Of 15 nuclear images, 14 were related to the White Sands missile range; none were related to the nuclear waste isolation plant being built near Carlsbad.

Table 7

Images of Nevada

STATES SURVEY

	Category	Frequency
1.	Gambling	359
2.	Cities in Nevada	354
3.	Geographic Features / Climate / Plants and Animals	309
4.	Casino-Hotels	117
5.	Entertainment	109
6.	Other Specific Geographic Locations	108
7.	Lights	53
8.	Money	44
9.	Sports and Outdoor Recreation	41
10.	Nuclear[a]	39
11.	Crime and Immorality	35
12.	Unappealing	28
13.	Crowds / People Types	24
14.	Beautiful / Appealing	24
15.	Fun and Good Times	17

[a] Includes nuclear testing, nuclear bomb, bombs, nukes, explosions, nuclear plants, radiation.

Basis: N = 400 respondents

Table 8

Preference for Nevada as a Vacation Site Among
Respondents Who Do and Do Not Exhibit Nuclear Imagery

		Nevada Preference Rank					
		1	2	3	4	N	Mean Rank
Nuclear imagery present	percent	3	3	46	49	39	3.41
Nuclear imagery absent	percent	6	16	51	27	354	2.98

Note: Cell entries are percentages within each row.

Results: Corporate Decision Makers Survey

Similar prediction analyses were conducted with the images and preferences of the corporate decision makers. Table 5 shows that the hit rates for predicting business siting decisions from image scores were similar to those for predicting job-preference locations in the cities and states surveys--a bit lower than hit rates for vacation preferences but nonetheless quite respectable.

Figures 4 and 5 and Table 6 indicate that the business-location preferences were represented very well by linear equations applied to image difference scores. The slopes of these equations were quite similar to the slopes obtained from equations predicting vacation, job, and retirement preferences among cities and states. Table 9 presents the hierarchy of images produced by the corporate sample in response to the stimulus word "Las Vegas." As found in the previous imagery studies, the gambling image was dominant. However, images about the physical and business climates were more frequent among the corporate decision makers; positive aspects of the business climate and opportunities in Las Vegas were more dominant images than entertainment and casinos. Nuclear images were infrequent, appearing only twice.

In summary, three separate surveys totaling more than 1200 respondents indicate that a simple summation model applied to sets of images does a good job of predicting expressed preferences for cities and states in which to vacation, take a new job, retire, or site a business. Predictability is good for all of the various types of preferences. Predictive models are highly linear in logit form (r = .96

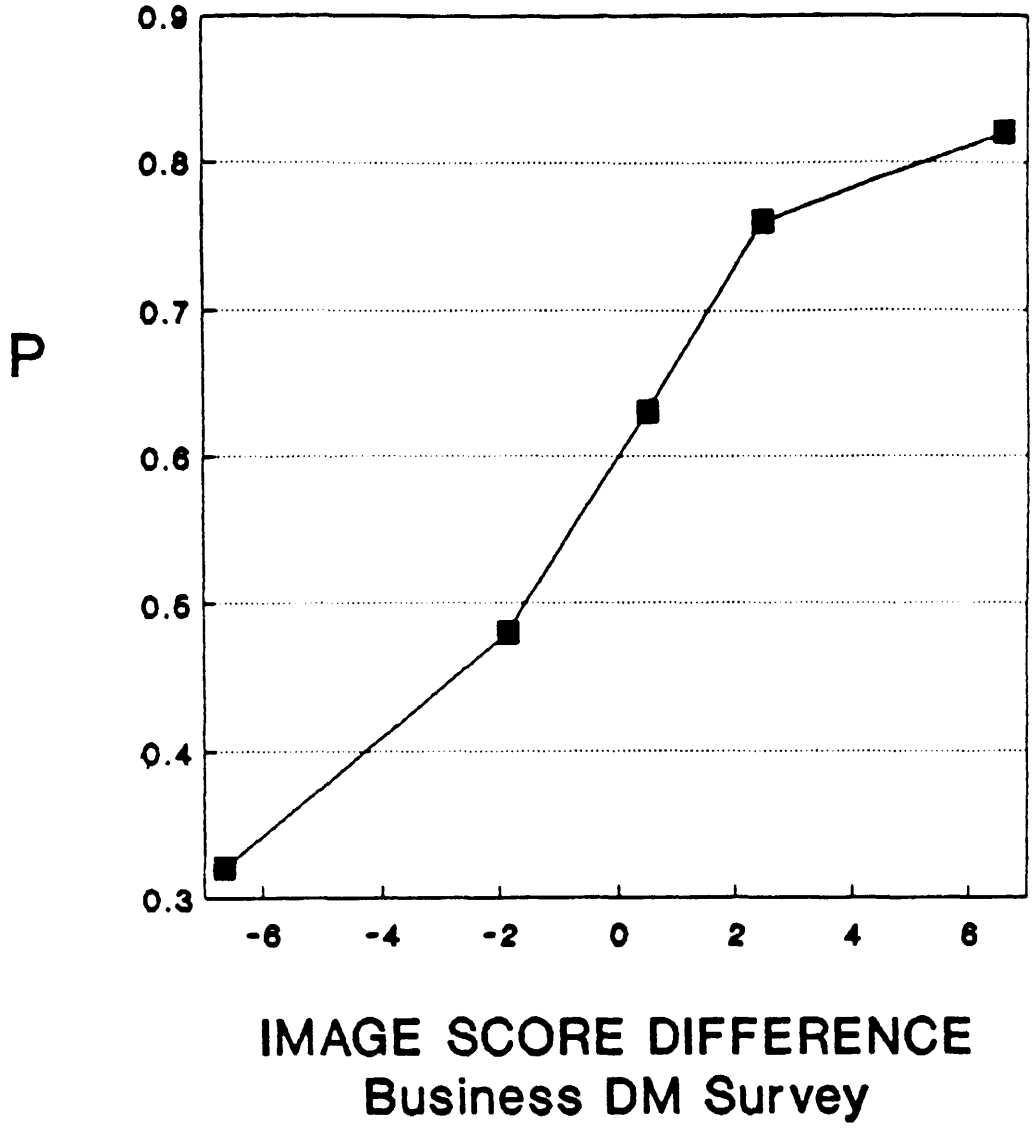


Figure 4
Relationships between images and business location preferences.

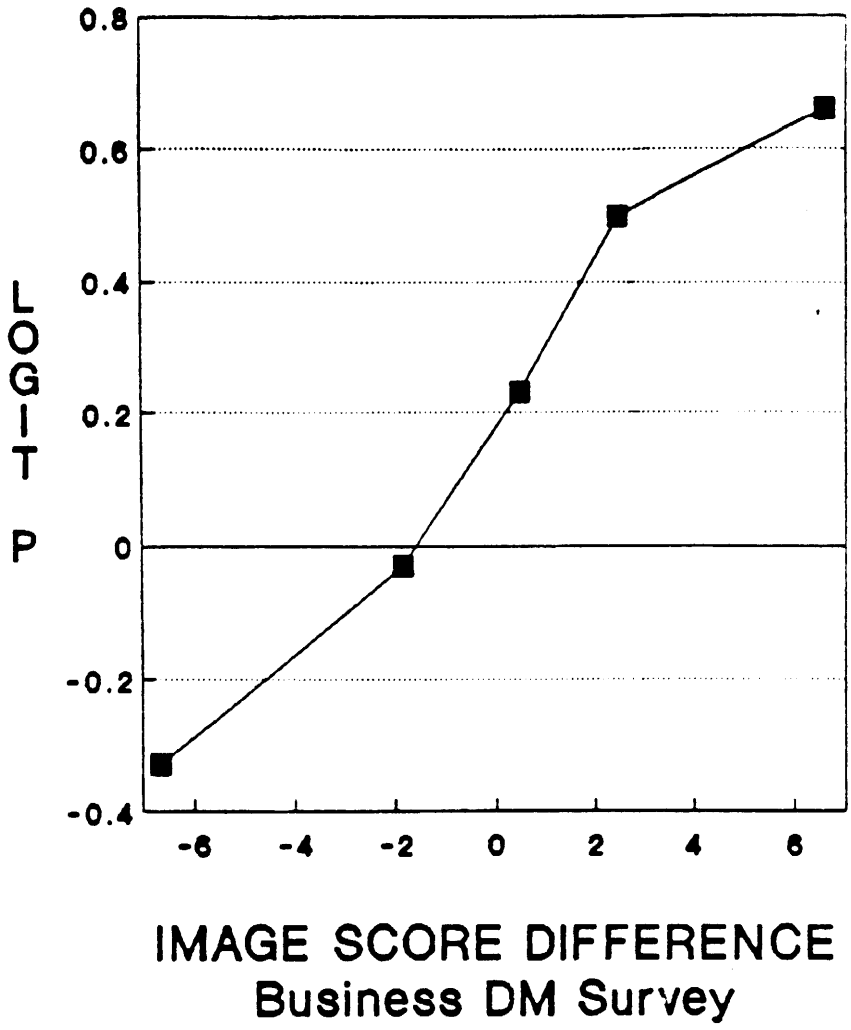


Figure 5
Logit transformation of the business location preferences shown in Figure 4.

Table 9

Images of Las Vegas
CORPORATE DECISION MAKERS

	Category	Image Frequency
1.	Gambling	263
2.	Climate/Natural Environment	186
3.	Negative General Attributes/Attitudes/Images	154
4.	Good Business Opportunity	113
5.	Good Business Climate	75
6.	Entertainment	70
7.	Resort Hotels, Casinos	63
8.	Lights	63
9.	Positive General Attributes/Attitudes	56
10.	Fun and Good Times	55
11.	General Attributes Not Clearly Positive or Negative	54
12.	Nighttime	30
13.	Sports and Recreation	29
14.	Crime and Immorality	27
15.	Limited Business Opportunity	27
16.	Money and Wealth	23
17.	Tourist/Transient	21
18.	Poor Business Climate	20
19.	Geographic Features	19
20.	Types of People	16
21.	Busy/Active/Fast	14
22.	Types of Business	14
23.	Lack in Interest/Ignorance	13

Basis: N = 400 respondents

to .99). The slopes of the best-fitting lines relating preferences among pairs of cities/states to differences in image values are quite steep, indicating that a change in one or two images could imply a substantial shift in preference probability.

Additional Analyses

Alternative scoring models. Additional studies were done to test and evaluate the link between imagery and preference. First, alternative ways of scoring a person's image set were examined. Two additional scoring models were applied to the data. One model weighted image ratings inversely proportional to the order in which the images were produced (i.e., the first image received the highest weight). The second model predicted preferences on the basis of the mean image rating rather than the sum (these differed when the respondent did not produce the same number of images for each city). Neither of these rules produced results that differed significantly from those obtained with the summation rule.

Independent raters. The predictive accuracy of the equations in Table 6 is remarkably high. One possible criticism of the data collection method is that the high degree of predictability is an artifact of allowing respondents to rate their own images. According to this hypothesis, subjects' ratings might influence their preferences, thus inflating the relationship.

To test this hypothesis, we conducted a fourth study, using samples of young adults from Eugene, Oregon as subjects. One group of subjects (N = 150) produced images for four cities and ranked the same cities

according to their attractiveness as vacation sites, much as was done in the survey of Phoenix residents. Some respondents produced images first and then indicated their vacation preferences. Others gave their preferences first. Unlike the Phoenix surveys, however, subjects in the Oregon survey did not score their own images. Instead, the more than 2000 different images produced by the subjects were compiled into a booklet and each image was rated by a different group of 28 subjects on a scale ranging from very positive (+5) to very negative (-5). The "artifact" hypothesis predicts that the summation model would have much poorer predictability in this study, because there is no possibility that image ratings can influence the preferences (or vice-versa). Also, to the extent that the independent raters might find some images difficult to rate (e.g. "is gambling a positive or negative image for this person?"), the predictive capability of the summation model would decrease.

The results of this study, shown in the fourth row of Tables 5 and 6, were surprising. The model's hit rates were excellent (Table 5) and the functions relating differences in image scores to preference probability were again remarkably linear (Table 6), with slopes only slightly less steep than those obtained in the Phoenix survey. The high predictive accuracy of the image models in Phoenix surveys does not appear to be an artifact of the procedures used in these studies.

Insensitive gamblers. Another challenge to the summation model was devised in the form of a hypothesis that people who like to gamble will not be influenced much by other attributes of Las Vegas. This

hypothesis was tested using 246 respondents in the cities survey who produced the term "gambling" as one of their images of Las Vegas. These individuals were separated into subgroups according to the value they assigned to the gambling image. Next, a separate analysis of the relationship between image difference scores and preference probability for Las Vegas, analogous to the analyses in Figures 1, 2, and 3, was performed within each subgroup. Difference scores were computed by pairing Las Vegas with each of the other cities and subtracting the score for the other city from the score for Las Vegas.

The hypothesis predicts that those who see "gambling" as extremely positive (i.e., who rated it as a +2) would have vacation preferences for Las Vegas that are less sensitive to image differences compared to the preferences of people who are less favorable toward gambling (i.e., who rate "gambling" as intermediate or negative in value). The data do not support the hypothesis. As shown in Figure 6, the curves relating image score differences to preference probabilities for Las Vegas were not significantly different for groups of people who differed in their evaluation of gambling. In other words, people who viewed gambling as a very positive feature of Las Vegas were just as much influenced by other positive and negative images as were people who had less positive views of gambling.

Imagery and past visits. If image scores reflect the attractiveness of a place, they should correlate highly with the frequency of previous visits to that place. To test this hypothesis, we examined the relationship between image scores for Las Vegas and the

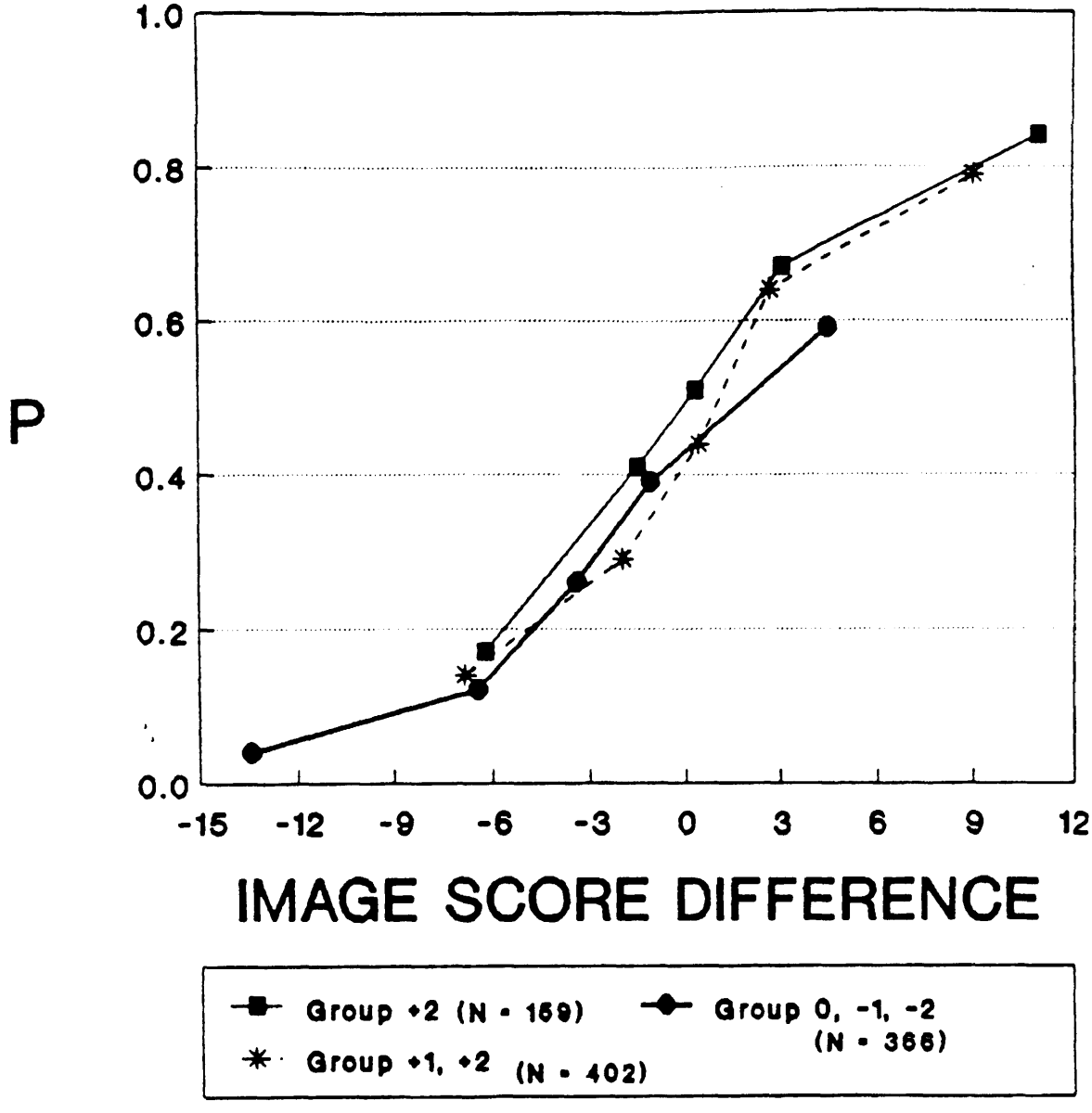


Figure 6
Relationship between image score differences and preferences for vacationing in Las Vegas for persons associating gambling with Las Vegas and evaluating gambling as very positive (+2), positive (+1 or +2), or neutral/negative (0, -1, or -2).

proportion of respondents who had visited Las Vegas within the past two years. A similar analysis was done for images of Nevada and previous visits to Nevada. Persons who had relatives in Las Vegas or in Nevada were excluded from these analyses.

The distributions of image scores for Las Vegas and for Nevada were each partitioned into three subgroups of approximately equal frequencies and the proportion of persons in each subgroup who had visited Las Vegas (or Nevada) was calculated. The relationships between probability of a previous visit and image scores were highly linear (see Figure 7). The equations for the best fit line were:

Las Vegas Visits: $P(visit) = .34 + .011$ (Image Score) $r = 1.00$

Nevada Visits: $P(visit) = .14 + .025$ (Image Score) $r = .997$

[Note: The coefficient is applied to the image score for Las Vegas or for Nevada rather than to the score differences as before.]

These equations demonstrate that image scores were related to past visits. The slope of the linear relationship between these variables was greater for visits to the state than for visits to Las Vegas. A one-point change in image score was associated with a 1% change in Las Vegas visitations and a 2.5% change in visits to Nevada.

Effects of repository knowledge and test site knowledge. Additional analyses were conducted using the states survey data to determine the impact of knowledge about the state in which the nuclear waste repository is to be located and knowledge about the state in which the nuclear test site is located upon images and preferences for Nevada as a vacation site. Table 10 shows that these two types of knowledge

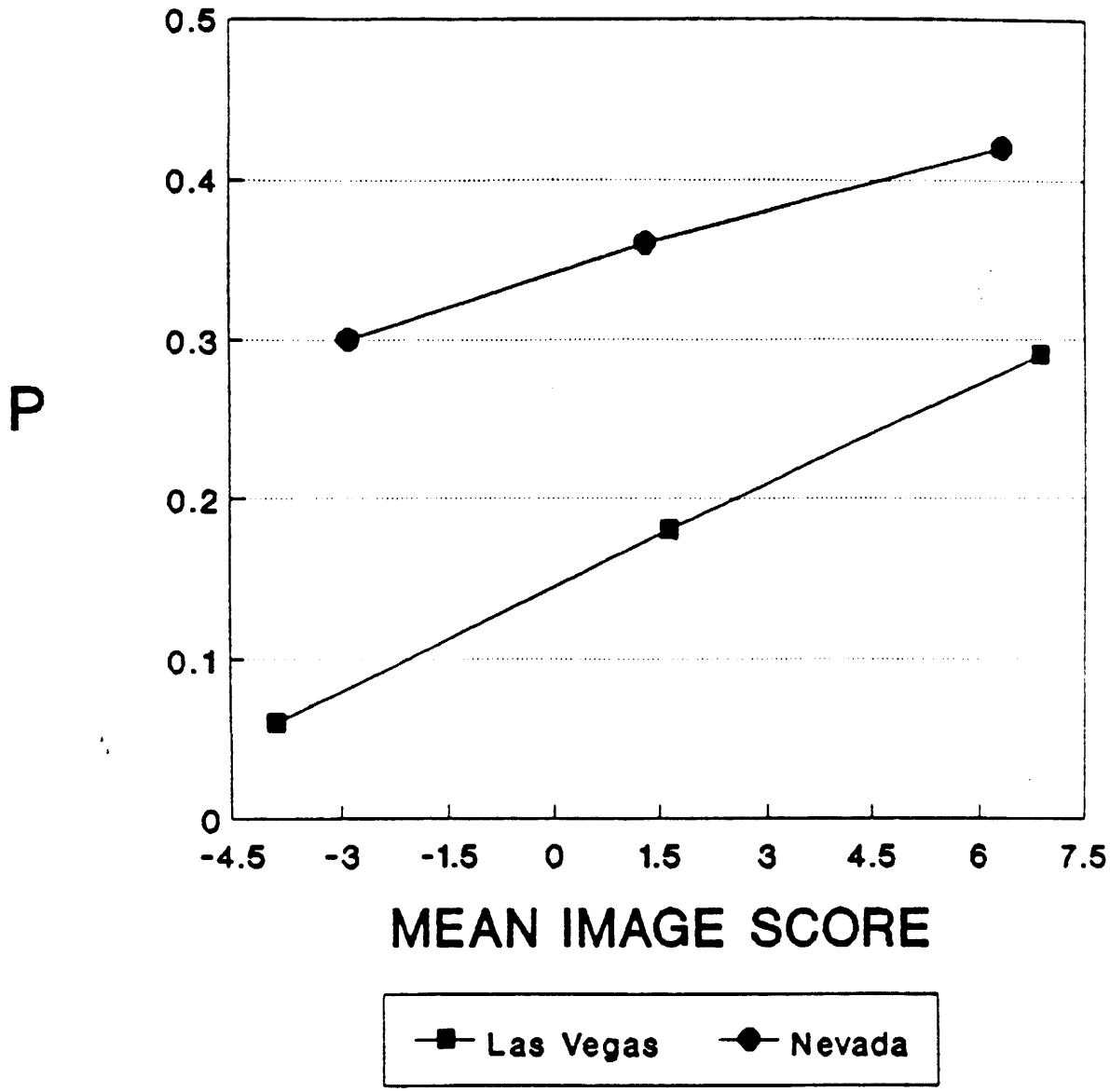


Figure 7
Relationship between mean image for Las Vegas and for Nevada and proportion of persons having vacationed in these places during the previous two years.

Table 10

Relationship Between Knowledge of the Repository Location and Knowledge of the Test Site Location

		Know test site location: No	Know test site location: Yes	
Know repository location	No	133 (.45)	164 (.55)	297
	Yes	28 (.29)	68 (.71)	96
		161	232	

Note: Cell entries are frequencies; parenthesized values are proportions within each row.

were slightly related. Persons who knew that the repository was planned for Nevada were somewhat more likely to know that the test site is in Nevada (71%) as compared to those who lacked knowledge of the repository (55%). Similar results were obtained in the cities survey, where the corresponding values were 70% and 41%.

Table 11 shows that the presence of a nuclear image in one's image set for Nevada was determined more by knowledge of the test site location than by knowledge of the repository location. As shown earlier in Table 8, person's exhibiting nuclear imagery were less likely to prefer Nevada as a vacation site.

Table 12 contrasts the knowledge of persons who exhibited nuclear images for Nevada and those who did not. Almost everyone (92%) who produced a nuclear image knew where the test site was. Of those who did not produce a nuclear image, only 55% knew the test site location. Presence of nuclear imagery was much less correlated with knowledge of the repository site.

Summarizing the results from Tables 10-12, we see that the proposed Yucca Mountain repository has not yet infiltrated people's images of Nevada and has not yet had much effect on their vacation preferences. The test site, which has been a feature of Nevada for many years, has had a stronger influence on images and preferences. Knowledge that the weapons test site is in Nevada appears to have led to an increase in nuclear-related imagery for Nevada and nuclear imagery is associated with decreased preference for Nevada as a vacation site.

Table 11

Proportion of Respondents Exhibiting One or More Nuclear Images in Their Image Set for Nevada

		Know test site location: No	Know test site location: Yes	
Know repository location	No	.02	.15	.09
	Yes	.04	.16	.12
		.02	.15	

Note: Cell entries are proportions of the cell frequencies shown in Table 10.

Table 12

Proportion of Respondents Knowing Locations of Nuclear Facilities

STATES SURVEY

	Proportion knowing location of Test Site	Repository Site
Respondents exhibiting nuclear imagery (N = 39)	.92	.31
Respondents not exhibiting nuclear imagery (N = 354)	.55	.24

DISCUSSION

The present study developed and applied a methodology based upon imagery in order to overcome concerns about the validity of direct questions regarding the potential influence of a nuclear-waste repository at Yucca Mountain upon economically important behaviors. The results supported the three propositions that the imagery research aimed to test: Images associated with cities and states had diverse positive and negative affective meanings which were highly predictive of expressed preferences for future vacations, job and retirement locations, and business sites (Proposition 1). The data indicated that a change in only one or two images could produce a substantial change in an individual's preference probability. Imagery was also closely related to previous visitations to a place. The concept of a nuclear-waste storage facility evoked consistent, extreme, negative imagery (Proposition 2). The nuclear test site, which has been around far longer than the Yucca Mountain project, has led to a modest amount of nuclear imagery associated with the state of Nevada. This provides indirect evidence for Proposition 3, which asserts that nuclear-waste related images will also become associated with Nevada and Las Vegas. Nuclear imagery, when present, was associated with much lower preference for Nevada. The verification of these three propositions implies that the repository will lead to an increase in nuclear imagery which, in turn, will produce adverse impacts on tourism and other economically important activities in Nevada.

This study is part of a larger research program designed to assess the potential socioeconomic impacts of the Yucca Mountain Repository. Within this broader program, described by Mountain West Research (1989), there have been six major surveys of more than 3,000 respondents. In addition to the surveys described in this paper, other studies have interviewed convention planners and residents within and outside of Nevada (see, e.g., Krannich & Little, forthcoming; Kunreuther, Desvousges, & Slovic, 1988; Kunreuther, Easterling, & Kleindorfer, 1988; Mushkatel, Nigg, & Pijawka, 1989). These additional surveys employed standard questions of the form "What would you do if ...?" In response to these questions, those interviewed consistently indicated that the presence of a nuclear-waste repository would make a region much less attractive as a place in which to vacation, attend a convention, take a job, or retire.

These surveys were further supplemented by a laboratory study of migration decision processes in the face of risk (Greenwood, McClelland, & Schulze, 1988). In a hypothetical but realistic decision task, persons selecting a city in which to take a new job were found to give substantial weight to considerations of hazards such as a nuclear-waste repository.

In our opinion, the cumulative weight of these many studies provides answers to the questions that motivated the inquiry. The mechanisms of perceived risk, social amplification, and stigma are observable in the record of past experience with nuclear and other types of hazards. In the context of the Yucca Mountain Repository, these

mechanisms appear to have the potential to cause substantial losses to each of the various economic sectors at risk. We believe that it would be unwise for development of the repository to proceed without taking these potential economic impacts into consideration.

Some analysts have suggested that the nuclear weapons test site provides evidence against the above conclusions, in view of the strong expansion of the visitor economy in the region during the operation of this facility. We disagree. Judging from the Phoenix survey, the test site has worked its way into the imagery of Nevada for only a small percentage of people and is rarely associated with Las Vegas. Nuclear-waste transport, the operation of the repository, and any controversies over the safety of those activities will be open to much closer scrutiny by the public and the media than the operation of the test site has been, assuming no major accidents at the latter. In particular, tens of thousands of nuclear-waste shipments by truck or rail throughout the United States will be a highly visible reminder of the repository and its risks. As these shipments converge upon Las Vegas, nuclear associations with that city may be built to a far greater extent than has occured with the secret, contained underground explosions at the test site. Finally, there is no evidence that the small degree of association of the site with the region has not actually impaired tourism and business development. Business development, in particular, has not shown much progress despite the potential attractiveness of Las Vegas for many kinds of industries.

It may also be the case that the test site and the repository will interact in a synergistic way to produce nuclear imagery to an extent that is greater than the sum of the individual contributions from each facility. Little is known about the dynamics of the process by which images become salient. It is certainly true, however, that individuals have a number of images associated with any particular place. There may be some threshold of repetition that moves a weak or unstable image from the periphery into the core image of a place. If so, Nevada's link to the nuclear test site may increase its potential for stigmatization from the repository relative to a state with no existing base of nuclear imagery.

Historical analysis of major risk events has documented substantial socioeconomic impacts, but these impacts have often been transitory. Will the same impermanence hold for impacts triggered by a nuclear-waste repository? In considering this question, we suggest that it is useful to distinguish two different kinds of stimuli emanating from the repository. First, there are the multitude of discrete events that are associated with the project. Second, there is the cumulative experience with the project, which reflects the characteristics of the project plus the experience across all project-related events. It is reasonable to suppose that an isolated, solitary event will generate a transitory response. It is also reasonable, however, to expect that the imagery of Nevada and Las Vegas held by the general population will reflect their cumulative experience with the repository program. Each of the discrete events that might result from the program, therefore,

would have the potential to trigger two kinds of consequences--immediate responses to the event itself, the duration of which would be related to the nature of the event, and responses based upon the cumulative image of the repository to which this event makes a contribution on the margin. Just as this imagery will take time to develop, it will also be more durable. In fact, to the extent that strong nuclear imagery became associated with the repository, the host state, or major communities along waste-transportation routes, the stigmatization could remain for a long time.

Although this research has clarified the *mechanisms* by which adverse economic impacts can be generated, predicting the precise magnitude and duration of those impacts is impossible. The uncertainties involved in repository development make it inevitable that the actual impacts--physical, biological, social, and economic--will differ from the best of impact projections. There are at least four categories of uncertainty. First, the Department of Energy (DOE) plans are still largely unspecified on crucial matters; for example, it is impossible to know at this time whether waste shipments will be made by truck or rail, over which routes, and with what frequency or safeguards. Second, the risk-management policies to be followed by state and local governments are largely unknown, and they could have a powerful influence on impacts. Third, there will certainly be external perturbations and surprises that may cause the repository development to differ from anything that can be foreseen at this time. Fourth, economically relevant decisions are always made in the context of

alternatives; quantitative prediction requires currently unavailable knowledge of the alternatives that individuals and society will have available in the future.

In sum, our analysis indicates that the development of the Yucca Mountain Repository will, in effect, force Nevadans to gamble with their future economy. The nature of that gamble cannot be specified precisely, but it appears to include credible possibilities (with unknown probabilities) of substantial losses to the visitor economy, the migrant economy, and the business economy. Policy decisions regarding the repository need to consider these possible impacts.

REFERENCES

Baker, E. J., Moss, D. J., West, S. G., & Weyant, J. K. (1977). Impact of offshore nuclear generating stations on recreational behavior at adjacent coastal sites (NUREG-0394). Washington, DC: U.S. Nuclear Regulatory Commission.

Boulding, K. E. (1956). The Image. Ann Arbor: University of Michigan Press.

Cohen, B. L. (1983). Before it's too late: A scientist's case for nuclear energy. New York: Plenum.

Dupont, R. L. (1981). Business Week, 7 September, pp. 8-9.

Edelstein, M. R. (1988). Contaminated communities: The social and psychological impacts of residential toxic exposure. Boulder, CO: Westview.

Freud, S. (1924). Collected papers. London: Hogarth.

Galton, F. (1880). Psychometric experiments. Brain, 2, 149-162.

Greenwood, M. McClelland, G., & Schulze, W. (1988). The effects of perceptions of hazardous waste on migration. Mountain West Research for the Nevada Nuclear Waste Project Office, Carson City, Nevada.

Kasperson, R. E., Renn, O., Slovic, P., Brown, H. S., Emel, J., Goble, R., Kasperson, J. X., & Ratick, S. (1988). The social amplification of risk: A conceptual framework. Risk Analysis, 8, 177-187.

Kearsley, G. W. (1985). Methodological change and the elicitation of images in human geography. Journal of Mental Imagery, 9, 71-82.

Kish, L. (1949). A procedure for objective respondent selection within the household. American Statistical Association Journal, 44, 380-387.

Krannich, R., & Little, R. (forthcoming). Rural Nevadans' risk perceptions: Survey findings. Mountain West Research for the Nevada Nuclear Waste Project Office, Carson City, Nevada.

Kunreuther, H., Desvousges, W., & Slovic, P. (1988). Nevada's predicament: Public perception of risk from the proposed nuclear waste repository. Environment, 30(8), 17-20; 30-33.

Kunreuther, H., Easterling, D., & Kleindorfer, P. (1988). The convention planning process: potential impact of a repository in Nevada. Mountain West Research for the Nevada Nuclear Waste Project Office, Carson City, Nevada.

MacInnis, D. J., & Price, L. L. (1987). The role of imagery in information processing: Review and extensions. Journal of Consumer Research, 13, 473-491.

Mazur, A. (1981). The dynamics of technical controversy. Washington, DC: Communications Press.

Moore, J. A. (1989, May-June). Speaking of data: The Alar controversy. EPA Journal, 15(3), 5-9.

Mountain West Research (1989). An interim report on the State of Nevada socioeconomic studies. Report prepared for the Nevada Nuclear Waste Project Office, Carson City, Nevada.

Mushkatel, A., Nigg, J., & Pijawka, D. (1989). Public response, risk perception, and intended behavior related to the Yucca Mountain

Nuclear Waste Repository: Analysis of a survey of the Las Vegas metropolitan area. Mountain West Research for the Nevada Nuclear Waste Project Office, Carson City, Nevada.

Nisbett, R., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. Psychological Review, 84, 231-259.

Paivio, A. (1979). Imagery and verbal processes. Hillsdale, NJ: Erlbaum.

Petterson, J. S. (1988). Perception vs. reality of radiological impact: The Goiania model. Nuclear News, 31(14), 84-90.

Saarinen, T. F., & Sell, J. L. (1980). Environmental perception. Progress in Human Geography, 4, 525-548 (1980).

SAIC. (1985). High-level nuclear waste transport and storage: Assessment of potential impacts on tourism in the Las Vegas area (Report No. DOE/NV/10270-1). (Available from NTIS).

Slovic, P. (1987). Perception of risk. Science, 236, 280-285.

Slovic, P., Lichtenstein, S., & Fischhoff, B. (1979). Images of disaster: Perception and acceptance of risks from nuclear power. In G. Goodman & W. Rowe (Eds.), Energy Risk Management (pp. 223-245). London: Academic.

Szalay, L. B., & Deese, J. (1978). Subjective meaning and culture: An assessment through word associations. Hillsdale, NJ: Erlbaum.

Weart, S. A. (1988). Nuclear fear: A history of images. Cambridge, MA: Harvard University Press.

West, S. G., & Baker, E. J. (1983). Public reaction to nuclear power: The case of offshore nuclear power plants. In R. F. Kidd & J. M. Saks (Eds.), Advances in Applied Social Psychology (Vol. 2, pp. 101-129).

Wundt, W. (1983). Uber psychologische methoden. Philosophische Studien, 1, 1-38.