Available online at www.sciencedirect.com
SCIENCE DIRECT®
Landscape and Urban Planning 66 (2004) 233–238
LANDSCAPE AND URBAN PLANNING
This article is also available online at:
www.elsevier.com/locate/landurbplan

Landscape mirror: the attractiveness of reflecting water

Jack L. Nasar*,[1], Minhui Li[2]

City and Regional Planning, 105 Brown Hall, 190 W. 17th Ave., Columbus, OH 43210, USA

Received 7 June 2002; received in revised form 29 January 2003; accepted 21 May 2003

Abstract

This research examined human preference for water and a key aspect of water, its reflection. We compared responses to reflection in water versus reflection in glass and responses to reflection versus transparency. Sixty respondents rated the attractiveness of four scale-models varied on those dimensions. High inter-item reliability across the rating scales called for their combination into a composite measure of attractiveness. The analysis revealed that individuals preferred the water to the glass and the reflective to the transparent surface. They gave the most favorable ratings to the scene with reflective water, suggesting the potential desirability of reflective ponds as a design element.

Keywords: Landscape evaluation; Preference; Water; Reflection

1. Introduction

At the presentation to the competition jury of his design for new The New York Times Headquarters' Building in Manhattan, the architect Piano (2000) talked about the aesthetic value of a shallow black reflective pool at the base of the building. He does not stand alone in the value designers, artists and others have placed on water and its reflection. Seventy-two years earlier Wright (1928) speculated on the aesthetic value of reflective water, describing it as "refreshing and beautifying in architecture, if architecturally used" (p. 13).

Water and reflection have a long precedent in Western art and design. For example, Impressionist and Post-Impressionist artists such as Camille Pissaro, Alfred Sisley, Georges Seurat, Paul Cezanne, and Claude Monet painted images reflected in bodies of water. Monet picked up the leitmotiv of reflection in water early in his career (House, 1986) and continued to paint natural and artificial objects reflected in bodies of water. His water lily paintings, which preoccupied him for the last 25 years of his life, represented a culmination of his interest in such reflected images. He saw the reflections in water as constantly changing source of beauty in the landscape.

In 20th century architecture, reflection in the form of the glass building represents one symbol of modernism (Heyne, 1982) and design theorists have speculated about the role of reflected light (Millet, 1996). According to one observer, "light reflected on surfaces links the visual environment with the human feelings" (Michel, 1996, p. 5). Writers on landscape architecture and outdoor spaces have also noted the aesthetic value of water in design (Campbell, 1978; Higuchi,

* Corresponding author. Tel.: +1-614-292-1457; fax: +1-614-292-7106.
E-mail address: nasar.1@osu.edu (J.L. Nasar).
[1] Professor of City and Regional Planning at The Ohio State University, edits the *Journal of Planning Literature*. He wrote Design by Competition: Making Design Competition Work (Cambridge, 1999) and The Evaluative Image of the City (Sage, 1997).
[2] Completed her Masters Degree in Landscape Architecture at The Ohio State University.

0169-2046/$20.00 © 2003 Elsevier B.V. All rights reserved.
doi:10.1016/S0169-2046(03)00113-0

1991; Simonds, 1983; Sorvig, 1991). In fact, one of the early texts on landscape architecture discussed the value of water for landscape compositions (Hubbard and Hubbard, 1917). Pitt (1989) describes a range of psychological theories on the human preference for water, and Bachelard (1983) theorizes that its aesthetic value rests in its naturalness, a point of view that fits the psychological theory that humans prefer naturalness (Kaplan and Kaplan, 1989; Nasar, 2000).

Reflection in water may have special value. Hubbard and Hubbard (1917) claimed that reflection on calm water enriches, creates harmony, adds appeal and, in small bodies of water, might attract and hold the viewer's attention. These ideas have design implications, because one can alter water reflectivity through the color used on the surfaces containing the water. More recent landscape theorists agree on the aesthetic value of reflective water (Booth, 1990; Litton and Tetlow, 1974; Miller, 1998); they note the continuously changing image it can offer and the variety of attractive elements—sky, buildings, trees, and sculptures—observers can see in the reflection. From psychology, Kaplan (1977, p. 287) noted that "water itself provides a continuing, unifying theme to the landscape and one that calls attention to itself. It has texture that easily sparkles, or reflects images, or ripples with the wind".

Research shows that people differentiate landscapes with and without water and favor landscapes with water (Carr et al., 1992; Pitt, 1989; Ulrich, 1983; Wherrett, 2000). Thus, in a controlled comparison, individuals should respond more favorably to water than to an artificial material such as glass. Although most designers do not propose artificial glass ponds, some avant-garde designers have used artificial materials such as broken glass in their "installations". For public policy, planners and designers could use some empirical basis for evaluating the desirability of such installations or to decide on the kinds of ponds to have in public spaces.

The present study had people evaluate four scale models that varied in whether they had a pond of water or an artificial material and whether its surface was reflective or transparent. The water (or natural) condition had shallow pool with still water; and as a proxy for an artificial condition, we used the same shaped pool drained of water and covered with a glass surface. Each condition had either a reflective or transparent surface. Like a mirror, the reflective surface reflected light and objects in the model; the transparent surface allowed light through; so the observer can see through it to objects on the other side (Rowe and Slutzky, 1997). All models had the same screening features, sometimes used by designers to reduce wind (Hubbard and Hubbard, 1917). We expected that respondents would rate the models with water and reflection as more attractive than the alternatives and they would rate the model with reflective water as the most attractive.

2. Method

2.1. Environmental stimuli

As surrogates for real ponds in real landscapes, we used a 1/4 in. to 1 ft scale model, designed to allow the display of two pairs of two different conditions: water versus glass and reflection versus transparency. The base of the model had space for a 9 in. × 13 in. pan representing a 36 ft × 52 ft pond, a size more suitable for a pond in a public place than in a typical private garden. It had a curved cardboard edge, covering the pan and simulating the edge of a pond. Two pans had still water (stilled before respondents saw it). The reflective water condition used a pan with a black bottom, so the surface reflected light. The transparent water condition used a pan with sand on the bottom. In two pans, we replaced the water with a glass surface. For reflection, the empty pond was covered with a tinted glass mirror; and for transparency, it had a clear piece of glass. Although the water was still during the experiment, it may have had more surface variety and a less perfect reflection than did the flat glass.

The model had an arc wall with a poster image of a natural scene around the pond. A slit in the front wall controlled the view allowing observers to see only the pond and the surroundings inside the model. To give the observer a sense of looking through a natural environment, the scene had several scale-model canopy trees in front. For scale, the scene also had scale benches, people and other elements. Fig. 1 shows views of each of the four conditions.

Pre-tests found that most people judged the model as looking realistic and similar to a real place. Furthermore, research suggests that responses to scale models may serve as accurate predictor of response to

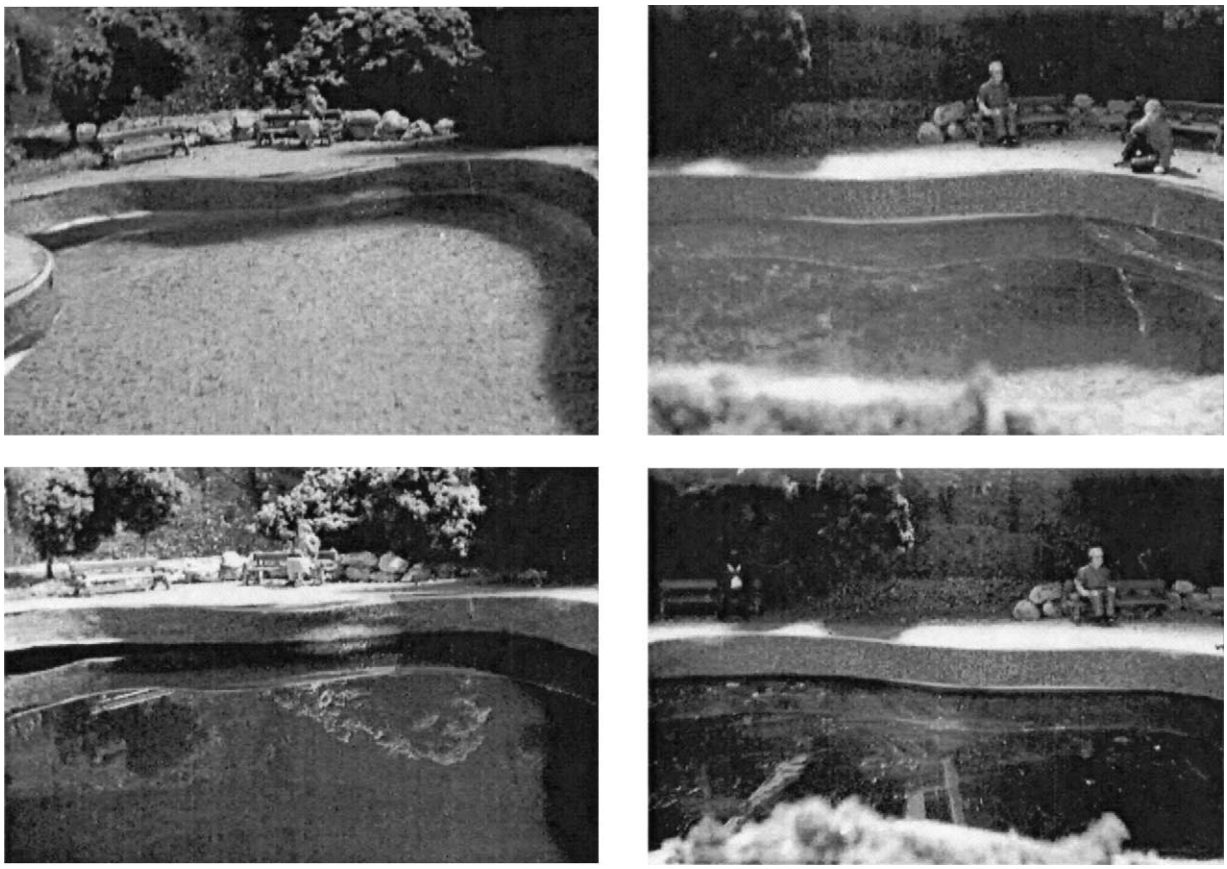

Fig. 1. The four models and their features (clockwise from upper left): transparent water (sand-bottom pool with water); transparent non-water (clear glass on top of sand bottom pool, no water); reflective non-water (mirror on top of pool); reflective water (black-bottom pool filled with water).

full-scale places (DeLong, 1977; Kaplan and Kaplan, 1989). A meta-analysis on simulation also supports the veracity of scale models (Stamps, 1993).

2.2. Respondents

Sixty adults took part in the study. To get a varied sample, we chose four sites in different areas of the city (Columbus, OH) for interviews: a housing development, a downtown hospital, a university park, and a community park. At each site, the interviewer used a systematic procedure to pick 15 respondents. Respondents varied in age (mean, 31.8 years; S.D., 8.7 years), gender (48.3% male), education (high school graduate or less, some college, college degree, some graduate school, or more) with the highest percentage having some graduate school (35%) and in occupation (manager/administrator, professional, technical support, customer service, skilled trade, student and other) with the highest percentages as students (35%) and professionals (23.3%) (Table 1).

2.3. Procedure

Interviews took place on sunny days under similar sun conditions (between 1:30 and 3:30 in the afternoon). Each respondent received a sheet of paper stating the study would look at their emotional responses to different scenes and that to participate they had to be at least 18-year-old. Those who agreed to

Table 1
Demographic characteristics reported by respondents

	($n = 60$)
Gender (%)	
Male	48.33
Female	51.67
Occupation (%)	
Manager/administrator	1.7
Professional	23.3
Technical support	16.6
Customer service	5.0
Skilled trade	1.7
Student	35.0
Others	16.6
Education (%)	
High school graduate or under	5.0
Some college	28.6
Bachelor degree	25.3
Some graduate school or higher	35.0
Others	6.0
Age (years)	Mean, 31.8; S.D., 8.7

participate received instructions stating there were no right or wrong answers, that their answers would be kept anonymous and confidential, and that they could stop or withdraw from the study at anytime.

The interviewer had the model and pans covered on the ground. For the tests, the interviewer installed a pan, lifted the model to a raised base to set the viewing window at eye level. Then, the respondent looked into the model and rated the scene on eight bi-polar scales. Then, the interviewer changed the pan and repeated the procedure for each of the other conditions. Changing the pans required <15 s; and the interviewer kept the model and pans under cover, so respondents could not see the manipulation. To reduce order effect, we randomized the order of the models and response scales across respondents.

From Kasmar's (1969) lexicon of bi-polar adjectives for describing environments, we selected four adjective pairs for pure evaluation: beautiful–ugly, attractive–unattractive, harmonious–discordant, and pleasing–annoying; three adjective pairs for the calming aspects of the environment: calming–upsetting, relaxed–tense, and gentle–stiff (cf. Russell, 1979; Russell and Snodgrass, 1987), and one adjective pair to get at a cognitive aspect of the experience: imaginative–unimaginative. Theory and research suggested that the scales for calming and pure evaluation would relate to one another, because the calming factor mixes one's arousal with pure evaluation (Nasar, 1994; Russell and Snodgrass, 1987). We did not know whether the cognitive measure would also relate to evaluation and calming. Analysis showed that it did.

Cronbach alpha test across the eight items found high inter-item reliability (Cronbach alpha of 0.94). This meant the eight bi-polar adjectives could be combined into a reliable composite scale. The subsequent analyses used a composite of the eight items as a measure of attractiveness. To get that composite attractiveness scale, we reversed some items so all items shared the same direction for positive and negative poles. Then, for each model, we calculated the mean score across the eight items.

3. Results

As expected, the analyses showed that individuals rated the water as more attractive than the artificial material and they rated reflective views as more attractive than transparent ones. Fig. 2 shows that respondents judged the reflective water as the most attractive, the transparent glass as least attractive, and the two water conditions as more attractive than the two artificial conditions. The differences between water and the artificial material and between the reflective and transparent surfaces achieved statistical significance (water: $F[1, 59] = 70.028$, $P < 0.001$; reflection: $F[1, 59] = 39.718$, $P < 0.01$). No significant interactive differences emerged. This means that: (1) water had similar positive effects in the reflective and non-reflective conditions; (2) reflection had similar positive effects in the water and artificial conditions; and (3) the combination of water and reflection did not exaggerate the effect. The F statistics translate into effect sizes of $r^2 = 0.29$ for water and $r^2 = 0.16$ for reflection, which means that water explained about twice as much variance in preference as did reflection; and that water represents a large effect and reflection represents a medium to large effect (Cohen, 1977).

Post hoc Bonferroni pairwise tests compared each pair of scores for water versus artificial material and for reflective versus transparent views. The results confirmed statistically significant differences for each comparison (for reflective views: water versus glass,

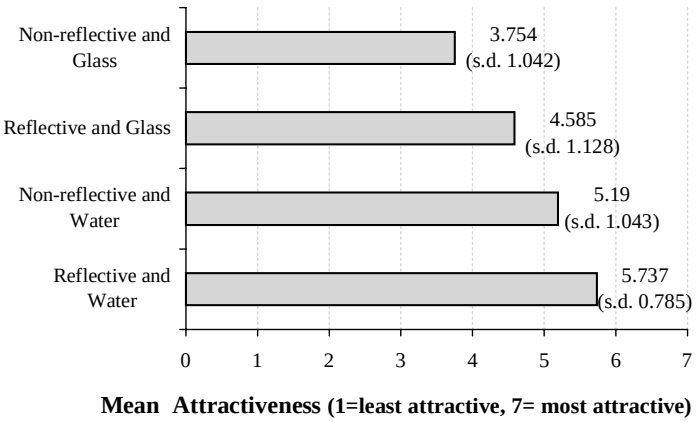

Fig. 2. Respondents preferred water and reflective surfaces to artificial material glass and transparent surfaces.

$t = 5.97$, $P < 0.01$; for transparent views: water versus glass, $t = 7.962$, $P < 0.01$; for water: reflective versus transparent view, $t = 4.055$, $P < 0.01$; for glass: reflective versus transparent view, $t = 5.001$, $P < 0.01$, $n = 59$ for each).

4. Conclusion

The high inter-item reliability across the eight scales came as a surprise. It suggests the presence of one dimension (attractiveness) that merged the evaluative, calming, and cognitive items, a result not expected by theory and research on environmental assessment (cf. Russell and Snodgrass, 1987). Still, this finding based on only four stimulated scenes may well represent a unique case. The findings for composite attractiveness supported the expectation that individuals would prefer water and reflection. For the single scene context, respondents rated the reflecting water as most attractive, followed by the transparent water; and they rated the scene with transparent clear glass as least attractive.

The preference for reflection may relate to the variety it offers through the number of objects visible in the reflective surface, to the promise of new information it provides as the observer moves, and to the vegetation reflected, factors which research has found related to preference (Kaplan and Kaplan, 1989; Nasar, 1994, 2000). The lower scores for the transparent conditions may relate to the plain view of sand under the water. In transparent water, a more varied view possibly with movement—consider a colorful coral reef or colorful fish—would likely receive higher ratings, but such conditions are uncommon in public ponds in urban areas.

The preference for water may relate in part to the atypical use of glass as a horizontal surface, but it may relate to visual features that differentiated the water from the glass, such as a less perfect reflection from water than glass. This study did not set out to study such features and we did not detect them, but future work should examine the visual features differentiating water from glass and test water and glass in vertical and angular conditions. Research has consistently shown that people prefer natural (vegetation) to artificial materials (Kaplan and Kaplan, 1989). Just as Wohlwill (1983) speculated on visual features that differentiate vegetation from built environments, perhaps certain visual features of water lead respondents to recognize it as more natural than the glass. If so, those features may explain the preferences. Research has also found restorative effects associated with the experience of nature in the form of vegetation (Herzog et al., 1997; Kaplan and Kaplan, 1989; Parsons et al., 1998; Ulrich et al., 1991). Perhaps water or reflective water would also have restorative effects.

The repeated measure design may have cued some respondents to the purpose of the study. Future studies could use a between-subjects design to rule out that potential bias. It could also have people rate photographs of a wide variety of settings that vary in reflection and water versus artificial surfaces. Doing so could offer a test of the generality of the findings

by allowing the variation of reflection and artificiality in a variety of ways. If the findings support our findings, they suggest that Renzo Piano's reflective pool for *The New York Times* Headquarters might add aesthetic value; and more generally, communities and designers could encourage reflective pools to make places more attractive.

References

Bachelard, G., 1983. Water and Dreams: An Essay on the Imagination of Matter. Pegasus Foundation, Dallas.

Booth, N.K., 1990. Basic Elements of Landscape Architectural Design. Prospect Heights, Waveland, IL.

Campbell, C.S., 1978. Water in Landscape Architecture. Van Nostrand Reinhold, New York.

Carr, S., Francis, M., Rivlin, L.G., Stone, A.M., 1992. Public Space. Cambridge University Press, New York.

Cohen, J., 1977. Statistical Power Analysis for the Behavioral Sciences. Academic Press, New York.

DeLong, A.J., 1977. The accuracy of spatial perception by informants in scale-model environment. Man–Environ. Syst. 7, 55–58.

Herzog, T.R., Black, A.M., Fountaine, K.A., Knotts, D.J., 1997. Reflection and attentional recovery as distinctive benefits of restorative environments. J. Environ. Psychol. 17, 165–170.

Heyne, P., 1982. Today's Architectural Mirror: Interiors, Buildings, and Solar Designs. Van Nostrand Reinhold Co., New York.

House, J., 1986. Monet: Nature Into Art. Yale University Press, New Haven.

Higuchi, S., 1991. Water as Environmental Art: Creating Amenity Space. Kashiwashobo, Tokyo, Japan.

Hubbard, H.V., Hubbard, T.K., 1917. An Introduction to the Study of Landscape Design. Macmillan, New York.

Kaplan, R., 1977. Down by the riverside: informational factors in waterscape preferences. In: Proceedings on the Symposium on River Recreation Management and Research, 24–27 January 1997 (Gen. Tech. Rep. NC-28, pp. 285–289). USDA Forest Service, North Central Forest Experiment Station, St. Paul, MN.

Kaplan, S., Kaplan, R., 1989. The Experience of Nature: A Psychological Perspective. Cambridge University Press, New York.

Kasmar, J., 1969. The development of a usable lexicon of environmental descriptors. Environ. Behav. 21, 153–169.

Litton, R.B. Jr., Tetlow, R.J., 1974. Water and Landscape: An Aesthetic Overview of the Role of Water in the Landscape. Water Information Center, Port Washington, NY.

Michel, L., 1996. Light: The Shape of Space: Designing with Space and Light. Van Nostrand Reinhold, New York.

Miller, J., 1998. On Reflection. National Gallery Publications, London.

Millet, M.S., 1996. Light Revealing Architecture. Van Nostrand Reinhold, New York.

Nasar, J.L., 1994. Urban design aesthetics: the evaluative quality of building exteriors. Environ. Behav. 26, 377–401.

Nasar, J.L., 2000. The evaluative image of places. In: Walsh, W. Bruce, Craik, K.H., Price, R.H. (Eds.), Person–Environment Psychology: New Directions and Perspectives. L. Erlbaum, Mahwah, NJ, pp. 117–168.

Parsons, R., Tassinary, L., Ulrich, R., 1998. The view from the road: implications for stress recovery and immunization. J. Environ. Psychol. 18, 113–140.

Piano, R., 2000. Presentation of Piano's design proposal for the competition for The New York Times Headquarters' Buildings. 11 September, New York, NY.

Pitt, D.G., 1989. The attractiveness and use of aquatic environments as outdoor recreation places. In: Altman, I, Zube, E.H. (Eds.), Public Places and Spaces. Plenum Press, New York, pp. 217–254.

Rowe, C., Slutzky, R., 1997. Transparency. Birkhäuser Verlag, Basel.

Russell, J.A., 1979. Affective space is bipolar. J. Personal. Social Psychol. 37, 345–356.

Russell, J.A., Snodgrass, J., 1987. Emotion and the environment. In: Stokols, D., Altman, I. (Eds.), Handbook of Environmental Psychology, vol. 1. Wiley, New York, pp. 245–280.

Simonds, J.O., 1983. Landscape Architecture: A Manual of Site Planning and Design. McGraw-Hill, New York.

Sorvig, K., 1991. Water design special effects. Landsc. Architect. 81, 72–75.

Stamps III, A.E., 1993. Simulation effects on environmental preference. J. Environ. Manage. 38, 115–132.

Ulrich, R., 1983. Aesthetic and affective responses to natural environment. In: Altman, I., Wohlwill, J.F. (Eds.), Behavior and the Natural Environment. Plenum, New York, pp. 85–125.

Ulrich, R.S., Simonds, R.F., Losito, B.D., Fiorito, E., Miles, M.A., Zelson, M., 1991. Stress recovery during exposure to natural and urban environments. J. Environ. Psychol. 11, 201–230.

Wherrett, J.R., 2000. Creating landscape preference models using internet survey techniques. Landsc. Res. 25, 79–96.

Wohlwill, J.F., 1983. The concept of nature: a psychologist's view. In: Altman, I., Wohwill, J.F. (Eds.), Behavior and the Natural Environment. Plenum, New York, pp. 5–37.

Wright, F.L., 1928. In the cause of architecture. Part VI: The meaning of materials—glass. Architect. Rec. 64, 11–16.