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SHORT COMMUNICATION

Evaluative Responses to Five Kinds of Water Features

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ABSTRACT *How do humans respond to different water features used by designers in urban plazas? Thirty participants viewed colour photographs of controlled views of five kinds of water features (Still, Flowing, Falling, Jet and Combination) and rated each scene on nine bi-polar adjective scales. The analyses focused on three composite scales, one for* Preference, *one for* Calming *and one for* Excitement. *Although the water features generally received favourable ratings, analysis of variance and tests of effect sizes revealed that participants had higher preferences for jets and combination; they rated still water as most calming; and they rated moving water as higher in excitement than still water. To test the generalization of the findings, replications in more realistic conditions are called for.*

KEY WORDS: preference, water feature, human response, pond

Introduction

Water is a dominant feature in many environments (Pitt, 1989). Humans experience it in many forms—oceans, rivers, lakes, streams, mist, fog, rain and snow. It affects climate and ecological balance. Living creatures need it to survive. Humans drink it and use it in irrigation, transportation and recreation (Booth, 1983). In addition it offers aesthetic pleasures (Campbell, 1978; Ulrich, 1983). With its unique features—plasticity, motion and reflectivity—it is also an important component in landscape design. Landscape designers use water in plazas, parks and gardens. Along with engineers they have specialized knowledge for solving technical problems in water design, but they lack information about human responses to different water features. Landscape theory and research suggests that people enjoy water (McCulley, 1976; Ulrich, 1983), but it does not tell the kinds of responses that different kinds of water feature evoke. The present study looks at human evaluative responses to some water features.

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We can classify water features into two broad categories: still and moving.[1] *Still water* refers to a flat, static, quiet and non-moving water (Booth, 1983), such as that found in some ponds, pools, lakes, puddles, tarns and holes from wear in road surfaces. *Moving water* refers to flowing, falling water and fountain jets, such as that found in fountains, step-shaped flows, cascades and waterfalls. Thus, moving water has at least three sub-categories: flowing, falling and jets. *Flowing water* refers to water moving in both natural and artificial channels (Booth, 1983) and moving "downward, along, over, and through various surfaces and forms" (McCulley, 1976). The water speed and movement depend on the volume of water, and the gradient, size and properties of the channel. *Falling water* refers to water that drops abruptly from a higher elevation to a lower one. Depending on vertical size and surface friction, the final speed of the water can vary (McCulley, 1976), and it can take the form of free-fall, obstructed fall or sloped fall (Booth, 1983). Factors such as the volume, velocity, height of fall and light can create different patterns of falling water. Finally, the category *Jets* refers to water rising to a higher elevation and then falling back. Fountain jets (henceforth referred to as jets) force "water up into the air through a nozzle in defiance of gravity" (Booth, 1983). The volume and pressure of water, the force of the jet, the height of jet, light and the sculptural form give different visual effects. Depending on the nozzle, jets can take the form of single, spray, aerated or formed jets.

Theorists (Booth, 1983; Dillon, 1991; Hannebaum, 1998; Treib, 1987; Whyte, 1980) often differ in their predictions of human responses to water features. For example, Booth (1983) argued that moving water would arouse people, Hannebaum (1998) described it as a source of relaxation, and Sorvig (1991) wrote that it could dazzle, soothe or induce sombre thoughts. Nevertheless, theorists agree that still water should have calming effects. Thus, Booth (1983) describes still water as evoking repose and tranquillity, and Hannebaum (1998) describes it as evoking serenity.

No published study has empirically tested these speculations about human responses to different kinds of water feature. Thus, this study takes an exploratory, empirical look at evaluative responses to still and moving water features. It focuses on water features (both moving and still) that might appear in urban spaces. The moving features included in this study comprise flowing water, jets, falling, and a combination of the three. If the results followed the theory, humans would respond differently to still and moving water, judging the still water as more calming and less exciting. They might differentiate between Falling, Flowing and Jet, but we cannot offer a prediction of how. Research has found strong commonalities across individuals in response to the environment (Stamps, 1999), and we expected to find the same for water features. Nevertheless, the study obtained information from respondents about their age, gender and social class in order to test whether these personal characteristics affected response. Social class has been shown to relate to differences in value, and some environmental responses differ with age and gender (cf. Evans, 1981; Michelson, 1976; Zube *et al.*, 1983).

Methodology

Participants

Thirty residents of central Ohio (15 males and 15 females) took part in the study.

Table 1. Characteristics of the sample

Personal characteristic ($n = 30$)	Per cent
Gender	
Male	50.0
Female	50.0
Education	
High-school graduate	13.3
Some college	13.3
Bachelor's degree	36.7
Some graduate school or higher degree	36.7
Occupation	
Manager/administrator	16.7
Professional	33.3
Technical support	6.7
Customer service	3.3
Skilled trade	10.0
Student	13.3
Other	16.7
Income	
Under $15 000	10.0
$15 000–24 999	20.0
$25 000–34 999	20.0
$35 000–49 999	16.7
$50 000–99 999	23.3
$100 000 +	10.0
Age (range from 22 to 63 years old)	Mean (standard deviation) 36.4 (10.51)

They were selected through a cluster procedure in which areas were selected at random in Columbus, Ohio, and then within each cluster blocks and houses on each block were selected at random. Interviewers visited each target house to interview an adult member of the household, alternating requests for a male or female adult. If no one was home, the interviewer went to one of the five houses surrounding the target home, picking the one that showed signs of occupancy, or if none had such signs, picking one at random. The interviewer repeated the process until obtaining an interview. More than 90% of those approached agreed to take part in the study. The resulting sample spanned a reasonable range of the observed personal variables (Table 1).

Water Scenes

For stimuli, the study used colour photographs representing five differently designed water features in urban places: still water, flowing water, falling water, jets, and a combination of moving water features (Figure 1). For control, each photo showed an eye-level front view of the feature, with the images cropped to show only the water feature. Research shows responses to colour photos as an accurate indication of on-site experience (Craik, 1983; Hershberger & Cass, 1974; Stamps, 1993; Trent *et al.*, 1987). Nevertheless, we acknowledge the importance

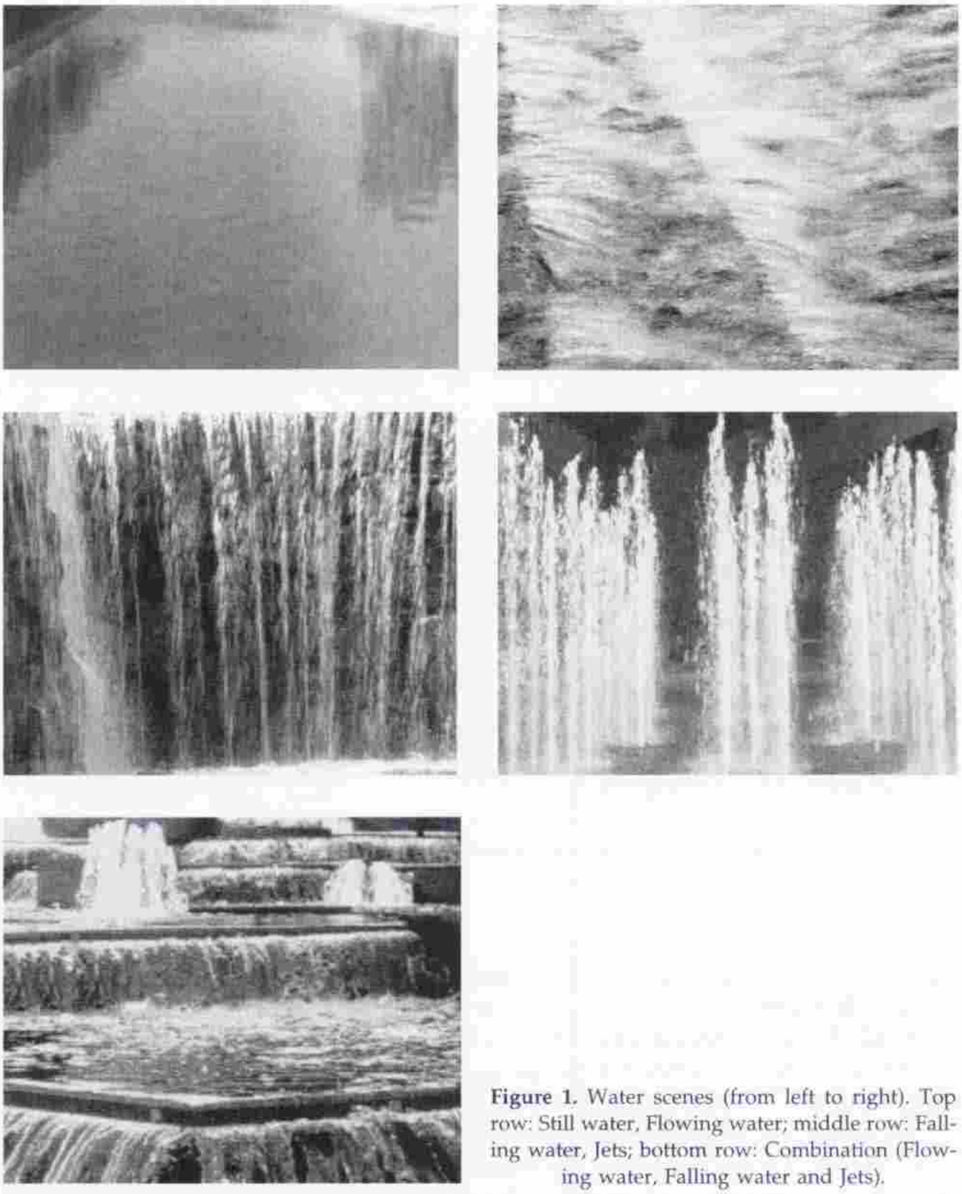

Figure 1. Water scenes (from left to right). Top row: Still water, Flowing water; middle row: Falling water, Jets; bottom row: Combination (Flowing water, Falling water and Jets).

of motion and sound in representing water landscapes (Anderson *et al.*, 1983), and thus the potential limitations of our static, visual representations with cropped views of the water. To capture sound and motion, we could have videotaped real fountains, taken respondents to real fountains or created computer simulations of fountains with sound and moving water. We chose still photographs over those alternatives for two reasons: still photographs enabled us to get a random sample of participants to experience each scene and allowed a control of extraneous factors that would not have been possible through videotape or on-site exposure.

Questionnaire and Procedure

The questionnaire had nine pairs of adjectives, drawn from Kasmar's lexicon (Kasmar, 1970). Kasmar derived a list of bi-polar adjectives useful for both describing different physical environments and carrying shared meanings across people. As research suggests that environmental appraisals have three components—*Preference, Calming, Exciting* (Russell & Snodgrass, 1987)—the questionnaire included adjective pairs for each component. For *Preference*, the questionnaire obtained ratings on pleasant–unpleasant, attractive–unattractive, happy–sad and cheerful–gloomy; for *Calming*, it had calm–busy, peaceful–hectic and calming–upsetting; and for *Exciting*, it had exciting–unexciting and stimulating–unstimulating. Each adjective pair was presented as a seven-point scale. For example, the rating for pleasant–unpleasant had Very Pleasant, Pleasant, Fairly Pleasant, Neither Pleasant nor Unpleasant, Fairly Unpleasant, Unpleasant and Very Unpleasant. The valence and order of scales was assigned at random in order to reduce response set and order effects.

To test for the repeatability or reliability of the items, we can calculate Chronbach alpha inter-item reliability scores. This statistic compares the scores on each item to the scores on each other item. A score of 0.80 and above is considered an acceptable level of reliability. The test revealed acceptable Chronbach alpha reliability scores across the four *Preference* items ($\alpha = 0.82$) and the three *Calming* items ($\alpha = 0.83$), but a lower reliability score for the two *Exciting* items ($\alpha = 0.70$).

Exciting and *Calming* share an evaluative component (Russell & Snodgrass, 1987): *Exciting* mixes high arousal with pleasure, while *Calming* mixes low arousal with pleasure. Factor analysis allows us to see the structure of relationships between the items. In this case, we ran a factor analysis with an equamax rotation, because it assumes the kind of relationship expected between calming and excitement. The analysis confirmed separate factors, with the four *Preference* items loading on the first (< 0.60), the three *Calming* items loading on the second (< 0.75), and the two *Exciting* items loading on the third (< 0.60). Tests of the consistency of response across the 30 participants to each composite scale showed high inter-observer reliability on each composite scale (*Preference*: $\alpha = 0.91$; *Calming*: $\alpha = 0.97$; *Exciting*: $\alpha = 0.92$).

Participants were told that there were no right or wrong answers and asked to rate each scene on all of the scales. Afterwards, the questionnaire asked about their gender, year born, education, occupation and income.

Results

As expected, participants rated Still water as more calming and less exciting than any of the moving water features. Jet and Combination received higher scores for *Preference* than did any other feature; Falling and Flowing received lower scores for both *Preference* and *Calming* than did any other feature. Table 2 shows the analysis of variance statistics for each scale. Table 3 shows the mean scores for responses to each scene, and it arranges those means from the highest to the lowest score. Hence, if you look at *Preference*, it shows that participants gave Jet and Combination the most favourable ratings, followed by Still, Falling and Flowing. (All of the scores exceed 4.0; this suggests that respondents rated each of the water features in the favourable part of the seven-point scale.) For *Calming*, the table shows that participants rated Still as most calming, followed

Table 2. ANOVA for *Preference, Calming* and *Excitement*

Source	SS	df	MS	F
Preference				
Participants				
Age	6.376	2	3.188	4.200*
Social class	5.468	4	1.367	1.801
Gender	3.056	1	3.056	4.026*
Stimulus				
Water feature	23.917	4	5.979	7.877**
Error	104.735	138	0.759	
Calming				
Participants				
Age	1.578	2	0.789	0.710
Social class	14.140	4	3.535	3.181*
Gender	2.728	1	2.728	2.455
Stimulus				
Water feature	121.559	4	30.390**	27.346**
Error	153.358	138	1.111	
Excitement				
Participants				
Age	3.798	2	1.899	2.077
Social class	3.609	4	0.902	0.987
Gender	4.033	1	2.728	4.411*
Stimulus				
Water feature	62.833	4	15.708**	17.178**
Error	126.193	138	0.914	

Notes: $^{*}p < 0.05$; $^{**}p < 0.01$. SS = Sum of Squares, df = degrees of freedom, MS = Mean Square, F = Analysis of Variance F-ratio.

by Combination and Jet, with Falling and Flowing receiving unfavourable scores. For each scale, the differences across the Water Feature achieved statistical significance.

Post-hoc pairwise *t*-tests in Table 3 show that, for *Preference*, Jet and Combination scored as significantly more preferred than Still, Falling and Flowing, which did not differ at a statistically significant level from one another. For *Calming*, Still scored as significantly more calming than any other feature; Falling and Flowing scored as significantly less calming than the others. For *Exciting*, Still water scored as significantly less exciting than each other feature.

Effect size refers to the magnitude of the effect. Think of the effect size as measuring whether (and to what degree) an environmental feature effects a response from the viewer, as might the addition of a mountain or a molehill to the scene (Stamps, 1998). Presumably a mountain would have a large effect and a molehill would have a trivial effect. We can arrive at a statistically significant effect (i.e., one which occurs rarely) that represents a small-sized outcome of the variable tested. Cohen (1977) noted that percent of variance $(PV)^2$ can give effect sizes, where $PV = 0.01$ is a small effect, $PV = 0.10$ is a medium effect and $PV = 0.25$ is a large effect. The *PV* statistics for Age,[3] Gender, Social Class[4] and Water Features reveal that Water Features had a medium to large effect on *Preference* ($PV = 0.19$), large effects on *Calming* ($PV = 0.44$) and *Exciting* ($PV = 0.33$). All of the personal variables except one had small effects ($PV\text{s} \leq 0.05$): Social Class had a small- to medium-sized effect on *Calming*

Table 3. Mean (standard deviation) *Preference, Calming* and *Excitement* of each water feature (1 = lowest preference, calming or excitement and 7 = highest score on each scale)

Feature	Mean (standard deviation)
Preference (from most to least preferred)	
Jet	5.650 (0.690)[a]
Combination	5.367 (0.827)[a]
Still	4.850 (0.990)[b]
Falling	4.833 (0.906)[b]
Flowing	4.550 (1.051)[b]
Calming (from most to least calming)	
Still	6.056 (0.695)[a]
Combination	4.522 (1.193)[b]
Jet	4.322 (1.267)[b]
Falling	3.767 (1.235)[c]
Flowing	3.456 (1.133)[c]
Exciting (from most to least exciting)	
Jet	5.383 (0.878)[a]
Falling	5.367 (0.939)[a]
Combination	4.850 (0.973)[a]
Flowing	4.750 (1.006)[a]
Still	3.516 (0.996)[b]

Note: For each scale, different superscript letters following values stand for statistically significant differences ($p < 0.05$) in pairwise t-test with Bonferroni adjustments for multiple claims.

($PV = 0.08$). Compared to the personal variables, Water Features had effect sizes that were three times as large for *Preference,* five times as large for *Calming* and 10 times as large for *Exciting.*

Table 4 shows the standardized difference between the means across the Water Features. The standardized *d*s also give a picture of the effect sizes for each environmental comparison. Stamps (1998) examined effect sizes for environmental interventions, finding that the mountains in Yosemite had an effect size of $d = 1.1$, addition of trees to a street had an effect of $d = 0.35$, and adding a molehill to Yosemite had an effect size of $d = -0.05$. With this in mind, consider the standardized mean difference (*d*s) in Table 4. For *Preference,* Jets represented a moderate improvement over Combination and large improvements over each other water feature. Combination represented a moderate to large improvement over Still, Falling or Flowing water; Still water offered virtually no improvement over Falling water, but each had a small to moderate improvement over Flowing water.

For *Calming,* Still water represented a large improvement over Combination Jet, Falling or Flowing water. Combination had a small effect relative to Jet but a moderate to large improvement over Falling or Flowing water. Jet had a moderate improvement over Falling or Flowing water. Falling water had a relatively small improvement over Flowing water.

Table 4. Standardized difference betrwwn means (*d*)[a] for water features (arranged for each scale from highest to lowest score)

Preference				
	Jet			
Combination	0.36	Combination		
Still	0.85	0.55	Still	
Falling	0.91	0.60	0.02	Falling
Flowing	1.06	0.80	0.29	0.26
Calming				
	Still			
Combination	1.24	Combination		
Jet	1.70	0.16	Jet	
Falling	1.50	0.56	0.43	Falling
Flowing	1.62	0.93	0.68	0.26
Excitement				
	Jet			
Falling	0.25	Falling		
Combination	0.54	0.31	Combination	
Flowing	0.64	0.41	0.17	Flowing
Still	1.41	1.29	1.14	1.05

Note: Standardized difference = difference between means divided by pooled standard deviation for the pair.

For *Exciting*, each moving feature represented a large improvement over Still water, with Jet and Falling water each representing moderate improvements over Combination or Flowing water.

Now consider the personal variables by referring back to the ANOVA statistics in Table 2. Here the personal variables showed statistically significant differences associated with age and gender on *Preference*, social class on *Calming* and gender on *Exciting*, but the effect sizes are trivial and tiny relative to the effect of the water features. Nevertheless, for Age and *Preference* (Figure 2), preference increased as age increased. For Social Class and *Calming* (Figure 3), lower class and blue collar participants gave higher *Calming* scores to the scenes, students gave lower scores, and the lower middle and upper middle class participants scored the scenes between the two extremes; and for Gender and *Exciting* (Figure 4), males rated the scenes as higher in *Exciting* than did females. More importantly, tests of interactions between Age, Gender or Social Class and Water Features revealed no significant interactions. This means that individuals who differed on these personal characteristics exhibited the same pattern of responses across the water features.

Discussion

The results showed differences in *Preference*, *Calming* and *Exciting* associated with the water features, and the pattern of responses did not differ with the personal characteristics (age, gender or social class) of the participant. Furthermore, in agreement with Stamps (1999), effects from personal characteristics were trivial relative to the environmental effects. As expected, participants judged the Still water as most *Calming* and least *Exciting*. For the other features,

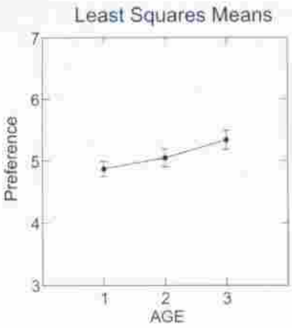

Figure 2. *Preference* (generally favourable) increased with age of respondent.

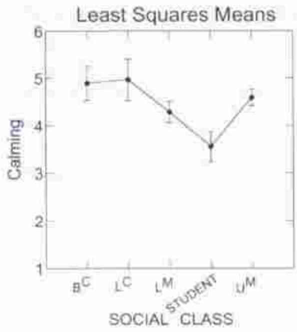

Figure 3. Rated *Calmness* increased from student to lower middle (LM) to upper middle (UM) to blue collar (BC) to lower class (LC).

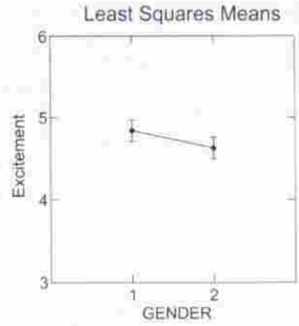

Figure 4. Males (1) had higher *Excitement* ratings than did females (2).

the results offer some tentative suggestions. Participants judged the Jets and Combination as most *Preferred*, Falling water as low in *Calming*, and Flowing water as low in *Preference* and *Calming*.

As a first look at human responses to these water features, caveats are in order. Recall that the cropped and static representations without sound may have reduced the effect of moving water. Future work should take a multiple-method approach, in which respondents experience the water features with movement and sound. One study might take still photographs of water features and compare the responses to those still photographs to responses obtained on site to the same photographs. Perhaps from previous experience, people infer from a still photograph the kind of movement and sound they would encounter. If so, to see whether the present results generalize to the class of water features tested, research should explore responses to a random sample of water stimuli, a larger number of them, and multiple examples of each kind of feature. Research should also consider other features, such as the form of the water feature, the container and the surroundings, as well as patterns of response to water features with sound and movement. There is further scope for comparing reactions to 'virtual' water features (for example computer simulations, video tapes) and to on-site appraisals within the full context of each kind of feature.

Subject to the constraints of the landscape sample and representation methods used, designers might try using jets or combinations of water features to enhance environmental preference; and they might try still water to create a calming or less exciting experience. Given the preliminary nature of the findings, one final research direction should be considered: designers should test the effects of their implemented design to see how well they achieve the desired evaluative response.

Notes

1. This description of still and moving water is by no mean comprehensive. For example, Treib (1987) also lists rippling, spilling, spraying, whistling, roaring, reflecting, colouring and elevating.
2. *PV* (percent of variance) = $[(v1^*F)/v2]/[1 + (v1^*F/v2)]$.
3. For Age, the analysis grouped year-born responses into three classes (25–34 years old, 35–44 years old, and 45 and over).

4. Lower class = high school degree or less, no or marginal employment, and income less than \$25 000/year; blue collar = high school degree or some college, skilled trade, income from \$15 000 to \$35 000/year; lower middle class = some college or college degree, technical support or customer service, income from \$15 000 to \$35 000/year; upper middle class (professional) = college degree–if high income and manager/administrator–or graduate degree, professional or manager/administrator, income from \$35 000 (if graduate degree and professional occupation) to more than \$100 000/year; cf. Michelson (1976). Respondents reporting occupation as student = student.

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