J. ENVIRONMENTAL SYSTEMS, Vol. 16(1), 1986-87

AN EVALUATION OF THE EFFECTIVENESS, COSTS AND BENEFITS OF LAYING A PAVED PATH TO PERMIT GRASS REGENERATION

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ABSTRACT

An ABAB design was used to evaluate the presentation and removal of a hard surfaced pathway over an area which was subject to considerable destructive lawnwalking and which was initially bare of grass in its heaviest traffic areas. The presence of the paved path significantly reduced (from 100% to 3%) the amount of destructive lawnwalking, when all crossings were taken into account. More importantly, it also significantly reduced the amount of destructive lawnwalking (from 32% to 3%) when the population that always (in both baseline and intervention) walked on the potential path area (i.e., the area that was covered by the paved path during intervention periods) was eliminated from the analysis. In addition, there was a significant (81%) increase in the number of pedestrians crossing the area when the paved path was present. Despite this increase, the average number of destructive lawnwalkers off the path area went from 5.4 (per 25 minute observation period) during baselines to 1.1 during interventions. These changes in behavior are discussed in terms of the competing contingencies present during baseline and intervention. Path laying also proved cost effective and a permanent path has now been constructed where the experimental path had been laid. This has resulted in a spontaneous regrassing of the areas adjacent to this path.

doi: 10.2190/ADU2-6GFB-52PB-DVN5
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Psychologists with a theoretical background in Behavior Analysis have now created a considerable body of literature which describes, and occasionally provides theoretical explanations for, successful programs to promote pro-environmental behavior. Some of this literature will be familiar to readers, as it appeared in the *Journal of Environmental Systems*. Much of the rest can be found in two other journals, *Environment and Behavior* and the *Journal of Applied Behavior Analysis*. Comprehensive and interpretive summaries of this literature are to be found in *Preserving the Environment* [1] and *Environmental Problems: Behavioral Solutions* [2]. Some of the same material plus provocative offshoots such as a review of population control measures considered in behavior analytic terms [3] are to be found in *Behavioral Community Psychology* [4]. Topics as diverse as litter control, energy conservation (both electricity and liquid fuels), and recycling have all been approached using this methodology. In addition, there is a study in the literature that looked at one of the kinds of environmental destruction which is ubiquitous within society, cross-cultural in nature, trivial in any single incidence (but destructive *in toto*) and one to which all of us are occasional contributors.

Hayes and Cone addressed the problem of destructive lawn walking [5]. They pointed out the advantages of passive as opposed to active interventions and the need for permanent, inexpensive changes. In addition they proposed, and measured their interventions against, two possible conceptualizations of the problem: First in terms of response difficulty and consequent competing contingencies. Jason and Liotta interpreted this, in a jay-walking study, as facilitating and non-facilitating conditions [6]. Squires and Fantino explored the likelihood of particular choices, given differential difficulty [7].

Second in terms of response chaining. This implies that the first behaviors in a sequence are likely to provide the discriminative stimuli for subsequent ones and hence are the most important to control.

In the present study a path was laid down across a lawn with the intention of giving the grass an opportunity to regenerate by encouraging people to walk on a small area of the lawn (i.e., on a path laid to cover part of the lawn), rather than walking over a wide area of the lawn. This process of crossing the lawn can be seen as a chain of responses. It was, therefore, predicted that if a person enters the area on the path and not on the grass, s/he would tend to stay on the path, setting the occasion for a desired response and continuously prompting that response (walking on the path).

It was also anticipated that the discriminative stimulus properties of the path would increase the number of pedestrians choosing to use the "shortcut" that the path represents [8]. There are many people who would not walk on the grass but who would walk on a path just as there are many people who wouldn't write on a wall but would write on a graffiti board [9].

METHOD

Subjects

Subjects in this experiment were people walking in the experimental area, during the observation periods, in the normal course of their day. A total of 1019 crossings were recorded, the majority of those crossing appeared to be University students.

Setting

The experimental area was a lawn approximately 12 meters in length and 5 meters wide. This lawn was sunken below the footpath approximately 10 centimeters and contained two trees, one at either end (Figure 1.). The grass and mud area was marked on the outside edges with short lines (and the arabic numerals, 0, 5 and 11) painted on street and sidewalk which divided both sides

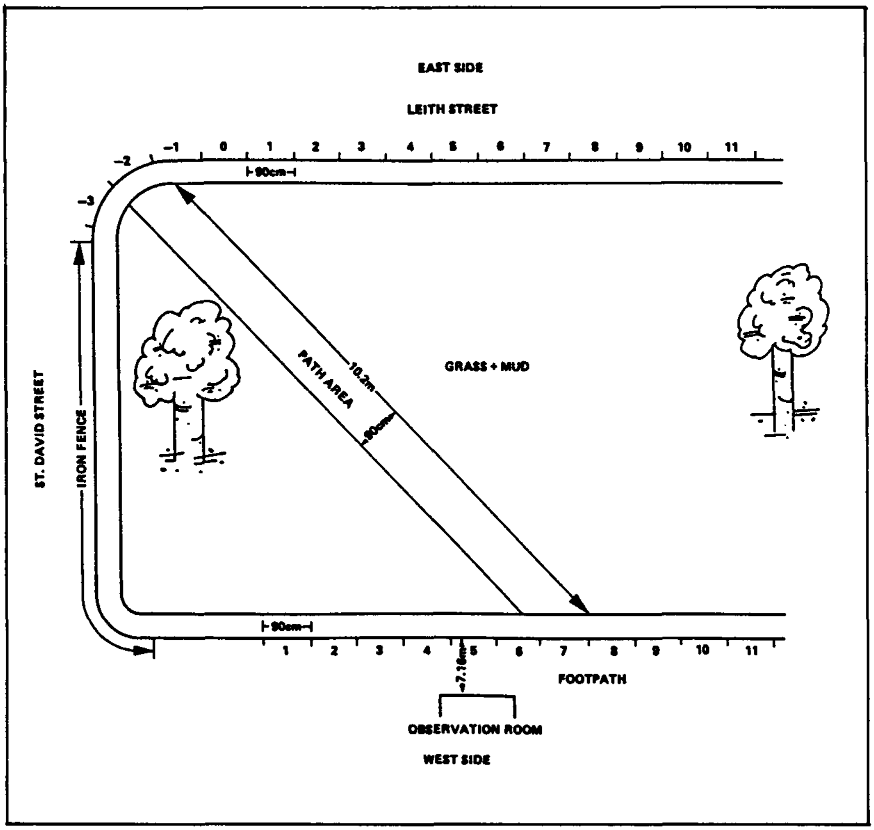

Figure 1. Experimental area.

into corresponding equal sized segments. These segments were numbered (on our data sheets) 1 to 11 on the West side and -3 to 11 on the East side. Each area was 90 cm wide.

Observations were made from a ground floor room in an adjacent building. Observers were approximately 7 meters from the closest point on the near (West) side of the grassy area and approximately 13 meters from the closest point on the far (East) side of the grassy area. Observers could be seen by some pedestrians but they were not obtrusive.

Apparatus

There were two data sheets (East and West) for subject by subject, area by area recording in five minute blocks. The paths were constructed of concrete, steel reinforced, pebble coated, paving blocks 60cm x 60cm x 5cm and concrete, steel reinforced, pebble coated, paving half blocks 30cm × 60cm x 5cm.

Procedure

The area was observed twenty-five minutes per day, four days a week—Monday through Thursday, from, approximately, 12:25 to 12:50. Morning classes finish at 12:20 and afternoon ones commence at 1:10, thus, this would be a moderate traffic time overall. Each observation period was divided into five minute intervals to assist in the calculation of interobserver reliability.

Two observers recorded data each day, one recording the number of people who entered or exited on the East side and whether those who entered remained on the path when the path was present. The other observer recorded the corresponding data for the West side. Interobserver reliability recordings were made by a third observer at least once a week. The reliability observer recorded either West or East side data alternately for each five minute period. The primary observers were unaware of which observer was being checked during any five minute period.

After two weeks of Baseline 1 observation, Treatment 1 was introduced. A path was laid across the grass area between the most commonly used numbered areas. The path was made of pebble covered steel reinforced concrete paving blocks and half blocks. The path went between areas 7(West side) and -2(East side) and was 10.2m long and 90cm wide (Figure 1). After two weeks (eight days of observation) in Treatment 1, the path was removed and the area swept with yard brooms to remove all traces of its presence. Comparison with "before" photographs indicated that this restoration to baseline conditions was successful. This was the beginning of Baseline 2 which ran for three weeks (twelve days). The increased length of this period resulted from the interruption of Baseline 2 (after two weeks) by a three week University holiday, during which no observations were made. Therefore, a third week of observation was instituted after the end of the holidays. At the end of Baseline 2 the path was relaid in the same place for Intervention 2, which lasted for two weeks (eight observation days).

Cost and benefit data were also collected. The cost in this study was the cost of laying a permanent path over the area covered by our experimental path. This was compared with the annual cost of regrassing the area and the change in the number of people engaging in "destructive lawn walking" [5] during equal periods of baseline and intervention. Additionally the costs of providing a new amenity for those who walked on the paved path, but walked around the area when the paved path was not present, were calculated.

RESULTS

Reliability

Interobserver reliability was computed using the formula

$$\text{Reliability} = \frac{\text{no. of agreements}}{\text{no. of agreements + disagreements}} \times \frac{100}{1}$$

for every five minute cell during each day of reliability observation. The daily cell average ranged from 64 percent (initially) to 100 percent, with an overall average value of 97.7 percent. Reliability observations were carried out on thirteen of the thirty-five days of observation. It is, of course, impossible to be certain that the people counted by the primary observers and reliability checkers were the same, however, the five minute constraint on comparison, the maximum count of thirteen subjects per five minute period and the average 97.7 percent agreement as to the number in each category during these periods makes this a very viable assumption.

Data Analysis

The average number of people crossing the area per twenty-five minute daily observation period and the proportion of those who, because they did not walk on a paved surface, can reasonably be assumed to have done some damage are presented in Table 1. This shows that the total number crossing per day was 1.8 times greater when the path was present and the number of destructive walkers 13.2 times greater when the path was not present. A one-way analysis of variance [10] across the four experimental conditions (Baseline 1, Intervention 1, Baseline 2, Intervention 2), with days as 'subjects,' was carried out on the usage data. This demonstrated a significant difference among conditions at $p < .002$ ($F = 8.73$, $df = 3.32$). In consequence a Student Newman-Keuls Multiple Range Test [11] was used to make internal comparisons between experimental phases and it demonstrated that in both Interventions there was

Table 1. Average Numbers of People Crossing Experimental Area Per Daily Observation Period and Proportion of Those Crossing Assumed to Have Damaged Area

	Ave. no. crossing to the grassy area including path per day	*% Crossings on path area*	*Ave. no. destructive crossings per day*	*% Destructive crossings per day*
Baseline 1	19.9	72	19.9	100
Intervention 1	40.6	95	1.9	4.8
Baseline 2	21.8	65	21.8	100
Intervention 2	34.7	96	1.25	3.6

significantly greater pedestrian traffic over the whole of the experimental area than in both Baselines. There were no significant differences between the two Baselines or between the two Interventions.

The data were analyzed in terms of the number of those crossing who potentially were on the path. During intervention periods these are the people who were on the path. During baseline periods, these are the people who walked over the portion of the area that was covered by the path during interventions (Figure 2).

A two-way analysis of covariance (ANCOVA) comprising the four conditions x two places i.e., entering and exiting, with days as 'subjects,' was carried out on the data [10]. The covariate being the total number of entries and/or exits each day and the dependent variable being the number actually or potentially (during baselines) on the path.

The ANCOVA demonstrated a significant difference among conditions, between the number of subjects entering into and exiting from the potential path area and in the interaction of these two variables (Table 2).

Internal comparisons were done using the Student Newman-Keuls Multiple Range test [11] for the between conditions result. This analysis found both Interventions significantly different from both Baselines ($p < 0.001$). The analysis found no significant difference between Intervention 1 and Intervention 2 nor any significant difference between Baseline 1 and Baseline 2.

The significant interaction between Condition and Place was investigated by plotting the means for each place (entrance point and exit point) against the conditions. The plot showed that the intervention(s) had a greater effect on the exiting behavior of subjects than on their entering behavior. This appears to be a function of there being more room for such change in exiting behavior as 46 percent exited somewhere other than on the path area during Baselines while only 10 percent entered somewhere other than on the path area during Baselines.

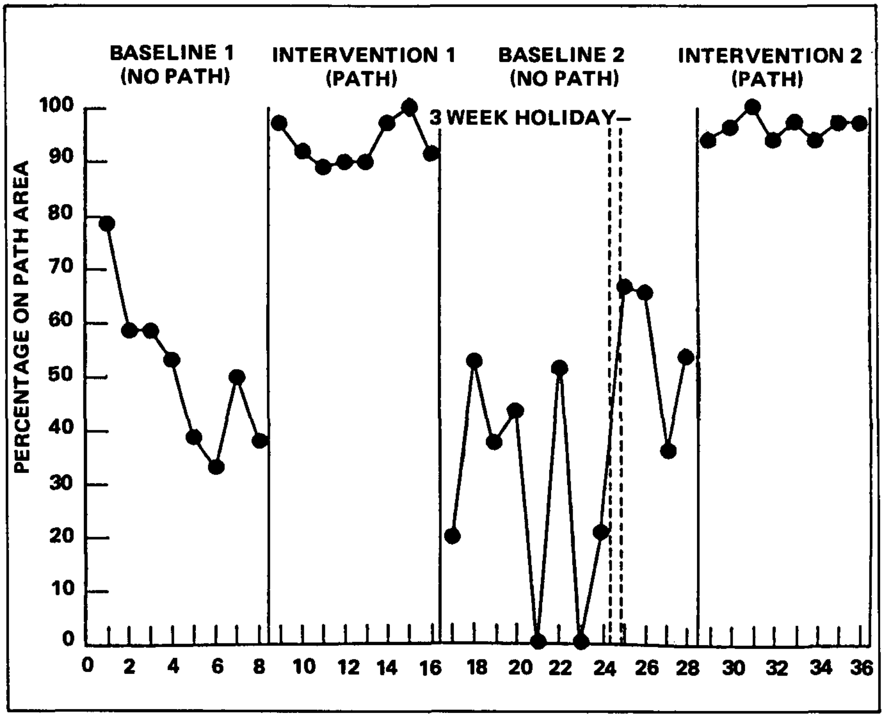

Figure 2. Percentage of crossings on area delimited by the path during interventions.

Costs and Benefits

During the twenty days of baseline 420 people walked across the grass and mud area. For a sixteen day period this is (*pro rata*) 336 walkers. During the sixteen days of intervention only twenty-five people walked across the grass and mud area, the rest walked on the path. If the contract cost of laying a permanent path is approximately $300 (R. Scott, Grounds Officer, personal communication, Dec. 21, 1984) then the cost of moving a single person during our twenty-five

Table 2. Summary of ANCOVA Results

(A) Condition	$F = 31.24$	$df = 3$	$p < 0.0001$
(B) Enter/exit	$F = 9.10$	$df = 3$	$p < 0.0001$
AB interaction	$F = 4.19$	$df = 9$	$p < 0.0001$

minute observation period is \$300/311 people = \$0.96. This is amortizing the cost of the path only over the sixteen days of baseline and the twenty-five minutes per day of observation. Amortized over the weekdays of a twenty-six week academic year and figuring pedestrian traffic for six hours per day at the moderate rate observed during our twenty-five minute observation period this is: \$300/(130 weekdays x 19.44 people x 14.4 periods of twenty-five minutes) = \$0.0082 per crossing. Every academic year that the path remains without needing maintenance would reduce this figure by the reciprocal of the number of years involved e.g., after the second year the cost would be 1/2 x \$0.0082 = \$0.004 per crossing.

Against the cost one would have to balance the benefits of removing an unsightly spot on campus or the cost of annual (or more frequent) regrassing at \$140 per time. Assuming annual regrassing, it will take three years of path presence to show a monetary savings of \$120 (i.e., to become cost-effective). Barring maintenance costs, thereafter there will be a savings of the full \$140 per annum.

In addition we can consider the convenience for the extra 278 people daily (19.28 per 25 min. x 14.4 such periods in a six hour day) who use the path when it is present and presumably walk around the area when it is absent. If saving the effort of his last group is considered a benefit, it costs (\$300/277.63 people per day x 130 days) \$0.0083 per person/crossing to achieve this benefit during the first year and correspondingly less each successive year. This cost is calculated independent of that involved in making grasswalkers into pathwalkers.

Combining the two desirable outcomes, the per person crossing cost comes to (\$300/558 people x 130 days =) \$0.004 per person/crossing benefited during the first academic year and approximately 558 such benefits are conferred daily. There is of course the same *pro rata* reduction in this cost with successive academic years.

As a result of this study a permanent path has been constructed across this patch of ground and there has been a consequent improvement in surrounding grass coverage and appearance (B. Dingwall, Senior Technical Officer, personal communication, Sept. 1985).

DISCUSSION

The introduction of the paved path significantly increased the proportion of people walking on the area of the path. Although the path was present only in the treatment conditions the data for all conditions were analyzed as the proportion of those crossing the area who entered/exited in the numbered areas where the path would be. This was because those crossing, during both baseline and interventions, where the path was to be laid could be considered unaffected by its presence or absence. When the path was present these people would walk on it not because the path altered their behavior but because that's where they would have walked anyway. The effectiveness of the path in altering people's behavior can be seen in the change in the proportion of people who were on the specific path area, from baseline to intervention. The change in this case was a significant increase in this percentage during intervention, indicating that the presence of the path was a prompt for walking over it instead of the grass. This means the path not only protected the area directly beneath the blocks from being churned into mud but also protected the uncovered grass by drawing traffic off these areas.

That the path decreased the proportion of people on the unpaved area outside the confines of the path/potential path reflects the low response difficulty involved in walking over the path compared with that involved in walking over the unpaved area (e.g., uneven muddy surface). Response difficulty, according to Jason and Liotta [6], is a major factor in walking behavior. In this study the path was laid along the route most commonly taken by students in baseline so as to make the response difficulty at least as low as that in the baseline condition.

The path also removed or changed the competing contingencies–it minimized the time and distance the subjects travelled while also minimizing damage to the grass and stopped subjects getting wet or dirty shoes when the ground was wet. This is evident in the significantly increased number of people crossing the area when the path was laid. The negatively reinforcing effects of causing grass destruction and the positively punishing effects of getting wet or muddy feet were eliminated by the paved path. Thus, many who previously walked around, rather than across, the experimental area, used the path when it was present. This indicates that they had previously found the negative aspects of crossing the experimental area outweighing the positive ones of decreased effort and travel time. The paved path removed most of the negative aspects of crossing the experimental area, without removing the positive ones [7].

The significant interaction between the experimental conditions and entering/exiting demonstrated that the treatment had a greater effect on exiting behavior than on entering behavior. This was probably because entering (on the path) behavior already exhibited a high rate (90%) for the desired response. Thus little change was or could be made, whereas exiting behavior initially exhibited a lower rate of the desired response (54%) and consequently the room for change in this behavior was much greater. Consequently we can conclude that once people were on the path, in intervention conditions, they tended to remain on the path. This supports the idea of a response chain in the crossing of an area, as proposed by Hayes and Cone [5]. That is, the first response prompts the second which simultaneously reinforces the first and prompts the third response etc. From this it was predicted that people who start on the path would remain on the path, as they did. The chaining concept could equally be used to argue that subjects should have stayed on the "path area" during baselines, however their "path area" was much wider than the path eventually laid so that only half of them stayed on the area later to be covered by the cement block path.

The Cost and Benefit analyses of the effects of the path lead to the conclusion that for a minimal one time cost ($300) it is possible to save maintenance funds, and both protect the grass and improve pedestrian traffic around campus for an estimated 20,000 pedestrian crossings per academic year. This has been recognized by the University, the path has been laid and grass cover is returning to the previously denuded areas adjacent to the paved path.

ACKNOWLEDGMENTS

The authors would like to thank the Grounds Department of the University of Otago for their aid and cooperation.

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