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Aesthetics and logistics in urban parks; can moving waste receptacles to park exits decrease littering?

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ABSTRACT

In this paper we test two approaches to reduce littering in urban parks that potentially reinforce each other: Relocating waste receptacles and the presence of watching eyes. Moving waste receptacles from the interior to the exits of a park makes waste collection more efficient, but can have opposing effects: Decreased littering because of greater care inspired by the perception of natural beauty in a park without artifacts like waste receptacles, or increased littering because of the greater distance to waste receptacles. Preceded by an online study ($N = 153$), three successive field studies showed mixed evidence for increased littering when moving waste receptacles to the exits (Study 2 and 3). However, when additionally attaching pictures of watching animal eyes to trees in the park (Study 4), litter levels seemed to decrease. We conclude that littering is best countered with a combination of persuasive communication and physical measures.

1. Introduction

City parks offer a network of natural areas in an urban context (Torabi et al., 2020). They provide opportunities for recreation (Low et al., 2005, p. 31) and offer the possibility to experience beauty, awareness of natural processes and connectedness to nature (More et al., 1988). Importantly, parks may serve as vital sources for psychological restoration (Hartig & Staats, 2006; Staats et al., 2010). Parks indeed enhance and promote social contact (Peters et al., 2010), physical exercise (Cohen et al., 2007), environmental education (Cranz & Boland, 2004), nature orientation (Lin et al., 2014), and better health at city level (Larson et al., 2016), and thus contribute to a general sense of well-being (Ayala-Azcárraga et al., 2019). Sometimes parks offer local residents the opportunity to grow and harvest vegetables, flowers, and/or herbs in community gardens (Armstrong, 2000). At a more general level, urban parks help increase biodiversity (Cornelis & Hermy, 2004), enhance air quality, and store CO^2 (Nowak & Crane, 2002).

Our premise is that such benefits are structurally affected by the cleanliness of a park environment. Litter – misplaced waste – is an important aspect of actual and perceived cleanliness. A common strategy to prevent littering is placing a large number of small waste receptacles (trash cans) for easy waste disposal where it is mostly produced, i.e., near benches, picnic areas, and/or lawn areas. This can be rather effective in small parks, provided that waste receptacles are emptied frequently. Another strategy is to have no waste receptacles at all and count on the visitors to take all their waste items with them. This applies more often to larger national parks or remote and hard to reach areas according to leave-no-trace principles (Backman et al., 2018). In between these extremes is an approach in which larger waste receptacles are concentrated in one or two places at moderate distances from the busiest locations, making waste collection less labor intensive and thus more efficient. Following similar initiatives across the world (e.g., Johnson, 2015), the latter approach was considered in our city of interest.

Largely unknown is how visitors respond to only having a couple of larger waste receptacles at the exits of a park. Assuming that people perceive a park without waste receptacles as more attractive, one possible answer would be that people will see that the park becomes more beautiful and therefore feel motivated to keep it that way and take their waste items with them (Keizer et al., 2008). On the other hand, distance to waste receptacles is a known predictor of littering (Schultz et al., 2013), perhaps because more distance to waste receptacles implies higher personal costs (i.e., effort), therefore making waste disposal less convenient (Diekmann & Preisendörfer, 2003). Hence, litter levels in the park could either increase or decrease. Moreover, if decreased littering is the goal, would supplementary interventions be required?

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1.1. Littering and waste collection

Litter is a broad term. It applies to anything that can be considered misplaced solid waste (Geller et al., 1980), and is the result of active (i.e., actively placing items in the area when leaving) or passive behavior (i.e., intentionally or unintentionally leaving items behind) (Sibley & Liu, 2003). In both cases, litter levels increase (Chaudhary et al., 2021). Littering in parks generally concerns the things people bring with them to eat, drink, or use for recreational purposes and may not expect to bring back home. Therefore, we focus on items that can be carried manually and should have ended up in a waste receptacle (Almosa et al., 2017a).

The presence of litter has many negative consequences at the environmental, aesthetic, and social level (Schultz et al., 2013). A moderately to heavily littered park will spoil the perceived naturalness of the location. It also suggests that people may not care about the park as much, ultimately creating problems with perceived or actual safety (e.g., Bateson et al., 2015). Crucially, the presence of litter may communicate that violating the common social norm of non-littering is acceptable, which invites more littering (Cialdini et al., 1990; Keizer et al., 2008).

Controlling litter in urban parks is a matter of shared, general interest. Ideally, litter control is a collaborative process in which visitors are responsible for proper waste disposal and the municipality for waste collection. The municipality provides the context for the desired (non) littering behavior mainly through the location and the number of waste receptacles. Given that distance to waste receptacles seems to be a main predictor of littering – further away means more littering (Schultz et al., 2013) – an intuitively effective and often applied strategy is to have a number of small waste receptacles across the entire park.

Such an approach has certain downsides. Even well-designed waste receptacles may take away from the perceived naturalness of the park and impede its potential psychological restorativeness (Hartig et al., 1996; Staats, 2012; Wohlwill & Harris, 1980). An abundance of waste receptacles may also communicate that it is normal to be able to dispose of food waste and other small items, describing a norm of ready availability of waste receptacles (Cialdini et al., 1990). Habituation to their presence will add to this, together with the expectation that all waste receptacles will be emptied frequently. However, emptying many small waste receptacles is extremely laborious because it needs to be done manually by workers on foot or using small vehicles. Removal can be organized much more efficiently by using fewer and centralized larger waste receptacles that can be accessed easily and be emptied by larger waste trucks. This change in logistics would lead to savings in time and money as well as to a lower environmental burden.

Extant research on anti-littering campaigns covers a variety of interventions using persuasive prompts or messages (written or oral), education, involvement or activation of the community, the removal of prior litter, and trash can design (for comprehensive reviews, see Almosa et al., 2017a; Chaudhary et al., 2021; Huffman et al., 1995). Focusing on shape and design, for instance, special lids on waste containers can improve recycling (Duffy & Verges, 2009), and more waste was collected in bird-shaped than unobtrusive receptacles, with less litter found in the vicinity (Geller et al., 1980). Persuasive design of trash cans and the environment reduced littering in a train station (De Kort et al., 2008) and on the beach (Portman et al., 2019). However, other than generally looking at distance (Bator et al., 2011; Schultz et al., 2013) or the effect of extra disposal options (Sibley & Liu, 2003), there is not much research on the relocation of waste receptacles to reduce littering. Building on literature that suggests that the organization of space can shape behavior which, in turn, can be linked with social function (Peponis & Wineman, 2002), we aimed to investigate if simple restructuring of a park environment could help reduce littering.

1.2. Hypotheses and present research

While reorganizing waste collection and removal to using large waste receptacles in easily accessible locations would be labor and cost efficient, it is unclear if such a strategy would be effective in keeping a park clean. Based on different theoretical perspectives, we can formulate contrasting expectations that result in two alternative hypotheses.

Approached from one perspective, removing waste receptacles from the interior of the park may enhance its perceived beauty and naturalness, which in turn can enhance park experience and thus restorativeness (Hartig & Staats, 2006; Lin et al., 2014; More et al., 1988). Seeing the beauty of the park, people may be motivated to protect this by holding on to their waste items until they can get rid of it in an appropriate way (Almosa et al., 2017b; Bator et al., 2011). Together, this leads to our first hypothesis:

Hypothesis 1. When waste receptacles are relocated from inside an urban park to the exits only, littering will decrease.

However, reasoning from a personal cost-perspective (Diekmann & Preisendörfer, 2003) and following findings showing that greater distance to waste receptacles predicts greater littering, litter levels should rather increase when waste receptacles are moved further away (Schultz et al., 2013). If littering becomes the descriptive norm, even slight initial increases may stimulate bigger increases (Cialdini et al., 1990). This leads to an alternative hypothesis with the opposite expectation:

Hypothesis 2. When waste receptacles are relocated from inside an urban park to the exits only, littering will increase.

Of course, relocating waste receptacles involves a simple change to the physical environment in an attempt to trigger a decrease in littering behavior. By itself, such an intervention may not be strong enough to elicit noticeable changes; additional measures may be needed. Literature offers various approaches. One of these uses the prosocial effect of watching eyes, which predominantly rests on concern for reputation (Conty et al., 2016; Manesi et al., 2016; Oda et al., 2011). Research suggests that watching eyes can indeed reduce littering in various environments (Bateson et al., 2015; Dear et al., 2019; Ernest-Jones et al., 2011). As a follow-up to our primary goal of testing the effect of relocating waste receptacles, we investigated if watching eyes could help decrease littering when there are no waste receptacles inside the park, only at the exits. Hence, we posited a third hypothesis:

Hypothesis 3. The presence of watching eyes strengthens the effect of decreased littering when waste receptacles are relocated to the exits of an urban park.

Next to testing these three hypotheses, we planned complementary online (pilot) studies and informative surveys to explore different variables that could explain, confound, counter, or strengthen potential effects of relocating waste receptacles or hanging watching eyes in the park. We did not postulate formal expectations for these variables. Given that beauty and cleanliness perceptions could affect littering (Hypothesis 1), we asked park visitors and online participants about such perceptions. To inform and develop future interventions, we were also interested to hear who people thought would be responsible for maintaining beauty and cleanliness: Park visitors or the municipality. Other factors that could affect littering in specific places – and help explain presence or absence of effects – are park attachment (Williams & Vaske, 2003) or restorative qualities of a park (White et al., 2013). In Study 4, concerns about one's reputation in general (De Cremer & Tyler, 2005) could interact with watching eyes.

Preceded by an online study on perceptions of beauty and cleanliness (Study 1), we conducted three field studies with a behavioral (litter count) and a psychological (questionnaire data) component. The studies were conducted in the context of three consecutive master (Study 1, 2, and 4) and bachelor thesis projects (Study 3). Our report follows the conceptual development of these projects. Hypotheses 1 and 2 were developed and consecutively tested in Studies 1–3. Study 3 was a replication of Study 2 in a different location. From the very beginning we counted with the possibility that relocating waste receptacles to the exits without prior or concurrent communication would not be enough.

Depending on the outcome of the first two field studies, an additional intervention could still be necessary. The specific intervention of watching eyes in Study 4 was proposed by the third group of students, who were informed of the general results of the first two field studies.

We targeted two different medium sized urban parks in Leiden, the Netherlands, a university city with a current population of around 125,000 and a clearly delineated historic inner city. Answers to the questionnaires were based on convenience sampling and collected in the parks at the times litter was counted. For Study 1 we used the online Prolific platform (see Peer et al., 2017). Below we only report on measures pertaining to our research questions. However, all studies contained additional measures; see the Supplementary Information for full details. All studies were approved by the ethics review board of the Institute of Psychology at Leiden University (CEP).

2. Study 1: Beauty in the park

One of the factors that could help reduce littering is greater perceived beauty when waste receptacles are removed from a park. To test if people would rate a park as more beautiful and cleaner when no waste receptacles are in sight, we ran an online study on the Prolific-platform.[1] Our sample consisted of 153 (87 male) participants between 17 and 73 years old, $M_{age} = 29.05$, $SD = 10.42$. Only 16% reported non-European nationalities, with the majority being British (29%); 59% worked full-time or part-time, 25% were students, 7% were looking for a job, 7% were a housewife/-man, 2% were retired. In a mixed 2 (Presence: Waste receptacles present vs not present; within participants) x 2 (Presentation order: Pictures with or without waste receptacles presented first; between participants) design we presented all participants with three pictures of the park also targeted in Study 2 with waste receptacles present, and three of the same location (identical frame, angle, and lighting) without waste receptacles present; see Fig. 1 for an example. We asked them to rate the pictures on a number of aspects regarding park experience. The order of pictures with and without waste receptacles was counterbalanced, and the order of pictures within conditions randomized. Ratings per condition were aggregated over pictures (αs > 0.76). Sensitivity analysis using G*Power (Faul et al., 2009) showed that when setting $\alpha = 0.05$, we had 80% power to detect small to medium effects of $f = 0.11$.

Across all ratings, perceived beauty and cleanliness were positively correlated, $r\,(153) = 0.53$, $p < .001$. Controlling for order effects and in line with expectations we found that a park without visible waste receptacles was consistently rated as more beautiful, $F\,(1, 151) = 95.88$, $p < .001$, $\eta_p^2 = 0.39$, $M_{no\ receptacle} = 5.12$, $SD = 0.95$, $M_{receptacle} = 4.49$, $SD = 1.04$, and more clean, $F\,(1, 151) = 27.93$, $p < .001$, $\eta_p^2 = 0.16$, $M_{no\ receptacle} = 5.76$, $SD = 0.97$, $M_{receptacle} = 5.36$, $SD = 1.24$, than a park with visible waste receptacles. It was also considered more inviting, $F\,(1, 151) = 66.51$, $p < .001$, $\eta_p^2 = 0.31$, $M_{no\ receptacle} = 5.27$, $SD = 1.04$, $M_{receptacle} = 4.72$, $SD = 1.17$, and was more expected to improve one's well-being, $F\,(1, 151) = 53.72$, $p < .001$, $\eta_p^2 = 0.26$, $M_{no\ receptacle} = 5.02$, $SD = 1.23$, $M_{receptacle} = 4.51$, $SD = 1.32$. Asked about responsibility, participants held the municipality ($M_{municipality} = 6.29$, $SD = 0.86$) more responsible for a beautiful park than its visitors ($M_{visitors} = 4.76$, $SD = 1.59$), $t\,(152) = -10.49$, $p < .001$, $CI_{95\%}$ [-1.82, −1.24], whereas visitors were believed to be more responsible for a park's cleanliness, $t\,(152) = 2.94$, $p = .004$, $CI_{95\%}$ [0.08, 0.43], $M_{municipality} = 6.18$, $SD = 0.99$, $M_{visitors} = 6.43$, $SD = 0.90$.

3. Study 2: Van der Werfpark I

Findings of Study 1 suggested that relocating waste receptacles to the exits of a park could positively affect perceived beauty and cleanliness, and thus help reduce littering. We tested this in a first field study. Data were collected in the Van der Werfpark, a well-contained rectangular urban park of about 1.5 ha. It only has exits on each of the short sides, and is bordered by a canal on the northern long side and a line of brick buildings on the southern side (see Fig. 2). Visitors to the park are typically a mix of locals, students, workers, expats, and tourists, and the park is used for a multitude of purposes. Waste receptacles were the ones we had photographed for Study 1 (see Fig. 1).

3.1. Participants and design

For this field experiment we used an A-B-A reversal design (Geller, 1987, 2002). In the first A-phase (Phase 1) we established a baseline with waste receptacles in their regular place within the park. In the intervention B-phase (Phase 2) we moved the waste receptacles to the exits of the park (Fig. 2). For the ensuing reversal A-phase (Phase 3) we restored the original situation. Each phase lasted two consecutive workweeks, starting on Monday morning and ending on Friday afternoon; litter was not counted in the intermittent weekends.

In addition to counting litter, we designed a questionnaire to explore park experience and investigate potential explanations. Participants were recruited throughout the data collection period by randomly approaching visitors to the park at the same timepoints as litter was measured. Answers were entered on the spot using paper and pen. There was no payment or other compensation involved. A total of 184 individuals provided responses. Four were excluded because they retracted their consent, did not understand the questionnaire, or turned out not to be of adult age. The final sample thus consisted of 180 participants (60 per phase), each providing unique responses. Due to some unanswered items, *N*s may vary per analysis. Reported ages ranged from 18 to 86 years, $M_{age} = 38.41$, $SD = 19.25$ ($N = 166$). A little over 50% reported being female; one reported "other" ($N = 177$). One hundred and fifty-one had the Dutch nationality, seven reported other nationalities, and 22 participants did not specify ($N = 180$). Most participants were students (34%) or worked full-time (23%) or part-time (17%) ($N = 175$). An equal number of participants visited the park daily or 2–3 times a week (24%); 30% did so between once a week and once a month, and 22% visited the park less than once a month ($N = 179$). Most visits lasted 15 min or less (64%); 14% stayed up to 30 min, whereas 23% spent more than a half hour ($N = 176$).

3.2. Procedure

Data were collected in the early spring of 2019 (February–April) by two experimenters taking turns following a brief shared calibration period. After noting down a first overall impression of litter level across the park (1 = *no litter* to 5 = *extremely littered*), litter was counted twice daily on weekdays at midmorning and late afternoon at three different locations of about 25 m^2 each. Counts were skipped if too many visitors were around or other unexpected factors hindered observations. This resulted in 60 counts in Phase 1, 54 in Phase 2, and 53 in Phase 3; 167 in total. Sensitivity analysis using G*Power (Faul et al., 2009) showed that with $\alpha = 0.05$ this provided 80% power to detect medium effects of $f = 0.24$.

We focused on the center area of the park (Fig. 2). Location 1 had a bench with a waste receptacle right next to it. This area covered part of the main path and part of a lawn. Location 2 also had a bench in the middle, but no waste receptacle directly next to it. This area covered part of a side path and part of a lawn. Location 3 was part of a lawn next to the main path. Litter was counted and rated on a 5-point scale (see Table 1).

Our main dependent variable was Overall Litter, i.e., mean litter count aggregated over all sizes and locations. To allow for additional analyses exploring potential differences between different sizes of litter, however, a distinction was made between fine (diameter ≤5 cm) and large litter pieces (diameter >5 cm). Because of the large number of individual pieces that for instance included cigarette buds, Fine Litter

[1] https://www.prolific.co.

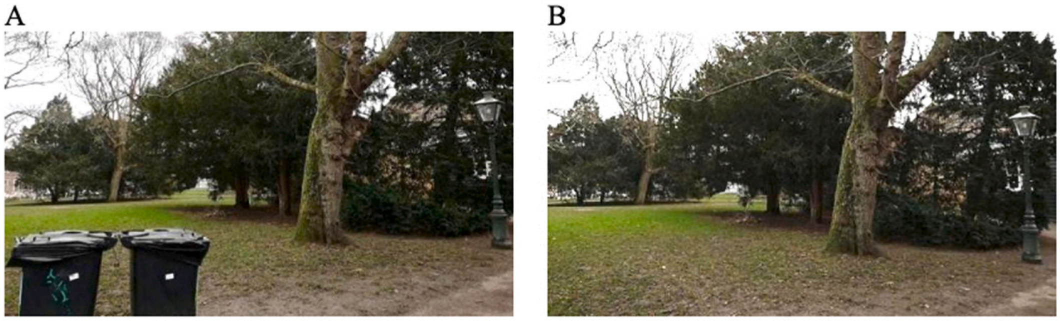

Fig. 1. Example of photos used in Study 1 with (A) and without (B) waste receptacles present. *Note*. Photos: Ellen Smit. All pictures are available in the Supplementary Information.

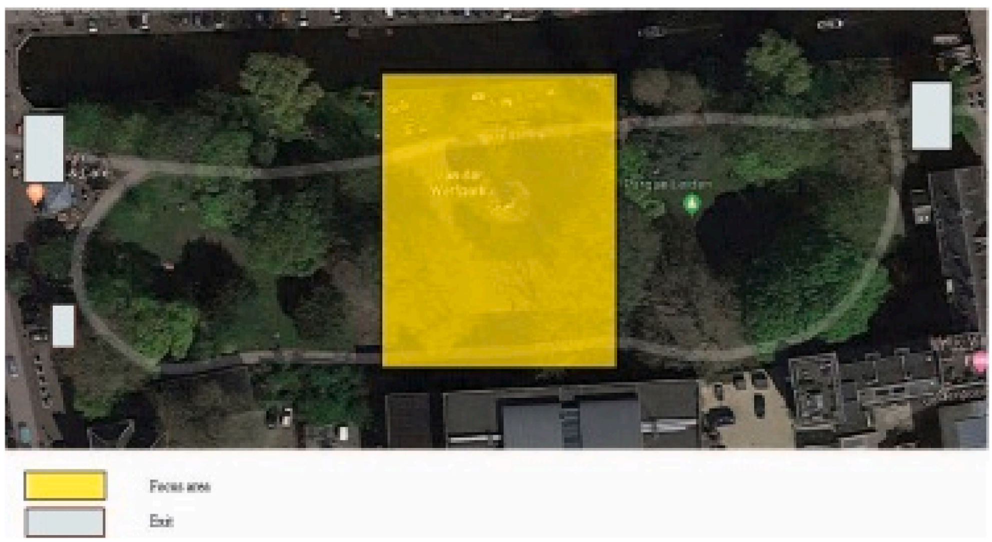

Fig. 2. Van der Werfpark: Layout, focus area, and exits. *Note*. Figure: Milada Speets. Satellite view retrieved from Google Maps.

Table 1
Litter scoring key in Study 2.

Fine Litter Counted per 1 m^2	*Score*	Large Litter Counted per 25 m^2	*Score*
0	1	0	1
1–3	2	1	2
4–10	3	2–3	3
11–25	4	4–5	4
26+	5	6+	5

was averaged across the location, but scored per 1 m^2 to enhance comparability with Large Litter, that was scored per 25 m^2 (Table 1). Weather conditions (temperature in °C, sunshine yes or no) and the number of visitors (7-point scale from 1 = *0–5* to 7 = *31+*) were logged.

In the questionnaire we first collected standard demographics and asked about frequency, duration and activities of park visits. Next, beauty (3 items, $\alpha = 0.87$) and cleanliness (3 items, $\alpha = 91$) of the park were rated on a 9-point scale with opposing anchors, e.g., 1 = *beautiful* (*clean*) to 9 = *ugly* (*dirty*). The scales were reverse coded to let higher scores reflect a more beautiful or cleaner environment. Park attachment was measured using a shortened, five item version (5-point scale from 1 = *strongly disagree* to 5 = *strongly agree*; $\alpha = 0.87$) of an often-used place attachment scale with items like "This park means a lot to me" (Williams & Vaske, 2003). We also asked if it was clear where waste items could be deposited in the park. Moreover, we assessed the perceived accessibility of the waste receptacles and the need for more; all questions were answered on a 7-point scale. In the intervention phase we additionally asked if people had noted the absence of waste receptacles within the park. Finally, we asked to what extent visitors are responsible for a beautiful and a clean park, and the same for the municipality (7-point scales from 1 = *not at all* to 7 = *very much*).

3.3. Results

3.3.1. Litter count

A Linear Mixed Model with Location as subject (random intercepts), Overall Litter (general mean across each phase) as dependent variable, Phase as independent variable, and controlling for number of people in the park and average temperature, revealed a significant main effect of Phase, $F(2, 160.00) = 4.57$, $p = .012$; see Fig. 3 for a visualization of the means per phase and location. Pairwise comparisons with Bonferroni corrections showed a significant difference between Phase 1 ($M_{\text{phase } 1} = 2.16$, $SD = 0.48$) and Phase 2 ($M_{\text{phase } 2} = 2.37$, $SD = 0.81$), $p = .010$, $CI_{95\%}$ [-0.38, −0.04], suggesting a general increase in litter when waste receptacles were moved to the exits of the park. There was no significant difference between Phase 2 and Phase 3 ($M_{\text{phase } 3} = 2.24$, $SD = 0.47$), $p = .196$, $CI_{95\%}$ [-0.04, 0.32], or Phase 1 and Phase 3, $p = .926$, $CI_{95\%}$ [-0.25, 0.10]. Thus, litter increased during the intervention phase, and decreased in the reversal phase to a comparable level as baseline, but not enough to significantly differ from the intervention phase. Number of visitors to the park or average temperature did not affect litter levels, $ps \geq .305$.

As shown in Fig. 3, the effect seemed mainly driven by an increase in

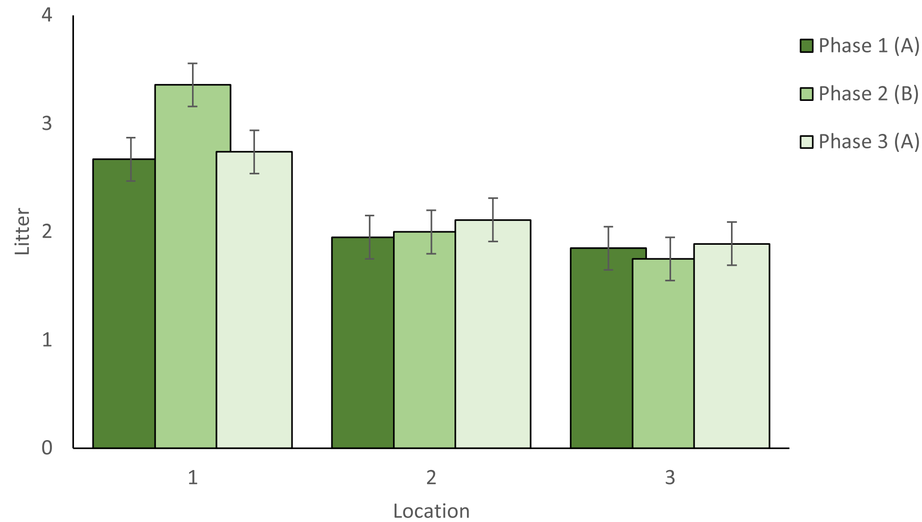

Fig. 3. Overall Litter per phase and location in Study 2. *Note.* Error bars indicate standard error per phase.

litter in Location 1, where a waste receptacle was located right next to the bench in the baseline and reversal phases. ANOVA limited to location 1 showed a main effect of Phase on Overall Litter, F (2, 52) = 18.08, $p < .001$, $\eta^2 = 0.41$. Post hoc tests using Bonferroni corrections showed significant differences between intervention (Phase 2) and baseline (Phase 1), $p < .001$, $CI_{95\%}$ [0.38, 0.99], and intervention (Phase 2) and reversal (Phase 3), $p < .001$, $CI_{95\%}$ [0.31, 0.95], with no difference between baseline (Phase 1) and reversal phase (Phase 3), $p = 1.00$, $CI_{95\%}$ [-0.37, 0.25]. Results were similar when focusing on Large Litter, F (2, 52) = 16.75, $p < .001$, $\eta^2 = 0.39$, but the effect disappeared when looking at Fine Litter, F (2, 52) = 0.90, $p = .412$, $\eta^2 = 0.03$. Thus, the larger pieces in Location 1 mostly determined the general litter increase during the intervention phase.

The pattern of our litter count was confirmed by ANOVA on the first, general impression the experimenters had noted down when entering the park at each observation round. Phase had a significant main effect, F (2, 165) = 10.19, $p < .001$, $\eta^2 = 0.11$, in the sense that the park seemed more heavily littered in Phase 2 (intervention), $M_{phase\ 2} = 2.44$ ($SD = 0.77$), than in Phase 1 (baseline), $M_{phase\ 1} = 1.90$ ($SD = 0.71$), or Phase 3 (reversal), $M_{phase\ 3} = 2.17$ ($SD = 0.38$). Pairwise comparisons using Bonferroni corrections showed the difference between Phase 1 and Phase 2 to be significant, $p < .001$, $CI_{95\%}$ [-0.84, −0.25]; the other two comparisons were not significant: Phase 1-Phase 3, $p = .085$, $CI_{95\%}$ [-0.56, 0.03], and Phase 2-Phase 3, $p = .078$, $CI_{95\%}$ [-0.02, 0.58].

3.3.2. Questionnaire responses

*N*s may vary due to missing data. Based on our questionnaire scores, the different phases did not affect perceived beauty, F (2, 176) = 2.67, $p = .072$, $\eta^2 = 0.03$ ($M_{phase\ 1} = 6.10$, $SD = 1.74$; $M_{phase\ 2} = 5.74$, $SD = 1.45$; $M_{phase\ 3} = 5.38$, $SD = 1.90$), or perceived cleanliness, F (2, 173) = 2.64, $p = .074$, $\eta^2 = 0.03$ ($M_{phase\ 1} = 5.84$, $SD = 1.82$; $M_{phase\ 2} = 5.65$, $SD = 1.64$; $M_{phase\ 3} = 5.08$, $SD = 2.15$). Compared using Bonferroni corrections, means per phase were not statistically different. This pattern held when controlling for park attachment. These results did not corroborate the findings of our online Study 1. Similar to Study 1, participants did think that the municipality ($M_{municipality} = 6.15$, $SD = 0.84$) was more responsible for a beautiful park than its visitors ($M_{visitors} = 3.82$, $SD = 1.54$), t (175) = −16.64, $p < .001$, $CI_{95\%}$ [-2.60, −2.05], whereas visitors were supposed to be slightly more responsible for a park's cleanliness t (175) = 2.94, $p = .004$, $CI_{95\%}$ [0.09, 0.45]; $M_{visitors} = 5.61$, $SD = 1.19$; $M_{municipality} = 5.34$, $SD = 1.11$.

In the intervention phase ($N = 58$), 29% realized that the waste receptacles had been moved only when they were approached to fill in the questionnaire ("something must be going on"), whereas another 29% said to have noticed directly when entering the park; 41% of the visitors had not noticed at all that the waste receptacles had been moved. Phase in general did have an effect on how clear it was where waste could be deposited, F (2, 175) = 13.37, $p < .001$, $\eta^2 = 0.13$; understandable as an effect of moving waste receptacles out of sight, it seemed more clear where waste could be left in the baseline and reversal phases than during the intervention phase ($M_{phase\ 1} = 6.25$, $SD = 0.84$; $M_{phase\ 2} = 4.81$, $SD = 2.24$; $M_{phase\ 3} = 5.86$, $SD = 1.29$). Comparing Phase 1 with Phase 2, post hoc comparisons (Bonferroni) showed a significant difference, $p < .001$, $CI_{95\%}$ [0.74, 2.13], as did Phase 2 versus Phase 3, $p = .001$, $CI_{95\%}$ [-1.75, −0.35], whereas there was no difference between Phase 1 and Phase 3, $p = .543$, $CI_{95\%}$ [-0.31, 1.08]. Results for accessibility of waste receptacles showed a comparable effect, F (2, 173) = 18.95, $p < .001$, $\eta^2 = 0.18$ ($M_{phase\ 1} = 5.93$, $SD = 1.07$; $M_{phase\ 2} = 4.37$, $SD = 1.88$; $M_{phase\ 3} = 5.71$, $SD = 1.40$), with equivalent differences between phases.

3.4. Discussion

Our first field study mainly provided support for Hypothesis 2: In one of the targeted locations litter levels significantly increased when waste receptacles were moved to the exits, but only for the larger pieces of litter. This was corroborated by the general impression the experimenters had logged. Given that the original situation had a waste receptacle directly next to a bench, it is likely that visitors who frequented that bench were not willing to hold on to their waste to deposit it later when leaving the park. Contrary to Study 1, the park was not perceived as more beautiful when no waste receptacles were present. However, the effect of a missing element on carefully cropped two-dimensional photos can certainly be expected to be much higher than in a 360° view of a diversified and sometimes rather busy park environment.

Moreover, cultural differences between the predominantly British (Study 1) versus Dutch (Study 2) samples may have affected the results, as well as the fact that the sample of Study 2 contained more students but was on average older than the sample of Study 1. On the other hand, results of Study 1 and Study 2 converge in suggesting that people agree on who they think is responsible for beauty and cleanliness of a park: In both cases, the municipality should take care of the structure of the park, whereas visitors do play a major role in preserving its cleanliness.

4. Study 3: Ankerpark

To see if the findings of Study 2 would replicate or were park-specific, we next collected data in a different park in the same city that is comparable in layout, the Ankerpark. More than the Van der Werfpark, the Ankerpark is predominantly visited by locals who visit the park rather regularly. Experimenter observations and several visitors' remarks suggest that the park is very often used for dog walking. Waste receptacles in the Ankerpark were identical to those in the van der Werfpark.

4.1. Participants and design

Similar to Study 2, we counted the number of litter pieces and collected responses to a questionnaire. Again using an A-B-A reversal design (Geller, 1987, 2002), we first established a baseline with waste receptacles in their regular place within the park (Phase 1); in the intervention phase (Phase 2) we moved the waste receptacles to the exits of the park; in the reversal phase (Phase 3) we restored the original situation. Litter was again counted at three locations twice a day (at end of the morning and the end of the afternoon) over a period of two workweeks per Phase, with no data collected during the weekends.

Individuals to answer the questionnaire were recruited among the visitors of the park right before the litter counts. Answers were entered on the spot using tablet computers. Although we aimed to recruit 180 participants, only 71 individuals (35 female, two preferred not to say) volunteered, providing unique responses ($N_{\text{phase 1}} = 28$, $N_{\text{phase 2}} = 30$, $N_{\text{phase 3}} = 13$). Age was assessed in five categories. Most participants were 18–25 years old (34%), followed by 26–30 (23%) and 31–50 (24%). A little over 14% was 51–65 years old, and a minority was 65 or older (6%). Over 90% reported Dutch as first nationality, six (9%) reported other nationalities or did not specify. Most participants worked full-time (25%) or part-time (25%) or were student (18%). A majority visited the park daily (35%); 21% visited the park 2–3 times a week, 28% between once a week and once a month, and 16% visited the park less than once a month. Almost 17% of respondents spent 15 min or less in the park, whereas 45% stayed 15–30 min; 38% stayed longer.

4.2. Procedure

Data for our second field study were collected in the late spring of 2019 (March–May) by a group of seven experimenters working in couples. Like Study 2, counting was skipped when too many visitors were around or when other unforeseen factors made a reliable count impossible. There were 51 counts in Phase 1, 60 in Phase 2, and 48 in Phase 3; sensitivity analysis using G*Power (Faul et al., 2009) told that at $\alpha = 0.05$, this provided us with 80% power to detect medium effects of $f = 0.25$.

Compared to Study 2 we decided to add a category for medium-sized litter for a better spread of litter kinds in our data. Littered items were scored as Fine when <5 cm, as Medium when 5–10 cm, and as Large when >10 cm. We scored Fine Litter per 1 m^2, and Medium and Large Litter per 25 m^2 by the same five scoring categories as in Study 2 (Table 1). All measures were combined into a general main dependent variable of Overall Litter.

Although the layout of the Ankerpark is different than that of the Van der Werfpark (Study 2), we chose similar locations with benches with a waste receptacle in the middle (Location 1), a bench with a waste receptacle that was a bit further away (Location 2), and a lawn area (Location 3), all covering about 25 m^2; see Fig. 4. Like in Study 2, weather conditions and number of visitors were logged per observation moment.

The questionnaire of Study 3 was practically similar to that of Study 2. Beauty of the park (3 items, $\alpha = 0.82$) and cleanliness (3 items, $\alpha = 86$) were rated, and park attachment was measured using five items ($\alpha = 0.91$) (Williams & Vaske, 2003). We also assessed to what extent participants felt that visitors versus municipality are responsible for a beautiful and a clean park.

4.3. Results

4.3.1. Litter count

A Linear Mixed Model with Location as subject (random intercepts), Overall Litter as dependent variable, Phase as independent variable, and controlling for number of people in the park and average temperature, showed a significant main effect of Phase, F (2, 152.09) = 35.87, $p < .001$. Pairwise comparisons using Bonferroni corrections revealed a significant difference between Phase 1 ($M_{\text{phase 1}} = 2.78$, $SD = 0.95$) and Phase 2 ($M_{\text{phase 2}} = 3.67$, $SD = 0.67$), $p < .001$, $CI_{95\%}$ [-1.16, −0.62], and between Phase 1 and Phase 3 ($M_{\text{phase 3}} = 3.45$, $SD = 0.74$), $p < .001$, $CI_{95\%}$ [-0.93, −0.31]. There was no significant difference between Phase 2 and Phase 3, $p = .227$, $CI_{95\%}$ [-0.10, 0.63]. Thus, litter increased during the intervention phase, but did not fall back to baseline levels. Even though visual inspection of especially Location 1 would suggest otherwise, the pattern seemed independent of location of data collection; additional ANOVA showed no interaction with Phase, $p = .111$ (Fig. 5). Separate analyses on the three different litter sizes showed comparable effects for Fine Litter, F (2, 151.02) = 23.72, $p < .001$, and Medium Litter, F (2, 126.11) = 50.46, $p < .001$, but not for Large Litter, F (2, 152.12) = 0.36, $p = .697$. The number of visitors to the park or the average temperature was not associated with overall litter levels, $ps \geq .217$.

Confirming this pattern, Phase affected experimenters' first impression of littering when entering the park, F (2, 159) = 9.36, $p < .001$, $\eta^2 = 0.11$. The park seemed less littered in Phase 1 (baseline), $M_{\text{phase 1}} = 2.11$ ($SD = 0.32$) than in Phase 2 (intervention), $M_{\text{phase 2}} = 2.47$ ($SD = 0.57$), which did not really decrease in Phase 3 (reversal), $M_{\text{phase 3}} = 2.44$ ($SD = 0.50$). Post hoc analyses with Bonferroni corrections confirmed that the difference between baseline (Phase 1) and intervention (Phase 2) was significant, $p < .001$, $CI_{95\%}$ [-0.57, −0.14]. Baseline (Phase 1) also differed from reversal (Phase 3), $p = .002$, $CI_{95\%}$ [-0.56, −0.10], whereas intervention (Phase 2) did not differ from reversal (Phase 3), $p = 1.000$, $CI_{95\%}$ [-0.19, 0.25].

4.3.2. Questionnaire responses

When asked about their perceptions, visitors rated neither beauty, F (2, 68) = 0.43, $p = .958$, $\eta^2 = 0.00$ ($M_{\text{phase 1}} = 6.48$, $SD = 1.51$; $M_{\text{phase 2}} = 6.59$, $SD = 1.47$; $M_{\text{phase 3}} = 6.51$, $SD = 1.40$), nor cleanliness of the park, F (2, 68) = 0.18, $p = .836$, $\eta^2 = 0.00$ ($M_{\text{phase 1}} = 6.17$, $SD = 1.90$; $M_{\text{phase 2}} = 6.42$, $SD = 1.47$; $M_{\text{phase 3}} = 6.28$, $SD = 1.28$), differently across phases (Bonferroni corrections). This was similar to the responses in Study 2. Controlling for park attachment did not change this. Like before, participants indicated that the municipality ($M_{\text{municipality}} = 4.28$, $SD = 0.83$) was more responsible for a beautiful park than its visitors ($M_{\text{visitors}} = 3.13$, $SD = 1.17$), t (70) = −6.85, $p < .001$, $CI_{95\%}$ [-1.49, −0.82]. However, in this sample there was no difference in perceived responsibility for a clean park t (70) = −0.12, $p = .902$, $CI_{95\%}$ [-0.24, 0.21], $M_{\text{municipality}} = 4.14$ ($SD = 0.80$), $M_{\text{visitors}} = 4.13$ ($SD = 0.99$).

4.4. Discussion

Like in Study 2, we found mixed evidence with regards to the effects of our intervention. Again, results mainly supported Hypothesis 2 by showing higher litter levels after starting the intervention. However, litter levels did not revert to baseline levels when the situation was restored. Therefore, the negative effect of moving waste receptacles on littering could not be confirmed unequivocally. This provided room to test if additional measures could counteract or even reverse the negative tendency we saw in Studies 2 and 3. For participants in the Ankerpark, responsibility for a clean park seemed to be equally shared between municipality and visitors. Like the previous study, perceived beauty was not affected by our intervention.

Fig. 4. Locations in the Ankerpark (Study 3). *Note.* Figure: Lisa van der Laan.

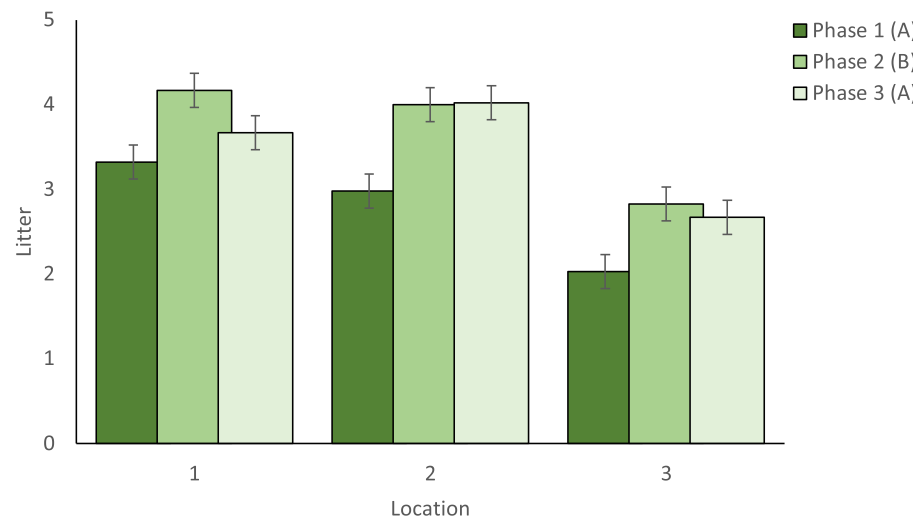

Fig. 5. Overall Litter per phase and location in Study 3. *Note.* Error bars indicate standard error per phase.

5. Study 4: Van der Werfpark II

In Study 4 we went back to the Van der Werfpark of Study 2 to see if supplementing waste receptacle relocation with an additional intervention would lead to the expected reduction in littering as stated in Hypothesis 3. We turned to the well-documented research on the effect of watching eyes on prosocial behavior in general and littering in particular (Bateson et al., 2015; Dear et al., 2019). However, the most relevant studies used pictures of human eyes that were attached to objects that potentially could become litter items. Here we decided to "give eyes to nature" by attaching pictures of animal eyes to trees in the real world setting of a park and to concentrate on regular, everyday litter. We first looked at the effect of watching eyes by itself, and then tested if watching eyes would enhance decreased littering when relocating the waste receptacles to the exits of the park (Hypothesis 3). On an exploratory basis, we also assessed reputational concerns, restorativeness of the park environment, and other variables relevant for park experience.

5.1. Participants and design

Following the previous field studies we counted litter in the park and collected responses to a questionnaire. We designed three conditions: A baseline measurement (Phase 1) followed by two cumulative interventions: Adding eyes to the park (Phase 2) and additionally relocating the waste receptacles to the exits of the park (Phase 3). Following Studies 2 and 3, litter levels were assessed at similar time points and locations across phases. Additionally, a total of 139 individuals from 17 to 78 years old, 82 of whom were female, $M_{age} = 33.44$, $SD = 16.43$ ($N = 136$), filled in our questionnaire on tablet computers. A majority reported being of Dutch nationality (58%), followed by other European (24%) and other nationalities (18%) ($N = 137$). Half of the participants (50%) was student, and 33% reported to be employed ($N = 138$). Most individuals visited the park either daily (22%) or weekly (43%) for recreational (48%) or restorative purposes (12%), and/or to walk the dog (24%) ($N = 139$).

5.2. Procedure

Following the previous procedures, we collected data in three consecutive phases of two workweeks each, not counting in the weekends. This third field study was conducted in the early fall of 2019 (September–October) in the same park as Study 2 (Van der Werfpark). We scheduled one week of break between Phase 2 and Phase 3 due to festivities surrounding Leiden Liberation Day; this is a highly visited local holiday with unrepresentatively high levels of litter by default. Similar to the previous studies, there were 58 counts in Phase 1, 56 in Phase 2, and 56 in Phase 3. Setting α at 0.05, sensitivity analysis using G*Power (Faul et al., 2009) indicated 80% power to detect medium effects of $f = 0.24$.

Following Study 2, we targeted three locations of about 25 m^2 each around the central statue in the park, which differed in the presence of benches right next to waste receptacles (Location 1), a bench with more distance to the nearest waste receptacle (Location 2), and a lawn area without waste receptacles (Location 3). In Phase 1 we took our baseline measures with the regular set-up of the waste receptacles within the park. For Phase 2, we attached ten pictures of animal eyes (five cat and five owl eyes; see Fig. 6) to trees in the vicinity and along the walkways to the counting locations (Fig. 7). The stimuli were selected based on a pilot study; see the Supplementary Information for procedure and results. In Phase 3 this was complemented by moving the waste receptacles to the exits of the park, away from their regular spot within the park (see Fig. 2).

Echoing Study 3, litter was assessed in three sizes: Fine (<5 cm), Medium (5–10 cm), and Large Litter (>10 cm), and was counted twice on workdays at mid-morning and late afternoon during two consecutive weeks per phase (six weeks total). In this study, litter was counted per individual piece. To better compare the results to those of Studies 2 and 3, we divided the scores for fine litter by 25 to reflect the amount of litter per 1 m^2. As our main dependent variable, we aggregated scores over all sizes of litter (Overall Litter). Like in the previous studies, we made note of the weather conditions and the number of visitors.

In the questionnaire, restorative power of the park (Restorativeness) was assessed with two items: "The park made me feel refreshed and revitalised," and "The park made me feel calm and relaxed" (5-point scale from 1 = *strongly disagree* to 5 = *strongly agree*; $r = 0.86$, $p < .001$; $\alpha = 0.92$) (White et al., 2013). We assessed place dependence and place identity as two dimensions of place attachment. Place Dependence was measured with four items, e.g., "I get more satisfaction out of visiting the Van der Werfpark than any other park." To improve an initially low reliability of $\alpha = 0.56$, we deleted one item: "The things I do at the Van der Werfpark I would enjoy doing just as much at a similar site" (reverse coded), resulting in a three-item scale, $\alpha = 0.68$. Place Identity was measured with seven items, e.g., "I identify strongly with the Van der Werfpark" ($\alpha = 0.91$), all answered on a 5-point scale from 1 = *strongly disagree* to 5 = *strongly agree.* The two factors were also combined into a full scale of Place Attachment ($\alpha = 0.90$) (Williams & Vaske, 2003). Finally, we assessed Concern for Reputation using seven previously validated items, e.g., "I wish to have a good reputation," answered on a 5-point scale from 1 = *not at all characteristic for me* to 5 = *extremely characteristic for me*; $\alpha = 0.74$ ($N = 138$) (De Cremer & Tyler, 2005).

5.3. Results

5.3.1. Litter count

Mean scores for Overall Litter per phase and location are presented in Fig. 8. Supporting Hypothesis 1, scores suggest that litter levels had decreased from Phase 1 (baseline) to Phase 2 (adding eyes) and Phase 3 (eyes still present and waste receptacles moved to exits); $M_{\text{phase 1}} = 7.21$, $SD = 6.38$; $M_{\text{phase 2}} = 5.93$, $SD = 6.17$; $M_{\text{phase 3}} = 4.43$, $SD = 5.01$. A Linear Mixed Model with Location as subject (random intercepts), Overall Litter as dependent variable, and controlling for number of people in the park and average temperature, revealed a significant main effect, F (2, 503.02) = 19.84, $p < .001$. Pairwise comparisons with Bonferroni adjustment showed all differences between phases to be significant: Phase 1-Phase 2, $p = .006$, $CI_{95\%}$ [0.40, 3.21]; Phase 1-Phase 3, $p < .001$, $CI_{95\%}$ [2.63, 5.90], Phase 2-Phase 3, $p < .001$, $CI_{95\%}$ [1.03, 3.89].[2] Moreover, more people meant more litter in this study, $b = 0.55$, F (1, 503.01) = 10.07, $p = .002$, which possibly partialled out the expected positive association of higher temperatures with more littering ($r = 0.04$, $p = .357$), $b = -0.58$, F (1, 503.00) = 14.52, $p < .001$.

Additional analyses with Fine, Medium, and Large Litter as separate dependent variables again showed significant main effects for Phase, $ps < .001$. The effect for Medium Litter was similar to that of Overall Litter reported above. Fine Litter showed the same pattern, although the difference between Phase 1 and 2 was not significant for this variable, $p = .193$, $CI_{95\%}$ [-0.33, 2.53]. For Large Litter the effect was actually reversed, in that levels increased from baseline, with no significant difference between Phase 1 and 2. However, this reversal may be attributed to the very few large items that were counted ($M_{\text{phase 1}} = 0.81$, $SD = 1.92$; $M_{\text{phase 2}} = 1.27$, $SD = 1.88$; $M_{\text{phase 3}} = 3.64$, $SD = 4.45$).

The effect of Phase on the experimenters' first general impression of littering when entering the park was not fully in line with the counted actual level, because the park was perceived as most littered in Phase 3; $M_{\text{phase 1}} = 2.90$, $SD = 0.89$; $M_{\text{phase 2}} = 2.42$, $SD = 0.68$; $M_{\text{phase 3}} = 3.50$, $SD = 0.74$. ANOVA revealed a significant main effect, F (2, 528) = 85.06, $p < .001$, $\eta^2 = 0.24$, with all pairwise comparisons (Bonferroni) showing significantly different, $p < .001$: Phase 1-Phase 2 $CI_{95\%}$ [0.28, 0.68]; Phase 1-Phase 3 $CI_{95\%}$ [-0.80, −0.40]; Phase 2-Phase 3 $CI_{95\%}$ [-1.28, −0.88].

5.3.2. Questionnaire responses

For an overview of correlations, see Table 2. Reputational Concern, Restorativeness, nor Place Attachment was affected by Phase, $ps \geq .072$. Notably, the general mean of restorativeness ($M = 3.91$) was higher than the scale midpoint of 3, t (138) = 10.76, $p < .001$, $CI_{95\%}$ [0.74, 1.08], confirming the functionality of a city park like the Van der Werfpark (Staats et al., 2016).

5.4. Discussion

Other than Study 2 and 3, Study 4 mainly provided support for Hypothesis 1: Litter levels decreased especially in the final phase when waste receptacles were moved to the exits of the park while watching animal eyes were still present in the park. Moreover – but depending on the analysis, see footnote 2 – the presence of such eyes in and of itself already helped to decrease litter. Remarkably, littering was counted as lowest in the last phase, but experientially (i.e., the first impression when entering the park) perceived as greatest. This may have been triggered by a few easily visible larger items.

One of the limitations of Study 4 is the order of the intervention conditions. We decided to use this order because we could build on the findings of Studies 2 and 3. However, it remains to be seen whether a similar effect would be found when waste receptacles are moved to the exits some time before the watching eyes are installed. Future research could test this to better tease apart the separate effects.

6. General discussion

The placement of waste receptacles in urban parks is an important issue in fighting litter. Many parks have a number of small waste receptacles strategically positioned across the grounds, preferably close to benches and along busy walkways. Emptying those is rather labor intensive, however. Relocating waste receptacles to the park exits for more efficient waste collection can offer a solution, but only under certain conditions. To investigate, we removed all waste receptacles from within an urban park and placed them at the exits in three consecutive field studies. We found that without further communication or other interventions litter levels increased from initial baseline (Study 2 and 3). However, adding a psychological intervention in the form of watching animal eyes reversed this effect and made for a slightly cleaner environment (Study 4).

[2] However, when using the original grand mean of absolute count of litter, the difference between Phase 1 and Phase 2 was not significant, $p = .309$ (Bonferroni), whereas Phase 3 still differed from Phase 1 and 2, $ps < .001$. When we additionally recoded the scores into categories like in Studies 1 and 2 (see Table 1), patterns and main effect remained, but only the difference between Phase 1 and Phase 3 was significant, $p = .013$ (Bonferroni). Using the less conservative LSD, the difference between Phase 1 and Phase 2 became significant as well, $p = .047$, with no difference between Phases 2 and 3, $p = .193$. Across all models, then, the difference between Phase 1 and Phase 3 seems most robust.

Fig. 6. Stimulus material used in Study 4. *Note.* Five prints of each stimulus were attached to trees throughout the park within eyesight of the data collection areas (see Fig. 7). Figure: Milada Speets.

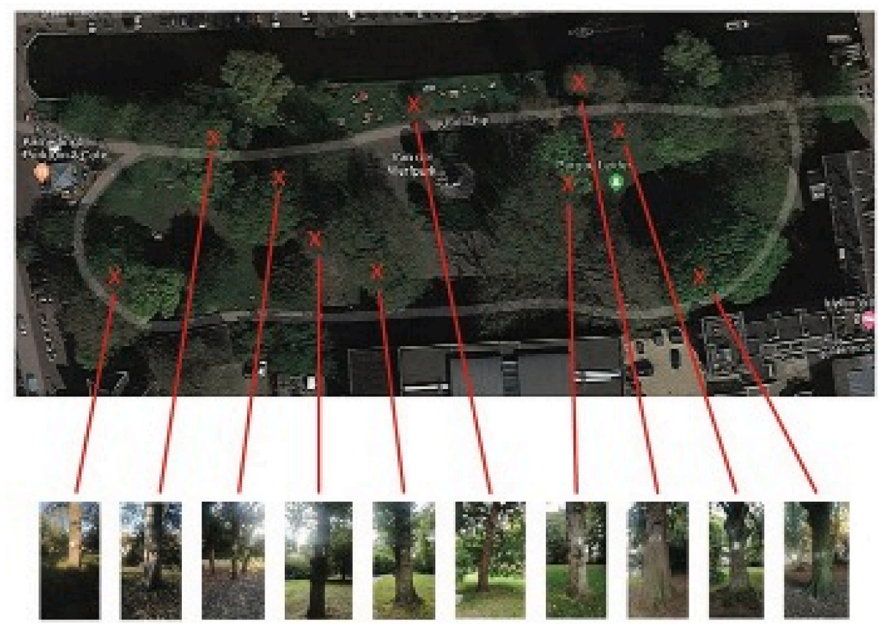

Fig. 7. Placement of the stimuli in Study 4 (Van der Werfpark). *Note.* Figure: Milada Speets. Satellite view retrieved from Google Maps.

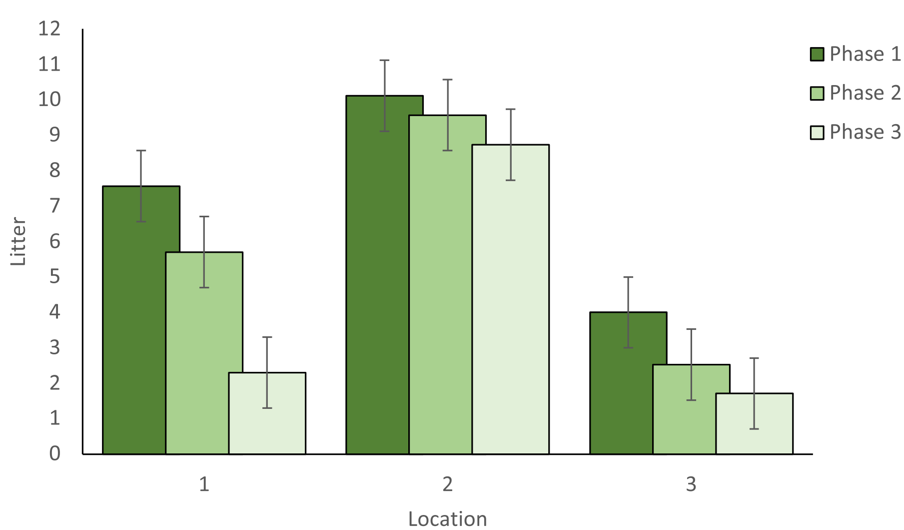

Fig. 8. Overall Litter per phase and location in Study 4. *Note.* Error bars indicate standard error per phase.

Table 2
Pearson correlations in Study 4.

		1	2	3	4
1	Reputational Concern	–			
2	Restorativeness	0.14	–		
3	Place Attachment (full)	0.03	0.19*	–	
4	*Identity*	0.10	0.23**	0.90***	–
5	*Dependence*	-0.05	0.22**	0.84***	0.61***

*$p < .05$. **$p < .01$. ***$p < .001$.

6.1. Hypotheses

We tested two alternative hypotheses predicting decreasing (Hypothesis 1) versus increasing (Hypothesis 2) litter levels following relocation of waste receptacles to the exits of a park. In two of our studies we found increased levels of litter, thus providing support for Hypothesis 2. When waste receptacles are too far away, people may not be prepared to hold on to their waste items for the next available opportunity to discard them (Schultz et al., 2013), very likely because they are not willing to spend the effort (Diekmann & Preisendörfer, 2003). People may also be habituated to specific locations for waste disposal and unsure where to leave their waste items when receptacles are not in their usual spot. To illustrate, on a few occasions we found some waste items deposited at the exact prior location of a removed waste receptacle in the experimental conditions, sometimes neatly wrapped in a plastic trash bag.

Additionally, other research found that around 25% of people say to only litter when there is no waste receptacle nearby, and that availability of waste receptacles would be most effective in preventing them from littering (Al-Khatib et al., 2009). Moreover, research on descriptive norms suggests that litter will attract littering (Cialdini et al., 1990). This may help explain why litter levels in Phase 3 generally did not revert to baseline levels (Phase 1) in Study 2 and 3. Together, evidence from the these two studies suggests that simply removing waste receptacles from parks is not a good strategy to address littering.

Hypothesis 1 suggested an opposite effect: Relocation of waste receptacles to the park exits would lead to a decrease in littering. This could be expected because the park would be more beautiful and feel more natural without the presence of a collection of human-made and not-so-pretty waste receptacles – in our case standard 240 l grey waste receptacles. A cleaner, more beautiful, and more natural environment should lead to a better experience overall, and to greater restorativeness (Hartig & Staats, 2006; Lin et al., 2014; More et al., 1988). Especially regular visitors may be inclined to protect this aspect of 'their' park (Williams & Vaske, 2003).

In Study 1, people indeed rated scenes from a park without waste receptacles as more beautiful and cleaner than the same scenes with waste receptacles. The waste receptacles on the photos were the same we used in the subsequent field studies, which were waste receptacles with closed lids so people could not see how full they were (Fig. 1). A park without waste receptacles was also considered more inviting and beneficial for one's well-being. However, these ratings were not replicated in the field studies. One explanation is that waste receptacles are but one element in a visually rather complex environment with a myriad of stimuli. Next to natural (trees, bushes) and structural (benches, pathways, statues) elements, there is also the number and diversity of human and canine visitors. If any, the effect of the presence of waste receptacles on beauty and cleanliness perceptions in real-life environments will be subtle and, more importantly, may only become visible when combined with other interventions.

The potential effectiveness of integrated interventions (Cingolani et al., 2016; Liu & Sibley, 2004) was emphasized in Study 4. In support of Hypothesis 3, the presence of watching animal eyes in the park (Fig. 6) in combination with relocating the existing waste receptacles to the exits of the park led to lower levels of litter overall – although visitors indicated that the few remaining large pieces of litter remained an eyesore. Once again, this confirms that reasons and hurdles for pro-environmental behavior are complex. It pays off to combine interventions that are based on different but complementary theoretical frameworks (Kollmuss & Agyeman, 2002). In our case, combining the expected psychological restorativeness of a cleaner and prettier environment derived from one body of literature (Berto, 2014) with the expected prosocial effects of watching eyes inspired on another line of research (Dear et al., 2019) may have led to the projected behavioral change.

6.2. Eyes in the park

Why would pictures of eyes in the park help reduce littering? Converging evidence suggests that the behavioral effects of watching eyes can be traced back to reputational concerns that come with the feeling of being watched (Conty et al., 2016; Oda et al., 2011). Although we have no data to support this, we can speculate that such concerns trigger a common social norm of non-littering. As argued in evolutionary psychology, this care for a positive reputation is likely related to the long-term behavioral benefits of cooperative behavior for the individual within the group. Provided that a sustainable environment is of collective interest, environmentally friendly behavior gives a costly signal that one is willing to make an effort for the common good (Griskevicius et al., 2010). Not littering by holding on to one's waste items until the next available waste receptacle would be a good example of such cooperative efforts.

Furthermore, research shows that pictures of eyes suffice to imply human presence. The depicted eyes do not even have to be realistic. For example, stylized eyespots increased cooperation in a series of dictator games (Haley & Fessler, 2005), and eyespots on butterfly wings enhanced attitudes towards nature conservation (Manesi et al., 2015). However, eyes do need to look like they are paying attention, and must not look away (Manesi et al., 2016). Such watching eyes then trigger heuristics or subconscious concerns regarding social exchange mechanisms that will promote prosocial behavior (Baillon et al., 2013; Conty et al., 2016). Findings have not always been consistent, though. Addressing this, a recent meta-analysis suggests that watching eyes are better at reducing antisocial behavior than at increasing prosocial behavior (Dear et al., 2019). That littering is often seen as antisocial supports the idea that watching eyes in the park contributed to the litter decrease in our combined intervention (Bator et al., 2011; Weaver, 2015).

It should be noted that we used animal eyes rather than human eyes to emphasize the natural environment of the park. We assumed that "giving eyes to nature" would give the park a hint of personality, including all the flora and fauna that belongs to it. Moreover, the effect of instantly anthropomorphizing eye-like shapes is well established, and also pertains to social effects across species (Haley & Fessler, 2005; Kwan et al., 2008; Root-Bernstein et al., 2013). Once the step from animal eyes to a person with an individuality is made, a next step of attributing mental states will follow (Waytz et al., 2010). Taken together, watching animal eyes might trigger reputational concerns in the same way as human eyes do; future research could investigate this more specifically.

6.3. Practical implications

When looking at the practical implications, the main finding of our studies is that a simple reorganization of waste collection by relocating existing receptacles to the exits of a park is not effective. Littering is likely to increase, which will require extra and usually costly cleaning rounds. However, a focused blend of appropriate interventions has more chance when fighting litter. We found that a combination of watching eyes and no waste receptacles within the confines of the park helped to decrease litter levels – even though it was small and not perceived as such (Study 4). From the perspectives of environmental protection and efficiency in waste collection, this is hopeful. Given the multifaceted and complex psychological mechanisms that shape environmentally friendly behavior, an integration of approaches is more likely to help reduce littering than targeting a single mechanism (Liu & Sibley, 2004).

We base this suggestion on our test of relocating waste receptacles in combination with watching animal eyes in a short intervention. Such a strategy may not be a long-term solution and does not disqualify other kinds of interventions and/or combinations. Instead of using eyes, one could think of (audiovisual) media campaigns at the local, regional, or even national level, or specific signposting at the entrances or throughout the park. Waste receptacles do not need to be located at the exits specifically, as long as there is an efficient way of emptying them on time to prevent spillage.

6.4. Limitations

When running field studies, controlling the test environment is notoriously difficult. Following a strict protocol that was similar across the studies, we standardized data collection as much as possible. However, we had no control over the weather, visiting frequency, unexpected social gatherings or the lack thereof, and other unforeseen events. We logged and statistically controlled for some of these, but caution is advised when generalizing our findings and conclusions. Also, the field studies were conducted at various seasons. On the one hand this provides valuable information on littering throughout the year, on the other hand it limits the internal comparability of the studies.

A similar caveat applies to the fact that we did not collect information on the cleaning routines within the parks. To preserve a realistic view we deliberately asked the municipality to maintain the parks in exactly the same way as always. This entailed emptying the waste receptacles and picking up litter when needed on visual inspection. We did not expect this to affect our conclusions, however, because cleaning routines are an inherent part of the status quo of any urban park. Moreover, we collected data twice a day to accurately assess the daily litter levels. The one-week break between Phase 2 and Phase 3 in Study 4 was designed to go back to baseline after the anticipated higher litter levels caused by a local holiday (Reiter & Samuel, 1980). Future research could additionally log waste collection to protect against any unexpected confounding effects.

A major limitation to our field studies is that our student raters were not blind to condition, a critically important criterion in observational studies. In the practical organization of data collection within the thesis projects this was not feasible. Hence, conscious or unconscious bias in the direction of the raters' hypotheses could not be ruled out. Our conclusions should be held against this light. This being the case, a priori agreement among raters was even more important. We defined a clear counting strategy at the beginning of all studies. Each individual rater received explicit instructions. The first two days of Study 2 and 4 started with two raters who counted individually and then compared and corroborated the results. After this, counts were performed mostly individually. In Study 3, there were always two raters working together, although not always the same. This strategy made it possible to collect the necessary data within the three student projects while maintaining intersubjectively validated counts. A downside is that we could not compute formal interrater reliability. Future research could use fully independent raters.

Another limitation pertains to the unique and different characteristics of the two parks we targeted. Each of the parks had its own specific mix of visitors. The Van der Werfpark attracts a variety of individuals ranging from locals and students to one-time tourists (Studies 2 and 4). The Ankerpark has a much more local clientele (Study 3). This was reflected in a slightly higher score on Place Attachment in the Ankerpark, $M_{\text{Study 3}} = 2.82$ ($SD = 1.08$), as compared to the Van der Werfpark, $M_{\text{Study 2}} = 2.53$ ($SD = 0.96$) and $M_{\text{Study 4}} = 2.73$ ($SD = 0.64$), respectively. However, only the difference between Study 3 and Study 2 was significant, $t\,(248) = 2.04$, $p = .043$, $CI_{95\%}$ [0.010, 0.561]. Future research could take such distinctions into account by targeting similar parks as well as extending the experimental scope to include different kinds of parks.

Finally, the experimental conditions in our field studies only lasted two weeks each, with a stepwise combined intervention over four weeks in Study 4. We have no data on long-term effects; future research could investigate if and how our findings fit in long-term anti-littering strategies.

7. Concluding remarks

Our studies confirm that littering is a complex issue with a mix of behavioral and psychological explanations that is best addressed with a similar mix of interventions. A decent body of work investigated behavioral solutions (Almosa et al., 2017a; Chaudhary et al., 2021; Huffman et al., 1995), whereas other work addressed various psychological factors and social contexts to understand littering (e.g., Bonnes et al., 2011; Brown et al., 2010; Long et al., 2014). However, successful anti-littering campaigns will require methodical combinations of the two approaches.

In terms of our research, complementary interventions are needed to decrease littering in urban parks. For example, only having (larger) roadside waste receptacles at the exits of parks with easy access for waste trucks seems attractive from a logistical (i.e., municipal) point of view, but our results suggest that this may lead to the opposite effect, compromising the benefits that urban parks may have in terms of natural environment and psychological wellbeing. More is needed to change the public's behavior. Giving eyes to nature may be one of the ways to guide behavior in the direction of a more sustainable city that offers the occasional green space to psychologically restore oneself.

CRediT authorship contribution statement

Niels J. Van Doesum: Conceptualization, Methodology, Supervision, Formal analysis, Writing – original draft. **Arianne J. van der Wal:** Conceptualization, Methodology, Writing – review & editing. **Christine Boomsma:** Conceptualization, Methodology, Writing – review & editing. **Henk Staats:** Conceptualization, Methodology, Writing – review & editing.

Declaration of competing interest

None.

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Appendix A. Supplementary Information

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2021.101669.

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