Littering in Context: Personal and Environmental Predictors of Littering Behavior

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Abstract

This article reports the results from a large-scale study of littering behavior. Findings are reported from coded observations of the littering behavior among 9,757 individuals at 130 outdoor public locations in the United States. The focus was on littering behavior of any item, but a separate sample is also reported on the littering behavior of only smokers. For smokers, the observed littering rate for cigarette butts was 65%. Results from the general littering observations showed that of all the disposal behaviors observed, 17% resulted in litter. Statistical analyses using multilevel modeling showed that age (negatively) was predictive of individual littering. At the level of the site, the presence of existing litter (positively) and the availability of trash receptacles (negatively) predicted littering. Supplemental analyses showed that among individuals who disposed of an item, distance to the receptacle was positively predictive of littering. Implications for litter prevention strategies are discussed.

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Litter is any piece of misplaced solid waste (Geller, 1980). This can range from small items, such as cigarette butts or candy wrappers, to abandoned automobiles, appliances, and even spacecraft. Most commonly, litter refers to items that are discarded by an individual, but it can include any item that is in an unacceptable location, regardless of the origin. This could not only include the candy wrapper dropped on the ground but also the newspaper that blows out of a trash can. The distinction here is between litter (the item) and littering (the behavior). Although the exact percentage of litter attributed to improper disposal behavior by individuals is unknown, there is evidence to suggest that a large majority of litter is linked with individual disposals (MSW Consultants, 2009). A recent analysis of the sources of litter along roadsides attributed 70% to individuals (52% to motorists and 18% to pedestrians). In comparison, 21% came from unsecured loads, 5% from the vehicles themselves (e.g., tires and vehicle debris), and 3% came from unsecured containers in the nearby vicinity. Similarly, at transition points such as bus stops, 88% of the small littered items were attributed to individuals, as was 90% of large items (69% to pedestrians and 21% to motorists). These findings underscore the importance of the individual as a source of litter.

Litter poses a number of important environmental, social, and aesthetic problems. As an environmental problem, litter is a substantial source of contamination. Misplaced plastics, Styrofoam, paper, glass, and many other commonly used consumer materials accumulate in the environment, posing a number of harmful environmental consequences. The social problems related to litter include safety hazards, fire hazards, human health hazards, and indirect health hazards from bacteria, rats, roaches, and mosquitoes that are attracted to litter. In addition, litter is predictive of changing crime rates in a community (Brown, Perkins, & Brown, 2004), and there is experimental evidence showing that the presence of litter results in an increase in other social transgressions like theft (Keizer, Lindenberg, & Steg, 2008). There are aesthetic issues

with litter, as there is near unanimous agreement that litter is unsightly (Pandey, 1990). Indeed, the presence of litter in a residential com- munity decreases property value, and litter in commercial areas reduces sales and attracts fewer customers (National Association of Home Builders, 2009; Skogan, 1990). Finally, there are the direct costs of litter cleanup, which conservatively tops US$11 billion annually in the United States (MSW Consultants, 2009).

Given the myriad of problems that result from litter, it is not surprising that a sizable amount of research has focused on understanding and preventing it. Litter was one of the first environmental problems to lend itself to systematic behavioral research, with studies going back more than 40 years. In an early 1968 study, Keep America Beautiful (KAB) reported on the attitudes, beliefs, and self-reported behaviors among a large national sample (Public Opinion Surveys, Inc., 1968). Subsequently, studies throughout the 1970s were used as a basis for creating litter prevention programs (Burgess, Clark, & Hendee, 1971; Cone & Hayes, 1980; Geller, Winett, & Everett, 1982). In the section below, the three dominant approaches to understanding litter and littering behavior are summarized.

Prior Studies of Litter

Who litters? One approach to understanding littering focuses on the demo- graphic and personal qualities of the type of person who litters—the "litter bug." Although much of these data come from surveys in which people self- report littering rates, a few studies have conducted observations (e.g., distributing a marked flyer or handbill under varying conditions and monitoring to see which accumulate as litter). The widely accepted conclusions from these studies are that littering is more common among males, younger adults, and individuals living in rural communities more than cities. However, the research results on these characteristics of the "litter bug" are far from conclusive and many studies have failed to find significant demographic predictors (Beck, 2007; Finnie, 1973; Geller, Witmer, & Tuso, 1977). As a result, there

is little consistent evidence for demographic characteristics of the "litter bug."

How often do people litter? Given the volume of litter that accumulates nationally and worldwide, it is important to understand the littering behavior of individuals. One way to address this question is by watching the behavior of individuals in public spaces (Geller et al., 1977; Heberlein, 1971). Although only a handful of studies have utilized observational methods, the results are instructive. An early study by Finnie (1973) reported observations of individuals in four outdoor spaces in Philadelphia as they ate hot dogs purchased from street vendors. Of the 272 observed individuals, 91 littered the wrapper (33%). Littering was more common in sites that were already littered and in sites without trash receptacles. Similarly, Cialdini, Kallgren, and Reno (1991) and Cialdini, Reno, and Kallgren (1990) placed flyers on the windshields of parked cars and observed the percentage of individuals who littered. In one illustrative finding, they found that 14% of the individuals littered when the environment was litter free, whereas 32% littered into an already-littered environment. In an interesting extension of these findings, Keizer et al. (2008) found that participants were more likely to litter into "disordered" settings (those with graffiti or fireworks or shopping carts left unreturned). These findings illustrate the importance of understanding the role of the physical context in facilitating or discouraging littering behavior, and similar results have been reported in other studies (Williams, Curnow, & Streker, 1997).

Collected litter. By far, the most commonly used method for litter research is to count and characterize the types of litter collected from different locations (KAB, 2007). Litter cleanups happen on a regular basis, including the KAB (2007) Great American Cleanup, regular Adopt-a-Highway cleanups, and the Ocean Conservancy's International Coastal Cleanup. In addition, states and local governments regularly conduct "litter surveys" to identify the types and sources of materials found along roadways throughout the country. These events remove millions of pounds of litter annually from roadways, parks,

shorelines, and natural areas worldwide. In the 2007 Coastal Cleanup, the Ocean Conservancy collected 6 million pounds of materials, including cigarette butts (1,971,551 or 27% of all collected items), food wrappers (10% of collected items), caps and lids (9%), bags (8%), plastic beverage bottles (7%), plastic utensils (5%), and glass beverage bottles (5%; Ocean Conservancy, 2007).

The current study involved making unobtrusive observations of disposal behavior of pedestrians at outdoor sites in which we simultaneously examined demographic characteristics of the participants as well as contextual variables such as the presence, characteristics, and placement of receptacles. As an extension of prior littering studies, the current work examined both person-level and context-level predictors of observed littering behavior using a multilevel modeling framework.

Current Project

Although there is a long history of research on litter and littering, a number of fundamental questions remain to be answered. In the current article, the results from a nationwide study of littering behavior are reported. This research investigation had three goals: (a) to conduct an observational study of littering behavior across a diverse sample of sites and locations; (b) to develop a set of observational methodologies for observing littering (including a modified protocol for observing smokers) that could be replicated over time and in different locations; and (c) to utilize a multilevel approach in a way that would allow for the simultaneous analysis of personal- and contextual-level determinants of littering. At the level of the individual, we examined the effects of variables found to predict littering in past research: gender (males littering more than females), age (younger littering more than older), and distance from a receptacle (greater distance at the time of disposal predicting higher littering rates). We also explored new potential predictors, including time of day, and whether being in a group might be associated with lower littering rates because of social disapproval. At the level of the

context, past research led us to expect that littering would occur more often: in sites that were high in existing litter, in sites with fewer receptacles, and in sites with no existing signage about littering. We also explored several less widely studied variables, including rural versus urban locations, cleanliness, landscaping, infrastructure, and the number of people within the location.

Method

Sites and Participants

During the spring of 2008, systematic observations of individuals were con- ducted in a wide range of outdoor public locations across the United States. The research design was developed as a multilevel model, with random samples of individuals "nested" within site (see Raudenbush & Bryk, 2002). At each location, random samples of individuals were selected, and their behavior was unobtrusively monitored as they moved through the site. A modified protocol was developed for monitoring the behavior of smokers, which included the various means by which smokers typically dispose of their butts.

Observations were conducted in 10 states (Arkansas, California, Georgia, Illinois, Kentucky, Nevada, New Mexico, New York, Utah, and Vermont), selected to represent a variety of regions across the country. Within each state, an urban, rural, and suburban city was selected using U.S. Census statistics. Finally, within each of those cities, specific observation sites were randomly selected from a list of all possible sites of each type: city center, fast food, recreation, gas station, and rest stop. Three additional site types were selected for observations of cigarette smokers: medical, bars/restaurant, and retail.

The final data set included observations of 9,757 individuals from 130 locations: 86 general litter and 44 focused on cigarette disposal. Of these, 30 were recreational, 24 city center, 22 fast food, 12 retail, 12 bars/restaurants, 11 gas stations with

convenience stores, 11 rest stops, and 8 medical facilities.

Procedure

Systematic observations were made by pairs of observers following a strict protocol that was developed after considerable training. The protocol and code sheets are available on request from the authors. On arrival at the research site, the field team first defined the physical boundary of the observation area. This would be an area that the team could clearly observe from an unobtrusive lookout point (e.g., in a public seating area or inside a parked car). This lookout point was typically at the back border of the observation area. This enabled the research team to remain forward facing (which was necessary when they were inside a parked car) and increased their ability to remain unobtrusive. These boundaries were typically areas of about 2,000 square feet that allowed for unobstructed and unobtrusive observations of individuals. This observation area always included the most heavily trafficked part of the site (e.g., the entrance/exits to the nearest building). Before observing any participants, the research team used a detailed codebook to record a variety of characteristics related to the setting.

Setting characteristics. The codebook provided a variety of categorical and continuous measures for the research team to record for each setting. The research team specified the site type—recreational, city center, fast food, retail, bar/restaurant, gas station with convenience store, rest stop, or medical facility (categorical measure); identified whether the location was categorized as rural, urban, or suburban (categorical measure); recorded the time of day as before noon, afternoon, or after 4:00 p.m. (categorical measure); rated the amount of existing litter in the location from 0 = *not at all littered* to 10 = *extremely littered* (continuous measure); indicated whether or not each of 9 different types of litter (e.g., paper, food wrappers, cans, bottles, etc.) was present or absent (categorical); rated the amount of cigarette butt litter present from 0 = *not at all littered* to 10 = *extremely littered* (continuous); counted the number of cigarette

butts in the observational area (continuous); rated the overall cleanliness of the site from 0 = *not at all clean* to 10 = *extremely clean* (operationalized as free from bad smells, litter, unkempt infrastructure, and objects that do not belong in the location; continuous); judged the landscaping (operationalized as the presence and care of foliage; continuous from 0 = *not at all landscaped* to 10 = *extremely landscaped*); and rated the overall infrastructure from 0 = *low infrastructure* to 10 = *high infrastructure* (operationalized as the placement of physical objects within a location as a means to increase the aesthetics, walk- ability, cleanliness, and landscaping of the area). This included planters, paved walkways, benches, and trash receptacles (continuous). The research team also recorded the number of trash receptacles for each of five receptacle types: trash can, ashtray, ash/trash combination, dumpster, and recycling (continuous). For analytic purposes, these were summed to produce a single score of the total number of available receptacles. The team recorded whether or not there was littering signage present (dichotomous, 1 = *yes*, 0 = *no*). Finally, they rated the crowdedness of the location from 0 = *not at all crowded* to 10 = *extremely crowded*, operationalized as the inability to move freely. It was defined for the observational team as the combination of the number of people in the location, given the features of the location (continuous). These measures of the setting were made to examine the impact of contextual variables on participants' littering behavior.

Participant characteristics. After recording the details of the setting, the research team randomly selected a participant by taking the Nth person to enter the space, with N determined using the crowdedness of the location and ranged from 1 to 6. Random selection of the individual participant at each site is a key aspect of this research protocol, and it provides data that can be used to calculate a littering rate for each site as well as the data needed to analyze the personal and contextual-level predictors of littering.

The research team recorded each participant's gender, approximate age, whether the selected participant was alone or

with one or more others, and noted one of three possible disposal options: the participant did not have an item to dispose, the participant had an item to dispose but left the site carrying the object, or the participant disposed of the object. No other observations were made for participants who had no object to dispose or who left the site with the object.

The research team made additional recordings for only those participants who disposed of an object. They recorded whether the object was disposed of properly or improperly. Proper disposal was operationalized as any disposal that resulted in the object being placed in a receptacle, including ashtray, trash can, or recycling bin. Items placed in the wrong receptacle (e.g., trash in a recycling container or cigarette butts in a trash can) were not coded as litter. For analytic purposes, these disposals were coded as "proper." Also coded as proper were pocketing the item or handing it to another person. Improper disposals included disposals on the ground, planters, bushes or shrubbery, or disposals on or around receptacles. The research team also recorded the type of object disposed using a code sheet with 13 options, including an open- ended option for "other."

Of those who were observed to have littered, the researchers recorded the person's intent to litter using eight categories, drawing on prior work by Williams et al. (1997): drop without intent, drop with intent, flick, shoot and miss, inch away, wedge, sweep, or 90%. All but the first coded category were classified as "with intent." Drop with intent was a subjective classification made by the coder and required one of two specific actions: the individual visually inspected the item either at the point of disposal or immediately fol- lowing, or there was an observable hand movement indicating an intentional discard (e.g., flick, toss, fling, wedge, and sweep). The disposal strategies of drop, flick, and shoot and miss involved the intentional placement of the item in an improper location; sweep strategies involved brushing items from a flat surface unto the ground; and "90%" codes included instances where the individual collected other items for proper disposal

but intentionally left one or more objects behind. More detailed descriptions of these eight intentional disposal strategies can be found in Williams et al.

Finally, the research team recorded littering participants' distance (in feet) from receptacles at the time they littered. Any discrepancies were resolved through discussion. Observations within each site continued until 30 participants were observed making a disposal (proper or improper) or until the conclusion of an 8-hour observation period. A minimum of 4 hours of observations were conducted at each site.

Results

Reliability Measures

During training, the research team conducted multiple sessions during which they practiced coding both the settings and individuals. These training sessions were conducted until the pairs of raters achieved a minimum of 80% agreement for the categorical variables of the setting and $r = .70$ for continuous variables of the setting. The reliabilities reported below are the average percentage agreements and correlations across pairs of team members on the final day of training:

- Did the person have an item for disposal in his or her hand (dichotomous, $1 = yes$ or $0 = no$)? Percentage of agreement, 93%.
- Did the person dispose of an item while within the observational boundary (dichotomous, $1 = yes$ or $0 = no$)? Percentage agreement, 95%.
- Did the disposal result in litter (dichotomous, $1 = yes$ or $0 = no$)? Percent- age of agreement, 97%. This variable served as the primary outcome.

- Type of item disposed? (categorical: 13 options plus "other"). Percentage of agreement excluding "other," 97%.
- For individuals who were observed littering, was there clear intent (dichotomous, $1 = yes$ or $0 = no$)? Percentage of agreement, 98%.
- For individuals who were observed littering, what was the distance to the closest receptacle at the point of littering, in feet ($r = .94$).

During actual data collection, additional reliabilities were computed using data from 127 observed individuals at three sites obtained from three pairs of the field team. The following percentage agreement was found: gender (95% agreement), approximate age ($r = .94$), whether the individual was alone (96% agreement), and time of day (100% agreement).

The data were analyzed as a multilevel model, which allowed for both individual- and context-level predictors of littering behavior (Hox, 2002; Raudenbush & Bryk, 2002). The summary below begins with basic descriptive statistics from the observations and then proceeds to report the results from the hierarchical linear model. Results from the multilevel models are reported following convention, with β representing unstandardized Level-1 coefficients (in these analyses, person-level predictors) and γ representing unstandardized Level-2 coefficients (in these analyses, context-level predictors). Measures of variability are also reported, with σ representing variance at Level 1 (person-level) and τ for variance at Level 2.

Descriptive Statistics

Across the 130 sites, 118 of them (91%) had at least one trash receptacle. These included 64 sites with uncovered trash cans, 58 sites with lidded trash cans, 43 sites with ash receptacles, 16 sites with recycling bins, 18 sites with combined trash can/ash receptacles, and 12 sites with dumpsters. Many of the sites had several types of receptacles, so the total exceeds 130. Of the

130 sites, only 2 had no visible litter within the observation boundary. By count, the most frequently observed visible litter included cigarette butts and miscellaneous paper. The number of sites with various types of litter is shown in Table 1. "Other" items included diapers, dog waste, fishing gear, clothing, and children's toys. These findings indicate that although trash receptacles are quite common in public spaces, ash receptacles, and (particularly) recycling bins are less common.

Observations of littering in general were made at 86 sites across 10 states. A total of 8,990 general observations were made; an additional sample of 767 smokers is reported separately below. The general observations were evenly divided across rural (33%), suburban (34%), and urban areas (33%). Observations were made throughout the day, with 27% made in the morning before noon, 58% in the afternoons between noon and 4:00p.m., and 16% in the evening after 4:00p.m. Of the observations, 56% of the observed targets were male, and 44% were female. Observed ages ranged from 1 to 82 ($M = 38$, $SD = 16$), and 50% of the observed individuals were alone.

Of the 8,990 people who were observed, 2,472 left the site with no object for disposal (28%), 4,534 left the site with an object (50%), and 1,962 dis- posed of an object while on site (22%). Among these disposals, there were 342 instances of littering observed. That is, of all 8,990 individuals that were observed moving through a diverse range of sites, 4% littered. In addition, of all the disposal behaviors that were observed ($N = 1,962$), 342 (or 17%) were improperly disposed by littering. The remaining proper disposals included trash receptacle (60%), pocketing the item (9%), handing the item to another person (6%), ashtray (6%), and recycling bin (1%).

Table 1. Percentage of Sites (out of 130) With that Litter Type Present and Percent of Participants who Disposed of that Item Improperly

Litter type	% sites with this type of litter present	% participants who disposed of item improperly
Cigarette butts	82 (f_o = 106)	57 (n = 194)
Paper	67 (f_o = 87)	7 (n = 20)
Food wrappers	45 (f_o = 58)	14 (n = 14)
Confections	34 (f_o = 44)	0 (n = 0)
Napkin/tissue	34 (f_o = 44)	8 (n = 9)
Miscellaneous plastic	33 (f_o = 43)	0 (n = 0)
Food remnants	24 (f_o = 31)	20 (n = 16)
Beverage cup	16 (f_o = 21)	3 (n = 5)
Beverage bottle: plastic	11 (f_o = 14)	5 (n = 5)
Food containers	9 (f_o = 12)	2 (n = 1)
Plastic bags	8 (f_o = 11)	5 (n = 2)
Beverage can	6 (f_o = 8)	12 (n = 8)
Beverage bottle: glass	5 (f_o = 6)	0 (n = 0)
Yard waste	5 (f_o = 6)	0 (n = 0)
Combination/mixed trash	0 (f_o = 0)	4 (n = 12)
Other	27 (f_o = 35)	37 (n = 46)
Unknown	0 (f_o = 0)	8 (*n* = 10)

Of the 1,962 coded disposals, the most frequent were cigarettes ($N = 340$), mixed trash ($N = 337$), and paper ($N = 272$). Table 1 also shows the types, frequencies, and littering rates for the disposed objects. The table shows the frequency of proper and improper disposals, along with the percentage of each type of material that was littered (computed as improper / proper + improper). The "other" category includes a number of low-frequency disposals, including pet waste, candy and other confections, matches and cigarette lighters, diapers, straws, chewing tobacco, and miscellaneous product pack- aging like price tags, foil wrappers, and twist ties.

The 342 acts of littering were coded into discrete disposal strategies, along with coded intent. The most frequent littering strategy was to drop with intent ($N = 183$, 54%). That is, the person committed a clear and deliberate act of littering. Other litter strategies included flick ($N = 68$, 20%) and drop without intent ($N = 42$, 12%). The behaviors were also coded into littering strategies found in prior research (Williams et al., 1997): inch away ($N = 8$), shoot and miss ($N = 8$), wedge ($N = 4$), sweep ($N = 3$), and 90% ($N = 2$). When combined, an estimated 81% of observed littering occurred with intent.

The observation team coded the distance (in feet) from the disposer to the nearest receptacle (trash, recycling, or ashtray). Although there were several instances of littering that occurred immediately adjacent to a receptacle, most littering occurred at a considerable distance (mean distance to a receptacle at time of littering was 29 feet).

Multilevel Modeling

Finally, a series of statistical analyses were conducted to examine the individual and contextual variables that were predictive of littering. The analysis was conducted using only data from observations where a disposal (either proper or improper) occurred ($N = 1962$). Multilevel modeling is a statistical technique that allows for "nested" data structures (in

this case, individuals nested within site). In addition, the multilevel approach does not require balanced data (i.e., equal numbers of observations per site) and instead utilizes all available information to estimate the underlying effects. The approach makes it possible to simultaneously model individual-level and contextual- level variables and to estimate the percentage of total variance in the out- come measure that results from each (quantified as the IntraClass Correlation Coefficient [ICC]). The analysis was conducted as a two-level model, with person at Level 1 and context at Level 2. The analyses were conducted in SPSS 19 using MIXED LINEAR. This analysis assumes a continuous and normal dependent variable (which was violated). A parallel set of analyses were also performed using the SPSS 19 GENLINMIXED procedure and specifying a logistic link function and binomial distribution. For ease of interpretation, we have presented the results in the original probability units from the continuous SPSS MIXED multilevel model (0 = *no littering* and 1 = *littering*), rather than log-odds units. The conclusions are the same as those obtained using a logistic link function.

The initial random effects model showed that the overall littering rate was .17. That is, of all disposals, 17% were improper, $t(74.86 = 9.87, p < .001)$. Across the 1,962 disposals, $\sigma = .12, Z = 30.66, p < .01$, and the 86 locations, $\tau_{00} = .022, Z = 5.71, p < .01$, there was considerable variability in the littering rate. The ICC was .15. This statistic is directly interpretable, and it indicates that 15% of the variance in littering behavior resulted from site-level variables, whereas 85% resulted from individual variability. This finding shows that on a national level, the large majority (85%) of littering behavior results from individual-level variables (e.g., age, gender, attitudes, and motivation). This is not saying that physical context does not matter, and in fact, these results show that 15% of the variance in observed littering behavior was due to some aspect of the context (e.g., existing litter, lack of convenient receptacles, etc.).

   The second set of analyses focused on individual-level predictors of littering behavior: age, gender, time of day, and whether the individual was alone. Results showed that age, $\beta =$

−.001; $df = 1943$, $t = −2.15$, $p < .05$, and gender, $\beta = −.06$; $df = 1943$, $t = −3.42$, $p < .05$, were the only significant predictors, with older individuals littering less than younger and males littering more than females. Time of day and being alone were not significantly predictive of littering. For clarification, age was coded into demographic categories. The highest rate of observed littering occurred for younger individuals, aged 18 to 29 years, for whom the littering rate was 26%. For adults 30 years and older, the littering rate remained steady at approximately 15%. Children and adolescents (younger than 18 years) had a littering rate of 13%. The gender effect in the general littering observations showed that men (21%) littered more than women (15%). No other individual-level variables were predictive of littering. However, the variability in the Level-1 equation remained statistically significant, indicating that other variables are required to fully explain individual variability in littering. Combined, age and gender explained less than 1% of the residual variance at Level 1.

Using the hierarchical structure of these data, the contextual predictors of littering behavior were analyzed: site type (e.g., city center and fast food), location type (rural, urban, and suburban), amount of existing litter present, beautification efforts in the area (included ratings for cleanliness, landscaping, and infrastructure), availability and number of receptacles (summed number across trash, ash, and recycling), posted signage about littering, and crowdedness of the location.

Given the relatively large number of predictor variables, particularly with the dummy coded categorical variables of site type and location type, the multilevel model was conducted through a building process as recommended by Raudenbush and Bryk (2002). The analysis started by testing each dummy-coded categorical variable, sequentially, and removing nonsignificant predictors. The continuous predictors were then examined, again removing nonsignificant predictors. The cumulative results from these analyses revealed two uniquely and statistically significant predictors: availability of disposal receptacles and amount of litter present. The first was the

number of disposal receptacles. As part of the site observations, the team counted the number of receptacles (trash, recycling, cigarette, and dumpster), along with the distance from the person at the time of disposal. The average was 5.8 bins per location, with a range from 0 to 19. The analysis for presence of receptacles revealed the expected finding that littering rates were higher when no receptacle was present. But more relevant to the current research questions, among sites with at least one receptacle, the statistical analysis showed that locations with more receptacles had a lower littering rate, $\gamma = -.01$, $df = 73.42$; $t = -2.52$, $p < .05$. This statistical coefficient can be interpreted directly, such that for every added trash receptacle, the littering rate decreased by 1% (from the overall rate of 17%).

The second statistically significant predictor of littering behavior was the presence of litter in the site. Locations with more litter were associated with a higher littering rate. The statistical analyses showed that the presence of existing litter (rated by the observers on a scale from 0-10) was predictive of littering behavior, $\gamma = .02$, $df = 82.01$; $t = 2.40$, $p = .018$. This indicates that for every unit increase in the amount of existing litter (from 0-10), the observed littering rate increased by 2%. With both predictors in the model, the variance at Level 2 remained statistically significant, indicating that more variables are needed to fully explain the variability across site. Combined, the two variables explained 9% of the Level-2 variance, but the variability in littering rates across the sites remained statistically significant, $\tau = .019$; $Z = 4.60$, $p < .001$.

Supplemental analyses were also conducted using the Level-1 predictor of distance to the nearest receptacle. This analysis was performed using the multilevel framework but only for observations at sites with at least one receptacle (of any type). Results showed that distance to a receptacle at time of disposal was strongly related to the likelihood of littering, $\beta = .007$; $df = 1926$, $t = 17.95$, $p < .001$. Distance to the receptacle explained 11% of the

residual variance at Level 1, $\sigma = .108$, $Z = 30.55$, $p < .001$. Note that distance was coded in feet, so that for each added foot of distance from a receptacle at the time of disposal, the probability of littering increased by .007. For clarification, we calculated littering rates for disposals at seven different distances, each of 10-foot increments. For disposals that occurred within 0 to 9 feet of a receptacle, littering rates were 12%. At the largest distance (60 or more feet), littering rates were 30% of disposals.

Observations of smokers. In addition to the large number of general littering observations, the field team also conducted a smaller number of observations of smokers. The separate focus on smokers was based on two considerations. First, unlike the general littering observations of individuals moving through a public space, all smokers have something to litter—a cigarette butt. Second, cigarette butts constitute the most frequently collected litter worldwide.

The observations were made using the same protocol described above, with a few modifications. First, only individuals who were (estimated) over the age of 21 were utilized. This qualifier was imposed to provide consistency across our observational protocol and to respond to the possibility of local restrictions on tobacco use for individuals younger than 21 years. Second, a measure of existing litter was included at each site that focused on the number of cigarette butts within the observational boundary. Third, the measure of existing receptacles focused on only ashtrays (or trash/ash combinations). As with the previous study, disposals of cigarette butts were coded as proper if they reached any type of receptacle and not necessarily an ashtray.

In total, observational data were obtained from 767 smokers from 44 sites (11 recreational, 12 bars/restaurants, 12 retail, 8 medical, and 1 city center). There were 412 males and 344 females, ranging in age from 21 to 72 ($M = 40$, $SD = 13$; 11 not coded). Of the 767 observed individuals, 206 (27%) left the observation area still smoking, and the disposal behavior of 31

smokers could not be clearly established. Of the remaining 530 smokers, 187 properly dis- posed of the butt (35%) and 343 improperly disposed (65%). When the butt was littered, drop with intent was the most frequently used strategy (35%), followed by flick (27%), stomp (27%), and "other" (1%, including placing the butt on or near a receptacle). Although there were several instances of littering near a receptacle, most littering occurred at considerable distance from a receptacle (average distance at time of littering was 31 feet).

The data analytic strategy followed the multilevel model approach used above, in which the individual and contextual predictors of littering were examined simultaneously. The reported results were calculated using the MIXED command in SPSS version 19, and the results are reported in original probability units. The analysis was performed on 530 cases (187 proper disposals and 343 littered). The results from the multilevel model showed that across the 530 individuals, $\sigma =$ .135, $Z = 15.70$, $p < .001$, and the 44 locations, $\tau_{00} = .081$, $Z = 4.73$, $p < .01$, there was considerable variability in the littering rate. The ICC was .38, indicating that 38% of the variance in cigarette littering resulted from contextual variables, whereas 62% resulted from individual variability. This is a considerably higher clustering effect than that observed for general littering behavior, and it suggests that cigarette butt disposal is more affected by contextual-level variables than are general disposals (see recommendations section below).

At the level of the individual (Level 1), only age emerged as a statistically significant predictor, with older individuals littering less than younger, $\beta = -.004$, $df = 518.49$; $t = 2.93$, $p < .01$. The highest littering rates occurred for smokers in their 20s (66% littering rate) and 30s (72%), compared with smokers in their 40s (58%), 50s (66%), and 60s (50%). Age explained less than 1% of the Level-1 variance, and the variability across individuals remained statistically significant, $\sigma = .134$, $Z = 15.59$, $p < .001$, suggesting the need for additional predictors. Neither gender, time of day, nor being part of a group were related to cigarette butt littering.

At the level of site (Level 2), analyses utilized the contextual

predictors used in the analyses of general litter (with minor modifications noted above). The results showed three uniquely predictive variables: site type, existing litter, and presence of ash receptacles. One of the strongest predictors of cigarette littering was the number of ash receptacles, $\gamma = -.09$, $df = 31.91$, $t = -2.13$, $p < .01$). The parameter estimate from the analysis is directly interpretable, and it indicates that for every added ash receptacle, the littering rate for cigarette butts decreased by 9% (from the initial base littering rate of 65%). The second significant predictor of cigarette litter was the amount of existing litter, $\gamma = .05$, $df = 39.01$, $t = 2.24$, $p = .03$, with more littered environments attracting more cigarette butt litter. Note that the existing litter is of any type and not just cigarette butts. Results also showed an effect for site type, where retail locations were associated with the lowest rate of littering (58%), followed by city centers (58%). Bars and restaurants were third (62%), whereas recreational (74%) and medical/hospital sites (75%) had the highest littering rates. Combined, these three variables explained 24% of the variance at Level 2, although the variability in littering rates across site remained statistically significant, $\tau = .061$, $Z = 3.21$, $p < .01$, suggesting the need for additional predictors.

Finally, supplemental analyses were conducted to examine distance to an ash receptacle at time of disposal. Commensurate with the previous analyses, this Level-1 predictor was examined within the multilevel framework but only using data from sites with at least one ash receptacle. Results showed that distance to the nearest receptacle was strongly predictive of littering, $\beta = .005$, $df = 292.79$, $t = 6.93$, $p < .001$. Although a few instances of littering were observed immediately adjacent to an ash receptacle, the average distance for litterers was 31 feet away.

Discussion and Conclusions

The results from these litter observations support a number of conclusions. First, the overall littering rate was 17%. That is, of all the disposals observed across the country, 17% were

improper. In addition, of the individuals sampled from 86 locations nationwide, 4% littered as they passed through the site. For cigarette butts, the littering rate obtained from the focused observations was 65%. This is a strikingly high number, despite the strong norm favoring proper disposal that has emerged over the past 40 years (see Bator, Bryan, & Schultz, 2011).

Importantly, this littering rate was generated from a random sample of individuals across a range of different locations and not just a few isolated observations or of one type of location. In addition, the results showed that in the majority of instances (81%), the littering occurred with intent.

The results from these analyses underscore findings from studies con- ducted nearly 40 years ago (Burgess et al., 1971; Finnie, 1973; Geller et al., 1977). Although much has been said about litter and littering over the years, no study has afforded the opportunity to simultaneously test the degree to which it is affected by personal and contextual variables. In fact, to our knowledge, this is the first article to examine the same behavior across a large number of contexts—a procedure which allows for a quantitative analysis of "personal" and "environmental" influences on behavior. The results of the current research indicate that 15% of general littering acts result from contextual variables, and 85% result from personal qualities. This finding is particularly instructive because it indicates that given the same infrastructure and opportunities to properly dispose, individuals will vary tremendously. Note that if the trend had been reversed, such that 85% of the variance was due to the situation, it would indicate that while individuals vary across settings, within a setting they act similarly (e.g., littering or not).

The results from the analyses of littering behavior identified only a couple of significant predictors. Interestingly, gender was not a consistent predictor of littering behavior. Gender was a significant predictor of littering in the general observations, with males littering more than females. However, gen- der was not a significant predictor of littering for cigarette butts. This

second finding runs contrary to prior data showing that men are more likely to litter than women (Meeker, 1997; Torgler, García-Valiñas, & Macintyre, 2008) but is consistent with other observational studies showing no gender effects (Finnie, 1973; Geller et al., 1977; Williams et al., 1997).

At the individual level, the results did show a consistent and statistically significant effect for age, with young adults (18-29) more likely to litter than older adults. The negative relationship between age and littering has been documented in several survey studies of littering behavior (Beck, 2007), with researchers reporting that younger people tend to litter more often than those who are older (e.g., Durdan, Reeder, Hecht, 1985; Finnie, 1973; Heberlein, 1971; Krauss, Freedman, & Whitcup, 1978). Krauss et al. (1978) also found that younger participants were more likely to litter. They considered that normative control requires both internal controls and cognitive information, both of which develop through the socialization process.

At the level of the location, presence and number of trash receptacles, along with the amount of litter present were significant predictors of littering behavior. These findings are consistent with previous studies (Cialdini et al.1990; Meeker, 1997), although Roales-Nieto (1988) reported results show- ing that adding more receptacles did not result in reductions in litter. This latter finding suggests that a raw count of receptacles is probably an overly simplistic consideration. Indeed, the current study shows that convenience (i.e., distance to a receptacle) plays an important role. One well-placed receptacle is likely to produce a larger reduction in littering than several inconveniently placed receptacles.

To this end, it is tempting to ask about the "optimal" spacing between receptacles. Although these data do not speak directly to this issue, there is evidence that the lowest littering rate occurs when receptacles are available and close at hand. This effect was consistent for both general littering and disposals of cigarette butts. Further inspection of the data showed that aggregated observed general littering rates were low (and

relatively flat at 12%) for receptacles less than 20 feet away. The littering rates increased linearly between 21 and 60 feet and then remained relatively flat at 30% for receptacles 61 feet away and beyond. It is also important to point out that "optimal" spacing will vary by location, and the key consideration is the distance to the receptacle when the individual has an item for disposal. The current results showed that the lowest rate of littering occurred when a receptacle was fewer than 20 feet away. To deter littering, we encourage thoughtful placement of receptacles so they are in the most easily accessible location depending on where pedestrians are likely to be when they are in need of making a disposal.

The observations of smokers revealed similar findings. First, with regard to cigarette butt litter, results showed an average national littering rate of 65%. This is substantially higher than that found for littering in general and corroborates the high number of cigarette butts collected in cleanups worldwide. As with general litter, younger individuals were more likely to litter than older, although the overall rate of improper cigarette disposal was above 50% for all age groups. With regard to the multilevel analyses, results showed a clustering effect of .38, indicating that a substantial amount of variability in littering behavior results from contextual variables. Subsequent analyses revealed that the lack of convenient ash receptacles, and sites with high levels of existing litter (of any type, not just cigarette litter), were predictive of higher litter rates. Although the littering rates reported in this article are based on a large, national sample, it is important to acknowledge a few methodological limitations. First, the sample cannot be considered representative of all individuals in the United States. Although the reported results are based on random samples of individuals within each site and of randomly selected specific site locations across the country, the type of sites where observations were made was not randomly determined. That is, eight specific types of sites were selected for observations (e.g., retail and recreational) at the outset of the study, and although diverse, these eight site types cannot be considered

representative of all physical environments across the country. Although drawing a random sample of physical locations across the country is methodologically desirable, it was not practically feasible in the current project.

Another limitation with the littering rate reported in this article is the potential bias toward large or more readily observable items. The observed littering rate of 17% is probably an underestimate for the true littering rate because there were certainly littered objects that went undetected by the field team. Small items, in particular, are likely to be underrepresented using the observational protocol by virtue of the difficulty in seeing them from a distance. It is also possible that the mere presence of the research team in the environments muted the littering rates, although the observational protocol was designed to minimize this influence.

Just as the observational protocol is likely to underestimate the littering rate, it is also likely to overestimate "intended" littering. In coding behaviors in the field, proper disposals are relatively easy to determine, as are intended littering behaviors. Although the observational team was meticulous in observing and coding behaviors, unintentional littering is inherently more difficult to detect. As a result, the reported 81% of litter that is intentional should be interpreted with caution. This limitation is more applicable to the general littering observations and less so for the focused smoker observations. Given that intentional littering has been found to be more easily deterred than unintentional littering (Sibley & Liu, 2003) and that we recorded substantially more unintentional littering behavior, we encourage tests of litter prevention techniques that promote awareness and individual-level motivation.

Finally, we offer a caution on our interpretation of the ICC. The ICC represents the degree to which the data "cluster", and in our study, it quantifies the proportion of variance in the dependent variable that is attributed to the site, rather than to the individual. At one extreme, an ICC = 1.0 would indicate that all of the variance in littering behavior was associated with site such that all individuals observed within each site were the same

(either littering or not) but that littering occurred at some sites but not others. On the other extreme, with an ICC = 0, all sites would show the same littering rate, but individuals would vary within each site. At the site level, we have used contextual variables like the availability of trash receptacles or the amount of existing litter as predictors. However, it is important to point out that site-level variance could also be due to shared regional or local norms associated with littering in different types of locations or even shared norms about littering in general. To illustrate, consider the case of cigarette butt disposal, for which we found an ICC of .38. Although some of this clustering is certainly due to contextual variables like the availability of an ashtray, some may also be due to the strong norm against smoking and littering in some contexts. For instance, had we included cigarette butt disposal by staff smoking in a designated area near an elementary school, the littering rates would likely have been affected more by the norm of social responsibility than by the availability of ashtrays.

Implications for Litter Prevention

The findings from this research point to several strategies for litter prevention. These strategies include a combination of both structural and motivational activities. This section of the article provides a series of recommendations for litter prevention that are consistent with the research findings. Importantly, this is not an exhaustive list, and readers are encouraged to think creatively about ways to link the reported findings to litter prevention. In addition, it seems likely that any single prevention activity will yield only small results, and the most effective approach will utilize multi-pronged strategies that target both structural and personal variables.

 Beautification. The current results clearly show that litter begets littering. This finding is not new, and indeed, it was noted in the early studies of litter (e.g., Cialdini et al., 1990; Keizer et al., 2008). However, although most of the early studies presented participants with an object to either litter or dispose of properly, the current research was completely

nonintrusive. We observed genuine behavior in a variety of settings across the United States. Given this methodology, we were able to learn that individuals use a variety of cues from their surrounding environment to determine what is a common and accepted behavior. The presence of litter communicates the norm for that situation and the acceptability of littering. In addition, the existing litter will require cleanup, so one more piece may seem inconsequential.

To this end, a key to the success of any litter prevention activity is to clean up and remove existing litter. Reducing the amount of existing litter in a location is a surefire way to reduce the rate of littering behavior (Casey & Lloyd, 1977; Huffman, Grossnickle, Cope, & Huffman, 1995). In addition, prior studies have found that involving community residents in cleanup activities can promote a long-term reduction in litter and increase an individual's motivation not to litter (Roales-Nieto, 1988).

Behavioral opportunity. Related to the recommendation for beautification efforts (above), there is also consistent evidence for the importance of opportunity. That is, the context should provide a convenient and accessible means for proper disposal of trash and recyclables. Although the current results show the widespread availability of receptacles in public places, results also revealed that distance to a trash can was a strong predictor of littering behavior. Providing easily identifiable, accessible receptacles, with clear and recognizable messaging and prompts, can go a long way toward reducing littering rates (De Kort, McCalley, & Midden, 2008; National Cooperative Highway Research program, 2009).

The issue of behavioral opportunity is especially important for cigarette butts. The reported observational data suggest that disposal of cigarette butts is more strongly clustered within locations, yet less than half (47%) of the locations in the sample provided an ash receptacle. Indeed, Liu and Sibley (2004) reported a 64% drop in cigarette butt littering by adding ashtrays on a university campus, although the change did not affect attitudes about litter. Similar results were reported by

Geller, Brasted, and Mann (1980) and by Sibley and Liu (2003). Given the increase in legislation prohibiting indoor smoking, an increasing number of smokers are moving outside to smoke. However, the infrastructure for collecting ashes and lit cigarettes is woefully behind these policies, and the reported data suggest that more efforts to afford smokers an opportunity for proper disposal are needed.

Awareness and motivation campaigns. In addition to the recommendations for beautification and infrastructure, there is an important role for litter prevention strategies that target individual-level motivation. The statistical analyses showed that 85% of the variance in general littering and 62% of the variance in cigarette butt littering resulted from individual differences. These include demographic, attitudinal, and motivational differences (among others), and they speak to the importance of understanding the individual-level motivations and barriers to littering (McKenzie-Mohr, 2002).

One way to promote individual-level motivations is through outreach and media messages (Nolan, Schultz, & Knowles, 2009). Although prior research has shown that such campaigns typically only produce small changes in behavior (if any), there is reason to continue utilizing media messages, and more importantly branding, in litter prevention efforts. Based on the reported data, and background literature, messages should highlight the dramatic decline in littering rates over the past 40 years, the generally infrequent over- all littering rate, and the widespread disapproval for individuals who litter (see also Cialdini, 2003).

In a related data set collected as part of the current study, surveys were con- ducted with observed individuals randomly sampled across the country. These surveys were conducted with both litterers and nonlitters, and the findings show a near unanimous disapproval for littering (Bator et al., 2011). This finding, coupled with other research on the role of injunctive and personal norms, suggests that messages should emphasize that only a few deviant individuals litter and that these individuals are disapproved of by the majority (see Cialdini, 2003; Grasmick,

Bursik, & Kinsey, 1991; Schultz, Tabanico, & Rendón, 2008).

    In closing, the data reported in this article represent the largest single study of littering behavior conducted to date. Data are reported from unobtrusive observations of nearly 10,000 randomly selected individuals across 130 diverse public locations across the country. The results show that of all the disposals that took place in these locations, 17% resulted in litter. For disposals of cigarette butts, the littering rate was even higher, at on observed rate of 65%. Statistical analyses are reported that utilize the multilevel framework and simultaneously examine both the contextual and personal predictors of littering behavior. The findings show that littering results from both personal and contextual factors and that both are critical in understanding littering behavior. This perspective is consistent with the traditional approach utilized by environmental psychologists and can be particularly instructive in efforts to reduce littering rates.

Author's Note

Supplemental Appendix of this article is available on the *Environment and Behavior's*
Web site: Sage Publishing (http://eab.sagepub.com/.)

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