Increasing Appropriate Composting in High-Traffic University Settings

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Abstract

Composting systems are poised to make a significant impact on waste-management strategies and greatly contribute to global sustainability efforts. However, risk of contamination by potentially detrimental compounds must be overcome before these systems can be widely adopted. Behavior analytic approaches to waste disposal adherence have consisted of antecedent and consequence strategies; many such strategies require continual oversight and significant investment of resources to maintain effectiveness. This project describes a field study that investigated a purely antecedent-based approach to nudge proper organic recycling on a university campus. Using a multiple-baseline design across dining sites, we demonstrate the efficacy of enhanced compost bins (i.e., green colored bins with a hinged door and an accompanying placard indicating site-specific materials that can and cannot be composted) to reduce product contamination by inorganic or unsuitable organic refuse. Implications for future research and suggestions for university implementation are discussed.

Keywords Antecedent intervention · Composting · Cues · Sustainability · Waste

In 2015, the U.S. Environmental Protection Agency (EPA) recorded the production of 262 million tons of solid waste by American citizens (EPA, 2018a). Of this material, roughly 91 million tons – about 35% – was reused. The majority of this reclaimed waste was comprised of organics such as paper/

paperboard (49.7%), wood (2.9%), and yard trimmings (23.3%), with the rest consisting of inorganics like plastics (3.4%), metals (9.1%), rubber, leather, and textiles (4.3%), glass (3.3%), and approximately 2% miscellaneous waste. Estimates suggest the diversion of these materials from landfills prevented roughly 186 million metric tons of carbon dioxide (CO₂) from being released into the air—the amount of emission equivalent to that of 40 million vehicles in a single year (EPA, 2018b).

The ecological benefits of responsible refuse reclamation are patent, yet reconstitution rates of products derived from municipal waste vastly underrepresent the potential of active participation in product recycling (EPA, 2018a). Among many proposed advancements, the integration of composting into preexisting waste disposal systems may serve as a productive means of increasing turnover for organic products (Lim, Lee, & Wu, 2016; Rogger, Beaurain, & Schmidt, 2011). Composting involves the decomposition of organic (i.e., carbon-based) waste such as foodstuffs and yard trimmings to yield a highly effective soil additive (Ahmad, Jilani, Arshad, Zahir, & Khalid, 2007; de Bertoldi, Vallini, & Pera, 1983). The outcome relies on natural biological processes through which organic compounds are broken down to produce a dense and nutrient-rich substance largely constituted by *humus* (Ahmad et al., 2007; Lim et al., 2016). Soil degradation or overuse can result in a diminished content of organic

- This work represents a replication of the efficacy of antecedent intervention for increasing sustainable behavior.
- The methods depicted herein demonstrate a low cost, low demand strategy for influencing behavior by adhering to a nudge-type framework—a relatively novel contribution to the behavior analytic sustainability literature.
- This study extends the existing body of literature with respect to behavior analysis and ecological responsibility, and provides a potential framework for similar work.
- The topic of the current work—composting—has thus far remained unmentioned through much of the behavior analytic work in sustainability. This study provides a novel approach for examination of composting-type behavior.
- The outcome of this research provides evidence for an easily implemented strategy to promote sustainability and ecological responsibility within an organizational setting.

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compounds which are essential for agricultural biota, but application of compost-generated byproducts can renew soil quality and significantly improve growth potential in these settings (Cogger, 2005). Although organic decomposition is at fault for generating sizeable quantities of climate-relevant gasses (e.g., carbon dioxide and methane [CH₄—two high-interest greenhouse gasses), the generally minor ecological impact of composting underscores its role as a favorable alternative to landfill procedures for waste management (Lim et al., 2016).

Composting has particular appeal in that systems can be easily and effectively integrated into preexisting waste management procedures. Hottle, Bilec, Brown, and Landis (2015) compared various strategies for dealing with waste following sporting events on a large college campus. An evaluation of composting strategies demonstrated a capacity to efficiently (i.e., via low-cost procedures) reduce landfill dependence, in some cases to near-zero rates (Hottle et al., 2015). This is particularly relevant when considering the expansion of composting systems beyond the small-scale to achieve a more sizeable waste reduction. Broad adoption of composting has the potential to address roughly half of an average city's waste output (Hoornweg, Thomas, & Otten, 2000), and given reports that food waste accounts for the greatest percentage of landfill space (EPA, 2018a), these systems are poised to significantly aid waste management and advance global sustainability efforts.

One difficulty faced when introducing a composting system is the potential for large degrees of contamination by products not suited for decomposition (de Bertoldi et al., 1983; Richard, 1992). Waste often used as fodder for compost (e.g., yard clippings) can conceal contaminants with high incidences of toxicity (e.g., batteries) that are easily missed when scanning bulk product for inappropriate refuse; even trace quantities of these inorganic substances can have detrimental effects on the quality of the compost product (Richard, 1992). Output with high content of select metals (e.g., lead [Pb], copper [Cu], zinc [Zn], and in extreme cases cadmium [Cd]) or plastic byproducts can result in harmful rather than beneficial outcomes for the agricultural host (Richard, 1992; Woodbury, 1992). Processing centers handling large quantities of organic municipal solid waste may not be properly equipped to remove sufficient levels of these contaminants (Montejo, Ramos, Costa, & Márquez, 2010), so the extent to which these pollutants are distributed in compost products is difficult to assess (Woodbury & Breslin, 1992). Further, because the composting process involves a thermophilic stage during which temperatures can exceed 60 °C (Ahmad et al., 2007), improperly separated product can pose dangers to system hosts or processing plant employees in the form of hazardous gas inhalation (Gillett, 1992; Richard, 1992).

Unfavorable outcomes of poor adherence to composting procedures can, however, be avoided through various means

(Richard, 1992; see also Woodbury & Breslin, 1992). An obvious step is to outright prevent contamination. As described by Geller (2016), applied behavioral science embodies a rich history of research evaluating the efficacy of a wide-range of interventions intended to serve as *nudges*¹ toward more sustainable action or compliance with sustainable movements. Many of these studies capitalize on the use of antecedent interventions (see Cone & Hayes, 1980; see also Friman & Poling, 1995) to generate change without need for coercive or expensive procedures. Work on environmental protection has demonstrated increased rates of receptacle compliance through contingent incentives (e.g., Burgess, Clark, & Hendee, 1971; Geller, Chaffee, & Ingram, 1975; Kohlenberg & Phillips, 1973; Witmer & Geller, 1976), posted feedback (e.g., DeLeon & Fuqua, 1995; Hamad, Bettinger, Cooper, & Semb, 1980; Hamad, Cooper, & Semb, 1977; Kim, Oah, & Dickinson, 2005), and manipulations of the proximity or form of receptacles (e.g., Austin, Hatfield, Grindle, & Bailey, 1993; Brothers, Krantz, & McClannahan, 1994; Geller, Brasted, & Mann, 1979; Ludwig, Gray, & Rowell, 1998; Luyben & Bailey, 1979; O'Connor, Lerman, Fritz, & Hodde, 2010). Capitalizing on these previous findings may reduce the effort required to curb problematic waste contamination.

Research oriented specifically toward compliance with waste-disposal procedures has thus far been fruitful. Barnes et al. (2015) sought to better understand the rationale behind the high levels of contamination in outdoor organic waste disposal receptacles on a college campus. Surveying of university faculty and students suggested generally pro-environmental attitudes, yet exhibited behavior revealed a discrepancy between these intentions and the observed extent of composting compliance. Follow-up with interviewees indicated a strong potential for signage as a means of improving compost quality. Similarly, Cina, Gezella-Baranczyk, and Wedl (2017) examined factors contributing to contamination across a multitude of organizational settings in a local municipality. Among their recommendations for improving the quality of compost was the incorporation of clear, explicit signage that identified compost-appropriate items available at each respective location. Other studies have examined the effects of modeling and prompting on rates of composting (e.g., Sussman & Gifford, 2013; Sussman, Greeno, Gifford, & Scannell, 2013) and demonstrate a general effectiveness of signs and confederate modeling in a cafeteria setting.

Duffy and Verges (2009) examined rates of recycling as a function of specialized lids affixed to receptacles intended for

¹ In the Thaler and Sunstein framework (2008; p. 6), *nudges* are “any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid.” As behavior analysts, we interpret this concept as an antecedent-based intervention grounded in behavioral science, with a high degree of social validity and maintenance effects.

glass, aluminum, and plastic products. Prior to intervention, researchers observed chronic cross-contamination of refuse by landfill waste or mixed recyclable products when receptacles lacked clear designation of proper product disposal (e.g., bins bearing product-specific labels and/or colors *only*). The addition of lids that topographically represent the intended waste category (e.g., bottles/cans) resulted in significantly greater yields of appropriately deposited recyclables, suggesting a potentially indicative relation between lids and waste disposal.

Binder, Glasser, and Fuqua (2017) synthesized previous findings in their implementation of modified waste receptacle centers during a push to improve recycling in a mid-western U.S. university. In a designated trial setting, typical waste receptacles were replaced with single-stream recycling systems capable of addressing separation of bottle/can products from paper products, while also providing a receptacle for landfill waste; bins were covered by product-specific lids representative of those employed by Duffy and Verges (2009) and displayed signs with information on materials appropriate for each bin. The new system resulted in multi-component improvements to recycling: relative to baseline, more appropriate waste was deposited into recycling as opposed to landfill receptacles, and fewer inappropriate (i.e., landfill) items were placed in recycling bins.

As large organizations begin to adopt composting as a part of their regular waste management strategies, adherence to proper refuse sorting will be a determining factor in the advancement and durability of these systems. The present study describes the success of a low-cost intervention to improve composting compliance at two popular dining locations on a large university campus. The nature of the investigation necessitates significantly smaller quantities of waste when compared with the overall rates expected by the university system, but serves to evaluate the response to adaptable modifications that are easily rolled-out on an organizational-level. We hypothesized that, by employing a modified design and introducing pictorial instruction for proper waste sorting, organic waste collected in these dining centers would demonstrate greater adherence to necessary sorting protocol.

Method

Participants and Setting

Probing of university infrastructure flagged two popular dining halls as ideal settings to host the evaluative manipulations. These dining halls comprise the largest on campus, having served 1,089,124 meals (KU Memorial Union, 2017) with a total dining budget equaling \$18,725,832 in 2017 (KU Budget Office, 2017), and are centrally-located on campus grounds, thereby attracting a diverse sample of university attendees. As such, the rate of waste disposal was anticipated to be greater than elsewhere in the campus system. Research was focused

on the permanent product created by the activity of the students, faculty, and staff who discarded trash in these locations during the hours which the manipulations were enacted (exact sample size and demographics were not collected).

Preexisting trash receptacles in target locations were standard 25-gal (94.64 L) plastic bins enclosed by a decorative wooden shell, primarily located near exits and in close proximity to cash registers. Bins were semi-permanent in design, in that relocation could not be easily achieved without significant environmental modification. Both settings had an established single-stream recycling center capable of separate deposits for paper-based goods, bottles/cans, and landfill waste, although these were located in inconspicuous locations distinctly apart from standing trash receptacles.

Bin Construction

Discard compost bin were constructed according to dimensions of university trash receptacles (1.22 m [height] × 0.61 m [deep] × 0.61 m [wide]) employed in target locations. All bins were stocked with 33-gal (124.92 L) biodegradable compost bags to facilitate the discard process.

BL Bins The *neutral compost bins* (BL) were designed to match the trash receptacles already placed in experimental settings; wooden shells were painted the same khaki shade as the university discard bins and the “deposit area” consisted of only a square opening of the same dimensions as the existing bins (27.94 cm × 43.18 cm). Shells bore a sign indicating the purpose of the receptacle (i.e., “Compostable Waste Only”).

mBins The experimental *modified compost bins* (mBin) were identical to the BL bin in size and general design, but were painted with a bright shade of green and affixed with a small hinged door which obstructed the deposit area of the receptacle cover. The bins retained the “Compostable Waste Only” sign but were supplemented with two (20.32 cm × 25.40 cm) placards: one bearing “YES” in large green font with visual cues (text and images) indicating the site-specific dining products (e.g., vendor materials and food) that should be placed in the bins, and one bearing “NO” in large red font with similar cues indicating which products should not be discarded in the bins (and which could be placed in existing university recycling bins). These “YES” and “NO” visual cue placards were held in rigid, upright plastic sleeves and placed on top of the mBins with text and graphics oriented toward the deposit area such that information was displayed at eye-level and was easily accessed upon approach.

Procedure

Prior to the implementation of the described procedure, compost collection bins had been absent from the experimental

settings. The introduction of novel waste discard bins thus served as an initial environmental modification which necessitated a baseline rate of proper compost disposal. During baseline conditions, BL bins were introduced beside ceiling support columns next to main walkways in the center of both dining locations between the hours of 12 and 1 pm on operating business days (i.e., Mon–Fri); this location was selected to better differentiate the compost-specific bin from the trash bins and recycling stations (typically placed on the outskirts of these dining locations) and to reduce effort associated with waste deposits (i.e., placed in a well-traveled location).

Waste sorting was overseen by the primary author—having had relevant training and a background in waste management—and was guided by a list of compost-approved products provided by a partnered organics supply company. This company offers a unique partnership wherein contracted organizations can receive waste audits, training, and guidance on sustainable waste management. In turn, all products offered in dining hall settings were cataloged according to preferential disposal method, thus facilitating the sorting process and greatly reducing the margin of error for product sorting.

Weight was measured using a professional-grade shipping scale with digital readout (LSS-400, LW Measurement, LLC) that was zero-calibrated with an empty sorting bin prior to each measurement; recordings were taken before and after product sorting to serve as an indication of compost contamination. Sorted refuse—separated as compostable or non-compostable—was placed into the bin on the zero-calibrated scale to render a numeric weight. Inter-observer agreement (IOA) was calculated for at least 30% of weight measurements to account for fine-grained variation in recordings. The dependent variable was therefore the proportion of contamination relative to the overall weight of the waste, calculated using the following:

$$\text{proportion contaminated} = \frac{\text{weight of contaminants}}{\text{total weight of refuse}}$$

Data were not recorded for any day in which the compost bag was less than 0.50 lbs. in total weight.

While continuing baseline data collection at Site B, the mBin was introduced to the dining area of Site A in place of the BL bin. Weight was assessed in the same manner as indicated during baseline conditions, and IOA on scale readout was again calculated for at least 30% of experimental sessions. After several days, the mBin was also implemented at site B. To demonstrate additional experimental control (given only two staggered baselines due to having only two dining facilities), we returned the BL bin to Site A for one additional week while holding Site B in the mBin condition.

Data collection continued over a 40-day span. IOA of weight calculations across all conditions was 100%. Recordings were halted for a brief lapse during week three of the intervention due to the start of campus' spring break.

To comply with university approved procedure, protocol, and academic calendar schedules, collection was terminated prior to reintervention of the BL bin condition for site B.

Results and Discussion

Figure 1 presents proportion contamination data plotted as a function of time. Following 3 days of increasing contamination rates approaching 0.35 in Site A (top panel of Fig. 1) baseline, the mBin was introduced in Site A and produced immediate changes in level (near zero), trend (stable), and variability (suppressed) of proportion contaminated. Site B (bottom panel of Fig. 1) baseline proportion contaminated remained stable and high (near 0.35); initial variability suppressed following 5 days of observation. These effects persisted despite introduction of the mBin in Site A, providing an initial demonstration of experimental control.

Upon implementation of the mBin in Site B, effects replicated those of Site A. Effects persisted throughout the remainder of the mBin condition, excluding the increase in Site B proportion contaminated in the first day following the university's spring break. In the Site A return to BL, Site A's proportion contaminated increased to the initial BL levels on an increasing trend; Site B's intervention effects maintained during this time.

We conducted post-hoc analyses to supplement the visual inspection and provide further evidence for this difference between BL and mBin conditions. Given deviations from normality and violations of such assumptions, we selected Mann-Whitney *U* tests as the most appropriate nonparametric alternative to independent *t*-tests. For Site A, contamination rate was significantly greater during BL ($Mdn = 0.22$, $IQR = 0.19$ to 0.29) as compared to the mBin condition ($Mdn = 0.06$, $IQR = 0$ to 0.07 ; $U = 8$, $p = 0.0038$), yielding a large effect size of $r = 0.66$ (see Fritz, Morris, & Richler, 2012). Similar results were found at Site B, with BL featuring greater contamination rates ($Mdn = 0.30$, $IQR = 0.23$ to 0.33) than mBin ($Mdn = 0.10$, $IQR = 0$ to 0.11 ; $U = 10$, $p = 0.0003$), yielding a large effect size of $r = 0.70$.

These findings provide support for the productive increase in appropriate composting compliance in college dining areas through simple antecedent nudges via modification of bin appearance and functionality. By manipulating the color of the bin shells to increase the discriminability of the composting bin from the landfill bins (and potentially capitalizing on existing stimulus classes regarding "green" products and behaviors), and incorporating a small door to increase response effort of waste disposal (and thus signifying a differential purpose for the mBin and potentially adding to the time for which participants are exposed to instructional materials on proper composting), overall quality of compost improved. Reimplementing the BL at Site A affords greater assurance that the span of time, and

Fig. 1 Multiple-baseline design across university dining facilities (Sites A and B) illustrating the effects of baseline (BL) and modified composting bin (mBin) conditions on proportion of total weight contaminated (depicted as semi-transparent gray circles) on the primary y-axis, with overall weight of waste plotted for reference (depicted as “X” figures) on the secondary y-axis. See text for details

thus accompanying changes in weather or human behavior, had little influence on these results.

Returning to our previous conceptualization of this form of intervention as a *nudge*, it is important to note two specific attributes that we identify as necessary components for such a classification. First, nudges must be socially valid. That this work was supported by the university’s composting service, Environmental Science Program, and Center for Sustainability, and that the first author won numerous campus awards for this work (including reviewed applications incorporating the study protocol) suggests a high degree of social validity. Nonetheless, no formal quantification of social validity was collected for research purposes, limiting our ability to capture this variable mathematically. Second, the nudges must demonstrate adequate maintenance. That the effects persisted over the duration of the academic semester, including the time following the university’s spring break (notwithstanding the outlying data point representing the first weekday following the break in Site B), we believe the study demonstrates sufficient maintenance. Finally, the university in which this study was conducted began a single-stream refuse program in its dining facilities the following Fall semester which included composting efforts (see <https://union.ku.edu/sustainability>).

Despite the aforementioned successes of this study, the described procedure can make no clear distinction between the effects of each individual component of trial bin

manipulation, and thus presents a limitation to methodology. An inability to parse apart the influence of each variable provides little in the way of distinction for the application of individual variables, and so future research could serve to distinguish the effects of clear signage and more distinct bin appearance. Doing so may increase the efficiency of bin design and construction, thereby reducing costs with producing such changes.

As an additional limitation, it remains unclear whether the placement of the bin near main walkways in the dining areas was necessary since we did not test the bins at locations close in proximity to existing waste receptacles (there was no room for such a new bin). Given that strategic bin placement has much support in the behavior analytic literature in diverting waste/litter (e.g., Brothers et al., 1994; Geller et al., 1979; Ludwig et al., 1998; Luyben & Bailey, 1979; O’Connor et al., 2010), we would recommend this be a critical component in any replications and applications. However, we note that the proximity of walkways in our baseline was unsuccessful in diverting compostable waste in the absence of mBin features, so we can merely speculate that placement is a necessary, but not necessarily sufficient, feature of a composting program in university dining centers.

The above limitations notwithstanding, the current research serves as a community-level intervention designed using interdisciplinary conceptualization and implemented using

sound behavioral science methods. Our findings add to the behavior analytic literature on the use of simple antecedent nudges to positively affect sustainability in organizational settings, specifically with respect to strategic bin placement and informative visual prompts (e.g., Austin et al., 1993; Witmer & Geller, 1976). These types of nudges may be more advantageous than consequence-based strategies given the resources necessary to sustain and maintain these latter interventions. Evidence to support the efficacy of antecedent nudges in decreasing contamination rates in compost is of particular importance to universities or other large public organizations seeking to reduce waste output and achieve greater benchmarks in sustainability, given the relatively stringent nature of compost and its permission of unsuitable waste. Further validation of the findings described here could help establish a standard protocol for introduction of composting bins at large establishments and organizations—a move which would serve to aid waste management at these locations and provide a valuable byproduct for regeneration of local natural settings.

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Compliance with Ethical Standards This project was supported and funded by the University of Kansas Environmental Studies Ruben Zadigan Scholarship and a KU Undergraduate Research Award awarded to the first author.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was unnecessary given the absence of individual participant data collection and sole reliance on outcome data (e.g., refuse/compost weights).

Conflict of Interest David Szczucinski declares that he has no conflict of interest. Brett W. Gelino declares that he has no conflict of interest. Christopher J. Cintron declares that he has no conflict of interest. Amel Becirevic declares that he has no conflict of interest. Derek D. Reed declares that he has no conflict of interest.

References

- Ahmad, R., Jilani, G., Arshad, M., Zahir, Z. A., & Khalid, A. (2007). Bio-conversion of organic wastes for their recycling in agriculture: An overview of perspectives and prospects. *Annals of Microbiology*, 57(4), 471–479. <https://doi.org/10.1007/BF03175343>.
- Austin, J., Hatfield, D. B., Grindle, A. C., & Bailey, J. S. (1993). Increasing recycling in office environments: The effects of specific, informative cues. *Journal of Applied Behavior Analysis*, 26(2), 247–253. <https://doi.org/10.1901/jaba.1993.26-247>.
- Barnes, S., Baxter, M., Birzer, H., Goodeve, A., Stensen, J., & Tse, J. (2015). *An investigation into the degree and reasons for contamination of outdoor organic waste stations at the University of British Columbia*. doi:<https://doi.org/10.14288/1.0223920>.
- Binder, K., Glasser, H., & Fuqua, R. W. (2017). A behavioral approach to the development of a campus-wide recycling system. *Sustainability: The Journal of Record*, 10(1), 39–44. <https://doi.org/10.1089/sus.2017.29082.kb>.
- Brothers, K. J., Krantz, P. J., & McClannahan, L. E. (1994). Office paper recycling: A function of container proximity. *Journal of Applied Behavior Analysis*, 27(1), 153–160. <https://doi.org/10.1901/jaba.1994.27-153>.
- Burgess, R. L., Clark, R. N., & Hendee, J. C. (1971). An experimental analysis of anti-litter procedures. *Journal of Applied Behavior Analysis*, 4(2), 71–75. <https://doi.org/10.1901/jaba.1971.4-71>.
- Cina, L., Gezella-Baranczyk, M., & Wedl, M. (2017). *Composting contamination in corporate settings*. Retrieved from <https://conservancy.umn.edu/handle/11299/192050>
- Cogger, C. G. (2005). Potential compost benefits for restoration of soils disturbed by urban development. *Compost Science and Utilization*, 13(4), 243–251. <https://doi.org/10.1080/1065657X.2005.10702248>.
- Cone, J. D., & Hayes, S. C. (1980). *Environmental problems/Behavioral solutions*. Monterey: Brooks/Cole.
- de Bertoldi, M., Vallini, G., & Pera, A. (1983). The biology of composting: A review. *Waste Management & Research*, 1(2), 157–176. <https://doi.org/10.1177/0734242X8300100118>.
- DeLeon, I. G., & Fuqua, R. W. (1995). The effects of public commitment and group feedback on curbside recycling. *Environment and Behavior*, 27(2), 233–250. <https://doi.org/10.1177/0013916595272007>.
- Duffy, S., & Verges, M. (2009). It matters a hole lot: Perceptual affordances of waste containers influence recycling compliance. *Environment and Behavior*, 41(5), 741–749. <https://doi.org/10.1177/0013916508323737>.
- Friman, P. C., & Poling, A. (1995). Making life easier with effort: Basic findings and applied research on response effort. *Journal of Applied Behavior Analysis*, 28(4), 583–590. <https://doi.org/10.1901/jaba.1995.28-583>.
- Fritz, C. O., Morris, P. E., & Richler, J. J. (2012). Effect size estimates: Current use, calculations, and interpretation. *Journal of Experimental Psychology: General*, 141(1), 2–18. <https://doi.org/10.1037/a0024338>.
- Geller, E. S. (2016). Actively caring for mother earth. In E. S. Geller (Ed.), *Applied psychology: Actively caring for people* (pp. 594–622). New York: Cambridge University Press.
- Geller, E. S., Brasted, W. S., & Mann, M. F. (1979). Waste receptacle designs as interventions for litter control. *Journal of Environmental Systems*, 9(2), 145–160. <https://doi.org/10.2190/SP46-8H2N-41JR-C2EJ>.
- Geller, E. S., Chaffee, J. L., & Ingram, R. E. (1975). Promoting paper recycling on a university campus. *Journal of Environmental Systems*, 5(1), 39–57. <https://doi.org/10.2190/E2LM-JNTV-NBJ6-ETJF>.
- Gillett, J. W. (1992). Issues in risk assessment of compost from municipal solid waste: Occupational health and safety, public health, and environmental concerns. *Biomass and Bioenergy*, 3(3–4), 145–162. [https://doi.org/10.1016/0961-9534\(92\)90023-J](https://doi.org/10.1016/0961-9534(92)90023-J).
- Hamad, C. D., Bettinger, R., Cooper, D., & Semb, G. (1980). Using behavioral procedures to establish an elementary school paper recycling program. *Journal of Environmental Systems*, 10(2), 149–156. <https://doi.org/10.2190/5TL9-EPP9-XKV1-3KJT>.
- Hamad, C. D., Cooper, D., & Semb, G. (1977). Resource recovery: Use of a group contingency to increase paper recycling in an elementary school. *Journal of Applied Psychology*, 62(6), 768–772. <https://doi.org/10.1037/0021-9010.62.6.768>.

- Hoornweg, D., Thomas, L., & Otten, L. (2000). *Composting and its applicability in developing countries (Urban Waste Management Working Paper No. 8)*. Washington, DC: Urban Development Division, World Bank.
- Hottle, T. A., Bilec, M. M., Brown, N. R., & Landis, A. E. (2015). Toward zero waste: Composting and recycling for sustainable venue based events. *Waste Management*, 38(1), 86–94. <https://doi.org/10.1016/j.wasman.2015.01.019>.
- Kim, S., Oah, S., & Dickinson, A. M. (2005). The impact of public feedback on three recycling-related behaviors in South Korea. *Environment and Behavior*, 37(2), 258–274. <https://doi.org/10.1177/0013916504267639>.
- Kohlenberg, R., & Phillips, T. (1973). Reinforcement and rate of litter depositing. *Journal of Applied Behavior Analysis*, 6(3), 391–396. <https://doi.org/10.1901/jaba.1973.6-391>.
- KU Budget Office. (2017). *The University of Kansas (Lawrence Campus) executive summary of the operating budget for fiscal year ending June 30, 2017*. Retrieved from https://budget.ku.edu/sites/budget.ku.edu/files/docs/Final_FY_2017_Executive_Summary.pdf
- KU Memorial Union. (2017). *The KU Memorial Union 2017 annual report*. Retrieved from <https://union.ku.edu/annual-report#tab4name>
- Lim, S. L., Lee, L. H., & Wu, T. Y. (2016). Sustainability of using composting and vermicomposting technologies for organic solid waste biotransformation: Recent overview, greenhouse gases emissions and economic analysis. *Journal of Cleaner Production*, 111(A), 262–278. <https://doi.org/10.1016/j.jclepro.2015.08.083>.
- Ludwig, T. D., Gray, T. W., & Rowell, A. (1998). Increasing recycling in academic buildings: A systematic replication. *Journal of Applied Behavior Analysis*, 31(4), 683–686. <https://doi.org/10.1901/jaba.1998.31-683>.
- Luyben, P. D., & Bailey, J. S. (1979). Newspaper recycling: The effects of rewards and proximity of containers. *Environment and Behavior*, 11(4), 539–557. <https://doi.org/10.1177/0013916579114006>.
- Montejo, C., Ramos, P., Costa, C., & Márquez, M. C. (2010). Analysis of the presence of improper materials in the composting process performed in ten MBT plants. *Bioresource Technology*, 101(21), 8267–8272. <https://doi.org/10.1016/J.BIORTECH.2010.06.024>.
- O'Connor, R. T., Lerman, D. C., Fritz, J. N., & Hodde, H. B. (2010). Effects of number and location of bins on plastic recycling at a university campus. *Journal of Applied Behavior Analysis*, 43(4), 711–715. <https://doi.org/10.1901/jaba.2010.43-711>.
- Richard, T. L. (1992). Municipal solid waste composting: Physical and biological processing. *Biomass and Bioenergy*, 3(3–4), 163–180. [https://doi.org/10.1016/0961-9534\(92\)90024-K](https://doi.org/10.1016/0961-9534(92)90024-K).
- Rogger, C., Beaurain, F., & Schmidt, T. S. (2011). Composting projects under the clean development mechanism: Sustainable contribution to mitigate climate change. *Waste Management*, 31(1), 138–146. <https://doi.org/10.1016/j.wasman.2010.09.007>.
- Sussman, R., & Gifford, R. (2013). Be the change you want to see: Modeling food composting in public places. *Environment and Behavior*, 45(3), 323–343. <https://doi.org/10.1177/0013916511431274>.
- Sussman, R., Greeno, M., Gifford, R., & Scannell, L. (2013). The effectiveness of models and prompts on waste diversion: A field experiment on composting by cafeteria patrons. *Journal of Applied Social Psychology*, 43(1), 24–34. <https://doi.org/10.1111/j.1559-1816.2012.00978.x>.
- U.S. Environmental Protection Agency. (2018a). *Advancing sustainable materials management: Facts and figures*. Retrieved from <https://www.epa.gov/smm/advancing-sustainable-materials-management-facts-and-figures>
- U.S. Environmental Protection Agency. (2018b). *Greenhouse gas emissions from a typical passenger vehicle*. Retrieved from <https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle>
- Witmer, J. F., & Geller, E. S. (1976). Facilitating paper recycling: Effects of prompts, raffles, and contests. *Journal of Applied Behavior Analysis*, 9(3), 315–322. <https://doi.org/10.1901/jaba.1976.9-315>.
- Woodbury, P. B. (1992). Trace elements in municipal solid waste composts: A review of potential detrimental effects on plants, soil biota, and water quality. *Biomass and Bioenergy*, 3(3–4), 239–259. [https://doi.org/10.1016/0961-9534\(92\)90029-P](https://doi.org/10.1016/0961-9534(92)90029-P).
- Woodbury, P. B., & Breslin, V. T. (1992). Assuring compost quality: Suggestions for facility managers, regulators, and researchers. *Biomass and Bioenergy*, 3(3–4), 213–225. [https://doi.org/10.1016/0961-9534\(92\)90027-N](https://doi.org/10.1016/0961-9534(92)90027-N).

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