

12-2018

A Component Analysis of Low-Cost Interventions to Decrease Cigarette Butt Litter in the Natural Environment

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**A Component Analysis of Low-Cost Interventions to Decrease Cigarette Butt
Litter in the Natural Environment**

by

Julia Turner

A Thesis
Submitted to the Graduate Faculty of
St. Cloud State University
in Partial Fulfillment of the Requirements
for the Degree
Master of Science in
Applied Behavior Analysis

December, 2018

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Abstract

The current study examines the effects of low-cost interventions such as prompts, feedback, and the addition of receptacles on littering behavior of cigarette butts in the natural environment. Two receptacles were placed at each experimental hole, one within twenty feet of the tee box, and a second within twenty feet of the edge of the green. Prompts included (1) a reminder of the location of receptacles, (2) a slogan prompting proper disposal of cigarette butts, and (3) one piece of information regarding consequences of cigarette butt litter. Feedback included a barometer specific to each hole indicating the decrease in cigarette butt litter on each individual experimental hole since baseline. An additive component analysis was used to determine effectiveness of each low-cost intervention. Results from this study expands the literature on cost-effective, low effort, and socially valid interventions tackling litter. In the current study, simply providing receptacles for proper cigarette disposal was deemed the more effective and preferred intervention to decrease cigarette butt litter.

Keywords: littering, cigarette butts, low-cost intervention, prompts, feedback, receptacles

Acknowledgements

I would like to thank the staff and management at Beauty Bay Golf Course for their cooperation, positive and meaningful feedback, and their warm welcome throughout my research.

I would also like to express my profound gratitude to my fiancé, Bryce Evason for his unwavering love, support, and encouragement no matter what I do.

Finally I would like to thank my parents, Craig and Teresa Turner, whose love and guidance are with me always. Thank you for always encouraging me to pursue my goals, and especially for all the cold, early mornings spent counting cigarette butt waste with me. This accomplishment truly would not have been possible without you. Thank you.

Table of Contents

	Page
List of Tables	5
List of Figure	6
Chapter	
1. Introduction.....	7
2. Method.....	12
Participants and Setting	12
Response Measurement and Data Collection	13
Total Count Interobserver Agreement	13
Experimental Design	14
Procedure	14
Social Validity Survey	14
3. Results.....	17
4. Discussion.....	19
References.....	23
Appendices	
A. Intervention Components	27
B. Social Validity Survey	31

List of Tables

Table	Page
1. Total Number of Cigarette Butts Properly Disposed	25
2. Social Validity Questionnaire	25

List of Figure

Figure	Page
1. Number of cigarette butts littered per person, per hole, and across various Conditions	26

Chapter 1: Introduction

Cigarette butt litter is prevalent, unsightly, and a substantial risk to our environment and wildlife due to its toxic materials leaching into their surrounding area. Reports indicate that cigarette butts are the most collected item in coastal cleanups, with 52,907,756 butts collected over a 25-year span (Ocean Conservancy, 2011) and 1,863,838 cigarette butts in 2017 alone (Ocean Conservancy, 2017). Keep America Beautiful, a campaign created to target littering behavior, reported cigarette butts were also the number one littered item in storm drains, around retail areas, recreational areas, and construction sites (Keep America Beautiful, 2007).

One of the main ingredients in cigarette butts is cellulose acetate, which is a compressed plastic product commonly used in products such as sunglass frames (Bonanomi, Incerti, Cesarano, Gaglione, & Lanzotti, 2015). Due to the high quantity of this material, cigarette butts are not biodegradable and have an extremely slow decomposition rate. Bonanomi et al. (2015) concluded that depending on the environmental conditions (e.g., exposure to UV light and water), one cigarette butt may partially decompose, but only by 30-35% in a two-year period. In this time of decomposition, cigarette butt litter can leach its hazardous materials and toxins into the ecosystem, be consumed by wildlife, or end up contaminating waterways. One study found that a single smoked cigarette butt in a litre of water is acutely toxic and likely to kill all marine and freshwater fish in it (Slaughter et al., 2011).

To date, minimal research has been conducted regarding cigarette-butt littering behavior. Historically, the tobacco industry has conducted such research with campaigns such as Keep America Beautiful (2007); however, results have not led to a decrease in littering behavior. An independent study by Rath, Rubenstein, Curry, Shank, and Cartwright (2012) identified the

importance of non-industry research to minimize potential biases due to the tobacco industry's overriding interest in keeping consumers instead of understanding littering of cigarette butts. The authors surveyed individuals regarding their smoking status, knowledge and beliefs about cigarette litter, and behaviors regarding cigarette litter (e.g., how they disposed of litter). The results showed that 75% of the people interviewed identified this litter as toxic, 82.4% agreed that cigarette butts are not biodegradable, and over 90% believed them to be toxic if consumed by a humans or marine life. Despite this, 55.7% of those surveyed reported personally littering cigarette butts in the past month alone. It also identified that individuals who did not consider cigarette butts to be litter were four times more likely to have littered in the past month. The authors noted that littering prevalence was likely underestimated due to the fact that self-report of littering is a sensitive behavior (Rath et al., 2012).

Schultz, Bator, Large, Bruni, and Tabanico (2013) attempted to identify controlling variables of cigarette-butt littering behavior, such as gender, age, presence of litter, and presences of receptacles. The study found that gender was not a predictor of littering behavior and that individuals between 20-30 years old were more likely to engage in littering, though the results were not significant. The study found that the amount of litter present and availability of receptacles were statistically significant predictors of cigarette-butt littering. The authors also determined that the optimal distance for receptacles in order to reduce cigarette butt litter is less than 20 feet away (Schultz et al., 2013).

Some research on littering in general has analyzed behavioral variables such as prompts (Cingolani, Barbera, Renison, & Barri, 2016; Dixon, Knott, Rowsell, Sheldon, & Moore, 1992; Liu & Sibley, 2004), posted feedback (Dixon & Moore, 1992; Dixon et al., 1992; Sibley & Liu,

2003), changes to the physical environment such as increasing or relocating receptacles (Liu & Sibley, 2004; Sibley & Liu, 2003), presence or absence of prior litter (Cingolani et al., 2016, Liu & Sibley, 2004), and consequences such as rewards for proper disposal or penalties for littering behavior (Liu & Sibley, 2004). The majority of studies that demonstrated effectiveness used treatment packages, making it unclear which method was the most effective in reducing littering behavior.

Liu and Sibley (2004) conducted a two-part study evaluating effects of various interventions on the littering behavior (cigarette and non-cigarette litter) of students on a college campus quad. In study 1, prompts in the form of a banner “be clean and green: please throw it in the bin,” smaller written prompts around the quad, and distribution of stickers labeled “quad slob” or “clean green quad machine” distributed to students engaging in littering, or proper disposal behaviors only reducing cigarette butt litter by 5.3%. Modeling appropriate disposal of trash was added in the second phase, but had minimal impact reducing cigarette butt litter by 0.8%. Study 2 replicated study 1 with the addition of posted feedback regarding gender differences on littering behavior from the previous day, which reduced litter by 16.9%, and a 64.3% reduction of litter was seen with the addition of receptacles. While this study demonstrated that attitude salience manipulations (e.g., banners, stickers, modeling) were ineffective in decreasing litter, and that the most effective method was the addition of receptacles, this study did not evaluate the effectiveness of increased receptacles alone, making conclusions regarding the relative impact of each component premature.

Cingolani et al. (2016) used a treatment package consisting of persuasive verbal requests to dispose of litter (they did not specify cigarette butt litter) as well as modeling the proper

disposal of litter on beaches. The results demonstrated a modest reduction of litter by 35% from baseline; however, it is unclear if verbal requests or modeling appropriate behavior was more effective. Both the Liu and Sibley (2004) and Cingolani et al. (2016) studies identified posted feedback to be more effective than prompts in reducing litter (e.g., a posted barometer with daily feedback of mean pieces of litter per person); behavioral research has also demonstrated that the effects of posted feedback can be maintained following the termination of the intervention (Dixon & Moore, 1992; Dixon et al., 1992). While the literature has identified antecedent interventions such as posted feedback and receptacles as effective methods in reducing littering behavior in general, specific research on cigarette butt litter is limited, and even fewer studies indicate methods that have been adopted into the public setting after research has concluded.

There is a growing body of literature demonstrating how behavior analytic practice and principles can be used to shape ecological behaviors in public settings (Geller, Winett, & Everett, 1982). Friman and Poling (1995) indicated that an increase in response effort has similar impacts as punishment on behavior and will therefore result in a response reduction. Friman (as cited in Friman & Poling, 1995) identified that reducing the response effort, such as increasing ashtray proximity, may be a viable intervention to reduce cigarette butt littering. There is an obvious need to reduce cigarette butt littering to protect our environment.

The purpose of this study was to investigate several low-cost interventions, individually and in combination, to increase the proper disposal of cigarette waste in the natural environment. Low-cost interventions selected included receptacles specifically for cigarette waste, signage promoting proper disposal of cigarette waste, and feedback from previous days' disposal. The primary purpose was to assess the most effective low-cost intervention to increase proper

disposal of cigarette waste and decrease cigarette butt litter. A secondary purpose was to identify interventions are socially acceptable and easily adopted by various organizations (e.g., require minimal effort and cost).

Chapter 2: Method

Participants and Setting

The study was conducted at Beauty Bay Golf Course in Kenora, Ontario. The eighteen-hole golf course is surrounded by a community of seasonal cottagers and rests against the shores of Black Sturgeon Lake where the cottagers use the water for cooking, bathing, fishing, swimming, and other recreational activities. Cigarette butt litter was identified by the manager of the golf course as a serious concern to the maintenance of their course and a nuisance to clean up. Cigarette butts were also identified as the likely cause of a fire on the golf course in the spring of 2018, and small burn marks are often found on the grounds surrounding where cigarette butts have been discarded. In addition to these aesthetic and safety concerns, the main water source for surrounding cottagers is Black Sturgeon Lake; therefore, it is a possibility that cigarette butt litter left on the course could enter the lake and leach toxins, causing water pollution or contamination of the marine life.

Currently the lawnmower or course staff pick up littered cigarette butts by hand. It is unclear if the cigarette butts cause damage the lawn mower equipment, and the total cost of clean-up in terms of staff hours is unknown. Managing staff shared that if the course had a choice, they would ban smoking altogether; however, they are concerned about the loss of business as a result of the ban. There are currently no methods in place to reduce littering behavior, and there are no ashtray receptacles anywhere on the course. Cup-holder ashtrays have been considered, but management was concerned that the occupancy of one of the cup holders in a golf cart would be undesirable to golfers.

Participants for this study were the patrons of Beauty Bay Golf Course on Friday and Saturday from August 24 to September 22, 2018.

Response Measurement and Data Collection

When asked if particular holes were a problem as far as cigarette butt litter is concerned, course management identified holes 4, 7, 14, and 17, with the tee box and green as the areas where littering behavior is most prevalent. A tee box is located at the beginning of a fairway. A green is at the conclusion of each fairway marked by a hole or “cup” and a flagstick or “pin”. Both the tee box and green can vary in size from hole to hole, but they are easily identified by closely trimmed grass as compared with the surrounding area and fairway. Holes 4, 7, 14, and 17 were cleared of all cigarette butts at dusk the day prior to implementation of each phase. Baseline and all interventions occurred on Friday and Saturday due to the increased number of patrons on those days. Holes 4, 7, and 17 were identified as the experimental holes where the interventions were placed; hole 14 was used for control measurements, and no interventions were placed on this hole. Permanent products were collected in marked bags on Saturday and Sunday mornings before the first tee time at 7am and then counted and recorded using paper and pencil.

Cigarette butt litter is defined as a whole or partial filter of a cigarette butt collected on any part of the tee box, fairway, or green on holes 4, 7, 14, and 17.

Total Count Interobserver Agreement

For 70% of observation days, a secondary observer surveyed the selected holes to ensure no cigarette butts were missed. This observer also independently counted cigarette butts collected by the primary observer. The secondary observer was provided the definition of cigarette butt litter and achieved 100% agreement with the primary observer on permanent

product counts during a practice session prior to initial baseline measurements. Total count agreement for total number of cigarette butts littered per hole was calculated by dividing the smaller total count of cigarette butts littered from one observer by the larger total count of cigarette butts littered from the second observer and multiplying by 100% (Cooper, Heron, & Heward, 2007). Total count agreement was 100% for total number of cigarette butts littered per hole.

Experimental Design

An additive component analysis with reversal was conducted with the following phases: (a) baseline, (b) receptacles alone, (c) receptacles plus prompts, (d) receptacles plus feedback, and (e) return to receptacles only. The duration of each phase was two consecutive days on Friday and Saturday to accommodate the days of highest visitation.

Procedure

Baseline. In baseline, data were collected on the number of cigarette butts found on the three experimental holes under the conditions currently in place at the golf course.

Receptacles alone. Prior to the first day of this phase, two receptacles were placed at each of the three experimental holes (hole 4, 7, and 17), one within 20 feet of the tee box boundary and the other within 20 feet of the fringe boundary surrounding the green, to reduce response effort of golfer's proper disposal of cigarette butts and to replicate the findings of Schultz et al. (2013; see Appendix A for location of receptacles). Receptacles were 19-litre multipurpose buckets filled halfway with sand. Attached to each bucket was a sign with an image of a cigarette with the slogan "butt out here" (see Appendix A). Receptacles were purchased for

\$4 a unit, the sand cost \$2.50, and the signs cost \$3 per receptacle, making the total cost of each receptacle \$9.50.

Receptacles plus prompts. Receptacles remained in place from the prior phase. Prompts promoting proper disposal included a sign at the cash register inside the clubhouse indicating at which holes cigarette ashtrays could be found with a slogan “keep the course green, keep it clean, don’t litter your cigarette butts” (see Appendix A), and a sign at the entrance to the selected holes, next to the receptacles, reminded golfers where the receptacles were located. The signs also included a single piece of information regarding cigarette butt litter (e.g., how long it takes to dispose, hazards to the environment such as fires, or the impact on surrounding wildlife and waterways) and a slogan prompting proper disposal of cigarette butt waste (see Appendix A). Each sign cost \$3 to create.

Receptacles plus feedback. During this phase the receptacles remained in place, but the prompts were removed from the cash register, and barometers replaced prompts at the start of each hole next to the tee box receptacle. The barometer indicated the total number of cigarette butts littered on each individual hole per week starting from initial baseline (see Appendix A). Each sign cost \$3 to create.

Social Validity Survey

At the termination of the research, a social validity survey was conducted with staff at the golf course. Social validity was measured using a 5-point Likert scale with 1 representing strongly disagree and 5 representing strongly agree. The purpose of the social validity survey for the golf course management was to investigate their overall satisfaction with the intervention, the acceptability of individual components of the intervention, how important this issue was to their

business, and the likelihood of adopting of one or more methods at their golf course (see Appendix B).

Chapter 3: Results

Figure 1 displays the number of cigarette butts littered per person over various interventions throughout the course of this study. Cigarette butts littered per person was calculated by dividing the total number of cigarette butts littered per hole across the two-day phase by the total number of patrons attending the golf course over those two days. During the baseline condition the average number of cigarette butts littered across experimental holes was 0.91, decreasing to 0.28 with the addition of receptacles, 0.25 with the addition of prompts and receptacles, 0.13 with the addition of feedback and receptacles, and finally 0.14 with the return to receptacles alone. During baseline, the average number of cigarette butts littered per person on the control hole (hole 14) was 0.15, decreasing to 0.06 with the addition of receptacles alone, increasing slightly to 0.07 with the addition of signage and receptacles, decreasing again to 0.02, and increasingly significantly to 0.12 with the return to receptacles alone.

Table 1 displays the total number of cigarettes properly disposed of in either the tee box or green receptacles over the course of the study. A total of 68 cigarette butts were properly disposed of on the experimental holes (hole 4, 7, and 17), with the majority disposed in the receptacles located on the green.

The results of the study show an overall decreasing trend in cigarette butt littered across all interventions. Introduction of the receptacles alone saw an immediate and substantial decrease in cigarette butt litter on the experimental holes by 69% from the initial baseline. Levels of cigarette butt litter remained low across the subsequent phases. In an effort to develop a low-cost intervention, the decreasing trend across interventions suggested that the presence of receptacles alone was a viable intervention to decrease cigarette butt litter. The number of properly disposed

cigarette butts shows that receptacles placed on the green were consistently used, and the location of the receptacle being within 20 feet from the green increased proper disposal of cigarette butt waste.

Table 2 summarizes results from the questionnaire distributed to the golf course management and staff. Of the six completed surveys, all respondents found the study to be favorable and meaningful to their business and indicated that adopting one or more of the study's components would be likely. Of the three interventions offered, the receptacles-alone condition was rated as the most favorable.

Chapter 4: Discussion

While previous studies have been conducted in an effort to shape littering behavior, the variables that lead to success are unclear. The primary purpose of this study was to assess which low-cost intervention (i.e., receptacles, signage prompting proper disposal, and feedback) was the most effective in increasing proper disposal of cigarette waste and decrease cigarette butt litter. The findings above indicate that all three conditions introduced in this study were effective in reducing cigarette butt litter from baseline levels. The secondary purpose was to identify interventions that are socially acceptable and easily adopted by various organizations (e.g., require minimal effort and cost). The golf course staff and management responded favorably to the interventions and indicated intentions to adopt one or more components. The reduction in cigarette butt litter on the golf course was expressed by the golf course staff as significant, resulted in increased awareness of the issue, kept the environment clean, and encouraged the golf course to take further action on this issue. The total cost for the receptacle condition was \$57, the addition of the prompts cost \$12, and the addition of the feedback signs cost \$9. The total cost of the interventions was \$78. Surveying additional stakeholders (e.g., Beauty Bay Board members, community members, golfers, etc.) did not occur and should be considered in future research to evaluate the importance of the issue to the community.

Slight variances were detected across conditions. Hole 4 and 7 overall saw decreasing trends across conditions, while litter on hole 17 increased with the addition of signage. It is possible the variation in results across conditions may have been due to frequency of smokers and variation of smoking behavior across holes. It is also possible that the persuasive slogan included in the prompts acted as an establishing operation by altering the reinforcing effects of

disposing of the cigarette butt properly. It is possible that on hole 4 and 7 the prompts either increased the aversiveness of littering, or provided negative reinforcement for proper disposal. Since litter increased on hole 17, however, it does not appear that the prompts acted as establishing operations, or that the additive effect from the prior messages had waned.

Variances between tee box and green receptacles was also present. It is possible this variability was a result of varying number of golfers across weekends, increased wait times at tee boxes during busier days, or increased tendencies to smoke on greens over tee boxes. Prior to the final phase, the return to receptacles alone, golf course maintenance staff requested the green receptacle on hole 7 be moved slightly further away to prevent an obstruction for golfers. This moved the receptacle outside of the 20-foot radius from the green, and a slight increase in litter was observed. Based on these results, it is possible that having the cigarette butt receptacles within a 20-foot radius decreased response effort, and increased proper disposal (Friman & Poling, 1995, Schultz et al., 2013). What may be an important issue to investigate is the effects response effort alone has on littering behavior. If response effort is directly related to increased littering behavior, stable receptacles may not be the most meaningful intervention. In a recreation environment where patrons travel hundreds of yards each hole with no set pattern, it is hard to predict their most likely path of travel.

This study had several limitations. The first limitation was the inability to control the number of smokers per day, thus making it difficult to determine if the reduction in litter was a result of the intervention or a low number of smokers that weekend. Future research could poll golfers when they are finished whether or not they smoked on the golf course that day to get a better idea of how many smokers and non-smokers that day. The second limitation was that each

phase only lasted for two consecutive days, making trends difficult to interpret. Future studies should run intervention phases for longer periods of time to achieve stable responding and more reliably determine effectiveness. A third limitation was the lack of replication due to seasonal changes. Future studies should begin early in the season to allow for increased opportunities for replication and allow for each intervention to be replicated to result in stronger findings.

While the majority of litter was located on the tee boxes and greens, stable receptacles prevented proper disposal of cigarette butts if smoked on the fairway. Based on Schultz et al. (2013) the stable receptacles were outside of the recommended 20-foot radius, thus altering response effort and potentially littering behavior. Receptacles were placed on the tee boxes and greens because golf course management identified them as problem areas, and because every golfer must play on the tee box and green, whereas playing the fairway is variable. As identified above, if response effort is correlated to littering behavior, and due to the nature of recreational environments such as golf courses, future research should evaluate the effectiveness of stable receptacles and cup holder receptacles. Cupholder receptacles can be purchased for as low as \$3 a unit, keeping in line with low-cost interventions. Additionally, a cupholder clip can be purchased for as low as \$3.75 per unit; clips would eliminate the concern over occupying a cupholder in the golf cart and would accommodate push-carts if a golfer preferred to walk. Costs of equipping golf carts and push carts with cupholder receptacles can be managed by handing them out to golfers when purchasing green fees in the clubhouse or having golfers pay a small rental fee.

This study expands the literature on cost-effective, low effort, and socially valid interventions tackling litter. In the current study, simply providing receptacles for proper

cigarette disposal was deemed the more effective and preferred intervention. This study also provides practical information for Beauty Bay Golf Course and other recreational establishments looking to decrease cigarette butt litter and engage in environmentally conscious practices.

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Table 1

Total Number of Cigarette Butts Properly Disposed

Intervention	Tee Box	Green
Receptacles Alone	10	16
Receptacles & Signs	21	10
Receptacles & Feedback	2	5
Receptacles Alone	0	4

Note. Receptacles were located on hole 4, 7, and 17 across interventions.

Table 2

Social Validity Questionnaire

Questions	Range of Responses	Mean Response
1. The intervention was acceptable.	4 – 5	4.7
2. The intervention did not interfere in any unfavorable way with the business.	4 – 5	4.7
3. The additional receptacles on the golf course holes was acceptable.	4 – 5	4.7
4. The use of signs and prompts was acceptable.	2 – 5	4.2
5. The use of feedback (barometer) was acceptable.	3 – 5	4.5
6. This is an important issue to your business.	4 – 5	4.7
7. You are likely to adopt one or more of these interventions following the completion of the study.	4 – 5	4.7

Note. Questionnaires were completed by golf course management and staff ($n=6$). A 5-point Likert scale was used to score responses, 1 representing strongly disagree and 5 representing strongly agree.

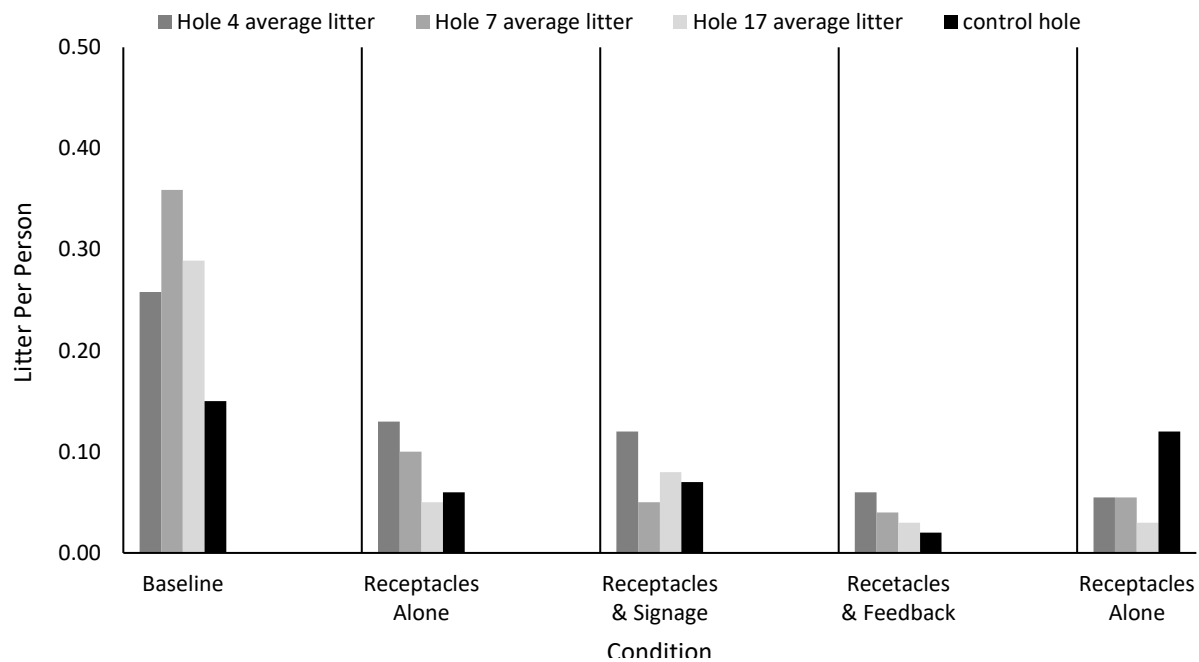


Figure 1. Number of cigarette butts littered per person, per hole, and across various conditions.

Appendix A: Intervention Components**Hole 4****Hole 7****Hole 17**

Appendix A.1. Layout of each experimental hole. Each star represents the location of the receptacles.



Appendix A.2. Receptacles located on tee box and greens.


Keep the golf course clean,
Keep it green,
Dispose of your cigarettes properly




Cigarette receptacles can be found on holes 4, 7, and 17.


DON'T BE AN ASH - 
CIGARETTE RECEPTACLES CAN BE FOUND ON THIS HOLE




Cigarette butts main ingredient is plastic.
Cigarette butts can take up to 10 years to decompose.



BE PART OF THE SOLUTION,
NOT THE POLLUTION
CIGARETTE RECEPTACLES CAN BE FOUND ON THIS HOLE



Hole #7

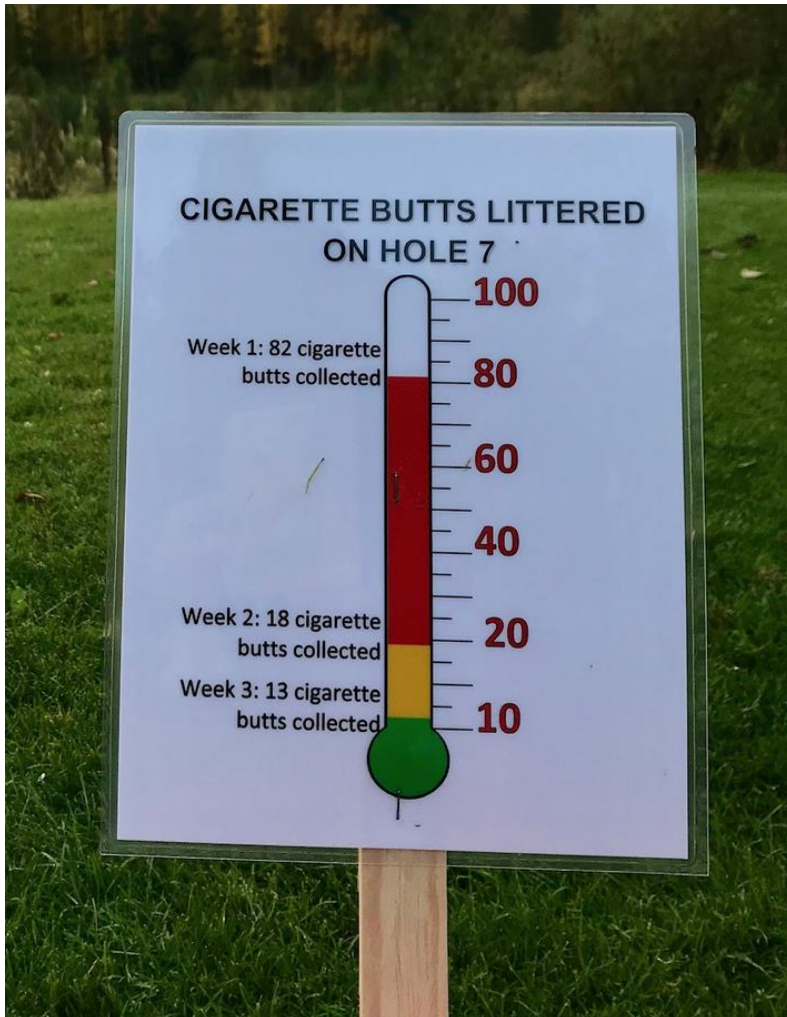
An organization called TERRACYCLE® will recycle all cigarette waste, free of charge, and even make a donation to a registered charity of your choice.


THE WORLD IS NOT YOUR ASHTRAY
CIGARETTE RECEPTACLES CAN BE FOUND ON THIS HOLE



When placed in a liter of water, toxicity leached from a single cigarette butt killed all fresh water fish residing in it

Appendix A.3. Prompts placed at the cash register in the clubhouse, and the start of each experimental hole reminding patrons to properly dispose of cigarette butt waste.



Appendix A.4. An example of barometers placed at the start of each hole representing the amount of litter collected since baseline.

Appendix B: Social Validity Survey

Social Validity Questionnaire
Golf Course Management and Staff

Please rate the following on a scale of 1 (strongly disagree) to 5 (strongly agree).

	1 Strongly Disagree	2 Disagree	3 Do Not Know	4 Agree	5 Strongly Agree
1. The intervention was acceptable.					
2. The intervention did not interfere in an unfavorable way with the business.					
3. The additional receptacles on the golf holes was acceptable.					
4. The use of signs and prompts was acceptable.					
5. The use of feedback (barometer) was acceptable.					
6. This is an important issue to your business.					
7. You are likely to adopt one or more of these interventions following the completion of the study.					

Appendix B.1. A sample of the social validity surveys distributed to golf course management.