Tear Here: the Impact of Object Transformations on Proper Disposal

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Abstract: Efforts promoting proper disposal of packaging generally focus on infrastructure and messaging. Significantly less attention has been given to how the attributes of packaging can be used to change disposal behaviour. This research shows how changes in packaging attributes (e.g. alterations in shape, colour, or size) influence two disposal behaviours: recycling and littering. Specifically, we use an implicit association test to measure the subconscious tendency to categorize altered objects as trash rather than recycling. The results indicate that 82% or respondents showed at least a slight effect and 53% showed a strong effect towards associating altered objects with waste. Next, we evaluate object transformations on littering behaviour through an observational field study. Observations (N = 2823) indicated that littering is influenced by deformed, torn, disassembled, and partially full packaging. No significant effect was found with regard to packaging that is wet, sticky, has undergone colour changes or that is has remains (e.g. sauce) on it. These findings suggest that the (re)design of packaging can significantly influence proper disposal. Based on this, packaging can be (re)designed in two ways. First, many types of packaging have scripted alterations such as the iconic 'tear here' indicator. These can be changed to preserve properties associated with recyclables and non-littering. Second, packaging can be designed so that there are fewer alterations during use. This work can also help identify inherent attributes that encourage proper disposal.

Keywords: recycling, litter, sustainability, behaviour.

1 Introduction

Most interventions around proper disposal—understood as recycling and avoidance of littering in this paper—have focused on changing the environment (e.g. bin placement, bin design, convenience of collection, clearing pre-existing litter, etc.) [1]–[7] or the consumer (e.g. messaging to change attitudes) [4], [7]–[13]. The emphasis on infrastructure and messaging may be due to the fact that waste management has been considered a municipal responsibility and has subsequently focused on interventions through which the municipality can exert some kind of control. More recently, producers have become far more interested in the proper disposal of waste. One reason for this is the development of global policies around extended producer responsibility (EPR) which posits that the responsibility for what happens to an object after the point of sale is shared with the producer of the object [14]. Packaging in particular is emphasized within EPR [15]. Business are also motivated by brand perception. The most littered objects come from the biggest brands in the world [16]. The perception of such brands is diminished when the brand's packaging is seen as litter [17]. As a result, several companies spend significant time trying to fight litter. In the UK, for example, McDonalds' employees conduct daily litter patrols to pick up litter on the streets [18].

With few exceptions, far less attention has been given to identifying how object-specific attributes can influence consumer disposal behaviours. Langley et al. suggest that making packaging easy to clean or separate could help facilitate proper disposal [19]. They also note that even keen recyclers with good intentions often place items in the waste bin. Accordingly, it may be the object's attributes or how it is perceived following its use that impacts such disposal decisions [20]. Trudel and Argo [21], [22] have led research in which they demonstrate how changes in an objects' attributes (e.g. size and form) leads to drastic reductions in recycling behaviour. Using paper and soda cans as examples of commonly recycled objects, they manipulated either the size or the form of the object (e.g. cut the paper, dent the can). Participants with altered objects recycled at a rate less than half of the control (unaltered) condition. Wever et al. [23] explored product attributes in the context of littering.

Specifically, they sought to understand how littering is impacted by the attribute of 'reclosability'. The idea behind this was that an object that is reclosable may retain perceived usefulness and not be littered. The results of the reclosable study suggested that the attribute facilitated longer storage and subsequent use.

The objective of this paper is to expand current understanding around how object attributes contribute to proper disposal. The approach used in this research focuses on transformations that occur during the use of packaging such as changes in form, size, colour, and content. We achieve this through two studies. In the first study we explore the implicit associations people have between waste and recycling. We show that simple object transformations of commonly recycled objects cause an implicit bias to associate altered objects with waste in 82% of the responses. The second study explores object transformations in the context of littering. This study suggests that deformed, torn, disassembled and empty packaging all encourage littering. Findings did not support the hypothesis that objects that are wet, sticky, discoloured, or those with food remains significantly contribute to increased littering.

The ultimate aim of this research is to identify ways in which packaging can be (re)designed such that it alters behaviour. There are at least two design directions this research informs. First, packaging might be redesigned such that it does not change those attributes that discourage proper disposal during use. Changes can occur through designed interactions (e.g. 'tear here') or through interactions that are not designed (e.g. crumpling). Second, this approach helps to identify absolute attributes and characteristics that encourage proper disposal. In the remainder of the paper, we describe the two studies and provide a general discussion and conclusions.

2 Recycling Study

As products move through use they are evaluated to determine if they are to be reused or disposed of depending on the value attributed them by the user [24]. The process of evaluating and discarding of an object can be a subconscious process leading to errors in how the packaging is categorized [22], [21]. Consistent with these studies, we hypothesize that alterations in the product packaging can contribute to users perceiving recyclables as waste. The purpose of this study is to measure this hypothesis by identifying the subconscious or implicit biases towards altered objects. This helps determine psychological reasons that contribute to the miscategorization of recycling and can aid in understanding how packaging design might influence proper recycling behaviour. An initial study uses field observation to inform the relationship between product attributes and the categorization of objects as recyclables or waste. Following this, we conducted a study in which we measure the tendency to have a cognitive bias towards associating altered objects (e.g. torn or deformed) with waste rather than recycling.

2.1 Procedure

In a preliminary study, 'bin raids' were carried out to assess the types of objects that were incorrectly sorted as either recycling or waste. The raids were conducted, with permission and defined protocols, in three locations on two separate days at a university campus in London, England. Each location examined was a 'recycling point' where individuals can choose to discard objects in one of four bins: general waste, paper and card, glass, and cans, tins and plastic bottles. In some instances, an additional bin was available for batteries (see Figure 1a). This setting provides an opportunity for individuals to easily dispose of objects in the appropriate bin. Subsequently, it provides an interesting scenario for us to investigate common attributes among objects that were erroneously categorized. The contents of each bin was collected and taken to an outdoor location where it was emptied and photographed (see Figure 1b). The discarded objects were then examined across the piles from each bin to identify anything that was incorrectly sorted. Observations were recorded with particular attention given to the attributes of the erroneously sorted objects.

Following the bin raids, we set out to quantify the unconscious or implicit associations users have with waste. To do this, we created an Implicit Association Test (IAT). The IAT measures the implicit association between categories (e.g. altered or unaltered packaging) and attributes (e.g. waste or recycling). This test is particularly useful in scenarios in which a decision must be made between two categories (e.g. placing items in a waste or recycling bin). The IAT uses a series of timed activities in which participants are tasked with sorting stimuli that appear in the middle of a screen to target categories and attributes on either side of the screen. An example is shown in Figure 2. In this figure,

Figure 1. a: recycling point where bin raids took place. b: image of waste examined during bin raid.

the image on the left shows an altered water bottle that would be grouped on the right side with the category *altered objects*. The image on the right shows the word garbage which would be grouped with *waste words*. Concepts that have come to be associated with each other are thought to be more readily grouped than those with little or no association [25]. Thus, by measuring the response time needed to group stimuli to categories an overall association can be found. The overall association is represented by an IAT score, or d-value, which is calculated using the scoring algorithm developed by [26]. Possible d-values range from -2 to +2. The break points for slight, moderate, and strong effect sizes are positive or negative 0.15, 0.35, and 0.65, respectively.

We created a custom IAT using software at www.SocialSci.com to measure the implicit associations of altered vs unaltered common recyclables (e.g. office paper, cardboard, soda can, water bottle). Following the collection of initial demographic information, participants were asked to sort stimuli according to how they can be grouped in the following: “altered objects,” “unaltered objects,” “recycling words,” and “waste words”. The altered and unaltered objects categories featured images of commonly recycled items. Examples of these items are shown in Figure 3. The categories of recycling words and waste words consisted of words that are commonly associated with each of those. For the recycling category, we used the words sustainable, green, environmentally friendly, and recycle. For the waste category, the words trash, rubbish, landfill, and waste were used. If a there is an implicit bias to associate altered packaging with one of the categories than we would expect to see a

Figure 2: Two screen shots of IAT tasks.

difference in response times represented in the d-scores. In this study, positive d-scores meant that respondents associated altered objects with waste, rather than recycling. While this method has been used with other packaging studies [27]–[30], this is the first time it has been applied to object attributes and disposal categories to the best of our knowledge.

Following the IAT, we sought to capture self-reported attitudes and behaviours participants had towards recycling. To do this, participants were posed with the following statements: I feel recycling is important; I recycle most of the time; I consciously think about whether something should be sorted in the recycling or the trash. Responses were recorded on a five-point scale from strongly agree to strongly disagree.

2.2 Participants

An initial group of 31 volunteers in Southeast England was used to validate the method. A subsequent 153 participants were recruited from Amazon Mechanical Turk to take the survey. Participants from mechanical Turk received USD $1 for taking the survey which, on average, took under six minutes to perform. Each participant completed the IAT and survey questions at their own computer but detailed instructions were provided. Consistent with the guidelines presented by [26], individual trials were discarded that took longer than 10,000 ms as were subjects who had more than 10% of trials under 300 ms showing that they had simply rushed through the task. In total, fifteen subjects were discarded due to timing issues or that they did not complete the entire survey resulting in 169 respondents (83 Female, M=36.2 years, SD=9.7). There was some difference in age between the volunteers (16 Female, M = 32.0 years, SD = 9.7) and those recruited from Mechanical Turk (67 Female, M = 37.2 years, SD = 9.4) but from here on, all findings consider all participants unless stated otherwise.

Figure 3: Examples of altered and unaltered objects used in the IAT

2.3 Results and Discussion

The bin raids confirmed a significant presence of miscategorised objects. These varied across product categories and not enough of any one category was identified to the point that statistical measures proved useful. There were, however, interesting anecdotal findings. For example, items were often placed in the general waste stream when they contained multiple types of recyclable materials such as plastic and card together. The same was true of objects with food on them. This supports the idea that individuals default to categorizing something as waste unless it is clear that it is recycling. Also in the bin raids were a number of altered objects. Consistent with [21], we found that paper that is deformed in some way was often included with waste rather than recycling. This was also true of soft plastics such as candy packages that easily alter form during use.

The most prominently miscategorised item was the paper coffee cup. These cups did not generally show signs that they had been altered other than, perhaps, some stains. Examining this cup is therefore beyond the scope of the current paper in terms of object transformations. It does, however, offer interesting insight with regard to miscategorisation. The cup was often placed in the general waste bin. This is the correct choice since the recycling contractors are not able to deal with the coating on the cup. It was also often placed in the paper and card bin. Presumably, this is because of its paper-based composition. This error may be compounded by the fact that some stores include the recycling logo on the cup which can mislead consumers to think that it is recyclable in the majority of cases [31]. Interestingly, the coffee cups were also frequently found amongst the contents of the bin designated for 'cans, tins & plastic bottles.' One reason for this may be that the geometrical attribute of the cup—its cylindrical form—suggested that it should be categorized together with the other cylindrical items. This lends support to the idea that items are miscategorised according to their attributes.

The IAT test also supports the idea that objects are miscategorised according to their attributes. The inclusive sample of 169 participants have an average IAT score of 0.587 (SD = 0.467). In total, 138 participants (82%) had at least a slight association between the two but perhaps more significantly, 90 participants (53%) showed a strong association between waste and altered objects (see Figure 4). Only 15 participants (9%) showed any kind of bias in the opposite direction. These results show a remarkable tendency for people to associate altered objects as waste.

In the questions following the IAT we found two categories in which the volunteers differed from the MTurk Participants. Volunteers were more likely to say that recycling was important (M = 4.74, SD =

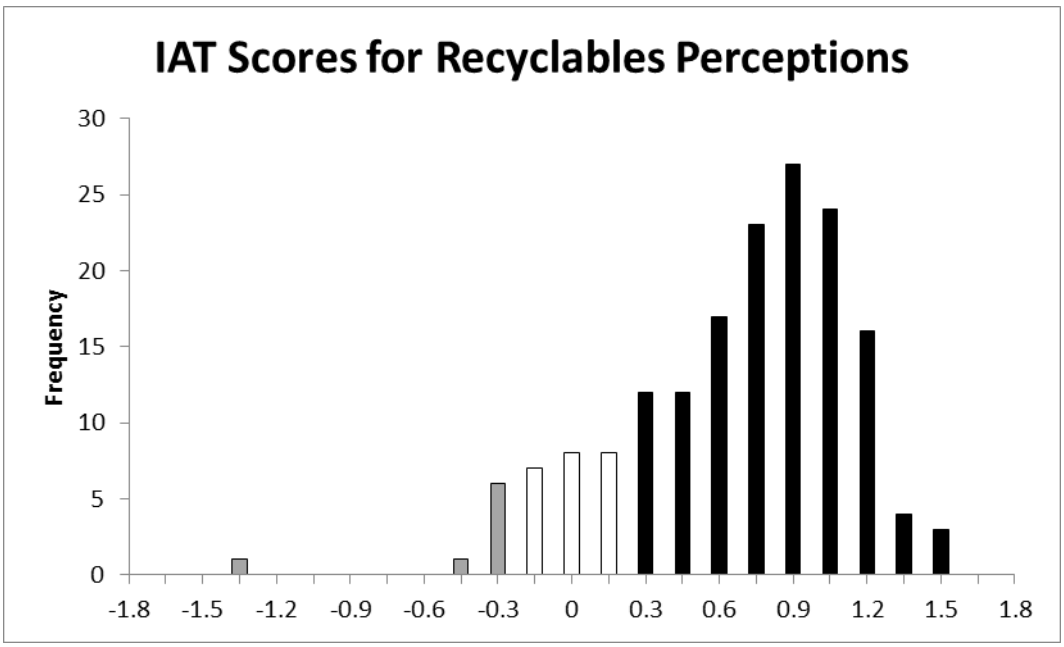

Figure 4: results from the IAT. Black represents those who associate altered objects with waste, white is neutral, and grey indicates participants who associated altered objects with recycling.

0.51) than MTurk respondents (M = 4.32, SD = 0.76, $p < 0.01$). Volunteers were also more likely to say that they consciously sort the trash and recycling (M = 4.45, SD = 0.57) than MTurk respondents (M = 3.91, SD = 1.09, $p < 0.01$). This is not surprising since most of the volunteers came from an environmentally conscious group within a university. There was, however, no difference in respondents saying they sort recycling most of the time ($p = 0.28$) nor in overall IAT scores ($p = 0.38$).

If this is truly an implicit effect we would not expect any of the self-reported indicators to influence the IAT scores. To check this, we ran multiple regressions on the data. We included age in this analysis thinking that perhaps certain age groups have developed different types of associations with the indicators. We found that neither age nor any of the questions had a significant impact on IAT scores. This emphasizes the significance of the effect regardless of user attitudes or behaviours.

3 Littering Study

The littering study considers how changes in packaging might impact feelings and behaviours towards littreing. To inform this strand of work we first conducted over 40 hours of observations in which littering behaviour and fallen objects were analysed to try to identify object attributes that might contribute to littering. From this we developed two hypotheses. First, altered objects may be perceived as more acceptable to litter due to changes in shape, size, colour, or other attributes. Under this hypothesis, the absolute property of size should also influence littering. While this seemed to be a trend, it has not been shown to influence behaviour in previous work dealing with how size impacts the littering of leaflets [32]. Second, we hypothesize that objects are more likely to be littered as they become disgusting due to use. For example, an object that is wet, sticky, has food remains on it or changes colour may produce a less-comfortable interaction with the user and they will be more likely to litter it. Work by Wever et al. [23] lends support to this hypothesis in research where they considered the difference between containers that are reclosable and those that are not. Their work showed that more reclosable containers were more frequently taken home suggesting that consumers may be willing to carry certain objects longer than others.

Research on littering can be difficult. Unlike recycling where there are only two possible appropriate behaviours at the point of choosing the bin, littering consists of a number of behaviours. Littering can occur while people travel with an object making it difficult to track objects. The act of littering is often done discretely making it difficult to observe. Finally, littering occurs across a variety of items and tracking one single item can prove problematic. In this research we acknowledge these limitations. To compensate, we try to distinguish between twelve types of behaviours and we make a large number of observations. Rather than tracking a product attribute relevant to one single type of packaging, we look at types of transformations that might be generalized across packaging types. This work was carried out in collaboration with Keep Britain Tidy and was sponsored by two global food companies.

3.1 Procedure

From the initial observations of littering and littered objects, six types of object transformations were identified. To test the first hypothesis—objects may become more acceptable to litter with transformations—we considered three types of transformations that can occur during use: packaging is (not) empty; packaging has extensive, minor or no changes; the object is disassembled or torn apart. The idea behind the object being empty or not has to do with how conspicuous littering is when the contents, such as food, are not fully consumed. The other two types of transformations have to do with making the object smaller so that it is perceived to be more appropriate to discard in some way. To test the second hypothesis—object transformations can make objects unpleasant to continue carrying—we identified another three types of transformations: the object changes colour; the object appears to be wet, sticky, or both; and the object has remains (e.g. sauce) on it.

Due to the nature of this work it was very difficult to try to quantify the object transformations. It seemed unreasonable, for example, to rate how sticky something is or how much something has been deformed. Instead, we rely on a subjective assessment of the object transformations during observation. Extensive observational studies were carried out to test the hypotheses at five urban locations throughout London, England. The observations were made by research assistants who were formally trained in recording observations on a custom form. The observation form consisted of recording typical information about the date, time, and area but also included much detailed information. Specifically, the form specifies between 32 types of littered objects, 12 behaviours, the six object transformations above as well as information about the behavioural setting, i.e. demographics

about the litterer, any people in proximity and any pre-existing litter in the vicinity. A breakdown of the types of packaging recorded and the types of littering behaviours is found in Table 1.

All observations were transferred to digital form and, where needed, the data was cleaned. For example, in instances where multiple behaviours were recorded on a single line this was corrected in the data. The data were then coded into littering and non-littering behaviours (Coded as 1 and 0, respectively). The difference here was made according to the assumed intention of the person. Intentional behaviours were determined to be the following coded behaviours: flagrant – fling/throw, drop with intent, inch away/left behind, sweep, accidental drop: noticed and left. Non-littering behaviours were the following: binned, placed next to bin, shoot and miss, unintentional drop, recycled. In the non-littering category, we include items that are technically littering but an effort was made to get it to the waste bin (e.g. shoot and miss, placed next to bin) or it was not noticed by the user. In those cases, the user either made a positive decision about disposal but perhaps did not follow through or made no decision at all. Subsequently, this does not tell us much about how object transformations impact disposal decisions. We have left out two behaviours from this analysis—wedge and leave area with food—because these cannot be accounted for in terms of intentional or unintentional conditions. In the case of the wedge, we do not know where this took place so it is difficult to assess. If it took place by the bin we may not consider this an intentional drop, if it took place away from a bin, however, it wold be intentional. In the case of leaving the area with the food we decided the action was inconclusive.

Next, all data were analysed through statistical analysis to determine relationships between the rate of litter and object transformations. For this, a chi-squared test was used. Objects were examined as they relate back to the hypotheses as large or small groups to gain insights. In order to prevent skewed data, we excluded cigarettes and gum, two of the most prolific objects in the study, unless it was relevant to the data on hand.

3.2 Results and Discussion

Initially, 2707 unique observations were gathered through the analysis. Many of the observations, however, included multiple observations that the researcher had included on the same line. Once this was accounted for, there was a total of 2823 observations. The observer could not always determine object transformations resulting in a smaller subset of observations that were useful for any given analysis. The following paragraphs report on the analysis of the recorded object transformations as they relate to littering. Each analysis reports a number of objects counted (N) that are applicable to the study at hand.

Objects that still contain material (e.g. food) in them are often larger and more conspicuous than others. These objects may also carry more value in them. Thus, we expect that this would result in fewer littered objects. To determine this, we assessed the (not) empty objects from the observational forms. When assessing objects across all product categories except gum and cigarettes for which we have information ($N = 721$) we found that *not empty* had a mildly significant effect on littering behaviour ($p = 0.08$). From the observations, we identified two categories that we expected would be particularly significant here: cups and wrappers. The effect became more significant when only considering the categories dealing with cups ($N = 297$, $p < 0.05$). Surprisingly, there was no effect seen with select wrappers such as crisp packets, aluminium foil, paper bag, and sandwich box ($N = 317$, $p = 0.97$).

Object changes refers to deformities in the object's shape and size. For example, a soda can with a small dent in it would be coded as a minor change while a smashed can is coded as an extensive change. The observations showed that alterations in the object's shape and size could contribute to discretely littering. Thus, we hypothesized that such changes would lead to increased littering due to a less conspicuous object. Objects that were commonly reported to undergo these changes included various types of wrappers and paper such as train tickets or flyers. Indeed, in the wrappers category we saw a significant effect on littering rates from changes in the object ($N = 225$, $p < 0.05$). As expected, paper and card also saw a significant effect ($N = 67$, $p < 0.05$).

Table 1: Comparison of observed behaviours and accompanying packaging types. The behaviours are classified as follows: 1 = Binned litter; 2 = Placed next to bin; 3 = Shoot and miss; 4 = Fling/throw; 5 = Drop with intent; 6 = Inch away/left behind; 7 = Wedge; 8 = Sweep; 9 = Accidental drop – did not notice; 10 = Accidental drop – noticed and left; 11 = Left area with food; 12 = Recycled.

Classification	Cigarette butt	Cigarette related	Gum	*1: Soft drinks cup*	*2: Plastic cup*	*3: Plastic bottle*	*4: Can*	*5: Glass*	*6: Hot drinks cup*	*7: Other (Specify)*	*Food packaging* - crisp packet, confectionery	*Food packaging* - polystyrene box/tray	*Food packaging* – cardboard box	*Food packaging* – plastic box/bowl	*Food packaging* – sandwich box	*Food packaging* – paper bag	*Food packaging* – aluminium foil wrapper	*Food packaging* – plastic/cellophane bag/wrapper	*Food packaging* – small packets (sugar, ketchup, etc)	*Food packaging* – other (please specify in comments)	Napkins	Straws	Utensils (fork, knife, spoon, stirrer…)	Food	Cellophane wrapping	*Paper* – train/bus tickets, receipts, flyers, leaflets	*Paper* – tissue	Card and board packaging	Newspaper/magazine	Plastic bottles/packaging (non-food or drinks related)	Plastic bags	Textiles	General litter (other)/Unsure * specify	**sum**
1	240	35	29	83	19	55	44	10	78	4	55	14	53	20	51	175	8	50	4	15	36	8	10	39	7	86	58	12	9	2	15	3	63	1390
2	10	1	0	1	1	1	2	3	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	1	2	2	1	2	0	0	2	0	0	32
3	3	1	1	0	1	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	12
4	135	0	0	5	0	1	3	0	0	0	3	2	3	3	3	5	0	2	3	2	7	0	0	9	1	2	2	0	0	0	0	0	4	195
5	398	10	4	4	3	1	3	2	4	1	5	1	4	3	1	7	1	5	4	3	5	3	0	7	4	11	3	1	2	1	2	0	6	509
6	4	2	0	12	5	3	8	1	14	0	7	0	8	0	7	12	0	2	0	3	3	2	0	0	0	0	0	0	1	0	1	0	0	95
7	2	0	0	0	0	1	1	1	3	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	13
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
9	0	2	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	3	1	0	2	1	0	4	0	4	0	0	1	0	0	0	0	22
10	2	1	0	1	0	0	0	0	0	0	3	0	1	0	0	1	0	1	2	1	0	0	1	6	0	3	0	0	0	0	0	0	2	25
11	0	0	0	115	24	16	8	0	41	0	10	4	18	14	5	165	0	4	3	0	1	2	4	2	0	0	3	0	0	0	0	0	0	439
12	1	1	2	4	3	9	9	1	3	0	1	0	2	3	5	6	0	3	0	0	2	1	0	1	0	16	11	0	1	0	1	1	3	90
	795	53	36	225	56	87	78	18	143	5	87	22	91	43	74	376	10	70	17	24	56	17	15	69	14	126	80	15	14	4	21	4	78	2823

Similar to the previous section about product changes, disassembled or torn objects can create a smaller and less conspicuous object. Thus, we expect such objects to be littered more readily. Across all categories this indeed had a significant effect. Objects that were torn were much more likely to be littered ($N = 1014$, $p < 0.05$). The most common objects to be torn were types of wrappers and paper such as bus tickets and flyers. Paper did show to be littered more once it was torn ($N = 105$, $p < 0.01$). Wrappers, however, did not show any such effect ($N = 265$, $p = 0.74$). Disassembled objects too had an impact across all of the product categories ($N = 952$, $p < 0.01$). Examples of disassembled packaging include a soft drink cup that consists of cup, lid, and straw, or layered packaging where there may be a cardboard box encompassing a second set of plastic film packaging. As predicted, disassembled cups were more likely to be littered than those that were not ($N = 356$, $p < 0.001$). There were too few observations with layered packaging to make a reasonable analysis.

Changes in an object's colour can result from normal use of the packaging such as the oil from a meal saturating the paper around it. Consistent with this example, wrappers of some kind, including paper bags, were the most common items to experience a colour change. These are thought to evoke disgust for the user and cause more willingness to litter the objects. Across all objects (other than gum and cigarettes), however, colour change does not lead to increased littering ($N = 1065$, $p = 0.74$). If we consider only wrappers, the effect is even worse ($N = 502$, $p = 0.86$). This was contrary to the hypothesis. A further investigation of the observations suggests that there may be other things that impact the change in colour that is not disgusting to the user and would not contribute to added littering in those situations.

Objects that are wet and/or sticky are less pleasant to hold. Consequently, we expected to see more frequent littering of wet or sticky objects. As anticipated, wrappers of different types were the most commonly recorded as being wet, sticky or both. Contrary to our prediction, however, we see no significant effect across wrappers ($N = 364$, $p = 0.55$). Only when we consider all categories, including gum and cigarettes, do we see a significant effect ($N = 1367$, $p < 0.01$). This is not surprising since gum would greatly skew these results.

Residue left on a package, such as sauce, could lead users to feel uneasy about holding the object leading to increased littering. The data does not support this hypothesis with no significant effect across all categories besides gum and cigarettes ($N = 1057$, $p = 0.53$). When considering only select types of wrappers that may be subjected to this type of condition, the effect is still not significant ($N = 365$, $p = 0.16$).

5 Discussion and Conclusions

This research has indicated how changes in packaging attributes, such as alterations in shape, colour, or size, influence two disposal behaviours: recycling and littering. 82% or respondents showed at least a slight effect and 53% showed a strong effect towards associating altered objects with waste. Littering behaviour observations indicated that littering is influenced by deformed, torn, disassembled, and partially full packaging. No significant effect was found with regard to packaging that is wet, sticky, has undergone colour changes or that is has remains on it. These findings suggest that the (re)design of packaging can significantly influence proper disposal. Based on this, packaging design might be influenced in three ways. First, the titular 'Tear Here' is an archetype of the scripts that are designed into packaging. So many packaging designs include scissor guides, perforated lines, and pull tabs. In the cases where object alterations lead to negative perceptions, these might be changed. The redesign of packaging such that it does not change might be considered a scripted strategy since it guides the user in how to use it [33]. Perhaps more accurately in this case, it does not misguide the user. The second implication for design considers how users alter objects through their natural (i.e. unscripted) interactions with objects. By altering physical characteristics such as stiffness, some interactions might be prevented that could encourage improper disposal. These first two implications deal with preventing changes in the packaging to preserve properties that are associated with recycling and non-littering. The third design implication has to do with identifying absolute or inherent properties that encourage proper disposal. By identifying how changes in packaging contribute to waste or littering perceptions we may begin to extract design heuristics that inform design for proper disposal. The recycling study, for example, exposes the unconscious biases around recycling. This suggests that any design for recycling might do well to include cues that force individuals to consciously make decisions. Likewise, the littering study suggests that changes contribute to a potentially less conspicuous form of littering. A design intervention might then focus on designing conspicuous objects.

Significantly, the effects of altered objects on proper disposal are not trivial. There are published empirical studies that show how object changes can lead to more than a 50% reduction in recycling [22], [21]. Similarly, our work on recycling consistently showed categories in which the statistically expected rate of litter was half of the actual rate under some conditions. This avenue of research seems to be a ripe area for considering packaging design. This is particularly promising in terms of companies taking more control over how they can influence disposal.

The recycling study confirms that individuals miscategorise altered objects as waste rather than recycling. We advance this thinking by quantifying the extent to which that miscategorisation occurs in a novel method. The use of the Implicit Association Test could be expanded to other studies on packaging design including how packaging design influences sustainable perceptions. One possible direction would look at perceptions of personal reuse of various types of objects.

The litter study shows clear support for the idea that changes in object attributes can lead to increased littering. Some areas in particular, such as deformations of various types, seem like a promising area to investigate further. Future studies should confirm this through trials with different packaging. The littering study did not show significant findings with objects that were wet, sticky, changed in colour or had residue on them. One possible explanation for this is that it can be difficult to assess some of these attributes through observation. Determining if an object is wet or sticky, for example, might require a more intimate examination of the litter than is possible. Any future analysis might try to carefully consider these attributes across specific types of objects.

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7 References

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