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The Impact of Sustainability Information on Consumer Decision Making

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Summary

This article presents an empirical analysis of the impact of sustainability information on consumer purchase intentions and how this influence varies by issue (health, environment, and social responsibility), product category, type of consumer, and type of information. We assess over 40,000 online purchase interactions on the website GoodGuide.com and find a significant impact of certain types of sustainability information on purchase intentions, varying across different types of consumers, issues, and product categories. Health ratings in particular showed the strongest effects. Direct users—those who intentionally sought out sustainability information—were most strongly influenced by sustainability information, with an average purchase intention rate increase of 1.15 percentage points for each point increase in overall product score, reported on a zero to ten scale. However, sustainability information had, on average, no impact on nondirect users, demonstrating that simply providing more or better information on sustainability issues will likely have limited impact on changing mainstream consumer behavior unless it is designed to connect into existing decision-making processes.

Introduction

In the United States, almost 70% of gross domestic product (GDP) is driven, in some way, by "personal consumption expenditures" (Emmons 2012). Markets for food, housing, apparel, transportation, electronics, and even cosmetics drive major aspects of the economy. The specifics of these purchases—the kinds of cars we drive, the food we eat, and the type of housing we live in—are central to the state of our economy, as well as to some of our largest social, environmental, and human health challenges.

The industrial ecology (IE) community has recognized the critical role of consumer decisions in sustainability issues for many years (Hertwich 2005; Jackson 2005a; Tukker et al. 2006a, 2006b, 2010). IE research has been extremely important in identifying the most significant consumer impact areas: mobility, food, housing, and energy-using products (Tukker et al. 2010). However, most IE research has remained focused on technical strategies to change products and production systems through the advancement of green chemistry, green product design, dematerialization, process efficiency improvements, supply-chain footprinting, life cycle thinking, end-of-life management, and so on. This has been critical work and has served to undergird recent initiatives related to sustainable development and the "circular economy."

However, much less research has been conducted on how this work might motivate consumers to change behaviors toward more sustainable products and systems, or even to understand what types of interventions (information, incentives, mandates, and "nudges") are most effective in influencing consumer decisions. As Tukker and colleagues (2006a) pointed out in the Oslo Declaration on Sustainable Consumption, "simply providing information to consumers does not lead to marked changes in behavior" (p. 12). And yet, information provision—through reports, articles, databases, public service

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announcements, education campaigns, and so on—remains a primary strategy of governments, international agencies, academics, and nongovernmental organizations (NGOs).

Almost a decade after the Oslo Declaration, significant questions remain around how to communicate sustainability information to the public in a way that will motivate a shift toward "greener" or reduced consumption. Though the IE community has continued to refine the science and presentation of life cycle assessments (LCAs), eco-footprints, eco-labels, and so on, we still know very little about which of these metrics and indicators, in which forms, delivered at what point in the consumer decision-making process, have the most impact.

As Tukker and colleagues (2010, 20) have noted, there also remains "considerable ambiguity in the contemporary understanding of how consumers actually choose products and services." Further, research over the last 10 years has identified an important gap between what consumers say they care about and what they actually do when faced with trade-offs around sustainability. Surveys have shown that 30% to 70% of consumers say they want to buy greener, healthier, more socially responsible products, but only 1% to 5% actually do (Mintel 2011; Packaged Facts 2011; Devinney et al. 2010). This gap between peoples' stated preferences and actual purchases not only presents an interesting empirical puzzle for consumer decision making, but it is also represents an important impediment to behavioral change that can support solutions to sustainability problems.

A growing body of research examines this "attitudes-behaviors gap" (Kollmuss and Agyeman 2002; Staats 2003; Jackson 2005b; Carrington et al. 2012; Young et al. 2010) by analyzing why consumers make the decisions they do and, more specifically, how values, attitudes, and knowledge regarding sustainability issues influence purchase behavior. Recent research (Carrington et al. 2012; Peattie 2010; Bray et al. 2011; Prothero et al. 2011) has identified a range of contributing factors that intervene between sustainability preferences and purchasing decisions. These include: a lack of credible information on environmental and social performance of products (US EPA 1998; Ipsos Public Affairs 2010); consumers' "willful ignorance" about product ethicality (Ehrich and Irwin 2005); negative beliefs about the quality and performance of "greener" products (Luchs et al. 2010; Chang 2011); brand loyalties that inhibit change (Seyfang 2009); skepticism about corporate claims regarding product and supply-chain sustainability (Gibbs and Soell 2010); and skepticism about the impact that an individual consumer can make (Hanss and Böhm 2010).

There has also been important recent research on the limitations of focusing on individuals as the unit of change around consumption. The emergence of "practice theory" (Brand 2010; Shove and Walker 2010; Spaargaren 2011) argues for the need to analyze the contexts and "systems of provision" within which consumer choices are made. Choices we make about how to commute, travel, and feed our families are often constrained by existing cultural and physical systems.

Although all of these dynamics may impede consumers acting on their values, we focus in this article on the foundational role of information in consumer decision making. People first need to know, and believe, that there are differing impacts from their decisions and they need to be able to access meaningful information that distinguishes one choice from another. Providing sustainability-related information is often the first strategy deployed to advance more sustainable lifestyles and consumption patterns. However, it is not clear what role this information plays in actually changing behaviors.

There has, of course, been significant research conducted on consumer decision making that spans the fields of psychology, marketing, and behavioral economics. Among the theoretical foundations that motivate this research is the long-standing exploration of individual decision making, particularly in the context of consumer behavior. From Schwartz's (1977) "Norm-Activation Theory" to Ajzen's (1991) "Theory of Planned Behavior" to Stern's more recent (1999) "Attitude-Behavior-Context" model, psychologists have sought to explain the processes that mediate between people's values and behaviors. This research has challenged "rational choice" theories in economics that model consumers as rational actors optimizing their utility through calculated trade-offs in price, quality, and so on. This rich field of research has shown that even the most straightforward acts of consumption can be complicated, conflicted, and appear irrational. People's behavior is not motivated solely by utility maximization (Kahneman 2011; Carlsson and Johansson-Stenman 2012); people sometimes make "automatic" and habitual decisions (Duhigg 2012), act within a social context, and are motivated by social approval and status (Jackson 2005b).

Bettman and colleagues (1998) expand this research to develop what they term "constructive" choice theory. Understanding how consumers construct a decision (often in real time) takes into account the goals of the decision maker, the complexity of the decision task, the context and framing within which the decision is made, the need for accuracy in the decision, the availability, completeness, and format of information presented, and the emotional and cognitive costs of making the decision. A key question that emerges out of this research—for both academics and business—is how and when consumers change their decisions and, further, whether information can lead to changed behavior (rather than just changed attitudes). Recent research (Janssen and Hamm 2012; Hainmueller et al. 2015) evaluates the impacts of information systems such as eco-labels and fair trade certifications on consumer behavior. This builds on questions around how consumers interpret "credence qualities" of products—such as environmental and labor impacts of supply chains—that are not immediately discernable. These types of product and company attributes—which are central to questions of sustainability and IE—require an independent source of information (such as from a government agency or NGO) to attest that a product or company meets certain environmental performance characteristics (Thompson et al. 2010).

However, as Thøgersen and colleagues (2010) argue, despite a growing number of eco-labels, there is still very little research analyzing consumer decision-making processes in response to eco-labels. Early research in this area was often based on surveys centered around two basic questions: Would a person buy environmentally certified products, and would they pay more (Aguilar and Cai 2010)? More recent research involves "real choice" experiments and analyses of sales data that study purchases of products labeled, for example, with carbon ratings (Vanclay et al. 2011). There has also been considerable research on labeling of food products, as well as specific reasons why people are buying more certified organic products. This research assesses "altruistic" concerns for the environmental impact of food production, as well as more "selfish" concerns about personal health impacts of products (Michaud et al. 2013).

Consumer decision making is clearly variable and multifaceted. Adding to this complexity are the major changes underway in where and how consumers access information, what sources they trust, and what they do with information once they have it. Given the complexities of shopping processes and the importance of context, it is desirable to move out of the controlled setting of the laboratory to study consumers in situ as they experience real trade-offs in purchasing decisions.

Our research seeks to build on this past research on consumer decision making and the impacts of information systems (such as eco-labels) to assess how sustainability information might influence purchase decisions.

Methodology

This research was designed to examine the impact of sustainability information—environmental, social, and health ratings of products and companies—on consumer purchases while they shop online. Specifically, this study analyzed the impact of sustainability ratings reported by the GoodGuide.com website. GoodGuide's staff, comprised of chemists, toxicologists, nutritionists, sociologists, LCA experts, and computer scientists, has rated more than 200,000 food, personal care, and household chemical products, as well as apparel, appliances, automobiles, and electronic devices. The website emphasizes both the expert-driven and third-party nature of the scoring process and provides an explanation of its methodologies, in order to maximize trust and legitimacy with users. The GoodGuide sustainability ratings combine product- and company-level metrics to assess: company transparency; environmental impacts; water, energy, and material use; environmental management practices; regulatory violations; presence of chemical hazards within products; as well as broad social and health impacts.[1]

All of this information, collected from more than 1,000 data sources, has been compiled into three scores, each ranging from zero to ten, addressing health, environment, and social impacts, respectively. The "health" rating has been modeled on human health hazard assessment, chemical risk assessments, and nutritional evaluations; the "environment" rating has been modeled on a simplified LCA of the product category; and the "society" rating has been modeled on corporate social responsibility reporting (along the lines of the Global Reporting Initiative). These subscores, along with an aggregated overall score, are reported on each product page, along with opportunities for users to explore the elements of subscore components, to compare similar products and buy products by clicking a "Buy Now" button, which brings them to one of several e-commerce sites selling the product. The GoodGuide product pages also display leading eco-certifications (such as USDA Organic, Fair Trade, Energy Star, Design for Environment, Cradle to Cradle, Leaping Bunny, and so on). In this regard, the GoodGuide information is much more comprehensive and detailed than a traditional eco-label.

GoodGuide incorporates and moves beyond eco-labels, presenting a multiattribute decision support tool that employs life cycle thinking to identify "hotspots" at both the product and company level and then translates data for these criteria into a form that consumers can understand. GoodGuide works to present information on what matters most in a product category, as well as how different products and companies compare along those dimensions. GoodGuide also moves beyond one of the key limitations of eco-labels—that they generally only cover the top 1% to 5% of products in a category—by working to rate the top 80% of products sold in each category, as well as the leading green brands.

Figure 1 shows an example of a GoodGuide product page with the breakdown of health, environmental, and social ratings for one product, along with a Buy Now button in the lower left, linking users to the product on one of several e-commerce sites.

The goal of our research was to study the impact of these types of quantitative sustainability ratings on consumer purchase intentions while shopping. We studied 12 months of consumers who visited the website GoodGuide.com in what is essentially a "field observation." We recorded data from all product pages on the website, 41,398 of which were viewed during the study period, measuring the number of times each page was viewed and the number of purchase events that occurred on each, analyzing these with respect to the sustainability ratings of each product (see table 1). We also examined the impact of product rankings and found very similar results. In none of the research presented here did we vary any conditions or subject any subgroups to control or varying treatments.

However, the analysis for this article moves beyond past research that has depended on surveys and focus groups to assess how much consumers care about sustainability issues. As Auger and Devinney (2007) have shown, research utilizing "unconstrained survey responses" regarding concerns about an issue are often plagued by "social desirability biases" and do not correlate well with what people actually do while operating in contexts where information is limited, trade-offs exist in price, quality, and so on, and no interviewer is judging them on their responses.

All data were collected retrospectively for the 12-month period from 1 November 2011 to 31 October 2012. All product ratings remained static throughout this time period.

For the main analysis, two data sets were combined. We first collected the number of purchase intention (PI) events that occurred on each product page over the study period (see table 1). Web analytics software was programmed to record a purchase intention event each time a user clicked the button labeled Buy Now and marked with a product's current price, sending them to the corresponding product page on an e-commerce site. The second data set measured the number

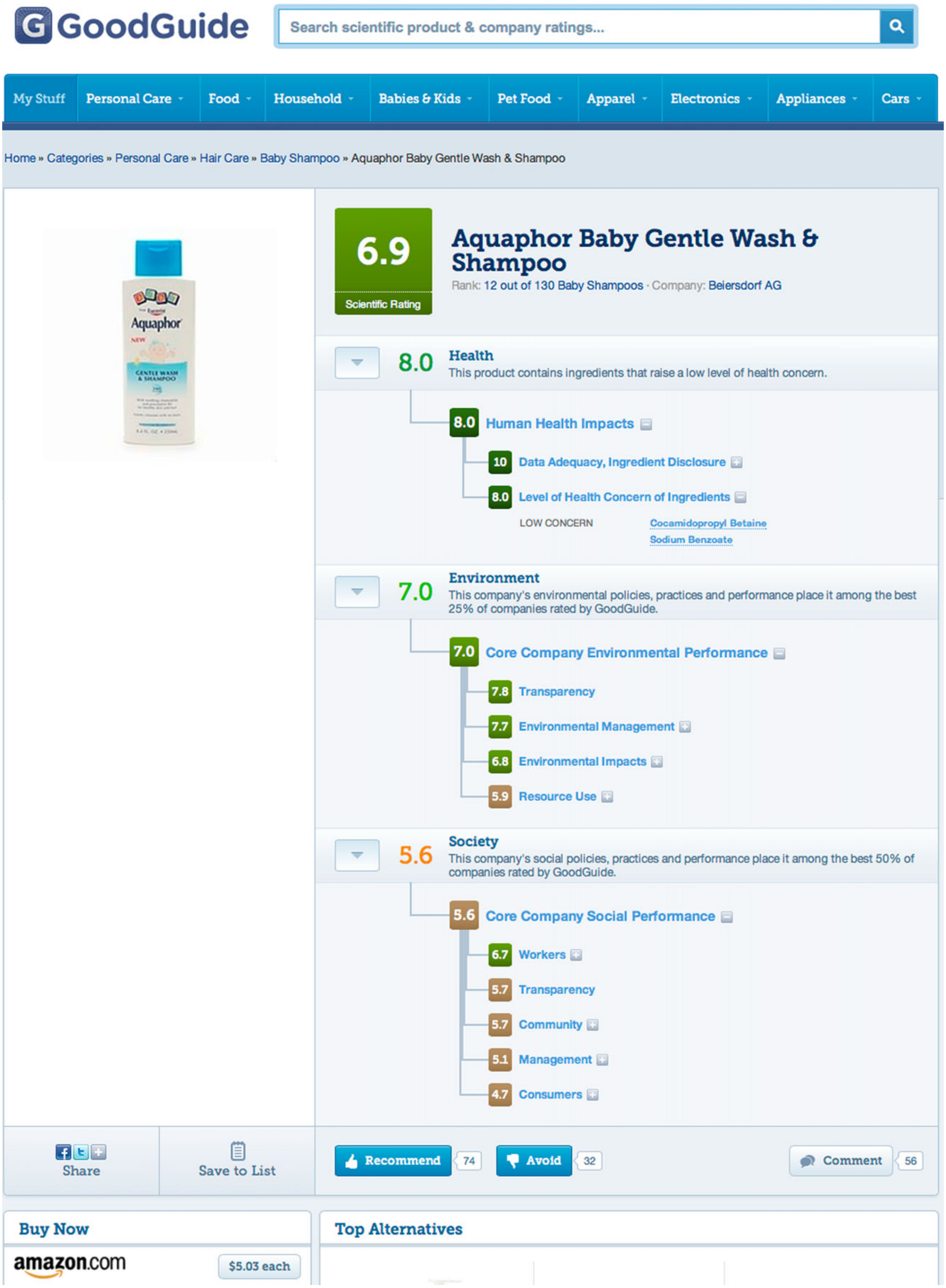

Figure 1 Example of GoodGuide product rating page.

Table 1 Visitors and purchase intention events

Metric	*Value*
Unique visitor sessions	269,287
Total purchase intention events	44,605
Unique product pages viewed	41,398

of times each product page had been viewed over the study period (see table 1). For each data set, user sessions of 5 seconds or less were excluded because these contained high rates of "bounces"—users leaving the site before engaging in any interaction.

These two data sets were then combined, and for each product, the purchase intention rate (PIR) was determined by calculating the ratio of Buy Now events to page views. Product pages were excluded from the analysis if missing subscores or an e-commerce site product match had caused the presentation of sustainability information or Buy Now button in a way inconsistent with other product pages.[2] This filtering yielded 41,398 product observations for analysis (see table 1).

The relationship between PIR and sustainability score was examined using increasingly narrow sets of product pages, measuring the response to both overall score and the three subscores. We first examined all pages together, then broke these down by broad product category (those for which there was adequate data included personal care products, household chemicals, staple foods, convenience foods, and pet food). Finally, we broke apart these broad categories into narrower categories in order to explore potential differences in the effect of scores across products that were broadly similar, but distinct, in certain characteristics. Additional tests were conducted in order to explore, first, potential nonlinearities in effect along the range of scores, and second, whether there was a response to changes in color distinct from that of numerical score.

To begin, users were stratified into two broad categories based on how they had arrived at the website: direct and nondirect users. Direct users comprised those who arrived having directly entered the URL GoodGuide.com, made use of a browser bookmark, or by a search engine having queried either: "GoodGuide" or some close variant; a product search including the words "healthiest," "safest," "greenest," and so on; or a product search including an issue of concern such as "parabens," "sweatshop-free," or "pollution." All others were considered nondirect users, including those who arrived by a search engine query for a generic topic or weblink without intentionally seeking to visit GoodGuide.com. The majority of nondirect users came to GoodGuide.com by search engine, having queried a phrase such as "best mouthwash" or "top baby shampoo," given that GoodGuide is often on the first page of search engine results for these types of terms. We assume that these shoppers were interested to purchase a top-performing product in these categories.

An analysis of PIRs between the two groups indicates significant differences in their overall purchase intention rates (see table 2).[3]

A simple linear model was fit in order to analyze the overall purchase rate for GoodGuide users:

Table 2 Purchase intention rates (PIR)

	PIR (weighted)	*n*
Direct users	3.8	21,712
Nondirect users	5.5	38,570
		$z = -9.2876$

Table 3 Correlations between subscores

Pair-wise correlations	*HealthScore*	*EnvScore*
EnvScore	0.034	
SocialScore	−0.006	0.853
VIF values		
HealthScore	1.08	
EnvScore	2.52	
SocialScore	2.52	

Note: VIF = variance inflation factors.

$$\text{Model1}: \textit{Purchase Intention Rate} = \beta_0 + \beta_{OVERALL}(\textit{Overall Score}) + \varepsilon$$

where β_0 is the intercept, that is, the expected PIR when overall score = 0 and β_1 is the coefficient of overall score, the expected increase in PIR for each point increase in overall score. ε is the residual unexplained by the model. A multiple linear regression model was also employed, in order to estimate the impact of the subscores on purchase rates:

$$\text{Model2}: \textit{Purchase Intention Rate} = \gamma_0 + \gamma_{HEALTH}(\textit{Health Score}) + \gamma_{ENV}(\textit{Env Score}) + \gamma_{SOCIAL}(\textit{Social Score}) + \varepsilon$$

A Breusch-Pagan test for heteroskedasticity indicated that, as expected, the two-stage sampling design introduced considerable nonconstant variance among PIR estimates. That is, data points based on fewer page views exhibited systematically higher variance ($\chi^2 = 20.42$). Thus, analytical weighting was employed throughout, according to the inverse of page view values (Gould 1994; Baum 2006).

A test of pair-wise correlations among the three subscore variables indicated a high level of correlation between the environmental score and social score, which leads us to be cautious of the reported effects of these variables. However, the variance inflation factors (VIF) did not indicate serious multicolinearity (Chatterjee and Price 1991), so we proceeded with the above model (see table 3).

Results

We analyzed the data for four primary questions:

1. Does sustainability information have an influence on purchase intent? If so, how much?

Table 4 Effect of overall scores: direct vs. nondirect users

	$\beta_{OVERALL}$	r^2
Direct users (n = 21,712)	1.2***	0.0494
Nondirect users (n = 38,570)	−0.12***	0.0003

Note: Asterisks indicate p values <.005 (***).

Table 5 Effects of environment, health, and social subscores

User type	*Constant*	γ_{HEALTH}	γ_{ENV}	γ_{SOCIAL}	*n*	*Adj* r^2
Direct users	−2.51	0.65***	0.06	0.22***	17587	0.0653
Nondirect users	6.46	−0.11***	−0.30***	0.32***	29340	0.0013

Note: Asterisks indicate p values <.005 (***).

2. Does this vary for different types of consumers (direct vs. nondirect users)?
3. Does this vary for different types of information (health, environment, and social ratings)?
4. Does this vary for different types of products?

In the aggregate, the data suggest that GoodGuide sustainability scores did influence users' purchasing behavior. Analyzing the two main user types separately, we see that this appears to be driven almost entirely by direct users (table 4).

Among direct users, each one-point increase in a product's overall score on a zero to ten scale is, on average, associated with a PIR increase of 1.2 PI events per 100 page views. Among nondirect users, there is essentially no response, particularly in consideration of the exceedingly low r^2. These results suggest real differences between direct and nondirect users in the degree to which sustainability information influences their purchase decisions.

We next explored whether there were differences in effect of the three subscores among the different types of users. As seen in table 5, among direct users, both health and social subscores are associated with increases in PIR, whereas environment subscores show no significant association. Among nondirect users, health and environment scores show significant negative relationships with PIR, whereas social scores show a significant positive relationship.

It should also be noted that the r^2 for direct users, though still low, are an order of magnitude higher than nondirect users. Breaking down the analysis further, we hypothesize that users have different responses according to product types. Table 6 shows results for direct and nondirect users, stratified across product categories. As can be seen in table 6, among direct users, health scores had the strongest association with increased PIR, particularly among personal care products and pet food. Environmental scores had positive association only for pet food, whereas social scores showed a positive association only for personal care. Social scores for pet food showed negative association. Among nondirect users, results were more mixed. Positive associations were found on household chemicals and pet food health scores and personal care social scores, whereas negative associations were found in a host of other categories, with very low r^2 values throughout.

As we break down the broad categories into narrower categories, we see that the influence of scores appears to be quite variable, even among related products. Table 7 shows, for instance, that among direct users, the influence of health scores in sun care, skin care, and baby care is considerably stronger than in deodorant and makeup.

Table 6 Multiple linear regression: direct and nondirect users, by broad product category

Product category	*User type*	*constant*	γ_{HEALTH}	γ_{ENV}	γ_{SOCIAL}	*n*	*Adj* r^2
Personal care	Direct	−2.72	0.77***	−0.02	0.27***	13,122	0.078
	Nondirect	6.96	−0.08***	−0.53***	0.49***	2,1640	0.002
Household chemicals	Direct	−3.73	0.39***	0.30	0.28	978	0.096
	Nondirect	4.27	0.35***	−0.26	0.03	1,304	0.007
Food: staples	Direct	−1.89	0.33***	−0.04	0.38	1,478	0.018
	Nondirect	7.38	−0.18**	0.09	−0.39	2,904	0.002
Food: convenience	Direct	0.92	0.31***	−0.36	0.28	1,284	0.008
	Nondirect	15.89	−0.38***	−1.22***	0.23	2,642	0.019
Pet food	Direct	−5.78	0.72***	1.24***	−0.98***	725	0.058
	Nondirect	−3.12	0.50***	−0.09	0.34	850	0.031

Note: Asterisks indicate p values <.01 (**) and <.005 (***).

Table 7 Direct users: personal care products

Product category	*Constant*	γ_{HEALTH}	γ_{ENV}	γ_{SOCIAL}	*n*	*Adj* r^2
Baby care	−5.27	0.86***	−1.42***	2.12***	374	0.188
Bath shower and soap	−6.64	1.05***	0.95***	−0.41	1,001	0.112
Feminine hygiene	9.64	0.46	−0.75	−0.54	104	0.013
Hair care	−3.58	1.03***	0.49***	−0.39*	2,512	0.0123
Medicine cabinet	−6.36	0.86***	−2.62***	4.04***	325	0.113
Men's grooming	−5.13	0.57***	−0.40	1.68***	242	0.136
Deodorants and antiperspirants	0.34	0.15*	0.75***	−0.57	545	0.020
Eye and ear care	1.20	0.84***	−0.78	0.61	191	0.134
Foot and nail care	7.19	0.52***	−0.41	−0.94	410	0.020
Fragrance and perfumes	−4.49	0.84***	−0.56	1.26	226	0.085
Makeup	−0.12	0.37***	0.32*	−0.32	3,156	0.016
Skin care	−0.93	0.87***	0.16	−0.41*	3,127	0.080
Sun care	−6.23	1.02***	−0.97*	1.81***	479	0.222
Oral care	2.08	0.74***	0.79	−1.57***	430	0.085

Note: Asterisks indicate p values <.05 (*), <.01 (**), and <.005 (***).

Table 8 Direct users: household chemicals

Product category	*Constant*	γ_{HEALTH}	γ_{ENV}	γ_{SOCIAL}	*n*	*Adj* r^2
Insect repellents	−1.85	1.19***	1.50	−1.92	56	0.047
Air fresheners	−0.71	1.01***	0.16	−0.59	144	0.110
Dishwashing	0.02	0.15*	1.35***	−1.31	139	0.194
Household cleaners	−6.22	0.40***	0.10	0.86*	367	0.077
Laundry	−3.78	0.58***	0.17	0.25	266	0.132

Note: Asterisks indicate p values <.05 (*), <.01 (**), and <.005 (***).

Table 9 Multivariate spline analysis: direct users all products (n = 17,587)

Subscore	*Spline*	*Coefficient*
Health	0–3	0.15
	3–6	−0.05
	6–8	1.03***
	8–10	1.22***
Environment	0–3	−4.09
	3–6	0.75***
	6–8	0.37***
	8–10	−2.38***
Social	0–3	5.06
	3–6	−0.94***
	6–8	1.91***
	8–10	−4.49***

Note: Asterisks indicate p values <.005 (***).

In table 8, we see similar variability among subcategories of household chemicals, such as the difference in health score effect between insect repellents and dishwashing products. Note as well the difference in the association demonstrated between health score and environmental score among dishwashing products.

Several further tests were undertaken to explore the dynamics within these results. Following indications of nonparametric behavior evident using kernel-weighted local polynomial smoothing (Fan and Gijbels 1996), we conducted spline analysis (Greene 2012) of the influence within ranges of scores, with nodes at 3.0, 6.0, and 8.0 reflecting broad ranges of scores as presented to website users.[4] These results, shown in table 9, indicate that the overall associations between score and PIR are driven predominantly by the effects of high-end scores. That is, the difference between a poor rating and a very poor rating matters little, whereas differences at the high end are strongly associated with PIR differences, at least among health scores.

We next set out to test whether there was any effect produced by the colors assigned to different scores. That is, behind each score on a product page, users see a color: red (for scores less than 3.1); orange (for scores higher than 3.1, but less than 6.1); light green (higher than 6.1, but lower than 8.1); or dark green (higher than 8.1). Using regression discontinuity analysis, we tested whether discontinuities occurred at the color changes of 3.1, 6.1, and 8.1, indicating an effect separate from that of the numerical scores.

We were interested in this question because there have been a number of studies recently showing the impact of "traffic light" labeling systems that show consumers red, yellow, and green symbols on products (Hallstein and Villas-Boas 2013). However, we did not observe evidence of discontinuities at any of the color changes. All Wald statistics were nonsignificant.

Discussion

This research represents a preliminary examination of the impact of sustainability information on consumer behavior in the natural conditions of a live website, rather than an experimental or survey setting. From these data, we draw a number of conclusions.

First, it is clear that many consumers are unaffected by sustainability information, and for some, a product deemed more "sustainable" may actually decrease purchase intent. On the other hand, consumers who have expressed previous commitment to sustainability issues appear to make use of this information as part of their purchasing process. Among these direct users, we found a statistically significant relationship between sustainability information on purchase intent, with more positive information associated with greater purchase intent. In examining subscores, we show that health ratings, those most related to self-interest, are the predominant source of this effect.

Interestingly, we observe evidence that sustainability measures can resonate differently across different product types, even within broad categories. Focusing on direct users and health scores, for instance, sun care, where there is an intrinsic connection to health, shows an increase of 1.02 PI events per 100 visitors for each point increase in health score and an r^2 of 0.22. Deodorants, on the other hand, represent a product type where consumers are particularly concerned about efficacy, and here we detected a much weaker impact of health scores (an increase of 0.15 PI events per 100 visitors for each point increase in health score). Many product types fall somewhere in between, with a weighted mean increase of 0.77 PI events per 100 visits for each point increase in health score across all personal care products. Health concerns also weigh heavily in consumer considerations of household chemicals. However, environmental concerns appear as well. In dishwashing soaps, for instance, there is a relatively strong effect of environmental ratings. These data suggest a number of hypotheses that might be explored in further research.

Some results are surprising. For example, among several product types, environment scores are negatively associated with PI among direct users, even where health ratings show a strong positive impact. That is, as environment scores increase, PI decreases. This might be ascribed to the altruistic nature of environment scores compared with the more self-interested health scores. Among nondirect users, both health and environment scores are, in some cases, associated with decreased PI, as with personal care products and foods. This may indicate an existing bias against "green" products.

As Chang (2011) points out, research has shown "ambivalent" attitudes from consumers toward green products. Negative perceptions are based around concerns that green products are more expensive and lower quality than equivalent conventional products. Consumers also express ambivalence around whether switching to greener products will have any appreciable impact on environmental problems.

With only a few exceptions, environmental and social scores show no positive association with purchase behavior. The only broad category where significant positive results were measured for environmental ratings was in pet food among direct users (which may reflect animal focused consumers equating environmental impact with being "animal friendly"). The only positive significant results measured for broad-category social ratings were in personal care products. These issues, as compared with health concerns, are, to a much greater degree, altruistic, and so this is an interesting demonstration of the source of behavioral motivations.

Finally, our statistical analyses show that consumer responses to sustainability ratings are not linear across the range of scores. Focusing on the health scores, where most of the significant responses occur, a change in scores among low-scoring products, that is, scores of 0 through 6, had very little impact on PI, whereas above this point, consumers showed a responsiveness to increasing scores. This is somewhat surprising, given that recent research (Hallstein and Villas-Boas 2013) has shown a stronger impact of "red lights" over "green lights" in consumer labeling. We hypothesize that, at least on this platform, positive health ratings help reinforce a purchase decision more than negative information dissuades a consumer away from purchase.

These empirical findings contribute to several important ongoing debates. First, in considering efforts to motivate changes in consumer behavior to advance sustainability, it is clear that consumers think of different types of products very differently. Information on the health and environmental impacts of these varied products thus influences consumer decisions differently as well. As Dhar and Wertenbroch (2000) and others have shown, consumers consider "hedonic" products very differently than "utilitarian" products. We would go further to posit that decisions around products that "just have to work," such as deodorant or hair dye, are very resistant to influence by sustainability information. Products that are more discretionary, or where it is difficult for consumers to determine differences in quality, are much better targets for informational campaigns to shift behavior. Similarly, products that are closely tied to "status" and that you consume publicly—even products displayed on your kitchen counter, such as dish soap—may be more open to influence from information campaigns. Finally, products that have clear personal health impacts (vs. those that only have environmental or social impacts removed from the consumer) are better targets for information influence.

It may equally be the case that complexity of sustainability information poses a major challenge for the use of IE information (such as life cycle, footprinting, and rating data) in informing consumer decisions. As such, it is critical to consider consumer perceptions and responses in the design of sustainability indicators. We hypothesize that, particularly in the environmental arena, consumers have difficulties understanding some measures of performance. Metrics for biodiversity loss, climate change, air quality, and so on, are difficult for GoodGuide to communicate simply to consumers. Complex data need to be translated into a format that works within "bounded" decision-making contexts. Further, learning from behavioral psychology, we believe there are important lessons from framing issues as losses (which are much more motivating), anchoring, and assisting consumers in comparing complex trade-offs.

It should be noted that this study is not without limitations. First, this study only looked at online decision making. While e-commerce is a rapidly growing segment of consumption, it is still much smaller than "brick-and-mortar" purchasing. Second, consideration of environmental, health, and social performance—the underlying components of the sustainability ratings we evaluated—account for only a small portion of the overall decision calculus for consumers. The fact that the regression goodness-of-fit measures (r^2) are quite low, generally below 0.1, indicate that, when making purchasing decisions, consumers are focused primarily on other issues, such as price and quality, variables we were not able to include in this analysis.

Further, our outcome variable measured purchase intent, rather than actual purchases. Whereas purchase intent is a behavior unto itself and valuable from a research perspective, we do recognize that it may introduce bias. In particular, a user who sees herself as sustainability minded may not express intention to buy a low-rated product while on a website where such issues are dominant, but may still purchase the item in a store where such concerns become less immediate and a variety of considerations come into play.

Implications and Future Research

Our research raises a number of questions for public policy and for strategies related to product transparency and consumer information. First, it is clear that we need to know more about how and under what conditions information can be designed and delivered to influence consumers that are not already seeking out information on the sustainability impacts of their choices (what we call nondirect users). More research and experimentation is needed that focuses on designing information with this public specifically in mind.

Along with efforts aimed at the provision of information, policy makers might consider a two-stage strategy, with efforts first directed at raising consumers' awareness of issues, and then presenting these same consumers with product-level sustainability information. However, simply providing more (or better) scientific information on sustainability and health measures appears to have limited impact on changing these consumers' behavior.

Further research is needed on designing information systems—not just the information visualization, but also the entire process of information delivery—to maximize its impact (Froehlich et al. 2010; DiSalvo et al. 2010; Kalnikaite et al. 2011). For instance, how can sustainability information be connected into peoples' actual purchasing processes? How can information systems leverage the lessons of behavioral psychology regarding the power of peer influence, status, and habit (Fogg 2009; Michie et al. 2013)? Further, of particular import for sustainability, how can information systems help overcome existing biases against greener products? For the IE community, it is critical to consider how the design and conduct of different forms of analysis interact with information delivery systems and, in particular, assess how information might be communicated and utilized from the earliest stages of IE research.

This is particularly relevant in light of recent government initiatives on "open data." Although government efforts to open information to the public are absolutely laudable, it is unlikely to have much impact on consumer behavior unless it is connected to the actual decision processes of consumers. This connects to a broader challenge in IE of how best to communicate complex sustainability information to different types of decision makers. Additional research and experimentation is needed around presenting rigorous science and LCA-related indicators in a form that can be understood and resonate with average consumers. Translation is required between LCA indicators, such as global warming potential, eutrophication, ecotoxicity, and so on, and how the public thinks about product and company impacts.

Regarding future research, we should note that though our method of data collection, by website monitoring, has presented opportunities previously unavailable for the observation of consumer behavior during normal consumption processes, it also introduced certain limitations. In particular, all data are retrospective and neither the website nor the analytics software were designed ex ante with the conduct of these analyses in mind. As such, certain data may be unmeasured or ambiguous, reflected in our low goodness-of-fit measures.

Nonetheless, we believe that an extension of this work to Web and mobile applications (apps) that connect to actual purchase decisions may provide a fruitful platform for experiments and learning (in place of notoriously inaccurate surveys and focus groups). As Tukker and colleagues (2010) note, there is still a need to study better ways to communicate sustainability information and present "a careful balance of persuasive and dissuasive strategies" that might drive consumer change (Tukker et al. 2010, 21).

There are a number of changes and additions we plan for future analyses in order to improve the explanatory power of our research and address more specific underlying dynamics of consumer decision making. These will take two forms: (1) technical changes that allow more reliable, statistically powerful hypothesis testing and (2) design changes that allow for controlled experiments.

We plan to study additional covariates in this research. For instance, preconceived impressions of product quality and efficacy may have a significant influence on consumers' propensity to purchase a product (Luchs et al. 2010). Clearly, there is a need to control for price and quality in future research. A number of further experiments are also suggested by the growing body of theory and empirical work on sustainable consumerism (Hainmueller et al. 2015). We plan to draw on recent research from behavioral psychology and information design to analyze what influences consumers to change their purchases (i.e., to switch between products) (Fogg 2009; Lee et al. 2011; Carlsson and Johansson-Stenman 2012).

Although preliminary, we believe this research has laid an important base for future experiments that study consumer behavior change underlying efforts to advance more sustainable consumption.

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Notes

1. GoodGuide's rating system combines product- and company-level information to characterize a product's health, environmental, and social impacts. A detailed description of the methodology is available at www.goodguide.com/about/methodologies.
2. For some products, no price was returned from Amazon.com, Pricegrabber.com, and so on. When there was no price displayed, the button that normally said "Buy Now" changed to "Check prices." We feel this is a quite different action than buying.
3. PIR = Purchase Intention Events/Pageviews
4. www.goodguide.com/about/ratings.

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