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Cutting the Internet's Environmental Footprint: An Analysis of Consumers' Self-Attribution of Responsibility

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Abstract

This research project investigates consumers' willingness to adopt online pro-environmental behaviors. First, we conducted an exploratory qualitative study that revealed respondents' low awareness of the environmental impact of Internet usage and reluctance to change their online behaviors. Consumers tend to decline all responsibility and expect companies and public authorities to take the necessary measures. Moreover, they are led by contradictory motives: not harming the environment on the one hand and continuing to use the Internet the way they currently do on the other. Based on these findings, two quantitative studies were conducted to investigate the determinants of consumers' self-attribution of responsibility to reduce the digital footprint of their online activity (e.g., using an eco-friendly search engine). Our conceptual model emphasizes the mechanisms of cognitive dissonance and highlights the crucial role of skepticism toward pro-environmental solutions. Implications for IT companies and public policy makers are discussed.

Keywords: Green computing; Green IT; Online pro-environmental behavior; Self-attribution of responsibility; Environmental skepticism

Introduction

According to recent forecasts, information, and communication technologies (ICT) could represent more than 14% of the global greenhouse gas emission by 2040, accounting for more than half of the current carbon footprint of the transportation sector (Belkhir & Elmeligi 2018). Given the unprecedented volume of data exchanged on the Internet every day, consumers' online practices require increasing amounts of energy and generate pollution. In particular, the energy consumption of data centers is very high (Guitart 2017). Every email sent, every video viewed, every request made on a search engine, every file stored on the cloud uses energy-intensive servers and indirectly generates greenhouse gases. Although consumers' awareness is still at an early stage, most of the major contributors who drive the Internet's infrastructure have been taking this issue very seriously over the past few years. Some of the largest Internet companies such as Facebook, Google, or Apple have adopted a 100% renewable energy commitment. Data centers are expected to improve their electricity intensity in the future; however, this will not necessarily solve the problem as the development of more energy-efficient technologies may backfire and result in an increase of the total energy consumption because of an increase in demand. This is known as the Jevons paradox (Blake 2005). In this case, improvements of electricity efficiencies will not be enough to cope with the continuous growth of the global data-center traffic (Andrae & Edler 2015; Jones 2018). The share of the world population with Internet access is increasing at an impressive pace (from 28.8% in 2010 to 58.8% in 2019; (Internet World Stats 2019). In this context, individual actions bear considerable weight, and consumers need to be included in the collective effort to reduce the environmental footprint of the ICT sector.

The goal of this research project is to understand the implications of this issue from the perspective of consumer behavior. Are consumers aware of the environmental impact of

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their online practices? How do they react to it? Are they willing to adopt greener behavior online? These questions have important marketing implications for many actors. (1) Green IT start-ups are the main protagonists. For these companies, it is crucial to identify consumers' expectations, motivations, and reservations toward green IT in order to adapt their products/services accordingly and communicate appropriately. (2) For public policy makers and pro-environmental NGOs, understanding consumers' psychological mechanisms could help promote behavior change toward sustainable Internet usage more effectively. Finally, (3) the Big Four tech companies (GAFA, i.e., Google, Amazon, Facebook, Apple) are also on the front line. Understanding the extent to which eco-friendliness is an important attribute for consumers would help them anticipate the potential impact of the growing environmental awareness on their future activity. As the environmental repercussions of the IT sector are increasingly pointed out, users of these platforms are likely to face paradoxical injunctions: while these companies aim at increasing user engagement and time spent on their platforms, environmental conservation necessitates a reduction of certain online activities. How consumers cope with these conflicting imperatives is an important issue to investigate for the future strategy of these companies.

As digitalization often leads to dematerialization, it is possible that the psychological processes leading to the adoption of ecological behavior differ in the virtual world. Given the emerging nature of the subject, we first conducted an exploratory study to identify consumers' reactions to the environmental impact of Internet usage (Study 1). Overall, the results show a low level of awareness and, though respondents were not indifferent to the subject, a low level of self-attribution of responsibility to undertake individual action. Next, we conducted two quantitative studies (2a and 2b) to better understand the forces that promote or hinder people's self-attribution of responsibility to adopt greener online behaviors, such as using an eco-friendly search engine.

General Framework

The Link Between Technology and Sustainability

Previous research highlights the link between technological advances and environmental sustainability. However, this relationship is complex, and its valence is not always consistent, depending on the situation. Several researchers emphasize the potential beneficial effects of technology in general (Ahn, Kang, & Hustvedt 2016) and ICT in particular (Cerri & Terzi 2016) on sustainability. Others also highlight the environmental costs generated by information technology (IT), such as high energy consumption, the rapid depletion of natural resources, and greenhouse gas emissions, and they focus on how to reduce this negative impact (Chugh, Wibowo, & Grandhi 2016; Watson, Boudreau, & Chen 2010).

Given the potential harmful consequences of traditional IT, companies and consumers are increasingly adopting green IT practices. Green IT, also known as green computing, is "the study and practice of designing, manufacturing and using computers, servers, monitors, printers, storage devices and networking and communications systems efficiently and effectively, with zero or minimal impact on the environment" (Murugesan & Gangadharan 2012, p. 2). Although green computing has attracted increasing interest in the past few years, most of the academic research published on this subject focuses on business practices (Bose & Luo 2011) or the behaviors of ICT professionals (Chugh et al. 2016); thus, little is known about consumers' willingness to adopt green behaviors when it comes to their digital use. Researchers who have examined the issue from an individual perspective stress the influence of both intrinsic and extrinsic motivations on the adoption of green IT. For example, Koo, Chung, and Nam (2015) show that both intrinsic (enjoyment) and extrinsic (cost savings) motivations affect perceived usefulness and the use of a smart green IT device intended to reduce electricity consumption. Through our research, we aim to contribute to this emerging literature, and we use a marketing perspective to investigate specifically consumers' green behavior online.

Characterizing Consumers' Online Pro-Environmental Behavior

Pro-environmental behavior refers to any behavior geared toward reducing the impact of human life on the environment (Axelrod & Lehman 1993). In the academic literature, most pro-environmental behaviors investigated to date are strongly embedded in the physical world, such as recycling waste (Bagozzi & Dabholkar 1994), avoiding polluting modes of transportation (Bamberg, Ajzen, & Schmidt 2003), or purchasing less harmful products (Schlegelmilch, Bohlen, & Diamantopoulos 1996). Nevertheless, recent technological developments are leading to a broadening of the spectrum of what pro-environmental actions entail. In particular, the conceptualization of pro-environmental behavior must embrace other types of actions that are not necessarily grounded in the physical world, such as some online behaviors. Therefore, any effort Internet users make to reduce their digital environmental footprint can be assimilated to ecological behavior.

To illustrate what can be considered an eco-friendly online behavior, we collected existing insights and recommendations from a diversity of sources (environmental agencies, consultancy firms, service provider websites, newspaper articles, academic articles, expert blogs, etc.[1]) and organized them in a non-exhaustive classification of environmentally friendly online behaviors (Table 1). These behaviors were grouped based on the type of online activity (search, emailing, data storage, etc.) and the nature of the behavior itself: optimization of current behavior vs. substitution. Avoidance and optimization behaviors involve the reduced solicitation of distant servers and data centers, which ultimately entails reduced energy consumption. However, the extent to which substitution behaviors are eco-friendlier can be debated as we lack factual and

[1] The exhaustive list is available upon request.

Table 1
Classification of online behaviors aimed at reducing Internet users' environmental impact.

Online activities	Optimizing current practices/reducing harmful practices	Substituting (alternative services, devices, or behaviors)
Search	- Using the URL bar (when address is known) instead of entering a keyword, then clicking on link. - Using browsing history instead of a search engine to find websites that I have visited before. - Saving frequently visited pages as bookmarks. - Choosing keywords carefully. - Using "previous / next" buttons in browser to avoid reloading pages that I have already visited. - Increasing cache memory size so that the browser can save more visited sites in the history instead of using remote servers. - Avoiding deleting browsing history too often. - Leaving tabs open in my browser for pages that I plan to consult again.	- Using environmentally friendly search engines (e.g., Ecosia, Lilo). - Using search engines that appear on a black page to consume less energy (e.g., blackle.com).
Emailing	- Reducing the size of emails, limiting attachment size, compressing a file before attaching it. - Saving my passwords. - Avoiding sending emails if not necessary. - Limiting the number of receivers copied in emails. - Unsubscribing from irrelevant newsletters. - Using an anti-spam filter to avoid receiving unwanted emails - Cleaning mailbox regularly. - When replying to emails, not including the history or original message. - When forwarding emails, removing attachments if they are not needed. - Deleting mailbox accounts that are no longer used. - Avoiding emailing files to myself as a backup. - Avoiding logos or large size images in email signature.	- Sending plain-text emails instead of HTML emails. - Using an eco-friendly email service that uses renewable energy (e.g., Tutanota). - Sending an SMS or calling a person directly instead of sending an email. - Using uploading/downloading solutions (e.g., WeTransfer, High Tail or Smash) instead of attaching a file to an email (not just for heavy files).
Video/music streaming	- Downloading music/videos that I intend to consult several times. - Avoiding watching TV via the Internet. - Not letting a loaded video run from the Internet if I do not intend to watch it. - Not leaving music loaded from the Internet if I do not listen to it. - Watching videos in standard definition rather than HD. - Avoiding watching videos/listening to music on platforms that are powered by polluting energy sources. - Avoiding opening the video of a musical piece if I just want to listen to it.	- Buying music or videos on legal platforms instead of streaming. - Watching television instead of streaming.
Data storage	- Avoiding/restricting data storage on the cloud. - Sorting files regularly and deleting unused/unwanted documents, pictures, or videos.	- Storing files on external hard drive instead of storing them online. - Using environmentally friendly online storage services.
Social media and instant messaging	- Saving passwords on the different platforms. - Deleting my account on social media platforms that I no longer use. - Limiting the storage of photos/videos on these sites. - Limiting conversations on chat tools. - Avoiding microblogging or instant messaging platforms that are not powered by clean energies.	- Sending an SMS or calling a person directly instead of using online messaging platforms.
Video games	- Avoiding online multiplayer mode and using offline mode whenever possible.	- If the physical disc game comes with a large amount of plastic packaging, purchasing the digital copy instead.
E-commerce	- Saving password on e-commerce platforms that I use regularly. - When considering buying a product, saving it to cart. - Avoiding e-commerce sites that are powered by polluting energy sources. - Deleting my account on e-commerce sites that I will no longer use.	- Whenever a product is available locally, purchasing it directly from a physical store instead of ordering online.
Web hosting	- When sharing a video on a website, if it is already available elsewhere on the Internet, sharing an external link to the video instead of uploading it.	- When creating a website, choosing an environmentally friendly web hosting provider (e.g., GreenGeeks).

objective data comparing the environmental footprint of commonplace digital behaviors and theoretically greener practices.

Moreover, even if these behaviors are beneficial to the environment, they seem relatively unknown to the general public. Yet, studies draw attention to the crucial role of consumers' awareness and knowledge in explaining their attitudes toward and intention to adopt green behavior (Bang, Ellinger, Hadjimarcou, & Traichal 2000; Kaiser & Fuhre

2003). Thus, the first step of this research project was to determine the extent to which consumers are aware of their environmental impact as Internet users. However, because knowledge is usually a necessary but insufficient condition to engage in concrete ethical action (Freestone & McGoldrick 2008), our second step was to seek to understand the antecedents of consumers' willingness to adopt green behavior online and, in particular, the determinants of consumers' self-attribution of responsibility.

The Role of Intangibility

In general, intangibility refers to what is impalpable and encompasses what cannot be touched, seen, smelled, tasted, or heard (Mittal 1999). The concept also includes a mental dimension, or any aspect that is difficult to imagine, define, or grasp mentally (Laroche, McDougall, Bergeron, & Yang 2004; McDougall & Snetsinger 1990). Several studies have investigated the impact of intangibility in the context of service marketing (Grove, Carlson, & Dorsch 2002; McDougall & Snetsinger 1990; Reddy, Buskirk, & Kaicker 1993). Others have examined the specific effects of intangibility on consumer online behavior (Mazaheri, Richard, Laroche, & Ueltschy 2014; Nepomuceno, Laroche, & Richard 2014), though mostly in a context of purchasing behaviors. Furthermore, these studies conceptualize intangibility mainly through the perspective of perceived risk (Laroche et al. 2004).

Consumers' difficulty in mentally grasping a phenomenon is likely to generate uncertainty about the potential negative consequences of their behavior. In the case of online behaviors, this factor might play a noteworthy role because dematerialization can lead to a lower level of perceived environmental harmfulness (Bartelmus 2003). Moreover, the environmental consequences of online behaviors are more difficult to visualize than other types of behaviors. For example, when managing household waste, consumers have a clear and tangible idea of the impact of their consumption on the environment. They are able to visualize their trash and thus can easily imagine landfills and the pollution they generate. In contrast, when looking for information on a search engine, the ecological impact of the flow of data is less clear. This is due to the intangible nature of the behavior itself but also to consumers' lack of knowledge, which makes it more difficult for them to mentally comprehend the concrete environmental impact of such an action. Our first study enabled us to explore consumers' reactions and to determine, among other things, whether the perceived intangibility of the environmental consequences of online behavior is a relevant variable to investigate.

Study 1: Exploring Consumers' Reactions to the Environmental Impact of Online Behavior

Method

Face-to-face, semi-structured, in-depth interviews were conducted with 17 French respondents with diverse socio-demographic profiles (Table 2). To avoid any bias related to researcher expectations, the interviews were conducted by three graduate students specializing in market research. The students were specifically trained for this type of interview, and their work was assessed within the curriculum. They were given the indications they needed to conduct the interviews properly, but they were not familiar with the entire research agenda. Once they completed their task, one of the authors conducted two additional interviews to ensure that no major theme was missing from the corpus.

The interviews lasted between 45 minutes and one and a half hours and were conducted at the homes of the participants between March and May 2015. The first part of the interview guide dealt with ecology in general. Respondents were asked about their perceptions of what is harmful to the environment and the extent to which they adopt environmentally friendly behavior in their everyday lives. If they made no mention of their Internet usage spontaneously, the interviewer raised the subject explicitly, though progressively. The second part of the interview guide addressed the issue of Internet pollution and began with the presentation of facts and figures, in order to obtain respondent feedback. The study results detailed below are focused on the second part of the interview guide. All the interviews were transcribed and examined via thematic content analysis (Braun & Clarke 2006). Data processing occurred through vertical and horizontal exploration.

Results

a) Consumers' Lack of Knowledge

Overall, the analysis reveals respondents' lack of knowledge about the environmental impact of the Internet: “I had no idea! Not at all, not for one second” (6). Some respondents even expressed strong reactions of surprise and concern when learning about this information: “I'm speechless” (15); “I am

Table 2
Profile of the interviewees (Study 1).

Respondent number	Name	Gender	Age	Job situation
1	Melissa	F	25	Student
2	Michel	M	66	Retired
3	Thomas	M	30	Engineer
4	Christophe	M	24	Masseur
5	Martine	F	57	Retired
6	Elena	F	27	Sales manager
7	Mélanie	F	24	Student
8	Karine	F	59	Executive assistant
9	Estelle	F	36	Customer advisor
10	Samy	M	25	Student
11	Mehdi	M	30	Teacher
12	Léo	M	19	Student
13	Pierre	M	60	Consultant
14	Simon	M	21	Real estate agent
15	Amina	F	54	Consultant in human resources
16	Alain	M	25	Computer scientist
17	Pauline	F	23	Student

shocked to hear that using the Internet generates so much pollution" (16); "It's absolutely terrifying" (5). Nevertheless, we found different levels of awareness. A few respondents showed less surprise: "Obviously, to make the entire Internet work, you need tons of servers, it requires a lot of energy" (3). Finally, some respondents seemed aware of the impact of equipment manufacturing only and did not appear to be conscious of the impact of the exchange of data: "Computers need to be built" (9).

Regardless of whether they were discovering the subject for the first time or not, many respondents indicated their willingness to learn more about it: "We should be informed about this. There should be a big sign on our laptops when we purchase them" (8).

b) Internet Pollution: An Acceptable Side Effect in View of the Many Benefits of Internet Usage

Respondents' replies reveal a recurring contrast between modernity on the one hand and ecology on the other. The Internet is widely perceived as a means of progress that facilitates everyday life. Conversely, ecology is often associated with the past: "I think [the Internet] has modernized societies ... Everything moves faster with the Internet" (4); "We must return to an old-fashioned way of life, go to libraries, research in the archives, and all that" (9). In general, respondents tried to put the environmental impact of the Internet into perspective in terms of its benefits. If the benefits have more weight, the cost–benefit balance obtained might justify the decision not to change current practices: "In the end, if there are more advantages in using Facebook, emails etc., than disadvantages, then I say why not ... You have given me a drawback, but the advantages should also be highlighted" (10).

c) Limited Intention to Change Online Behavior Reflecting Many Obstacles

Overall, the respondents were either unwilling to act or willing to act but only under certain conditions. Some were adamant that they could not change their online behavior to reduce their environmental footprint: "I couldn't change my behavior on the Internet ... no, no it's impossible" (7). Others were willing to try, provided that doing so did not jeopardize their performance and did not require too much effort: "If it's not too demanding, if it doesn't decrease the speed, etc., I'd be happy to" (17). Respondents were often reluctant to change their habits, especially because the use of the Internet, as they know it today, is a kind of social norm they do not wish to oppose: "not if I have to swim against the current" (13).

Given the ubiquity of the Internet in their lives, many respondents believed that it would be impossible to reduce their current use, which in turn generated a strong feeling of powerlessness: "It is hopeless, we cannot do otherwise" (2). Among other obstacles, some respondents admitted that their behavior is partly influenced by individualist considerations that lead them to place their personal concerns above ecology: "I am also very selfish ... I won't use this or that technology because it's environmentally friendly" (16). In the end, consumers seemed to deny their individual responsibility and to blame companies and public authorities for the environmental impact of the Internet. They seemed largely unaware of a phenomenon that extends beyond them: "If measures were taken at the legal level or simply at the corporate culture level, then yes. But we lack support" (13).

d) Lack of Consensus About the Severity of the Environmental Threat

To strengthen their position and justify their reluctance to change their behavior, many respondents expressed skepticism about the seriousness of the environmental impact of Internet usage: "I think if we really put this in perspective with other human activities, we'll find that it's actually quite low" (3); "I'm not entirely convinced by this information" (10). Different neutralization mechanisms are present in this perspective. For example, some respondents argued that any alternative to their current Internet usage would be equally harmful to the environment: "If there wasn't this energy consumption how would messages travel? We would have to send them anyway, send them with paper. Paper means deforestation again, it also means transportation using boats, airplanes. So in the end, it's the same thing" (4). Another strategy consisted of mitigating the gravity of their carbon footprint in general: "We mustn't forget that the planet has a capacity for regeneration. I mean, it's a cycle. We release CO_2, but the planet is also able to absorb some of it" (10).

Conversely, other respondents believed that the environmental repercussions of Internet usage are very serious and reacted vividly: "This is what I call an ecological disaster" (12); "It's getting worse and worse … the Internet is not that old, and we've reached already I don't know how many data centers and millions of data … [What] are we going to do 20 years from now?" (7).

e) Perceived Effort of Green Behavior Online Vs. in "Real Life"

Some respondents found it more difficult to adopt environmentally friendly behaviors in the virtual sphere: "Now we're often connected, real-time applications, and all that. It has become part of our daily lives. I think reducing all this would be more constraining than walking for grocery shopping that is 5 minutes away instead of using the car" (4). Others believed that ecological behavior in real life requires a higher level of effort: "As long as you're passive in front of a computer, I don't see how it can be more burdensome than in real life, clearly. Everything that happens on the Internet is less burdensome than in real life anyway" (16). Yet, other respondents believed that it is equally constraining to adopt ecological actions in the physical or virtual world: "One is not easier than the other. It's just a matter of habit" (11). Although the intangibility of behaviors did not emerge as the most decisive factor in the process leading to intentions to act, the intangibility of the environmental consequences of Internet usage was an issue. One respondent tied this intangibility to the lack of information, as described previously: "The fact that all this is a grey area for many people is the reason why they don't feel they have an impact on the environment" (16).

f) Various Recommended Solutions Depending on Attribution of Responsibility

We observed differences in stances when respondents were asked about which measures should be implemented to curb the environmental impact of Internet usage. First, the suggested solutions differed depending on how respondents viewed technological innovations. While some perceived them as the source of the problem, others described them as opportunities. The latter group did not question the Internet as a tool but expected evolutions of media devices to reduce its impact: "Now we need to improve the equipment to make it less energy consuming" (2).

Second, the most significant differences in respondents' suggestions depended on whether they attribute the responsibility to act to consumers, to companies, or to public authorities. Those who believed that it is consumers' responsibility to reduce the environmental impact of the Internet mainly suggested reducing or changing current Internet usage: "Avoid sending emails unless it's necessary... [I] prefer communicating by phone or texting rather than using the Internet" (16); " Take fewer pictures or sort them afterwards but store fewer" (10). Among the transformations expected from companies, some respondents called for innovations that would reduce the Internet's environmental impact, but many also suggested a change in data storage practices: "It's up to Google to do something about it … at some point, there should be a purge to reduce the number of data centers" (7); "Big companies want to store everything, but they don't even know what to do with the data anymore" (12). Respondents also questioned companies' online advertising practices: "We should limit advertising.... When you load a page and you have 10 pop-ups and 15 ad banners, obviously, it requires a lot of energy" (3). Finally, respondents especially called for the government to legislate or punish non-ecological practices: "There should be penalties, bonuses or … you know ... restrictions on Internet data flows" (4). Respondents also expected public policy makers to support research initiatives to develop less polluting materials, to impose greener sources of energy supply, and to educate people as early as in childhood to make them aware of this issue: "It can be done in schools, by integrating it into the curriculum" (11).

Discussion and Conclusion of Study 1

Our qualitative study reveals that consumers are disinclined to accept their share of responsibility to curb the Internet's environmental footprint because they are awaiting solutions from companies and governments. This reluctance can be interpreted in light of the growing embeddedness of digital behaviors in consumers' lives. Our participants' discourse suggests that the adoption of alternative environmentally friendly online behaviors is viewed as a constraining disruption of the routine. Digitalization is associated with services that enable consumers to achieve their goals efficiently and easily, which tends to freeze digital habits and to make change more costly (Aarts & Dijksterhuis 2000). The qualitative study also reveals discrepancies of opinion among our participants about Internet users' responsibility to act in favor of environmental preservation. How can these differences of opinion be explained? Two rationales seem to emerge from our findings. First, some respondents expressed doubts about the reality and severity of the environmental problem raised by digitalization. Second, most respondents suggested that it would be too difficult and costly for them to change their behavior, thus providing evidence of psychological conflict: even if Internet users perceive that digitalization causes severe damages to the environment, they may also perceive the necessary effort to change their practice to be too overwhelming.

Quantitative data are needed to extrapolate our findings to a wider population and to quantify the effects of these competing motivations on consumers' willingness to endorse responsibility.

Study 2a: Investigating the Effect of Perceived Severity and Sacrifice on Self-Attribution of Responsibility in Various Online Contexts

Based on insights from the qualitative part, Study 2a serves as a pilot quantitative study to test the effect of perceived severity of the threat and perceived sacrifice associated with alternative online behaviors that are environmentally friendly.

Perceived severity of the environmental threat is a commonly used concept in the literature on environmentally friendly behavior and is sometimes interchangeably labeled as "awareness of the negative consequences" or "problem awareness" (De Groot & Steg 2009). According to well-established theories of human behavior, when exposed to a threat, individuals tend to estimate the severity of its consequences and the response efficacy, either because they are motivated to help others (Schwartz 1977) or to protect their own well-being (Rogers 1975). Perceived severity represents an important motivation to adopt a new behavior, but at the same time, individuals assess the cost of such behavioral change. In this case, perceived sacrifice includes all the costs consumers face when giving up an online habit to adopt pro-environmental online behavior. We assessed the effect of these two variables on individuals' self-attribution of responsibility (also known as "self-ascription of responsibility" or "endorsement of responsibility"), a central concept in pro-social behavior theory (Schwartz 1977; Stern, Dietz, Abel, Guagnano, & Kalof 1999), which, according to our qualitative findings, emerges as a relevant dependent variable to investigate.

The effects of perceived severity of the threat and perceived sacrifice associated with substitute solutions may vary across the multiple uses of the web. To account for this variability, we examined four different domains of the online activities identified in Table 1, namely search, emailing, data storage, and video/music streaming. In each of these areas, we expected consumers' self-attribution of responsibility to be positively influenced by the perceived severity of the environmental threat caused by online activities and negatively influenced by the level of perceived sacrifice associated with behavior change.

Method

Data collection was conducted online by a marketing research company among a sample drawn from an online panel of French consumers. Between 107 and 119 questionnaires were administered depending on the category of online activities. Respondents were asked to read a short text explaining the environmental impact of Internet usage, with an emphasis on one of the four activities. Filtering questions assessing understanding and attention led us to discard between 24 and 31 questionnaires (Appendix A).

Perceived sacrifice associated with behavior change (3 items), perceived severity of the environmental threat associated with each practice (2 items), and self-attribution of responsibility (3 items) were inspired and adapted from previous studies mobilizing these concepts, for instance in the context of the Norm-Activation Model (Steg & De Groot 2010; Tanner 1999). All answers used a 5-point Likert scale. The detailed list of items and information about the reliability of the scales are provided in Appendix B.

Results

Self-attribution of responsibility was regressed on the average scores of perceived severity and perceived sacrifice for the four online activities examined. Familiarity with the domain was included as a control variable. Results are reported in Table 3.

We observe a regular pattern across digital activities. First, self-attribution of responsibility to change online behavior in the four domains is mainly explained by the perceived severity of the consequences of the activity for the natural environment. Second, perceived sacrifice associated with behavioral change exerts a smaller opposite effect on self-attribution of responsibility. For online storage only, this effect is not significant ($\beta = -0.016$, $p = .879$). Third, we also checked for potential interaction effects between perceived severity and perceived sacrifice, but none were significant. Therefore, the effect of perceived severity on self-attribution is not moderated by the perceived sacrifice, and reciprocally, the negative effect of perceived sacrifice is not attenuated by the perceived severity of the consequences induced by digital activities. Moreover, these two constructs are weakly correlated, except for storage (r Email = −0.284, $p = .006$; r Search = −0.234, $p = .022$; r Storage = −0.413; $p < .001$; r Streaming = −0.180, $p = .131$).

Discussion and Conclusion of Study 2a

This pilot study suggests that Internet users seem to cope with two contradictory motivations. Except for storage, for which sustainable alternative behaviors are less familiar (see self-reported familiarity means in Appendix C), consumers are more likely to endorse individual responsibility when they are aware of the severity of the consequences of their behaviors; at the same time, however, they are held back by the perceived sacrifice associated with their online behavior change. These conflicting logics seem to act mostly in an independent way. However, it is important to further investigate their underlying mechanisms and potential mediators.

The purpose of our next study is to provide a comprehensive framework for understanding the effects of sacrifice and severity on endorsement, based on the mechanism of cognitive dissonance. To do so, we need to focus on a specific online eco-friendly practice. This online practice should not be too mainstream, but at the same time, the general domain it pertains to should be as familiar as possible to facilitate consumers' projection into a realistic scenario. The data from Study 2a show that search and email are unsurprisingly the most familiar online activities. Storing files on the cloud and music/video streaming are significantly less familiar. Search was selected as the focal activity for Study 2b. Among the three practices associated with search, using environmentally friendly search engines (e.g., Ecosia, Lilo) was reported as the least familiar activity (see Appendix C) and thus the one that requires the greatest change. Our next study examines consumers willingness to endorse responsibility by switching to a green search engine.

Study 2b: Modeling Consumers' Self-Attribution of Responsibility to Adopt Greener Online Behavior: The Case of Eco-Friendly Search Engines

This study investigates the underlying mechanisms of Internet users' endorsement of responsibility to adopt greener online behavior. We developed an explanatory model of

Table 3
Regression model predicting self-attribution of responsibility to change behavior related to email, search, storage, and streaming activities.

	Email		Search		Storage		Streaming	
	β	SE	β	SE	β	SE	β	SE
Perceived severity	0.682***	0.079	0.749***	0.062	0.559***	0.102	0.750***	0.073
Perceived sacrifice	−0.154*	0.075	−0.165**	0.069	−0.016	0.100	−0.228**	0.075
Familiarity with the domain	−0.058	0.124	0.003	0.124	0.052	0.113	0.061	0.084
R^2	0.527		0.634		0.300		0.645	

*** $p < .001$.
** $p < .01$.
* $p < .05$

consumers' self-attribution of responsibility and tested it in the context of an eco-friendly search engine.

Conceptual Model

A Cognitive Dissonance Approach

The findings of Studies 1 and 2a prompted us to mobilize the theory of cognitive dissonance (Festinger 1957). This theory helps explain the discrepancies between consumers' pro-environmental or ethical beliefs and attitudes and their actual behavior (McDonald, Oates, Thyne, Timmis, & Carlile 2015; Thøgersen 2004).

The results of the qualitative study show that when Internet users become aware of the environmental impact of their online practices and of the existence of pro-environmental alternatives, they sometimes express skepticism and question the reality of the environmental problem. Moreover, our findings in Study 2a suggest that Internet users experience a contradiction between competing motivations. On the one hand, they are aware of the threat and do not want to harm the environment; on the other hand, they do not want to change their online behavior, as doing so would involve significant sacrifice. We can interpret these reactions in terms of cognitive dissonance. If Internet users perceive pro-environmental online solutions as less practical and less functional than their usual online tools and habits, a change of behavior would be associated with significant sacrifice and effort (e.g., developing new usage scripts, forsaking the performance of the usual solution). In this situation, a possible coping strategy would be to adjust their beliefs about the problem and/or the solution (Kiviniemi & Rothman 2006; Thøgersen 2004). For example, consumers might convince themselves that the proposed solution is not relevant. Thus, if they perceive the alternative behavior as highly binding (i.e., its adoption represents great perceived sacrifice), they are likely to be skeptical toward the solution, which will negatively influence their self-attribution of responsibility.

Consumer Skepticism

Skepticism toward a pro-environmental solution refers to individuals' mistrust of the power of the solution to actually limit the environmental impact of an activity (Mohr, Eroglu, & Ellen 1998). We expect skepticism toward a pro-environmental solution to mediate the negative relationship between perceived sacrifice and self-attribution of responsibility. In other words, perceived sacrifice positively influences skepticism toward the pro-environmental solution, and in turn, skepticism negatively affects self-attribution of responsibility.

H1: Perceived sacrifice associated with the adoption of a pro-environmental solution negatively influences consumers' self-attribution of responsibility through the mediating effect of skepticism toward the pro-environmental solution.

Reducing cognitive dissonance can also lead to changes in beliefs about the severity of the environmental threat. If web users do not perceive the problem as serious, they will likely be skeptical about any proposed solution, which in turn will negatively influence self-attribution of responsibility. Thus, we expect perceived severity of the environmental threat to have a negative impact on skepticism but a positive indirect impact on attribution of responsibility.

H2: Perceived severity of the environmental threat positively influences consumers' self-attribution of responsibility through a negative effect on skepticism toward the pro-environmental solution.

Perceived Superiority of the Current Solution

According to our model, skepticism toward a pro-environmental solution has two antecedents: perceived sacrifice (positive effect) and perceived severity of the threat (negative effect). These antecedents, in turn, may be influenced by a common variable; our qualitative study suggests that the mechanism underlying consumers' lack of enthusiasm about online behavior change is their satisfaction with their current solutions. They consider the tools they use to be efficient and are reluctant to switch to alternatives. This phenomenon is consistent with the theory of diffusion of innovations (Rogers 2003). When the perceived superiority of the current solution is high, the eco-friendly alternative presents a negative relative advantage, which constitutes a major obstacle to its adoption (Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidou 2004).

The level of appropriation of the current solution plays a crucial role in the process leading to acceptance or denial of responsibility. If consumers perceive their current solution as superior to the alternative, the perceived sacrifice associated with the behavior change will be even greater.

H3: Perceived superiority of the current solution positively influences the perceived sacrifice associated with the adoption of the pro-environmental alternative.

Moreover, the perceived superiority of the current solution puts Internet users in a situation of cognitive dissonance: they discover the negative environmental impact of a valued and frequently used online service. In this case, users tend to use selective attention to focus on information that justifies their behavior and reject information that can fuel dissonance (Kiviniemi & Rothman 2006; Thøgersen 2004). One way to reduce dissonance is to question their perceptions of the environmental threat engendered by the dominant solution. In other words, consumers may attempt to neutralize the threat by denying the injury (Chatzidakis, Hibbert, Mittusis, & Smith 2004). These assumptions are in line with the results of our qualitative study.

H4: Perceived superiority of the current solution negatively influences perceived severity of the environmental threat.

Fig. 1 synthesizes our theoretical model and hypotheses.

Method

Among the list of possible actions that would reduce the environmental impact of Internet usage (Table 1), we selected a

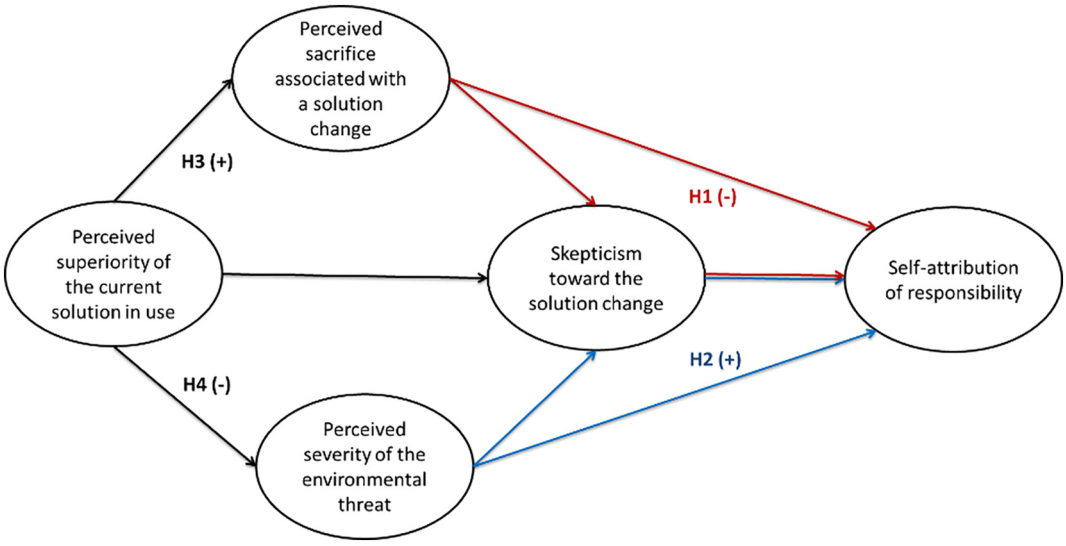

Fig. 1. Conceptual model and hypotheses.

solution that requires significant behavior change in users' daily life—that is, the adoption of a green search engine. We selected an engine with a clear ecological engagement: Ecosia.org. The organization donates at least 80% of its advertisement income to reforestation and tree-planting programs. According to the latest company data of February 2019, Ecosia has already planted 50 million trees, representing the absorption of 2.5 million tons of CO2 from the atmosphere. Reforestation is a critical issue as it helps to mitigate the effects of global warming (Palos-Sanchez & Saura 2018). Examining Internet users' willingness to adopt Ecosia as a search engine provided the opportunity to examine an unusual practice, but one providing a real environmental benefit.

The survey was carried out online by a professional market research company with a quasi-representative sample of the French population in terms of gender, age, and professional category (n = 250). Respondents were asked to read a short text presented as an excerpt of an article published recently in a major national newspaper (Appendix D). The article explained the environmental impact of Internet usage, including search engines, and presented the solution offered by green search engines. An understanding check question and two attention questions helped ensure respondents' commitment. We also checked interview duration and removed individuals who completed the questionnaire too quickly (average time minus two standard deviations). Subjects whose responses did not vary for a number of questions were excluded (outliers). Combined, these measures led us to discard 65 observations. The resulting exclusion rate (26%) is usual for web surveys (Alvarez, Atkeson, Levin, & Li 2019).

Measurement scales for perceived severity of the environmental threat (5 items, Chronbach's alpha = 0.93) and self-attribution of responsibility (3 items, Chronbach's alpha = 0.90) were adapted from previous studies mobilizing these concepts (Steg & De Groot 2010; Tanner 1999). Skepticism toward the alternative solution was measured with three items (Chronbach's alpha = 0.87) following Szykman, Bloom, and Levy's (Szykman, Bloom, & Levy 1997) contention that "skepticism measures a person's perception of accuracy of the claim" (p. 229). In this case, the claim was that using a green search engine such as Ecosia would reduce people's environmental footprint. Perceived sacrifice was measured with three items (Chronbach's alpha = 0.77). The perceived superiority of the solution currently in use was measured with a single item. Appendix E provides the exhaustive list of our measurement scales and descriptive statistics.

Preliminary Results

Before testing our model and hypotheses, our first concern was to confirm our prior conclusions regarding consumers' tendency to reject responsibility. After they were informed of the environmental consequences of usual online activities (e.g., data storage in the cloud, search engines), respondents indicated the extent to which taking action to reduce this environmental impact was the responsibility of Internet users, firms, or public authorities, using three items on a 7-point Likert scale ("It is primarily the responsibility of Internet users to change their habits to reduce pollution generated by search engines"; "It is primarily the responsibility of companies (Google, Yahoo, etc.) to make efforts to reduce the pollution generated by their own tools"; "It is primarily the responsibility of public authorities to take measures to reduce the pollution generated by search engines"). The results show that consumers assign the responsibility to address the problem primarily to companies (M = 6.32; SD = 0.94) and, to a lesser extent, public authorities (M = 5.48; SD = 1.55). Internet users received the lowest (M = 4.52) but the most highly dispersed score (SD = 1.79). All means are significantly different from the others ($p < .01$). This result is consistent with the findings of the qualitative study.

Table 5
Correlation matrix and discriminant validity.

	(1)	(2)	(3)	(4)	(5)
Skepticism toward the pro-environmental solution (1)	**0.7**				
Perceived severity of the environmental threat (2)	−0.42 *** (0.17)	**0.78**			
Perceived sacrifice associated with solution adoption (3)	0.30 *** (0.09)	−0.20 ** (0.04)	**0.56**		
Self-attribution of responsibility (4)	−0.49 *** (0.24)	0.75 *** (0.57)	−0.33 *** (0.11)	0.74	
Perceived superiority of the current solution (5)	0.33 *** (0.11)	−0.28 *** (0.08)	0.57 *** (0.32)	−0.36 *** (0.13)	**0.79** [a]

Square correlations are in parentheses. Average variance extracted is in bold on the diagonal.
[a] Following Anderson and Gerbing (1988)'s approach for constructs measured by a single item, the item loading is set at 0.95. Therefore, variance $=95^2 = 0.79$.
*** $p < .001$.
** $p < .01$.

Structural Model Estimation

We used structural equation modeling to test the proposed theoretical model. The analyses were conducted on AMOS 23.0 with maximum-likelihood estimation. First, we estimated the measurement model that includes all the latent constructs. We followed Anderson and Gerbing's (1988) recommendations to fix the loading value for the path between the factor "Perceived superiority of the current solution" and its single indicator and the residual variance. The model fits the data adequately, as all fit indices are acceptable (Appendix E) but fails to achieve the perfect fit ($\chi^2 = 168.15$, df = 81, $p < .001$), possibly owing to a violation of multivariate normality (West, Finch, & Curran 1995). Mardia's normalized estimate equals 23.29, suggesting that the data are non-normally distributed in the sample, which can result in a spuriously high value of χ^2 and artificially low standard errors (West et al. 1995). Because the standard errors are underestimated, the regression paths and factor/error covariances become statistically significant, although they may not be so in the population (West et al. 1995; Byrne 2010). In this context, several authors recommend using a bootstrapping procedure to make sure that loading values are not artificially significant because of multivariate normality violation (West et al. 1995). We took the results of 2,000 bootstrap replications and compared the average loadings with those estimated from the initial sample. The discrepancies are all lower than 0.007, suggesting that loading values are not distorted. Moreover, as shown in Table 5, the five constructs are significantly correlated with each other. However, each one shares more variance with its own indicators than with the other constructs, indicating discriminant validity.

To examine the potential effects of common method bias, we used the confirmatory factor analysis marker technique, as recommended by Richardson, Simmering, and Sturman (2009). We used three items to measure guilt proneness (Cohen, Wolf, Panter, & Insko 2011). The standardized loadings between the latent marker and all other indicators measuring the five constructs are very low (between 0.045 and 0.051), and none are significant. We also observe only slight changes in the Pearson correlation coefficients (less than 0.03) between latent factors. Taken together, these results suggest that common method variance is not an issue.

We specified only the links corresponding to our hypotheses and verified that no other link specification could improve model fit through the Lagrange Multiplier test. Fig. 2 shows the estimated structural model. Considering that the condition of multivariate normality is not met, with potential inflation of χ^2 and underestimation of TLI (Byrne 2010), the adjustment is acceptable ($\chi^2 = 171.137$, df = 84, $p < .001$; TLI = 0.95, RMSEA = 0.07 [0.06;0.09], p-close = 0.007; GFI = 0.89; SRMR = 0.057) and not significantly different from the CFA model adjustment ($\Delta\ \chi^2 = 2.98$, Δ df = 3, $p = .395$).

To test the mediation hypotheses, we analyzed the significance of the indirect effects by examining the 95% bias corrected confidence interval resulting from 2,000 bootstrap estimations (Preacher & Hayes 2004). The estimated indirect effect of perceived sacrifice on self-attribution of responsibility through skepticism is significant (−0.040 [−0.116; −0.007]). The indirect effect of perceived severity through skepticism is also significant (0.061 [0.016; 0.179]), as the confidence interval does not include zero. Thus, H1 and H2 are supported. Though marginal in comparison with the direct effect of perceived severity on self-attribution of responsibility (0.66, $p < .001$), the indirect path suggests that being aware of the seriousness of the problem is paramount to counterbalancing the skepticism that naturally arises from the perceived sacrifice associated with a solution change. As Fig. 2 shows, the results also confirm that perceived superiority of the current solution positively affects perceived sacrifice and negatively affects perceived severity of the environmental threat. H3 and H4 are supported.

Discussion and Conclusion of Study 2b

Study 2b confirms the conclusions of Study 2a and extends prior findings with the identification of indirect effects. The positive impact of perceived severity of the threat and the negative impact of perceived sacrifice on self-attribution of responsibility are replicated; however, these effects are shown to work through the mediation of consumers' skepticism toward the solution. As already shown in Study 2a, the positive influence of perceived severity of the threat on endorsement of responsibility is stronger than the negative influence of perceived sacrifice. However, the results of Study 2b also show that the perceived threat decreases when users are particularly satisfied with their usual behavior (perceived superiority of the solution currently in use), which ultimately reduces their self-attribution of responsibility. Our findings

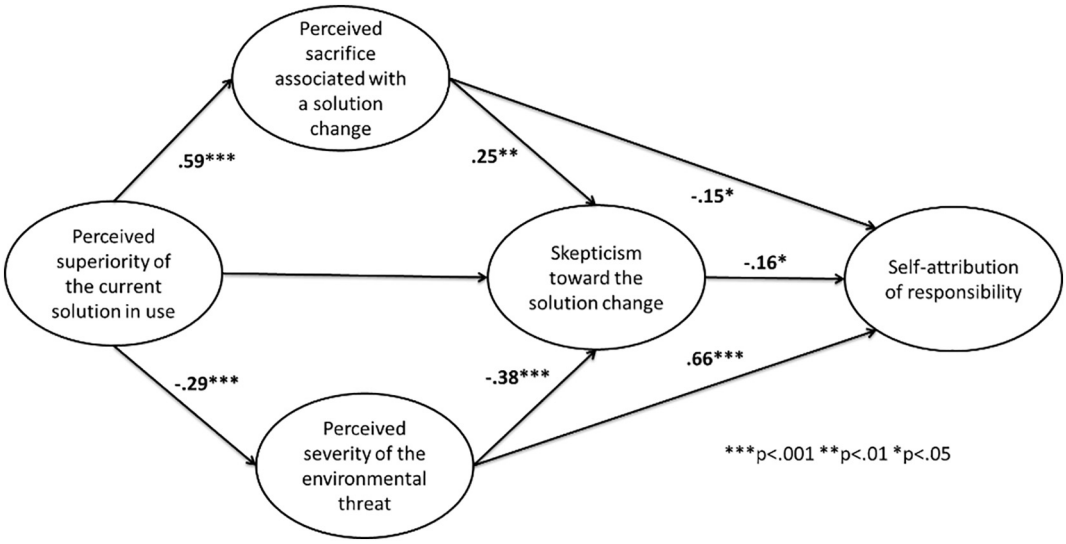

Fig. 2. Structural model estimation.

highlight the critical role of consumers' satisfaction with their current behavior as a source of cognitive dissonance.

General Discussion

Theoretical Contributions

This research project contributes to the emerging literature on the environmental impact of ICT by providing new insights from the perspective of consumers. Our qualitative study reveals low awareness of the issue and reveals respondents' reluctance to change their behavior. Interestingly, perceived intangibility does not emerge as a critical factor to explain the unwillingness to adopt green behavior online. According to the respondents, the ubiquity of the Internet makes behavior change difficult to achieve. In line with previous work on ethical consumption, our results show the obstacles related to lack of information but also to consumers' inertia and even cynicism (Bray, Johns, & Kilburn 2011). Consumers seem disinclined to accept their share of responsibility; instead, they await solutions from companies and governments. This low endorsement of responsibility is due to the combination of feelings of helplessness and consumers' perceived inability to change their habits for fear of losing the many advantages gained through new technologies. Nonetheless, the respondents did not seem insensitive to the potential negative consequences of those habits on the environment; on the contrary, many explicitly expressed concern. It thus appears that consumers are torn between competing motivations—not harming the environment on the one hand, and continuing to use the Internet the way they currently do on the other, not only because it is convenient but also because any behavior change would incur too many sacrifices.

The objective of our two quantitative studies was to better understand the determinants of consumers' self-attribution of responsibility to act in favor of limiting the environmental impact of Internet usage. Given the inconsistencies in consumers' motivations, we adopted a perspective based on cognitive dissonance theory. Study 2a and Study 2b both show that self-attribution of responsibility is positively influenced by the awareness of the environmental impact of online behaviors and negatively influenced by the perceived sacrifice associated with the alternative pro-environmental solutions. Study 2b indicates that both effects are mediated by skepticism toward pro-environmental solutions. In other words, if consumers judge the solutions to be too constraining, they tend to become skeptical about their effectiveness and reject responsibility. This process reflects consumers' strategy to reduce cognitive dissonance. In the specific case of a search engine—a domain where there is a main leader, namely Google—cognitive dissonance could also emerge through the link between perceived superiority of the current (dominant) solution and perceived severity of the environmental threat. This suggests that satisfaction with their current tools could lead consumers to downplay the severity of the environmental threat.

Analyzing the process leading to consumers' willingness to endorse responsibility for pro-environmental behavior through a cognitive dissonance perspective is a major contribution of this research project. It appears that there are two main ways of reducing cognitive dissonance: minimizing the severity of the threat through skepticism or accepting the sacrifice associated with the pro-environmental solutions and then endorsing the environmental issue. What factors drive consumers toward one or the other remains unclear and requires further investigations. Individual explanations (e.g., personality traits, habits) or contextual explanations (e.g., availability of pro-environmental alternatives) are possible.

Implications for Public Policy Makers and Companies

Our findings have practical implications for public policy makers and pro-environmental NGOs, green IT start-ups, and

the Big Four tech companies. The results of our qualitative study show lack of consumers' knowledge about the environmental impact of their Internet usage. Yet, awareness is a necessary condition to seize an issue and engage in concrete action. All concerned stakeholders (e.g., public policy makers, environmental organizations, companies involved in green computing activities) should communicate to increase consumers' awareness of the issue. As the environmental consequences of Internet use are still too abstract to grasp for consumers, these awareness campaigns should break down the ecological value chain into key steps to help individuals visualize the link between online behaviors and their tangible environmental effects.

Our findings also reveal that consumers expect companies to take on the responsibility of reducing the environmental impact of Internet usage. As such, companies, especially the GAFA, should communicate more about their actions in this area. According to the 2017 update of the Greenpeace report *Clicking Clean*, "[the] major internet [*sic*] companies' leadership has been a catalyst in driving a broader set of corporations to adopt 100% renewable goals, contributing to a dramatic increase in renewable deals in the U.S. signed directly by corporations" (Cook et al. 2017). These firms could further emphasize their commitment and publicize the actions they undertake in this direction to show consumers that they are accepting their share of responsibility.

Internet users also have high expectations of companies' ability to develop new solutions that are less environmentally harmful but equally functional. They do not want to choose between ecosystem preservation and their personal comfort and efficiency. To develop innovative solutions that are beneficial on all aspects, the IT industry must increase R&D efforts in this area. At the same time, public authorities should encourage these efforts through financial support.

When new solutions are launched, companies should make sure they publicize clearly their effectiveness and positive environmental impact, to prevent skepticism. Green IT companies may, for instance, frame the adoption of green IT products as a means to decrease cognitive dissonance by aligning Internet users' environmental values and online behaviors. They should also try to reduce perceived sacrifice by stressing ease of use.

Most of the above-mentioned recommendations are related to communication and persuasion, but the actors involved may also foster green online behavior through other approaches including coercion, incentives, and nudges. Although coercive measures were spontaneously mentioned by our participants in the qualitative study, this type of approach is somewhat extreme and usually unpopular. Another approach would be to encourage individuals to engage in eco-friendly online behavior by giving them something that motivates them, such as financial benefits. For example, service providers could design their pricing model in a way that fosters consumers' responsibility and awareness. This can be done by taking into account usage levels in their pricing model or by offering consumers significant discounts when their consumption is reduced. Finally, nudges involve inciting individuals to adopt a behavior just by changing the choice architecture, namely presenting information or choices in a specific way (Thaler & Sunstein 2008). Setting a green search engine as the default search engine on new computers and smartphones is an example of nudging. Another way to nudge consumers would be to provide them with online services or applications that would help them better control their online behavior. Apple's Screen Time feature, for instance, allows to track and limit time spent on a device or on specific apps and websites. Empowering consumers by helping them regulate their own digital behaviors is all the more critical to avoid rebound effects associated with energy efficiency improvements (i.e., the Jevons paradox).

Limitations and Future Research Directions

The literature on consumer behavior suggests the existence of several other potential determinants of self-attribution of responsibility. Two paths seem promising: the first one deals with individual characteristics of web users. Because the intention to adopt a specific behavior depends on individuals' perceived control, as stressed in protection motivation theory or planned behavior theory, an internal locus of control could encourage users to endorse more responsibility for the environmental problems associated with their Internet use. In the same vein, individuals' beliefs about their ability to have a positive impact on the environment by modifying their online behavior could be analyzed in the light of learned helplessness theory (Abramson, Seligman, & Teasdale 1978), which provides drivers to reduce helplessness that could be applied to our case.

The second path pertains to the way the threat is framed. In our three studies, we presented the threat in a rather general way and did not necessarily emphasize the direct impacts on the respondents themselves. Yet, the framing of the threat is likely to influence its perception and perceived vulnerability. Two parameters could be manipulated: the proximity of the negative consequences (threat to the environment or some other people vs. direct threat to the individual) and the temporality of the threat (i.e., imminence of the negative effects).

In parallel, the perceived sacrifice associated with behavior change should be further investigated. IT companies tend to lock customers in through switching costs. Google, for instance, offers an impressive list of features and services that are connected to each other, making it more difficult for Internet users to switch to other platforms. Future research should assess more accurately the sacrifice induced by switching search engines (on any other online service), by asking respondents to evaluate the extent to which they would be affected by different switching costs. An experiment could also help uncover how consumers deal with this tradeoff, for example, through a factorial design manipulating different

levels of switching costs and different levels of environmental efficacy associated with an online service.

Among other limitations, this paper does not address the impact of the devices used by Internet users to access the web. Over the past few years, there has been a considerable shift from desktop to mobile and tablet devices. In 2018, mobile phones alone accounted for 52% of worldwide website traffic (We Are Social 2018). It is likely that the type of device used affects the environmental footprint of Internet users. For instance, although smartphones tend to be increasingly energy efficient, they encourage a more intensive use of online tools (Fehske, Fettweis, Malmodin, & Biczok 2011). Belkhir and Elmeligi (Belkhir & Elmeligi 2018), compared the evolution of the contribution of each category of devices between 2010 and 2020 in terms of greenhouse gas emission footprint and found that smartphones had the biggest increase (from 4% to 11%). Further investigations are required to understand the impact of devices on consumers' self-attribution of responsibility to reduce the Internet's environmental footprint. In particular, it would be worth examining consumers' reactions to the environmental footprint of smart objects that connect to the Internet through Wi-Fi, 4G, and soon 5G networks.

Acknowledgements

Data collection of our study 2b was carried out as part of the Movida research program, funded by the French Ministry of Ecology, Sustainable Development and Energy.

Appendix A. Sample characteristics (Study 2a)

	Total sample	Email	Search	Storage	Streaming	Test of independence/Mean comparison
Initial sample	n = 449	n = 118	n = 119	n = 109	n = 103	
Cleaned sample	n = 342	n = 92	n = 95	n = 83	n = 72	
Gender						
Female	59.9%	60.9%	54.7%	61.4%	63.9%	Chi^2 = 1.65; df = 3; p > .05
Male	40.1%	39.1%	45.3%	38.6%	36.1%	
Professional category						
Upper	47.9%	38.0%	49.5%	46.9%	59.7%	Chi^2 = 8.64; df = 6; p > .05
Lower	18.8%	20.7%	21.1%	18.5%	13.9%	
Unemployed	33.2%	41.3%	29.5%	34.6%	26.4%	
Age						
Mean	43.26	44.46	44.96	42.33	40.57	F = 1.76; df = 3; p > .05
s.d.	13.81	15.15	12.90	14.32	12.29	
Min	18	18	19	18	21	
Max	75	75	67	70	67	
Intensity of Internet use						
Mean	4.21	4.13	4.12	4.27	4.36	F = 2.11; df = 3; p > .05
s.d.	0.73	0.80	0.71	0.65	0.72	
Min	2	2	2	3	2	
Max	5	5	5	5	5	

Appendix B. Scale items and statistics (Study 2a)

		Email	Search	Storage	Streaming
Perceived severity [7-point Likert scale]	Mean	3.66	3,8	3.72	3.43
-The environmental impact of [e.g. music and video streaming] represents a serious problem	SD	1.14	1.05	1.04	1.23
-[e.g. music and video streaming] has severe consequences for the environment	α	.92	.95	.91	.96
Perceived sacrifice [7-point Likert scale]	Mean	2.28	2.11	1.97	2.21
-It would be a significant sacrifice to change my habits regarding [e.g. music and video streaming]	SD	1.07	.97	1.04	1.09
-It would be a substantial effort to change my habits regarding [e.g. music and video streaming]	α	.84	.85	.88	.83
-It would be less efficient for me to [e.g. access music and video streaming] in a more ecological way					
Self-attribution of responsibility [7-point Likert scale]	Mean	3.96	4.04	3.85	3.67
-Now that I am aware of the existing solutions, it is up to me to act in order to limit the ecological impact of [e.g. music and video streaming]	SD	1.07	1.00	.99	1.05
-Reducing pollution related to [e.g. music and video streaming] is also my responsibility.	α	.95	.95	.94	.92
-I have a feeling of responsibility to change my behavior related to [e.g. music and video streaming]					

Appendix C. Mean of familiarity with practice (Study 2a)

	Environmentally friendly online practices	Self-reported familiarity
Search	Save frequently visited pages as favorites/bookmarks	3.71
	Use ecological search engines (e.g., Ecosia, Zutopi, Lilo)	2.06
	Leave tabs open in my browser for pages that I plan to consult again	3.56
Streaming	Download music/videos that I intend to consult several times	2.81
	Buy music or videos on legal platforms	1.99
	Watch videos in low to medium quality rather than HD	2.47
Emails	Compress a file before attaching it to an email	2.53
	Send text messages instead of emails	4.47
	Clean mailbox (e.g., delete old messages, spams)	4.28
Storage	Use ecological online storage solutions	1.72
	Store files on external hard drive	2.52
	Restrict online data storage	3.59

Appendix D. Text presented to the participants of Study 2b at the beginning of the questionnaire (translated from French)

[...] Today, the environmental impact of the Internet is not in doubt. The main source of pollution is linked to the increasing use of energy-intensive servers. According to a recent study, information and communication technologies generate the same amount of greenhouse gas emissions as the aerospace industry, with a growing rate of 20% per year.

Solutions exist. [...] In particular, it is possible to limit our ecological footprint when surfing the web by preferring "green" search engines such as Ecosia.org or Ecogine.org. Ecosia, for example, is committed to neutralizing all CO2 emissions related to web search queries and donates 80% of its advertising revenue to plant trees.

D.1. Descriptive statistics and results of confirmatory factor analysis (Study 2b)

Items [a]	M/SD [b]	St. B [c]	AVE [d]	ρ [e]
Perceived superiority of the current solution				
- There is nothing better than the search engine I am currently using	4.89/1.77	.95 [f]	–	–
Skepticism toward the pro-environmental solution			0.70	0.87
The suggested solution [using a green search engine]				
- does not seem very serious.	3.38/1.67	0.79		
- has a negligible impact on CO_2 emissions.	3.72/1.72	0.84		
- seems irrelevant.	3.77/1.64	0.89		
Perceived severity of the environmental threat			0.78	0.93

(*continued*)

Items [a]	M/SD [b]	St. B [c]	AVE [d]	ρ [e]
- The increase of CO_2 emissions associated with Internet usage is a serious problem.	5.09/1.53	0.90		
- The increase of CO_2 emissions associated with Internet usage has significant negative consequences on the environment.	4.94/1.49	0.89		
- The increase of CO_2 emissions associated with Internet usage is a threat to the environment.	5.13/1.42	0.94		
- One day, my quality of life will be altered by CO_2 emissions associated with Internet usage.	4.83/1.59	0.82		
- I will suffer from the increased CO_2 emissions associated with Internet usage.	4.90/1.51	0.89		
Perceived sacrifice associated with solution adoption			0.56	0.77
- A search engine switch would represent a real sacrifice.	3.61/1.67	0.88		
- It is a huge effort to change my habits regarding search engines.	4.22/1.71	0.67		
- Green search engines like Ecosia are certainly less efficient than the engine I currently use.	4.63/1.58	0.66		
Self-attribution of responsibility			0.74	0.90
- Now that I am aware of the existence of green search engines, it is up to me to act in favor of environmental preservation.	4.66/1.75	0.92		
- Green search engines are a way to empower me as a defender of the environment.	5.10/1.70	0.94		
- Now that I have heard about green search engines, I believe I need to take responsibility for changing my behavior.	3.69/1.81	0.74		

Model fit (confirmatory factor analysis) χ^2 = 168.15, df = 81, $p < .001$; TLI = 0.95, RMSEA = 0.07 [0.06;0.09], *p*-close = 0.005 GFI = 0.91; SRMR = 0.06.

[a] Likert format (1 = totally disagree; 7 = totally agree).

[b] Mean/standard deviation.

[c] Standard factor loading.

[d] Average variance extracted.

[e] Jöreskog rho.

[f] This value was set following (Anderson & gerbing 1988) recommendation for latent constructs measured by a single item.

References

Aarts, Henk and Ap Dijksterhuis (2000), "Habits as knowledge structures: Automaticity in goal-directed behavior," *Journal of Personality and Social Psychology*, 78, 53–63.

Abramson, Lyn Y., Martin E. Seligman, and John D. Teasdale (1978), "Learned helplessness in humans: Critique and reformulation," *Journal of Abnormal Psychology*, 87, 1, 49.

Ahn, Mira, Jiyun Kang, and Gwendolyn Hustvedt (2016), "A model of sustainable household technology acceptance," *International Journal of Consumer Studies*, 40, 1, 83–91.

Alvarez, Michael, Lonna Rae Atkeson, Ines Levin, and Yimeng Li (2019), "Paying attention to inattentive survey respondents," *Political Analysis*, 27, 2, 145–62.

Anderson, James C. and David W. Gerbing (1988), "Structural equation modelling in practice: A review and recommended two stage approach," *Psychological Bulletin*, 27, 1, 5–24.

Andrae, Anders and Thomas Edler (2015), "On global electricity usage of communication technology: Trends to 2030," *Challenges*, 6, 117–57.

Axelrod, Lawrence J. and Darring R. Lehman (1993), "Responding to environmental concern: What factors guide individual action?" *Journal of Environmental Psychology*, 13, 49–159.

Bagozzi, Richard and Pratibha Dabholkar (1994), "Consumer recycling goals and their effect on decisions to recycle: A means-end chain analysis," *Psychology and Marketing*, 11, 4, 313–40.

Bamberg, Sebastian, Icek Ajzen, and Peter Schmidt (2003), "Choice of travel mode in the theory of planned behavior: The roles of past behavior, habit, and reasoned action," *Basic and Applied Social Psychology*, 25, 3, 175–88.

Bang, Hae-Kyong, Alexander E. Ellinger, John Hadjimarcou, and Patrick A. Traichal (2000), "Consumer concern, knowledge, belief and attitude toward renewable energy: An application of the reasoned action theory," *Psychology & Marketing*, 17, 6, 449–68.

Bartelmus, Peter (2003), "Dematerialization and capital maintenance: two sides of the sustainability coin," *Ecological Economics*, 46, 1, 61.

Belkhir, Lotfi and Ahmed Elmeligi (2018), "Assessing ICT global emissions footprint: Trends to 2040 & recommendations," *Journal of Cleaner Production*, 177, 448–63.

Blake, Alcott (2005), "Jevons' paradox," *Ecological Economics*, 54, 1, 9–21.

Bose, Ranjit and Xin Luo (2011), "Integrative framework for assessing firms' potential to undertake green IT initiatives via virtualization—a theoretical perspective," *Journal of Strategic Information Systems*, 20, 1, 38–54.

Braun, Virginia and Victoria Clarke (2006), "Using thematic analysis in psychology," *Qualitative Research in Psychology*, 3, 2, 77–101.

Bray, Jeffery, Nick Johns, and David Kilburn (2011), "An exploratory study into the factors impeding ethical consumption," *Journal of Business Ethics*, 98, 4, 597–608.

Byrne, Barbara M. (2010), *Multivariate applications series. Structural equation modeling with AMOS: Basic concepts, applications, and programming* 2nd ed. New York, NY, US: Routledge/Taylor & Francis Group.

Cerri, Daniele and Sergio Terzi (2016), "Proposal of a toolset for the improvement of industrial systems' lifecycle sustainability through the utilization of ICT technologies," *Computers in Industry*, 81, 47–54.

Chatzidakis, Andreas, Sally Hibbert, Darryn Mittusis, and Andrew Smith (2004), "Virtue in consumption?" *Journal of Marketing Management*, 20, 5–6, 527–44.

Chugh, Ritesh, Santoso Wibowo, and Srimannarayana Grandhi (2016), "Environmentally sustainable information and communication technology usage: awareness and practices of Indian information and communication technology professionals," *Journal of Cleaner Production*, 131, 435–46.

Cohen, Taya R., Scott T. Wolf, A.T. Panter, and Chester A. Insko (2011), "Introducing the GASP scale: A new measure of guilt and shame proneness," *Journal of Personality & Social Psychology*, 100, 5, 947–66.

Cook, Gary, Jude Lee, Tamina Tsai, Ada Kong, John Deans, Brian Johnson, and Elizabeth Jardim (2017), "Clicking clean: Who is winning the race to build a green Internet?" *Greenpeace, 2017 Update*.Washington, D.C. Accessed January 27, 2017 http://www.greenpeace.org/international/en/publications/Campaign-reports/Climate-Reports/clicking-clean-2017/.

De Groot, Judith and Linda Steg (2009), "Morality and prosocial behavior: the role of awareness, responsibility and norms in the norm activation model," *Journal of Social Psychology*, 149, 425–49.

Fehske, Albrecht, Gerhard Fettweis, Jens Malmodin, and Gergely Biczok (2011), "The global carbon footprint of Mobile communications - the ecological and economic perspective," *IEEE Communications Magazine*, 49, 8, 55–62.

Festinger, Leon (1957), *A theory of cognitive dissonance*. Evanston: Row Peterson.

Freestone, Oliver and Peter McGoldrick (2008), "Motivations of the ethical consumer," *Journal of Business Ethics*, 79, 4, 445–67.

Greenhalgh, Trisha, Glenn Robert, Fraser Macfarlane, Paul Bate, and Olivia Kyriakidou (2004), "Diffusion of innovations in service organizations: Systematic review and recommendations," *The Milbank Quarterly*, 82, 4, 581–629.

Grove, Stephen J., Les Carlson, and Michael J. Dorsch (2002), "Addressing Services' intangibility through integrated marketing communication: an exploratory study," *The Journal of Services Marketing*, 16, 5, 393–411.

Guitart, Jordi (2017), "Toward sustainable data centers: A comprehensive energy management strategy," *Computing*, 99, 6, 597–615.

Internet World Stats (2019), "Internet usage statistics," Retrieved on Oct 23rd 2019 from https://www.internetworldstats.com/stats.htm.

Jones, Nicola (2018), "The information factories," *Nature*, 561, 7722, 163–6.

Kaiser, Florian G. and Urs Fuhre (2003), "Ecological behavior's dependency on different forms of knowledge," *Applied Psychology: An International Review*, 52, 4, 598–613.

Kiviniemi, Marc T. and Alexander J. Rothman (2006), "Selective memory biases in individuals' memory for health-related information and behavior recommendations," *Psychology & Health*, 21, 2, 247–72.

Koo, Chulmo, Namho Chung, and Kichan Nam (2015), "Assessing the impact of intrinsic and extrinsic motivators on smart green IT device use: Reference group perspectives," *International Journal of Information Management*, 35, 1, 64–79.

Laroche, Michel, Gordon McDougall, Jasmin Bergeron, and Zhiyong Yang (2004), "Exploring how intangibility affects perceived risk," *Journal of Service Research*, 6, 4,373–389.

Mazaheri, Ebrahim, Marie Odile Richard, Michel Laroche, and Linda C. Ueltschy (2014), "The influence of culture, emotions, intangibility, and atmospheric cues on online behavior," *Journal of Business Research*, 67, 3, 253–9.

McDonald, Seonaidh, Caroline J. Oates, Maree Thyne, Andrew J. Timmis, and Claire Carlile (2015), "Flying in the face of environmental concern: Why green consumers continue to fly," *Journal of Marketing Management*, 31, 13–14, 1503–28.

McDougall, Gordon H.G. and Douglas W. Snetsinger (1990), "The intangibility of services: Measurement and competitive perspectives," *Journal of Services Marketing*, 4, 4, 27.

Mittal, Banwari (1999), "The advertising of services: meeting the challenge of intangibility," *Journal of Service Research*, 2, 1, 98–116.

Mohr, Lois A., Dogan Eroglu, and Pam Scholder Ellen (1998), "The development and testing of a measure of skepticism toward environmental claims in marketers' communications," *Journal of Consumer Affairs*, 32, 1, 30–55.

Murugesan, S. and G. Gangadharan (2012), *Harnessing Green IT: Principles and Practices*. Chichester: John Wiley and Sons.

Nepomuceno, Marcelo Vinhal, Michel Laroche, and Marie-Odile Richard (2014), "How to reduce perceived risk when buying online: The interactions between intangibility, product knowledge, brand familiarity, privacy and security concerns," *Journal of Retailing & Consumer Services*, 21, 4, 619–29.

Palos-Sanchez, Pedro and J. Jose Ramon Saura (2018), "The effect of Internet searches on afforestation: The case of a green search engine," *Forests*, 9, 2, 51.

Preacher, Kristopher J. and Andrew F. Hayes (2004), "SPSS and SAS procedures for estimating indirect effects in multiple mediator models," *Behavior Research Methods, Instruments, and Computers*, 36, 717–31.

Reddy, Allan C., Bruce D. Buskirk, and Ajit Kaicker (1993), "Tangibilizing the intangibles: Some strategies for services marketing," *Journal of Services Marketing*, 7, 3, 13–7.

Richardson, Hettie A., Marcia J. Simmering, and Michael C. Sturman (2009), "A tale of three perspectives examining post hoc statistical techniques for detection and correction of common method variance," *Organizational Research Methods*, 12, 4, 762–800.

Rogers, Everett (2003), *Diffusion of Innovations* 5th ed. Simon and Schuster.

Rogers, Ronald W. (1975), "A protection motivation theory of fear appeals and attitude change," *Journal of Psychology*, 91, 1, 93–114.

Schlegelmilch, Bodo B., Greg M. Bohlen, and Adamantios Diamantopoulos (1996), "The link between green purchasing decisions and measures of environmental consciousness," *European Journal of Marketing*, 30, 5, 35–55.

Schwartz, Shalom H. (1977), "Normative influences on altruism," in *Advances in Experimental Social Psychology.* L. Berkowitz, editor. *, New York: Academic Press, 221–79.*

Steg, Linda and Judith De Groot (2010), "Explaining prosocial intentions: testing causal relationships in the norm activation model," *British Journal of Social Psychology*, 49, 725–43.

Stern, Paul C., Thomas Dietz, Troy Abel, Gregory A. Guagnano, and Linda Kalof (1999), "A value-belief-norm theory of support for Social movements: The case of environmentalism," *Human Ecology Review*, 6, 81–97.

Szykman, Lisa R., Paul N. Bloom, and Alan S. Levy (1997), "A proposed model of the use of package claims and nutrition labels," *Journal of Public Policy & Marketing*, 16, 2, 228–41.

Tanner, Carmen (1999), "Constraints on environmental behavior," *Journal of Environmental Psychology*, 19, 2, 145–57.

Thaler, Richard and Cass Sunstein (2008), *Nudge: Improving decisions about health, wealth and happiness*. New Haven, CT: Yale University.

Thøgersen, John (2004), "A cognitive dissonance interpretation of consistencies and inconsistencies in environmentally responsible behavior," *Journal of Environmental Psychology*, 24, 1, 93–103.

Watson, Richard T., Marie-Claude Boudreau, and Adela J.W. Chen (2010), "Information systems and environmentally sustainable development: Energy informatics and new directions for the ISCommunity," *Management Information Systems Quarterly*, 34, 1, 23–38.

We Are Social (2018), *Percentage of all global web pages served to mobile phones from 2009 to 2018 [Chart]*. In Statista. Retrieved July 09, 2019, from https://www.statista.com/statistics/241462/global-mobile-phone-website-traffic-share/.

West, Stephen G., John F. Finch, and Patrick J. Curran (1995), "Structural equation models with nonnormal variables: Problems and remedies," in *Structural Equation Modeling: Concepts, Issues, and Applications.* R.H. Hoyle, editor. Thousand Oaks, CA: Sage, 56–75.