BEING INNOVATIVE WHILE BEING GREEN: AN EXPERIMENTAL INQUIRY INTO HOW CONSUMERS RESPOND TO ECO-INNOVATIVE PRODUCT DESIGNS

Abstract

Eco-innovations are an effective way for companies to strategically align themselves with customers' growing environmental concerns. Despite their crucial role, scant research has focused on eco-innovative product designs. Drawing from the sustainability and innovation literature, this article proposes that in the design of an eco-innovation, its degree of innovativeness, level of eco-friendliness, and detachability significantly affect consumers' adoption intentions. This article develops various conceptual models tested through three independent online experiments with U.S. consumers. The findings support the hypotheses and provide useful insights into the underlying mechanisms of how and why consumers respond to eco-innovative product designs across various high-tech product categories. Specifically, the results show (1) a positive effect of innovativeness degrees of eco-innovative attributes on consumers' perceptions of product eco-friendliness and on their adoption intentions as well as a significant moderating role of consumers' need for cognition (Study 1); (2) a positive influence of eco-friendliness levels of eco-innovative attributes on consumer adoption intentions in the case of high-complexity products but not for low-complexity products, emphasizing the need to adopt different approaches when developing eco-innovations to ensure favorable consumer reactions (Study 2); and (3) a significant impact of the detachability of eco-innovative attributes on consumers' perceptions of trade-offs between environmental benefits and product functionality and on their intentions to adopt eco-innovations (Study 3). These findings add to existing theoretical knowledge, provide actionable managerial implications, and identify fruitful avenues for future research.

Keywords: eco-innovation; new product design; eco-friendly products; innovation adoptions.

PRACTITIONER POINTS

- Increasing innovativeness degrees of new eco-friendly attributes should be a key priority for firms aiming to encourage high eco-innovation adoption rates.
- Need for cognition (NFC) is an important criterion when identifying target market segments with heterogeneous consumer response functions to eco-innovation introductions.
- Managers need to focus more on product eco-friendliness by investing in specific types of eco-innovations that are more likely to trigger positive consumer responses. For high-complexity products, communication campaigns should highlight different types of eco-innovations while for low-complexity products, they should concentrate more on general environmental claims
- Firms should consider developing eco-innovative attributes as optional/detachable accessories because consumers are often uncertain about their new eco-friendly product purchases. It would be useful to employ experiential marketing techniques to highlight the detachability of eco-innovative attributes.

Introduction

Environmental challenges have put mounting pressure on people to minimize their ecological footprint by adopting more sustainable lifestyles, shopping habits, and consumption patterns (Kotler, 2011; Scott and Weaver, 2018). Recent evidence indicates that consumers are increasingly concerned about the environmental consequences of their purchases and product usage. Notably, a *National Geographic*'s (2014) study among 18 emerging and developed countries indicated that one in two consumers considered themselves "environmentalists" (i.e., minimizing waste, saving energy, and buying eco-friendly products). Many firms have responded strategically to these consumer-related environmental trends by integrating more sustainable attributes into new products and by building on eco-innovations as a means of attracting, retaining, and growing customers (especially those from the green-sensitive segment of the market) (e.g., Katsikeas, Leonidou, and Zeriti, 2016). A case in point is Samsung, which has adopted a new eco-design process, giving top priority to incorporating social and environmental values in new product development (NPD). Its two recent eco-innovations, Galaxy S8 smartphone with high energy efficiency and QLED televisions with cadmium-free quantum-dot technology, have been well received by consumers (Samsung, 2018).

Given the increasing practitioner interest in "greening" new product designs, a notable amount of scholarly work has been conducted on the subject. The bulk of this research has focused on investigating *why* and *how* companies respond to ecological market trends, such as adopting eco-design practices (Pujari, 2006), implementing a sustainable innovation orientation (Varadarajan, 2015), and engaging in eco-friendly NPD (Katsikeas et al., 2016). However, understanding *when*, *how*, and *under what conditions* consumers evaluate and respond positively to the introduction of eco-innovative products has received only scant empirical attention, thus limiting knowledge of the underlying mechanisms guiding consumer behavior toward the adoption of eco-innovations (Heidenreich, Spieth, and Petschnig, 2017).

Exploring eco-innovative products from the consumer perspective is imperative. First, consumers are important innovative actors and change agents in the development of sound marketing programs and strategies oriented toward sustainable innovations (Kotler, 2011). Second, there is an increasing discrepancy between what marketers/product designers believe to be innovative and what consumers perceive as useful, which can seriously hinder new product performance, particularly in the case of eco-innovations (Pujari, 2006). Third, even within the same sociocultural context, consumers' tastes can vary in terms of their preferences for or reactions to new eco-friendly products due to differences in personality, experience, and design acumen (Bloch, 1995; Bloch, Brunel, and Arnold, 2003). Fourth, because insufficient demand is a key reason for new product failure, it is vital to identify and understand the consumers who are most likely to adopt eco-innovations (Pujari, 2006; Pujari, Wright, and Peattie, 2003). Fifth, consumers are often reluctant to replace "browner" products with "greener" alternatives, especially when they are forced to make compromises in certain product features (Luchs, Brower, and Chitturi, 2012; Olson, 2013).

Given these arguments, this article aims to shed light on consumers' responses to eco-innovations regarding three key design aspects: the degree of innovativeness, the level of eco-friendliness, and the detachability of eco-innovative attributes. Specifically, the objectives of this research are to (1) examine the facilitating or inhibiting role of innovativeness degrees of eco-innovative attributes in consumers' intentions to adopt eco-innovations and investigate the moderating role of consumers' need for cognition (NFC), (2) assess the impact of eco-friendliness levels of new attributes on consumers' eco-innovation adoption decisions across product complexity levels, and (3) explore whether the detachability of eco-innovative attributes from the base product systems can influence consumers' perceptions of trade-offs of and adoption intentions toward eco-innovative products.

Our research makes a threefold contribution to product innovation management literature. First, drawing on Bloch's (1995) framework, this article empirically investigates the roles of three key eco-innovative product design factors (i.e., the degree of innovativeness, the level of eco-friendliness, and the detachability of eco-innovative attributes) in stimulating consumers' adoption intentions across various product categories. Although these factors have been widely examined in the mainstream innovation literature, their importance has been overlooked in the context of eco-innovation introductions. Our study provides insight into how a firm's decisions on these design aspects can favorably affect consumers' adoption decisions.

Second, this research responds to calls from marketing scholars (Kotler, 2011; Varadarajan, 2015) to explore the processes and mechanisms that consumers use to evaluate and respond to eco-innovative product designs. Specifically, our findings show that consumers' perceptions of product eco-friendliness and trade-offs in eco-innovative product designs play mediating roles in the relationship between eco-innovative product design and adoption intentions. Our study also offers fresh insights into specific boundary conditions under which different eco-innovative design factors can have beneficial, negligible, or detrimental effects on consumer responses across diverse product categories. Our results suggest that psychological traits (e.g., NFC) and contextual factors (e.g., product complexity) exert significant moderating effects on the link between eco-innovative product design aspects and consumer responses.

Third, this research focuses on high-tech products to provide rigorous answers about the extent to which eco-innovative product design factors significantly affect consumer adoption intentions. To create a more sustainable world, integrating eco-friendly benefits into innovative product designs has been an inevitable trend in advanced technology development (Gapchup et al., 2017). Environmentally conscious high-tech products positioned as sustainable innovations provide new opportunities to accelerate the adoption of new products/services, while proactively confronting growing ecological challenges (Varadarajan, 2015). Our findings contribute to research on eco-innovations (i.e., new products that are both state-of-the-art and eco-friendly) to suggest promising paths for companies to tap into the growing market of eco-conscious consumers and ensure sustainable development in the modern business world.

Background Research

Recent decades have witnessed a growing body of research on the integration of ecologically conscious NPD and innovation designs (Katsikeas et al., 2016; Varadarajan, 2015). However, despite a plethora of relevant studies, there is neither a widely accepted definition nor a conceptually sound understanding of what an eco-innovative product design is, much less one that can be translated into a measurable construct (Varadarajan, 2015). Indeed, the operationalization of this construct varies considerably across studies, which inhibits comparability and generalizability of findings. Importantly, there has been no systematic conceptualization of eco-innovative product designs from the consumer standpoint, which makes the discussion woefully incomplete.

Eco-innovative product designs enable consumers to enjoy both better product functionality (relative to conventional alternatives) and ecological soundness (Coad and Pritchard, 2017; European Commission, 2012). For example, the introduction of digital cameras eliminated the use of traditional film and other equipment associated with film development, which contained highly toxic, hazardous, and nonbiodegradable chemicals. Eco-innovative product designs serve as a signal of a company’s efforts to be innovative, while also reducing the impact of its ecological footprint. By adopting the eco-innovation concept in NPD, companies can move from a merely reactive response, due to changes in environmental regulations or pressures from stakeholders, to a strategically proactive orientation toward long-term sustainability (Pujari, 2006). As such, by introducing eco-innovations, firms help consumers overcome uncertainty about the potential negative consequences of purchasing high-tech products (Majid and Russell, 2015).

Two key issues require deeper investigation in relation to eco-innovative product development: *product attribute innovativeness* and *product attribute eco-friendliness*. With regard to product attribute innovativeness, much of the literature stresses that innovativeness plays a crucial role in defining and classifying various types of innovation. Different taxonomies of product innovations based on levels of attribute innovativeness have been proposed, such as incremental innovations (i.e., minor improvements and modifications to existing products) versus radical innovations (i.e., major technological developments and considerable changes in consumers' perceptions and usage behaviors) (Mugge and Dahl, 2013). The degree of product attribute innovativeness influences consumers' mental schemas and their categorization process (Moreau, Lehmann, and Markman, 2001a; Moreau, Markman, and Lehmann, 2001b), thus affecting their product evaluations and ultimately their adoption decisions (Rindova and Petkova, 2007).

Regarding product attribute eco-friendliness, many scholars have investigated the link between eco-friendly product attributes and various consumer responses (see Appendix A). However, prior work has yielded mixed findings, triggering a debate about the mechanisms through which eco-friendly product attributes influence consumer responses. Several empirical efforts (e.g., Hartmann and Apaolaza-Ibáñez, 2012; Haws, Winterich, and Naylor, 2014; Majid and Russell, 2015) show that consumers respond positively to product offerings that incorporate sustainability elements. Indeed, Tully and Winer's (2014) meta-analysis of 80 empirical studies on sustainable products reveals that the majority of consumers are willing to pay a premium for products that benefit humanity and preserve the natural environment.

However, other scholars (e.g., Luchs et al., 2010; Newman, Gorlin, and Dhar, 2014) argue that sustainability may not always be a valuable asset for firms and, in some cases, may even have a negative impact on product preferences. Although consumers are positively predisposed toward environmentally sensitive products, product performance, rather than green issues, tends to be the key driving force in their buying decisions (Luchs et al., 2012). In other words, consumers may not be willing to risk "standard" benefits (e.g., convenience, durability, functionality) to obtain environmental benefits in the products they buy (Luchs et al., 2012; Olson, 2013). Eco-friendly attributes are often associated with indirect and other-focused benefits (e.g., pollution reduction for society), as opposed to direct and self-focused benefits (e.g., operating performance) (Bodur, Tofighi, and Grohmann, 2016). In general, consumers perceive eco-friendly products as costing more, being of lower quality, and exhibiting greater uncertainty in product functionality than standard products, thus making them less effective and less desirable under certain conditions (Lin and Chang, 2012; Luchs et al., 2010). This explains, to a large extent, the high failure rates of new eco-friendly product introductions in recent years (Carrington, Neville, and Whitwell, 2010, 2014).

Notwithstanding these problems, the introduction of eco-innovations (i.e., new products that combine both eco-friendly benefits and innovative performance) is still a promising approach for enhancing consumer responses and achieving more positive market performances (European Commission, 2012; Kotler, 2011). Ideally, an eco-innovation based on advanced technologies could be an effective way to encourage greater consumption of sustainable products, by providing both better functionality and environmental protections. However, in reality, consumers tend to be not only uncertain about the usefulness of eco-innovative attributes but also doubtful about the trade-offs between innovative performance and environmental benefits (Luchs et al., 2012; Olson, 2013).

Conceptual Models and Hypotheses

Bloch's (1995) model specifies how a new product form, in terms of its exterior appearance and interior design elements, triggers a variety of consumers' cognitive (i.e., product beliefs, categorization) and affective (i.e., positive/negative attitudes) responses, which consequently affect their behavioral intentions and product choices. The relationships among these constructs in Bloch's (1995) model are moderated by individuals' characteristics and situational factors, reflecting potentially important variations in consumer responses to new product designs. In the past decade, empirical studies have found support for the validity and generalizability of this model across different product categories, such as wine (Celhay and Trinquecoste, 2015), mobile phones and home appliances (Creusen and Schoormans, 2005), and automobiles (Landwehr, Wentzel, and Herrmann, 2013).

Although Bloch's (1995) model offers rich insights into how consumers respond to new product design cues in general, it still remains unclear how product designers should mix key design factors and define the extent of congruity among them to achieve superior market outcomes. Moreover, as Noble and Kumar (2010) argue, both the conceptualization and operationalization of "product form" remain largely unexplored and inconsistently explained in extant literature. Together, these gaps represent the "black box" in product innovation research, casting doubt on the generalization capacity of previous models and preventing scholarship development and practical advancement in the new product design field.

This issue is becoming particularly important in the sphere of eco-innovations, in which there is often a trade-off in choosing between environmental benefits and product functionality (Luchs and Swan, 2011). The novelty of eco-innovations may also escalate the uncertainty inherent in adoption decisions as consumers must (1) deal with higher "learning costs" associated with radically new green product attributes (Mukherjee and Hoyer, 2001); (2) consider negative aspects of eco-friendly products, such as higher prices, limited availability, usage inconvenience, and lesser effectiveness than conventional counterparts (Lin and Chang, 2012; Luchs et al., 2010); and (3) exert greater effort to deconstruct existing/habitual consumption patterns and construct new habitual routines for pro-environmental behaviors associated with using new/really new products (Carrington et al., 2014).

Drawing from prior work on consumer diffusion (Gatignon and Robertson, 1985; Herzenstein, Posavac, and Brakus, 2007) and new product design (Homburg, Schwemmle, and Kuehnl, 2015; Mugge and Dahl, 2013), this is an effort to conceptualize an eco-innovative product design as one that incorporates eco-friendly elements which are purposely selected to influence consumers' psychological and behavioral responses. Our conceptual framework suggests that eco-innovative product designs can influence consumers' product beliefs (i.e., product innovativeness, product eco-friendliness, and trade-offs between eco-friendly benefits and product functionality) (Bloch, 1995). This in turn can affect consumers' categorization processes, such that they try to understand a new product by situating it within an existing category or creating a new one (Moreau et al., 2001b). Subsequently, these inferences lead to consumers' behavioral responses (either adopting or rejecting the new product).

Because eco-innovations aim to resolve environmental issues through innovative product attributes, this study proposes that the combination of the innovativeness and eco-friendliness aspects of a new product design can positively affect consumer responses in two ways. First, owing to halo effects, if consumers evaluate a new product as superior on one observable attribute (i.e., innovative performance), they will also rate it favorably on other product aspects (i.e., eco-friendly benefits), and vice versa (Luchs et al., 2010). Second, as the eco-innovation concept focuses on developing innovative product attributes with positive environmental benefits, the presence of a desired attribute (i.e., innovative performance) will not compromise the innovation's sustainability superiority (Coad and Pritchard, 2017). Thus, it is expected that eco-innovations lead to a win-win situation and allow consumers to avoid attribute trade-offs, thereby significantly and positively influencing their responses.

Consumers' reactions to eco-innovations vary significantly depending on how they deal with the incongruence between a new product and their existing knowledge (Moreau et al., 2001a). Therefore, this study suggests that individual differences in terms of intrinsic motivations to engage in effortful cognitive endeavors to resolve this incongruence significantly affect how consumers react to eco-innovations. In addition, given the complex and unique nature of different product categories, consumers may engage in different information-processing and categorization strategies in their adoption decision-making processes (Mukherjee and Hoyer, 2001).

Figure 1 presents our conceptual models, which are theoretically anchored on Bloch's (1995) model. Specifically, this article focuses on three key eco-innovative product design stimuli: the degree of innovativeness, the level of eco-friendliness, and the detachability of eco-innovative attributes. Our models propose that these three stimuli influence consumers' intentions to adopt an eco-innovation. This research also aims to broaden understanding of the mechanism and boundary conditions of the impact of these design factors on consumer responses by examining the mediating effects of perceived product eco-friendliness and perceived trade-offs, as well as the moderating roles of NFC and product complexity.

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Innovativeness Degrees of Eco-Innovative Attributes

A cost–benefit analysis indicates that consumers' judgments about new products are often based on an appraisal of potential benefits derived and related costs incurred, leading to a positive or negative net outcome (Johnson and Payne, 1985). Regarding eco-innovations, in which innovative and eco-friendly attributes converge, it is argued that consumer responses will involve value- and cost-related inferences of both product innovativeness and eco-friendliness. In the case of value-related inferences, according to Rogers's (2003) diffusion of innovation theory, consumers are more likely to adopt an innovation that offers superior characteristics (e.g., greater efficiency, greater convenience) to current alternatives. Thus, novel attributes, even when they are sometimes irrelevant and ambiguous, enable faster and more widespread adoption of the new product in the market (Carpenter, Glazer, and Nakamoto, 1994). By the same token, it is expected that consumers will consider novel eco-friendly attributes a cue to make inferences about the additional values provided by the manufacturer.

Regarding cost-related inferences, although the uncertain and risky nature of new/really new products increases consumers' learning cost inferences, innovations trigger curiosity, desirability, and feasibility (Alexander, Lynch, and Wang, 2008) and potentially fulfill consumers' unmet needs in a better way than existing alternatives (Herzenstein et al., 2007). Similarly, Arts, Frambach, and Bijmolt's (2011) meta-analysis of 92 innovation adoption articles shows that novel benefits of a new product exert the most influence on consumers' adoption decisions, especially in the early stages of the diffusion process. Because consumers tend to associate values/benefits with specific novel attributes, eco-innovative attributes could augment customer value, enhance related product beliefs (i.e., perceived product eco-friendliness), and ultimately lead to favorable behavioral outcomes (i.e., adoption intentions) (Hartmann and Apaolaza-Ibáñez, 2012; Majid and Russell, 2015; Mukherjee and Hoyer, 2001). Thus, the more innovative eco-friendly attributes are, the easier it is to reach consumers and accelerate new product adoption (Li, Zhang, and Wang, 2015). This leads to the following hypothesis:

H1: *Compared with standard or incremental eco-innovative attributes, radical eco-innovative attributes increase consumers' (a) perceptions of product eco-friendliness and (b) intentions to adopt eco-innovative products.*

This study goes beyond the direct impact of attribute innovativeness on consumer responses by investigating the moderating role of NFC. Drawing on categorization theory for really new products, Mugge and Dahl (2013) posit that the more innovative a new product is, the more cognitive efforts consumers make to transfer knowledge from their (multiple) existing schemas to formulate a new representative category of the product. Individual differences in terms of intrinsic motivation to engage in effortful cognitive endeavors significantly affect innovative behaviors across different contexts (Wood and Swait, 2002; Wu, Parker, and De Jong, 2014). This research proposes that NFC mitigates the effects of attribute innovativeness on consumer responses on four major grounds. First, high-NFC individuals tend to be involved in and enjoy novel, complex, and uncertain situations, which can trigger their curiosity and logic to generate more task-relevant thoughts (Cacioppo et al., 1996). Using the elaboration likelihood model, Petty and Wegener (1998) posit that NFC is a key driver of consumer involvement, such that high-NFC consumers will scrutinize intrinsic product attributes for rational product evaluations (Zhang and Buda, 1999). It is therefore reasonable to expect that the positive influence of radical attributes on product evaluation and adoption intentions is stronger among high-NFC individuals because of their greater involvement in complex and incongruent information processing (Gatignon and Robertson, 1985). Conversely, as social judgment theory predicts, low NFC in cognitive information processing could result in a higher likelihood of new products (e.g., products with radically new eco-friendly attributes) being rejected, because these types of individuals perceive such products as complex, uncertain, and thus beyond their level of acceptance (Sherif and Hovland, 1961). Second, in the pursuit of comprehension, high-NFC individuals are more capable of connecting new and existing schemas to obtain new knowledge and solve complex problems, thus facilitating the categorization and adoption decision-making process (Nair and Ramnarayan, 2000). Third, high-NFC individuals are more cognizant of key attributes and credence qualities of new products. Therefore, they are more likely to emphasize innovativeness degrees of new eco-friendly attributes when forming their product beliefs and making adoption decisions than their low-NFC counterparts (Hansen, Samuelsen, and Sallis, 2013). Fourth, as high-NFC individuals exhibit greater receptivity to new ideas and a higher preference for varied sensations than low-NFC individuals, they are more likely to promote and favor really new products (Cacioppo et al., 1996). Thus:

H2: The effects of NFC on consumers' (a) perceptions of product eco-friendliness and (b) adoption intentions are strong and positive for radical eco-innovations, strong and negative for standard products, and weak for incremental innovations.

Eco-Friendliness Levels of Eco-Innovative Attribute Types

The success of an eco-innovative product design largely relies on how well consumers understand and categorize various ecological benefits derived from its product attributes (Luchs et al., 2012). Eco-innovative attributes refer to new/really new technologies, physical features, and associated symbolic values that offer environmental benefits, such as recycling, carbon emission reduction, energy saving, and renewable energy use. Varadarajan (2015) identifies three major types of eco-innovative attributes: (1) *resource use reduction/efficiency innovations*, which improve the productivity and efficiency of resource inputs (e.g., fuel, water, electricity) used in the consumption process; (2) *resource use elimination innovations*, which eliminate the use of a resource as an input without significantly affecting product functionality and performance (e.g., excluding ecologically harmful ingredients or various complementary items); and (3) *resource use substitution innovations*, which substitute nonrenewable resources with renewable resources, more harmful nonrenewable resources with less harmful nonrenewable resources, less abundant nonrenewable resources with more abundant nonrenewable resources, or a below-ground-mined raw material with an above-ground-mined raw material.

Our argument is that different types of eco-innovations distinct in innovative ecological benefits (i.e., eco-friendliness levels) might trigger different consumer product evaluations and adoption intentions. This study uses categorization theory to conceptualize the effects of eco-friendliness levels on consumer responses. In general, this theory posits that individuals tend to name and group objects as categories according to their richness (i.e., number of attributes) and distinctiveness (i.e., differentiating attributes) (Sujan and Dekleva, 1987). Over time, consumers develop representations of each category and respective expectations (Rosch et al., 1976). When considering a new/really new product, consumers cope with the challenges of using cues from multiple existing categories to formulate their expectations of and preferences for the product (Moreau et al., 2001a). Thus, consumers are more likely to rely on the first plausible category label provided by marketers for their categorization process and to transfer knowledge from existing categories to maximize the perceived similarity of the new product to existing product categories in memory (Moreau et al., 2001b).

This study focuses on the distinctiveness aspect of the categorization approach and concept formation in the context of eco-innovations, in which new products have both innovative performance and ecological benefits. It is argued that consumers will use eco-friendliness levels of eco-innovation attribute types as the first plausible category cue to facilitate their categorization processes of eco-innovations. Specifically, the distinctiveness (in eco-friendliness) of different eco-innovative attribute types should elicit different categorization-based knowledge transfer processes, significantly influencing consumers' adoption intentions (Moreau et al., 2001a; Moreau et al., 2001b). Thus:

H3: The more consumers perceive a new attribute as eco-friendly, the higher their intentions to adopt an eco-innovative product will be.

Research (e.g., Mugge and Dahl, 2013; Swait, Popa, and Wang, 2016) has repeatedly investigated product complexity, or the extent to which consumers believe that products are difficult to understand and/or use effectively, as a conditioning factor of the association between new product attributes and consumer responses. Consumers tend to have lower product evaluations and adoption intentions in the case of highly complex innovations (e.g., digital cameras), while the opposite is true for less complex products (e.g., washing machines) (Mukherjee and Hoyer, 2001). Drawing on Shugan's (1980) cost-of-thinking theory, this study suggests that product complexity can also serve as a boundary condition for the impact of eco-friendliness levels of new attributes on consumers' product evaluations and adoption intentions. This theory maintains that cognitive efforts necessary for decision making are directly associated with the perceptual complexity of one particular product category (Shugan, 1980). The difficulty in understanding, comparing, and using highly complex products increases consumers' perceptions of risk, uncertainty, and negative outcomes associated with these products (Holak and Lehmann, 1990).

To reduce the uncertainty of possible outcomes resulting from the purchase of high-complexity innovations, consumers need to engage in in-depth information collection and costly comparisons across salient attributes (Shugan, 1980). The higher the product complexity, the more information, time, and skills consumers require to categorize new products (Burnham, Frels, and Mahajan, 2003). As product complexity increases, consumers are more likely to focus on the categorization process to compare the alternatives effectively. In other words, when evaluating different eco-innovation types to make adoption decisions, consumers tend to rely more on salient and relevant aspects of new products (e.g., attribute eco-friendliness) for comparison purposes in high-complexity products than in low-complexity products. Thus:

H4: The effect of eco-friendliness levels of a new attribute on consumer's adoption intentions is stronger for high-complexity products than for low-complexity products.

Detachability of Eco-Innovative Attributes: Core versus Peripheral

Pertinent literature has repeatedly recognized innovation locus as an important parameter in new product designs. Managers need to decide whether to develop new features either as an integral part (a core locus) or as a detachable accessory (a peripheral locus) (Gatignon et al., 2002; Kim, Kumar, and Kumar, 2012). Similarly, in new product eco-designs, managers need to decide whether eco-innovative attributes will be either situated on the periphery of the product or built into the core of its innovation system. For example, consider new electric battery technology in the automobile industry. While Nissan built this new eco-friendly functionality into the "core" of its new cars (e.g., Nissan Leaf), Toyota offered the same eco-innovative feature peripherally as a plug-in hybrid electric vehicle (e.g., Toyota Prius). The detachability of eco-innovative attributes in new product designs can significantly influence consumers' responses, such that positioning eco-innovative attributes in a peripheral locus offers a certain advantage over integrating them into the core (Ma, Gill, and Jiang, 2015).

According to Ma et al. (2015), (1) the detachability of really new features results in higher schema congruity with the base product category knowledge structure, as these features are not likely to affect the core product functionality; (2) really new features are often associated with higher performance risks, and therefore placing them in a peripheral (vs. core) locus can reduce consumers' perceptions of risks; (3) from an incongruity resolution perspective, it is easier for consumers to understand and accept really new products when they are offered as peripheral components; and (4) the detachability of really new features allows for greater perceived usage flexibility and greater control for consumers. Similarly, it is expected that attribute detachability has a positive effect on shaping favorable consumer responses to eco-innovative products. As in efficient markets, consumers may follow a "compensatory inference strategy" to draw inferences about the trade-offs among product attributes in eco-innovative product designs (Chernev and Carpenter, 2001). Specifically, when trade-offs are readily apparent, consumers are less likely to prefer eco-friendly alternatives (Olson, 2013). Because detachable accessories do not significantly influence the functioning of the base product, trade-offs between eco-friendly benefits and product functionality become less apparent, leading to a greater likelihood for innovation adoption (Luchs et al., 2012; Ma et al., 2015). Thus:

H5: The detachability of eco-innovative attributes (a) reduces consumers' perceptions of trade-offs between eco-friendly benefits and product functionality and (b) enhances their adoption intentions.

Overview of Studies

To test the hypothesized relationships in our conceptual models, three empirical studies using a scenario-based experimental approach were conducted. Study 1 examines the mechanism that underlies the effects of innovativeness degrees of eco-innovative attributes on consumer responses and focuses on the moderating role of consumers' NFC. Study 2 investigates whether and how eco-friendliness levels of different eco-innovative attribute types affect consumer adoption intentions and examines the moderating role of product category complexity. Study 3 focuses on how the detachability of eco-innovative attributes (i.e., the importance of an attribute for the functioning of the new product) influences consumer responses. The research design, the stimuli used, the statistical analysis conducted, and the findings are presented for each study below.

Product Category Selection

All three studies focus on high-tech products, particularly those of a "smart"/connected nature. These products are designed as "dynamic service platforms," thus forcing manufacturers to differentiate them not only on price but also by taking into consideration convenience, flexibility, and heterogeneity in the consumption process (Ng et al., 2015). Guided by informal interviews with consumers, four durable product categories: automobiles, vacuum cleaners, smartphones, and televisions (TVs) were selected for our experiments. These product categories were chosen because (1) manufacturers in these categories are increasingly adding eco-innovative attributes to their new product introductions (e.g., Hyundai Ioniq Electric's 100% electric engine, Samsung Powerbot R7070's visionary mapping plus, Samsung S6's ultra-power-saving mode, and Samsung QLED TV's cadmium-free design); (2) purchasing products from these categories requires high levels of involvement and rational decision criteria, typically involving cognitive information processing with a focus on product functionality (Ratchford, 1987); and (3) rapid technological changes in these categories are responsible for their highly innovative product designs and shorter product life cycles (Mahadevan, 2015). To test consumer familiarity with these product categories, a pretest was conducted among 72 participants, split equally between men and women (M_{age} = 41.42 years, SD = 13.76), asking them to rate product category familiarity (1 = "not familiar at all," 7 = "very familiar"). The results reveal that participants were familiar with all four product categories ($M_{familiarity} \geq 5.47$), while differences in familiarity levels among these product categories were not statistically significant (ps > .05).

Product Complexity and Relative Price

Another pretest (n = 74; 52.7% male; M_{age} = 40.96 years, SD = 10.70) was conducted to investigate whether participants perceived these four product categories as differing in their relative prices and complexity levels. As expected, the majority (i.e., 73%) of the participants rated these categories as relatively high-priced products. Thus, by focusing on these product categories, the possibility of any effects of product category price (confounded by the importance/price that consumers assign to eco-innovative attributes) is minimized (Park, Jun, and MacInnis, 2000). Next, participants were asked to evaluate these product categories on Mukherjee and Hoyer's (2001) two-item scale (i.e., difficulty to learn/use and level of complexity) ($\alpha > .70$). The results reveal that these categories were statistically significantly different in perceived product complexity. Specifically, participants perceived cars ($M = 4.78$) and smartphones ($M = 4.72$) as more complex and difficult to learn to use effectively than TVs ($M = 4.08$) and vacuum cleaners ($M = 2.99$) (ps < .01). To conserve participants' energy, three combinations of distinct product categories: cars/vacuum cleaners (Study 1), smartphones/TVs (Study 2), and cars/TVs (Study 3) were used. In all studies, the manipulations included fictitious company and brand names associated with the same general slogan (i.e., "an innovation for life") to control for the potential effects of company/brand names.

Study 1: Innovativeness Degrees of Eco-innovative Attributes

Study 1 explores the effects of innovativeness degrees of eco-innovative attributes on consumers' perceptions of product eco-friendliness and their subsequent adoption intentions (H1a and H1b). Study 1 also investigates the role of consumers' NFC as a boundary condition in the relationships between attribute innovativeness and consumer responses (i.e., perceived product eco-friendliness and adoption intentions) (H2a and H2b).

Stimuli

Pretest: Mutability of product attributes. This study adopted the concept of "mutability" Love and Sloman (1995) to manipulate innovativeness degrees of new eco-friendly attributes. As Love and Sloman (1995) suggest, changes in an immutable feature lead to significant shifts in consumers' perceptions of an innovation's discontinuity. This, in turn, drives consumers to transfer knowledge from multiple existing product category schemas to the new product to facilitate categorization and form their preferences and expectations (Moreau et al., 2001b). To obtain mutability ratings for common features in the car and vacuum cleaner categories, a pretest was conducted, following the three-phase methodology with an online series of brainstorming sessions with U.S. participants recruited via Amazon Mechanical Turk (MTurk) online national panels (see Appendix B) (Love and Sloman, 1995; Moreau et al., 2001a). The results reveal that engine and suction power were the most immutable features for cars and vacuum cleaners, respectively. The manipulations included the textual descriptions of a radical (incremental) eco-innovation based on significant (minor) changes in the immutable features, with all changes being environmentally beneficial for each product category (see Appendix C). To control for participants' assumptions about product eco-friendliness, the same environmental benefit (i.e., "36% energy saving consumption") was used in all stimuli. The real product image and two other functional attributes were identically provided across all conditions in each product category.

Method

Participants and study design. Three hundred and two participants (48.3% male; M_{age} = 40.36 years, *SD* = 13.32) were recruited from MTurk to take part in a 12-minute study in exchange for a small cash incentive ($.50–$1.00). The majority (71%) of the participants had an annual household income of more than $40,000 and a minimum of a bachelor's degree. Participants were randomly assigned to a 3 (attribute innovativeness: standard product vs. incremental eco-innovation vs. radical eco-innovation) × 2 (product category: cars vs. vacuum cleaners) mixed design. This study measured attribute innovativeness as a between-subject factor and product category as a within-subject factor for replication purposes. To exclude the possibility of any sequencing effects, the order of product categories (order: vacuum cleaner first vs. car first) was counterbalanced.

Procedure. All participants read short descriptions of a new product that was going to be launched in the vacuum cleaner (car) product category in the local market. In all cases, participants were told that they were looking at the website of an online store dedicated to vacuum cleaners (cars) because they were considering purchasing a new vacuum cleaner (car). Then, all participants were randomly assigned to one condition and were given an advertisement with the same picture of a vacuum cleaner (car), along with respective product descriptions, and were asked to think about this new product for 45 seconds. Then, participants responded to the same measures of dependent variables for each product category (presented one after the other) and provided their demographic information.

Dependent variables and manipulation checks. Unless otherwise noted, all items were evaluated on a seven-point scale, with higher scores indicating endorsement. This study measured product eco-friendliness using a three-item scale (Gershoff and Frels, 2014) and adoption intentions with three semantic differential items adopted from Hassan, Shiu, and Shaw (2014). Participants' NFC was assessed with a six-item scale adopted from Epstein et al., (1996). The attribute innovativeness manipulation was checked by having participants evaluate attribute innovativeness degrees, using a three-item scale derived from Moreau et al., (2001a).

Control variables. In line with prior work (e.g., Brough et al., 2016; Gleim et al., 2013; Haws et al., 2014) on sustainable consumption and innovation adoption, this study also controlled for several variables that may influence consumer decisions to adopt an eco-innovation. Specifically, control variables included consumers' demographic profile (i.e., age, gender, education, income), green values (Haws et al., 2014), eco-friendly product knowledge (Lin and Chang, 2012; Mohr, Eroğlu, and Ellen, 1998), risk-taking behaviors (Duclos, Wan, and Jiang, 2012), financial cost inferences (Mukherjee and Hoyer, 2001), and subjective product knowledge (MacKenzie, Lutz, and Belch, 1986). Moreover, it is argued that people living in greener "neighborhoods" are more sensitive to environmental issues, due to the eco-friendly policies (e.g., recycling, reducing energy consumption, using renewable energy) enforced by state authorities (Kiernan, 2018). Therefore, this study incorporated the greenness levels of "neighborhoods" (measured at the state level) as a covariate by asking participants to provide zip codes of their current addresses. The total greenness score of each state, obtained from the 2018 WalletHub report (Kiernan, 2018), referred to the state's environmental quality, eco-friendly behaviors, and climate-change contributions. Finally, a single item on a 10-point scale was used to assess scenario/new product advertisement realism. Perceived realism of the stimuli was consistently high across all conditions (*M*s ≥ 7.05) (for the full list of measurement scales, see Appendix D).

Results

Manipulation check. To test whether our manipulation of innovativeness degrees of eco-innovative attributes was successful, a 3 × 2 × 2 mixed analysis of variance (ANOVA) was performed with perceived product innovativeness as the dependent variable and manipulated attribute innovativeness, product category, and presentation order as the independent variables. A significant main effect for innovativeness degrees of eco-innovative attributes was found ($F(2, 296) = 58.34$, $p < .001$, $\eta^2 = .28$). As predicted, across the two product categories, participants rated radical eco-innovations as significantly more innovative than either incremental eco-innovations or standard products (see Table 1). There were no significant two-way and three-way interactions among product category, attribute innovativeness, and presentation order (*p*s > .13) (see Appendix E).

…insert Table 1 about here…

To test H1a and H1b, two 3 × 2 × 2 mixed analyses of covariance (ANCOVAs) were performed with perceived product eco-friendliness and adoption intentions as the dependent variables and attribute innovativeness, product category, and presentation order as the independent variables. These analyses also included demographic (i.e., consumer age, gender, education, income), psychographic (i.e., green values, eco-friendly product knowledge, risk-taking behaviors, financial cost inferences, and subjective product knowledge), and contextual (i.e., "neighborhood" greenness scores) covariates to control for extraneous effects.

Across the product categories, the ANCOVAs revealed that innovativeness degrees of eco-innovative attributes had statistically significant effects on perceived product eco-friendliness ($F(2, 284) = 83.99$, $p < .001$, $\eta^2 = .37$) and adoption intentions ($F(2, 284) = 9.66$, $p < .001$, $\eta^2 = .06$). In addition, the patterns of means for the two product categories separately confirmed our results, in support of H1a and H1b. Specifically, for both product categories, participants reported that they were more likely to adopt radical eco-innovations than incremental eco-innovations and standard products. These results confirm that innovativeness degrees of eco-innovative attributes override their eco-friendliness aspect to influence consumer responses to eco-innovations. Counterbalancing the order produced no significant main effects or interactions (*p*s > .14) (see Appendix E). The results indicate that participants' age, income, green values, risk-taking behaviors, financial cost inferences, and "neighborhood" greenness scores were significant covariates (*p*s < .05).

To check the robustness of the results, multiple regressions were performed to test the main effects of innovativeness degrees of eco-innovative attributes on consumer responses for each product category separately for replication purposes. Dummy variables, indicating the respective innovativeness degree (i.e., standard product [reference category], incremental eco-innovation, and radical eco-innovation), were created. In further support of H1a and H1b, the positive effects of the innovativeness dummies on consumer responses were found.

Mediation analysis. A bootstrapping analysis was conducted for the single-mediator model (Process Model 4; Hayes, 2013) for each product category. The results show the full mediating effect of perceived product eco-friendliness on the link between attribute innovativeness and adoption intentions across the two product categories (see Appendix E).

Moderating role of NFC. To test H2a and H2b, two 3 × 2 × 2 mixed ANCOVAs were conducted on consumers' perceptions of eco-friendliness and adoption intentions, with product category as a within-subject variable and attribute innovativeness and NFC[i] as between-subject variables. These analyses included consumer age, gender, education, income, green values, eco-friendly product knowledge, risk-taking behaviors, financial cost inferences, subjective product knowledge, and “neighborhood” greenness scores as covariates. Consumers’ age, gender, education, income, green values, financial cost inferences, and subjective product knowledge exhibited significant effects (*p*s < .05), and these variables were included for further analysis.

The results reveal significant two-way interaction effects of attribute innovativeness and NFC on perceived product eco-friendliness ($F(2, 287) = 3.85$, $p < .05$, $\eta^2 = .03$) and adoption intentions ($F(2, 287) = 3.24$, $p < .05$, $\eta^2 = .02$), in support of H2a and H2b, respectively. These effects did not vary significantly between the two product categories, as the three-way interaction effects were not statistically significant (*p*s > .68). Across the two product categories, low-NFC participants responded more positively to the standard products and incremental eco-innovations, while high-NFC participants responded more positively to the radical eco-innovations in terms of product eco-friendliness and adoption intentions (see Figure 2). A series of pairwise comparisons of the means of dependent variables was also conducted across three innovativeness conditions and two levels of NFC. In addition, a moderation analysis using Hayes’s (2013) PROCESS macro (Model 1) and spotlight analyses (see Appendix F) were carried out. The results provide further support for H2a and H2b, which posit that NFC has a significant moderating effect on the relationships between innovativeness degrees of eco-innovative attributes and consumer responses to eco-innovations.

…insert Figure 2 about here…

Study 2: Eco-Friendliness of Eco-Innovative Attribute Types

In Study 1, participants responded more positively to radical eco-innovations than to incremental eco-innovations and standard products. However, the product descriptions of

Study 1 used the same eco-friendly benefit across the conditions. Study 2 attempts to shed light on *whether* and *how* eco-friendliness levels of different eco-innovative attribute types affect consumer adoption intentions (H3). This study also examines the role of product complexity as a conditioning factor in the impact of eco-friendliness levels on consumers' intentions to adopt an eco-innovation (H4).

Stimuli

Pretest 1: Categorization of eco-innovative attributes. During the brainstorming session in Study 1, in addition to cars and vacuum cleaners, the mutability of common features of smartphones and TVs was investigated. The results indicate that phone battery and screen characteristics were the most immutable features for smartphones and TVs, respectively (see Appendix B), which provide the focus of Study 2. One hundred and fifty-seven people from an online Facebook group called "Eco-friendly products" (51.7% male; M_{age} = 41.87 years, SD = 13.74) were asked to participate voluntarily in the pretest. Participants had sufficient knowledge of eco-friendly products (M = 4.69, SD = 1.13), as measured on a seven-point scale (α = .93). Participants received definitions of different eco-innovation types and were asked to classify a list of the latest eco-innovative versions of smartphone batteries and TV screens into three categories: (1) *resource use reduction features* (reducing energy consumption), (2) *resource use elimination features* (eliminating harmful ingredients), and (3) *resource use substitution features* (using renewable energy), with an optional answer "none of the groups above." To avoid possible confusion about the types of eco-innovative features perceived by consumers, the product descriptions used the words "reduce," "eliminate," and "substitute" in the three categories, respectively.

The product features which more than half the participants classified as typical for each of the three categories were selected. For smartphones, these features were as follows: (1) resource use reduction features: "fast wireless battery charging" (88.2%) and "ultrabattery-power-saving mode" (78.8%); (2) resource use elimination features: "minimized GHG emissions and ultra-low radiation battery" (78.8%) and "a new battery made of 90% radically new materials–free of toxic and hazardous chemicals" (80.0%); and (3) resource use substitution features: "solar-powered battery" (78.8%) and "energy independent battery-nano generators" (55.9%). For TVs, the most frequent features were the following: (1) resource use reduction features: "screen energy-saving switch" (95.8%) and "automatic screen brightness control" (86.1%); (2) resource use elimination features: "LED screen–free of mercury, a toxic metal" (79.2%) and "screen screwless design for easier recycling" (73.6%); and (3) resource use substitution features: "solar-powered screen" (83.3%) and "new solar battery attached screen" (79.2%).

Pretest 2: Eco-friendliness levels of eco-innovative attribute types. In the second pretest, a different pool of French individuals in shopping malls in Lille, France (n = 36; 44.4% male; M_{age} = 36.33 years, SD = 10.26) were asked to evaluate eco-friendliness, attractiveness, and functionality of the selected features from Pretest 1, using the direct rating method suggested by Bottomley, Doyle, and Green (2000). For each feature, participants rated from 1 to 100 how eco-friendly, attractive, and functional it is in the whole product operation. The higher the score, the more prevalent the dimension was in the feature. The items in the list of eco-innovative attributes were presented in a random order and counterbalanced the version of eco-innovative attributes for each product category. Repeated ANOVAs were conducted with three types of eco-innovative attributes as the independent variables and attribute eco-friendliness, attractiveness, and functionality as the dependent variables. To rule out the possibility of confounding effects, three eco-innovative attributes were selected, each representing three types of eco-innovations. These attributes were significantly different in perceived eco-friendliness but maintained the same level of attractiveness and functionality (see Appendix G).

For smartphones, the results show a statistically significant difference among the three types of eco-innovative attributes (i.e., fast wireless battery charging, minimized GHG emissions/ultra-low radiation battery, and solar-powered battery) in terms of their eco-friendliness ($F = 8.97$, $p < .001$) but no statistically significant difference in attractiveness and functionality (*p*s > .10). Follow-up pairwise comparisons (using Bonferroni adjustment) revealed that the solar-powered battery ($M = 78.92$) had the highest eco-friendliness score, followed by minimized GHG emissions/ultra-low radiation battery ($M = 64.58$) and fast wireless battery charging ($M = 52.81$; *p*s < .05). For TVs, the results show a statistically significant difference among the three eco-innovative attribute types (i.e., automatic screen brightness control, screen screwless design for easier recycling, and solar-powered screen) in terms of their eco-friendliness ($F = 14.13$, $p < .001$) but no significant difference in attractiveness and functionality (*p*s > .10). Pairwise comparisons using the Bonferroni test indicated that participants perceived the solar-powered screen ($M = 76.47$) as more eco-friendly than screen screwless design for easier recycling ($M = 63.00$) and automatic screen brightness control ($M = 44.36$) (*p*s < .05). Three manipulations were created based on the pretests in each product category (see Appendix C).

Method

Participants and study design. Three hundred and fourteen participants (47.0% male; M_{age} = 41.56 years, $SD = 12.42$) were recruited from MTurk to complete a 15-minute study in exchange for a small cash incentive ($.50–$1.00). Almost three-quarters (70%) of the participants had an annual household income of more than $40,000 and a minimum of a bachelor’s degree. This study used a 3 (eco-friendliness levels of eco-innovative attribute types: *low* [resource use efficiency innovation] vs. *medium* [resource use elimination innovations] vs. *high* [resource use substitution innovations]) × 2 (product complexity: *high* [smartphones] vs. *low* [TVs]) mixed design. Eco-friendliness was a between-subject factor, and product complexity was a within-subject factor. The order of product categories (order: smartphone first vs. TV first) was counterbalanced.

Procedure. All participants read short descriptions of an eco-innovative product that was about to be launched in the smartphone (TV set) product category in the local market. In all cases, participants were told that they were looking at products from an online store dedicated to smartphones (TVs) because they were considering purchasing a new smartphone (a new smart TV). All participants were randomly assigned to one condition and were given an advertisement with the same picture of a smartphone (a smart TV). They had 45 seconds to read the respective product descriptions and "think about this new product." Finally, participants responded to the same measures of dependent variables for each product category (presented one after the other) and provided demographic information.

Dependent variables, control variables, and manipulation checks. This study employed the same measures for perceived product innovativeness and adoption intentions as in Study 1 and the pretests. In line with prior work on sustainable consumption (e.g., Brough et al., 2016; Gleim et al., 2013; Haws et al., 2014), this study included the following control variables: consumers' demographic profile (i.e., age, gender, education, income), green values, eco-friendly product knowledge, risk-taking behaviors, and financial cost inferences. A multiple-choice question (i.e., "It seems that the description focuses on the company's effort in …") referring to the three alternative eco-innovation types, with "none of the groups above" as a fourth option was used for a manipulation check. Perceived product complexity was confirmed by analyzing participants' responses on a two-item scale (Mukherjee and Hoyer, 2001), as in the pretest. Perceived realism of the stimuli was consistently high across all conditions (*M*s $\geq$ 7.17) (for the full list of measurement scales, see Appendix D).

Results

Manipulation check. Participants' answers to the multiple-choice question about the types of eco-innovative attributes, reflecting their categorization of three new product descriptions in each product category, were used for manipulation check. The further analysis included only participants who had the same answer as the manipulated eco-innovative attribute type to which they were assigned in the final sample. After the manipulation check, twenty-three responses that had wrong answers were eliminated, leaving 291 valid responses for further analysis.[ii] A 3 (eco-friendliness levels of eco-innovative: low vs. medium vs. high) × 2 (product complexity: high vs. low) × 2 (order: smartphone first vs. TV first) mixed ANOVA was conducted. Regarding eco-friendliness levels of the three eco-innovative attribute types, the results show that participants perceived the resource use substitution features as more eco-friendly ($F(2, 285) = 23.50$, $p < .001$, $\eta^2 = .14$) and innovative ($F(2, 285) = 22.84$, $p < .001$, $\eta^2 = .14$) than resource use elimination innovations or resource use reduction innovations (see Table 2).[iii] Counterbalancing the order produced no significant main effects or interactions (*p*s > .15). The product complexity manipulation was successful, as there was a statistically significant difference between low-complexity products (TVs: $M = 2.67$) and high-complexity products (smartphones: $M = 3.07$; $F(1, 290) = 49.46$, $p < .001$).

To test H3, a 3 × 2 × 2 mixed ANCOVA was performed, modeling consumer adoption intentions as a function of the eco-friendliness condition, product complexity, and presentation order. Age, gender, education, income, green values, eco-friendly product knowledge, risk-taking behaviors, and financial cost inferences were covariates. In support of H3, for both product categories, participants reported higher adoption intentions ($F(2, 276) = 3.84$, $p < .02$, $\eta^2 = .03$) for resource use substitution features with the highest eco-friendliness scores than for resource use elimination innovations or resource use reduction innovations. Consistent with H4, the interaction effect of product complexity and eco-friendliness levels of eco-innovative attribute types on adoption intentions was statistically significant ($F(2, 276) = 4.45$, $p < .015$, $\eta^2 = .03$). As Table 2 shows, participants' adoption intentions were significantly different across the three eco-innovation types in the high-complexity product category (i.e., smartphones). However, for the low-complexity product category (i.e., TVs), eco-friendliness levels had no significant effect on adoption intentions. Education, green values, and financial cost inferences were significant covariates (*p*s < .05). Counterbalancing the order produced no significant main effects or interactions (*p*s > .15) (see Appendix G). In addition, the results were confirmed by performing multiple regression analyses on consumer responses, with the use of dummy variables indicating the respective eco-friendliness level (i.e., *medium*: resource use elimination innovation [reference category]; *low*: resource use efficiency innovation; and *high*: resource use substitution innovation) for each product category separately (see Appendix G).

…insert Table 2 about here…

Mediation analysis. As in Study 1, a bootstrapping analysis was performed to test the single-mediator model (Process Model 4; Hayes, 2013) for each product category. The results showed that there was full mediation for the relationships of eco-friendliness levels in the high-complexity product, while there was partial mediation in the case of the low-complexity product (see Appendix G).

Study 3: Detachability of Eco-Innovative Attributes: Core versus Peripheral

The results of Studies 1 and 2 suggest that radically new and resource use substitution attributes with the highest eco-friendliness scores are more likely to trigger positive consumer responses than other alternatives. Study 3 aims to demonstrate whether the development of these eco-innovative features (i.e., radically new attributes enabling renewable resource usage) as a core or peripheral component affects consumers' perceptions of trade-offs between eco-friendly benefits and product functionality (H5a), as well as their adoption intentions (H5b).

Stimuli

Innovative automobiles and smart TVs were used as the base eco-innovative product categories to show that the advantages of the peripheral locus of a resource use substitution feature (i.e., a solar battery) in new product designs are contingent on its detachability from the base product. These two product categories were selected for their high penetration levels in the U.S. market and relevance to U.S. consumers. These product categories are consumed in different contexts and vary significantly in terms of complexity. Solar battery storage was chosen as a stimulus because of its recent introduction as a complementary solar energy system in many innovative cars and TV models in the U.S. market (Solar Energy USA, 2017). In addition, consumers in developed markets (e.g., Australia, the United States) are increasingly using batteries to store solar power for later use, instead of exporting excess energy obtained from the rooftop solar system to the grid, which creates a totally new market for solar battery storage (Nogrady, 2017). Using the idea of solar batteries, product descriptions for each condition were developed (see Appendix C).

Pretest: Detachability of product attributes. A separate pretest was conducted with 93 U.S. participants recruited from MTurk (61.8% male; M_{age} = 40.07 years, SD = 13.30) to check the validity of our attribute detachability manipulation. Perceived attribute detachability was measured by using a one-item scale, developed in accordance with Ma et al.'s (2015) definition (i.e., "The solar battery could be physically separated from the car/TV without affecting its functioning"). This study used a 3 (detachability: core-nonoptional vs. core-optional vs. peripheral) × 2 (product category: cars vs. TVs) mixed design. Perceived attribute detachability was a between-subject factor and product category was a within-subject factor for replication purposes and the order of product categories was counterbalanced.

A 3 (detachability: core-nonoptional vs. core-optional vs. peripheral) × 2 (product category: cars vs. TVs) × 2 (order: car first vs. TV first) mixed ANOVA was performed on perceived attribute detachability. The results show that the manipulations were successful ($F(2, 87) = 30.12$, $p < .001$, $\eta^2 = .41$). Across the two product categories, participants perceived eco-innovations as more detachable in the peripheral condition ($M = 6.03$) than in the core-optional ($M = 4.09$) or core-nonoptional ($M = 2.88$) conditions. Counterbalancing the order produced no significant main effects or interactions (ps > .36) (see Appendix I). Moreover, a one-way ANOVA on attribute detachability conducted for each product category confirms the success of the manipulation (all differences were statistically significant at $p < .05$). Furthermore, there are no statistically significant differences in perceived product innovativeness and product eco-friendliness or in financial cost inferences of the eco-innovative attribute across conditions (ps > .05) (see Appendix I).

Method

Participants and design. Two hundred and ninety-two participants (49.7% male; M_{age} = 40.14 years, $SD = 12.70$) were recruited from MTurk to complete a 12-minute study in exchange for a small cash incentive ($.50 –$1.00). More than two-thirds (i.e., 68%) of the participants had an annual household income of more than $40,000 and a minimum of a bachelor's degree. Participants were randomly assigned to a 3 (detachability: core-nonoptional vs. core-optional vs. peripheral) × 2 (product category: cars vs. TVs) mixed design. Attribute detachability was a between-subject factor and product category was a within-subject factor for replication purposes. The order of product categories (order: car first vs. TV first) was counterbalanced.

Procedure. At the beginning of the survey, all participants learned about the fictitious innovative car (smart TV) brand. They were told that the innovative car (smart TV) model had recently been introduced in the local market with a new eco-friendly attribute (i.e., new solar battery technology) that is an alternative power mode for cars (smart TVs). In all conditions, participants were told that they were looking at the innovative car (smart TV) description that appeared on the automobile (TV) manufacturer's website because they were considering purchasing a new car (smart TV). Subsequently, participants were randomly assigned to one of the conditions and showed them an advertisement with the same picture of a car (smart TV) and respective product descriptions. Participants had 45 seconds to read the advertisement and think about the new product. Finally, participants responded to the same measures of dependent variables for each product category (presented one after the other) and provided demographic information.

Dependent variables and manipulation checks. Consumers' perceptions of trade-offs between eco-friendly benefits and product functionality were measured using a bipolar scale (i.e., "To what extent do you think the solar battery mentioned in the advertisement negatively affects product functionality?", +3 = "very high trade-offs," –3 = "no trade-offs at all"). This study employed the same instruments as in the previous studies to measure perceived product innovativeness, perceived eco-friendliness, and adoption intentions. To enforce and check the manipulation of detachability, participants were asked to respond to a one-item scale (i.e., "The solar battery could be physically separated from the car/TV without affecting its functioning").

Control variables. In line with the innovation and sustainable consumption literature (e.g., Brough et al., 2016; Haws et al., 2014; Ma et al., 2015), this study included consumers' demographic profile (i.e., age, gender, education, income), green values, eco-friendly product knowledge, risk-taking behaviors, financial cost inferences, and subjective product knowledge as covariates. Because consumers usually face difficulties in categorizing new products with core-optional or peripheral attributes (e.g., a hybrid car), it is argued that this could also affect their adoption intentions for these products. For this reason, this study included perceived difficulty in categorizing an eco-innovation with a one-item scale (i.e., “How difficult is it to categorize this product into the existing car [TV] category that you have known?”) as a covariate. Moreover, attribute importance in consumers’ adoption decisions was assessed by using Gershoff and Frels’s (2014) three-item scale for controlling for possible confounding effects. Perceived realism of the stimuli was consistently high across all the conditions (*M*s ≥ 7.21) (for the full list of measurement scales used, see Appendix D).

Results

Manipulation check. A 3 × 2 × 2 mixed ANOVA was performed with perceived attribute detachability as a dependent factor and manipulated attribute detachability condition, product category, and presentation order as independent variables. This analysis shows that the detachability manipulation was successful ($F(2, 286) = 68.91$, $p < .001$, $\eta^2 = .33$). As expected, across the two product categories, participants in the core-nonoptional condition rated the eco-innovative attribute as less detachable ($M = 2.94$) than those in the core-optional ($M = 4.23$) or peripheral ($M = 5.86$) conditions. Counterbalancing the order produced no significant main effects or interactions (*p*s > .12). Moreover, a one-way ANOVA on perceived attribute detachability conducted for the two product categories separately confirmed the success of the manipulation (all differences were statistically significant at $p < .05$) (see Table 3). In line with the pretest, there were no statistically significant differences in perceived product innovativeness and perceived eco-friendliness or in perceived financial costs of the eco-innovative attribute across the conditions (*p*s > .10).

…insert Table 3 about here…

To test H5a and H5b, a 3 × 2 × 2 mixed ANCOVA was performed on consumers’ perceptions of trade-offs and their adoption intentions, with product category as a within-subject variable and attribute detachability and presentation order as between-subject variables. In all tests, consumers’ age, gender, education, income, green values, eco-friendly product knowledge, risk-taking behaviors, financial cost inferences, subjective product knowledge, categorization difficulty, and attribute importance were included as control variables.

Consumers' perceptions of trade-offs between eco-friendly benefits and product functionality. The ANCOVA results show a main effect of attribute detachability ($F(2, 271) = 5.74$, $p < .01$, $\eta^2 = .04$), with participants reporting lower perceived trade-offs in the peripheral ($M = -1.05$) and core-optional ($M = -1.07$) conditions than in the core-nonoptional ($M = -.39$) condition across the two product categories, in support of H5a. Only subjective product knowledge was significant covariate ($p < .05$). Counterbalancing the order produced no significant main effects or interactions (*p*s > .30) (see Appendix I).

Adoption intentions. The ANCOVA results indicate that attribute detachability had a main effect ($F(2, 271) = 22.06$, $p < .001$, $\eta^2 = .14$), with participants reporting higher adoption intentions when the eco-innovative attribute was detachable ($M = 5.22$) and optional ($M = 5.22$) than when it was core-nonoptional ($M = 4.20$), supporting H5b. Age, categorization difficulty, and attribute importance were significant covariates (*p*s < .05). Counterbalancing the order produced no significant main effects or interactions (*p*s > .11) (see Appendix I).

The results of a one-way ANOVA for each product category confirm the positive effects of detachability of eco-innovative attributes on consumers' responses for each product category separately (see Table 3). In addition, multiple regressions were used to check the robustness of the conclusions in each product category. Dummy variables, indicating the respective detachability level (i.e., core-nonoptional [reference category], core-optional, and peripheral), were created. The results of the multiple regression tests were consistent with the conclusions obtained from the mixed ANCOVA (see Appendix I).

Mediation analysis. As in the previous studies, a bootstrapping test for the single-mediator model (Model 4) was conducted for each product category in the PROCESS macro

(Hayes, 2013). The indirect effect of attribute detachability on adoption intentions through consumers' perceptions of trade-offs was statistically significant for both cars and TVs. Across both categories, perceived trade-offs partially mediated the link between attribute detachability and adoption intentions (see Appendix I).

Discussion

In an era marked by rising environmental concerns, rapid technological developments, and increasing competitive intensity, it is critical for firms to develop new products that are both innovative and eco-friendly to satisfy consumers' changing needs. A clear understanding of the factors affecting consumers' adoption of eco-innovative product designs is of paramount importance for achieving successful NPD, crafting sound marketing strategies, and obtaining superior performance outcomes. Our findings complement those of an emerging body of knowledge in the sphere of NPD, indicating that consumers' perceptions of product eco-friendliness and their adoption intentions largely depend on attribute centrality, attribute strength, and trade-offs between environmental benefits with functional performance and other conventional features. Our research adds to this body of knowledge by showing that innovativeness degrees, eco-friendliness levels, and detachability of eco-innovative attributes also determine consumer responses to eco-innovations.

Study 1 finds that consumers express higher adoption intentions for products with radically new eco-friendly attributes than for incremental eco-innovations or standard products. Our findings also highlight the conditional role of NFC, with high-NFC (vs. low-NFC) consumers showing a greater likelihood for innovation adoption in the case of radical eco-innovations than incremental eco-innovations or standard products. Study 2 shows that different approaches to "greening" new product designs (i.e., eco-friendliness levels of eco-innovative attribute types) significantly and positively influence consumers' adoption intentions. Indeed, participants expressed higher adoption intentions for resource use substitution innovations with the highest eco-friendliness score than for resource use efficiency or resource use elimination innovations. Finally, Study 3 demonstrates that a peripheral and a core-optional (vs. core-nonoptional) locus can reduce consumers' perceptions of trade-offs between eco-friendly benefits and product functionality, which in turn generate stronger intentions to adopt eco-innovations.

Theoretical Implications

Our research offers three important theoretical implications. First, it broadens and deepens the understanding of how consumers respond to eco-innovations regarding key aspects of new product designs. While the focal point of prior work on eco-innovations has been on the importance of eco-innovation orientation and development for firm performance (Katsikeas et al., 2016; Varadarajan, 2015), our research concentrates on the long-standing debate about uncertainty in eco-innovation adoption from a consumer's perspective. This research problem is particularly important because an eco-innovation requires a long take-off phase, and consumers might be reluctant to replace "browner" products with "greener" alternatives because of trade-offs inherent in new eco-friendly product designs (Luchs et al., 2012). Specifically, the results show that (1) radical eco-innovative attributes can elicit higher adoption intentions than incremental eco-innovations and standard products; (2) different approaches in "greening" new product designs with different degrees of eco-friendliness have distinct effects on consumers' responses, and these effects vary significantly across different product complexity levels; and (3) including really new and highly eco-friendly features in new product designs in the peripheral and optional locus is more advantageous than doing so in base products and the core locus.

In response to repeated pleas from business scholars (Gershoff and Frels, 2014; Kotler, 2011; Scott and Weaver, 2018; Varadarajan, 2015), our research extends existing theoretical knowledge by illuminating the psychological mechanisms underlying the effects of different design aspects on consumers' adoption intentions by identifying certain moderators and mediators. This research specifies and extends Bloch's (1995) framework in the context of eco-innovation with domain-specific mediators (i.e., psychological responses, such as perceived product eco-friendliness and perceived trade-offs between eco-friendly benefits and product functionality), specific moderators (i.e., individual differences [NFC]) and contextual factors [product complexity]) that enhance adoption intentions. For this purpose, our research develops various conceptual models with eco-innovative product design as the central construct. Building on various theories, these models identify important design factors and their boundary conditions that need to be considered to make sound decisions about developing and marketing eco-innovations.

Our results provide evidence for the win-win logic of eco-innovative product designs, indicating that design factors, innovativeness degrees, eco-friendliness levels, and detachability, generate higher adoption intentions through increasing consumers' perceptions of product eco-friendliness while reducing their trade-offs between environmental benefits and product functionality. This article also uncovers the important roles of NFC and product complexity in the success of eco-innovation introductions. Our study reveals that the effects of innovativeness degrees of eco-innovative attributes are significant and strong for high-NFC (vs. low-NFC) consumers, due to their tendency to engage in more cognitive and complex purchase tasks. Given the strategic importance of targeting the "right" consumers in a new product launch, our findings provide a better understanding of how consumers respond to eco-innovations depending on their dispositional individual differences. Moreover, differentiation in terms of eco-friendliness levels of different eco-innovation types could pay off more for high-complexity products than for low-complexity products. Finally, this research goes beyond the direct effect of innovation locus on adoption intentions suggested in prior work (e.g., Ma et al., 2015) by specifying the underlying mechanism of this effect in the context of sustainable innovations. Our findings suggest that placing eco-innovative attributes in the peripheral locus can mitigate consumers' uncertainty about adopting an eco-innovation by reducing their perceptions of trade-offs between eco-friendly benefits and product functionality, which in turn enhances their adoption intentions.

Managerial Implications

Our research also provides important and actionable implications for managers. In recent years, firms have extensively invested in integrating environmental concerns into their NPD and marketing strategies. In practical terms, this means that managers must make decisions about the best approaches for developing eco-innovations that will secure superior financial performance while satisfying consumers' needs and wants. However, the negative effects of "greenwashing" in marketing (Delmas and Burbano, 2011) and high consumer skepticism toward environmental claims (Mohr et al., 1998), coupled with higher prices, limited availability, and generally lower perceived effectiveness (Luchs et al., 2010), have frustrated market share for sustainable products. Our findings indicate that firms can accelerate the adoption of eco-innovative products by properly handling innovativeness degrees, eco-friendliness levels, and detachability of eco-innovative attributes.

Our findings provide compelling evidence that, with regard to new green products, consumers respond more positively to radical eco-innovative features, which they perceive as more innovative and eco-friendlier, than incrementally new or standard features. Therefore, increasing innovativeness degrees of new eco-friendly attributes should be a key priority for firms aiming to encourage high eco-innovation adoption rates. An example of radical eco-innovation is the Samsung Powerbot R7070 vacuum cleaner (with its Visionary Mapping™ Plus), which creates an optimal cleaning path by scanning the layout of the home and its surroundings, thus enabling significant energy savings. This really new robot vacuum has managed to dominate the premium robot vacuum market in Korea with a 90% share since its launch in 2014 (Samsung, 2018). Our findings also stress the moderating role of NFC; high-NFC consumers were more likely to respond positively to radical eco-innovations than low-NFC consumers, who tend to react more favorably to incremental eco-innovations and standard products. Thus, NFC is an important criterion when identifying target market segments with heterogeneous consumer response functions to eco-innovation introductions. However, as in the case of other psychological factors, the complex nature of NFC makes its use as a segmentation criterion a challenging task.

Companies also need to direct their efforts to higher levels of eco-friendliness by investing in specific types of eco-innovations that are more likely to trigger positive consumer responses, particularly when they have other investment options with similar environmental payoffs (Paparoidamis and Tran, 2019). Our findings show that consumers consider resource use substitution features with the highest eco-friendliness scores among the most favorable eco-innovations. The results of our study also imply that firms should consider developing eco-innovative attributes as optional/detachable accessories because consumers are often uncertain about their green product purchases. Detachability of eco-innovative attributes reduces consumers' perceptions of trade-offs between eco-friendly benefits and product functionality, which in turn generates stronger adoption intentions.

Marketing communications strategies can also benefit from our findings. First, it is crucial that communications bring the radically new eco-friendly benefits of the firm's eco-innovations to the attention of consumers using several means, such as advertisements, websites, and social media. Second, to reduce consumer uncertainty about eco-innovative new products, it would be useful to employ experiential marketing techniques to highlight the detachability of eco-innovative attributes, such as creating personal experience around eco-innovations using promotional events and forming online communities to discuss and share eco-innovative ideas. Communication campaigns should also be adjusted according to the level of product complexity by offering compelling messages about differentiating types of eco-innovations with different levels of eco-friendliness for high-complexity products and promoting general environmental claims for low-complexity products.

Limitations and Future Research

Our findings should be interpreted in the context of some limitations, which could provide the basis for future research. First, although the experimental approach enables us to test the hypotheses with some degree of generalizability, future research could enhance the external validity of our findings by replicating our study in other country settings (e.g., emerging economies) and other product categories that do not necessarily belong to the high-tech market and are characterized by fewer eco-innovations. Second, our research focuses only on situations in which one firm introduces an eco-innovation to the market. However, because competitors can respond swiftly to such innovations by offering similar products, consumers' reactions to the pioneer's eco-innovation may change dramatically (Ma et al., 2015). Therefore, considering potential confounding effects of external factors, such as competitors' movements, market dynamism, and industry environmental impact, would be useful.

The manipulations in all experiments use fictitious brands for all product categories investigated. However, consumer responses might differ if the eco-innovation is framed as an extension of a well-known brand (e.g., iPhone or Samsung for smartphones). Future studies should therefore examine how various brand-related factors (e.g., equity, reputation, longevity) moderate the impact of eco-innovative product designs on consumers' adoption decisions. Moreover, although our research sheds light on the role of three aspects of innovative product designs (i.e., innovativeness, eco-friendliness, and detachability of eco-innovative attributes) in consumer responses, future research could explore other important factors that affect consumer behavior, such as the range and ease of use of eco-innovative attributes, within-alternative conflict, and aesthetic product design. The roles of country of design and country of manufacture also warrant investigation.

To simplify our experiments, the manipulations use identical selling prices (expressed in terms of the average retail price of each product category in the U.S. market in 2018 based on Consumer Reports) across all conditions. However, there are often significant differences in price among different versions of eco-innovative products. For example, the lowest price for a Hyundai Ioniq Electric, a 100% electric car, is $29,500, while the price for the hybrid model starts at $24,950, and a conventional Hyundai car only costs $15,600. Therefore, it is important for researchers to investigate factors that facilitate or hinder the impact of eco-innovative product designs on consumer evaluations of selling prices and their price elasticity. It is also crucial to examine whether competitors' prices for similar products strengthen or weaken consumers' inferences of price fairness regarding a firm's eco-innovation.

Although our research investigates innovativeness degrees and eco-friendliness levels of eco-innovative attributes as two separate variables, these can have potential confounds, which necessitates a full-profile conjoint analysis to predict consumer choice among different sets of closely matched product categories. This research also treats consumer adoption as the intention to adopt an eco-innovation, even though many scholars (e.g., Carrington et al., 2010; Hassan et al., 2014) report a serious value–action gap in the sustainable consumption context. Thus, studying actual adoption behavior (i.e., first trial) and actual consumption (i.e., real usage) may provide more reliable insights into the adoption process, because early adopters, though characterized by strong adoption intentions, are often reluctant to actually purchase an eco-innovation. Finally, given our focus on product-related factors, future research might examine the conditioning effects of individual characteristics (e.g., personality traits), situational factors (e.g., temporal distance), and country-related variables (e.g., cultural orientation) on consumer adoption of eco-innovations.

In conclusion, marketing efforts aiming to promote eco-innovations, where innovative and eco-friendly attributes converge, are prone to underperform due to complex adoption dynamics and diffusion processes (Heidenreich et al., 2017). Although this phenomenon has been approached from different perspectives in the past, our study stresses the instrumental roles of innovativeness degrees, eco-friendliness levels, and detachability of eco-innovative attributes in the success of the eco-innovation introduction through the creation of more favorable consumer psychological and behavioral responses.

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Table 1: Comparison of Consumer Responses to Different Innovativeness Degrees of Eco-innovative Attributes in Two Product Categories

Product Categories	Dependent Variables	Standard Product		Incremental Eco-innovation		Radical Eco-Innovation		*F*-value
		M	*SD*	*M*	*SD*	*M*	*SD*	
Vacuum cleaners	Perceived product innovativeness	3.35_a	2.66	4.57_b	2.09	6.32_c	2.22	$F(2, 299) = 40.97^{***}$
	Perceived product eco-friendliness	3.55_a	1.39	4.93_b	1.05	5.49_c	1.04	$F(2, 299) = 72.79^{***}$
	Adoption intentions	3.93_a	1.62	4.59_b	1.56	5.15_c	1.55	$F(2, 299) = 15.16^{***}$
Cars	Perceived product innovativeness	2.99_a	2.70	4.01_b	2.32	6.25_c	1.92	$F(2, 299) = 51.32^{***}$
	Perceived product eco-friendliness	2.73_a	1.70	4.99_b	1.18	5.86_c	.98	$F(2, 299) = 150.75^{***}$
	Adoption intentions	3.46_a	1.83	4.45_b	1.60	5.11_c	1.53	$F(2, 299) = 25.33^{***}$

Notes: Subscripts should be interpreted only within the row. Means with the same subscript are not significantly different from each other. Means with different subscripts are significantly different at $p < .05$, based on Tukey's post hoc test.
$^{*}p < .05$ (two-tailed); $^{**}p < .01$ (two-tailed); $^{***}p < .001$ (two-tailed).

Table 2: Comparison of Consumer Responses to Different Eco-friendliness Levels of Eco-Innovative Attribute Types in Two Product Categories

Product Categories	Dependent Variables	Eco-Friendliness Levels						F-value
		Low		Medium		High		
		Resource Use Efficiency Features		Resource Use Elimination Features		Resource Use Substitution Features		
		M	*SD*	*M*	*SD*	*M*	*SD*	
Smartphones	Perceived product innovativeness	4.04_a	2.49	4.52_a	2.42	6.22_b	2.22	$F(2, 288) = 22.60^{***}$
	Perceived product eco-friendliness	4.60_a	1.21	5.11_b	1.04	5.61_c	.95	$F(2, 288) = 21.52^{***}$
	Adoption intentions	4.30_a	1.77	4.64_a	1.58	5.26_b	1.49	$F(2, 288) = 8.85^{***}$
TVs	Perceived product innovativeness	4.63_a	2.58	4.68_a	2.47	6.43_b	2.16	$F(2, 288) = 17.59^{***}$
	Perceived product eco-friendliness	4.76_a	1.30	5.16_b	1.08	5.74_c	.98	$F(2, 288) = 18.26^{***}$
	Adoption intentions	4.81_a	1.86	5.05_a	1.40	5.09_a	1.60	$F(2, 288) = .80$

Notes: Subscripts should be interpreted only within the row. Means with the same subscript are not significantly different from each other. Means with different subscripts are significantly different at $p < .05$, based on Tukey's post hoc test.
$^{*}p < .05$ (two-tailed); $^{**}p < .01$ (two-tailed); $^{***}p < .001$ (two-tailed).

Table 3: Comparison of Consumer Responses to Different Levels of Detachability of Eco-Innovative Attributes in Two Product Categories

Product Categories	Dependent Variables	Core-Nonoptional		Core-Optional		Peripheral		F-value
		M	SD	M	SD	M	SD	
Cars	Attribute detachability	2.67_a	1.99	4.34_b	2.08	5.77_c	1.50	$F(2, 289) = 66.75^{**}$
	Perceived trade-offs	$-.25_a$	1.54	$-.98_b$	1.55	$-.90_b$	1.77	$F(2, 289) = 5.90^{**}$
	Adoption intentions	4.25_a	1.92	5.03_b	1.40	5.02_b	1.36	$F(2, 289) = 7.81^{***}$
TVs	Attribute detachability	3.22_a	1.54	4.16_b	1.55	5.94_c	1.77	$F(2, 289) = 52.62^{**}$
	Perceived trade-offs	$-.44_a$	1.71	-1.31_b	1.49	-1.16_b	1.68	$F(2, 289) = 7.85^{***}$
	Adoption intentions	4.37_a	1.82	5.16_b	1.39	5.46_b	1.31	$F(2, 289) = 13.18^{***}$

Notes: Subscripts should be interpreted only within the row. Means with the same subscript are not significantly different from each other. Means with different subscripts are significantly different at $p < .05$, based on Tukey's post hoc test.
$^{*}p < .05$ (two-tailed); $^{**}p < .01$ (two-tailed); $^{***}p < .001$ (two-tailed).

[i] A new dummy categorical variable for NFC (1 = low NFC, 2 = high NFC) was created by splitting the continuous variable of NFC using the median as the cutoff point.

[ii] When the 23 invalid responses that did not pass the manipulation check were included in our data set, the results reveal that manipulation check failure (a dummy variable ["yes/no"]) had no statistically significant moderating impact on the relationships between eco-friendliness levels and adoption intentions (see Appendix H).

[iii] Participants were asked to compare innovativeness and eco-friendliness aspects of three eco-innovative attribute types on a 15-point bipolar scale, anchored by "extremely innovative, but not eco-friendly" (–7) and "extremely eco-friendly, but not innovative" (+7), with "neither innovative nor eco-friendly" being the middle choice (0). On average, participants evaluated eco-innovative features to be more on the eco-friendly side than on the innovative side of the scale for two product categories (smartphones: Ms ≥ +3.36; TVs: Ms ≥ +3.14).