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LUMINOUS INSIGHTS

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Research Article

Psychological Barriers to Sustainability: Understanding Consumer Demand for Products with Redundant Functionalities

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ABSTRACT

Despite the proliferation of multifunctional products, survey data suggests that instead of relying on one multifunctional product, consumers now rely on a community of multifunctional products, using them interchangeably to perform similar tasks. Such consumption patterns stand in stark contrast to consumers' well-documented aversion towards waste. Why are consumers willing to dispose of multifunctional products that still have some working capabilities and/or to pay for functional redundancies? We suggest that controlling for the absolute level of performance (e.g., the megapixels of the camera), consumers perceive the same functionality to be less valuable when it is performed by a multifunctional product (e.g., the camera on a smartphone) than by a single, dedicated product (an inexpensive digital camera). We investigate this phenomenon across a series of four experiments which are aimed at documenting the basic effect and elucidating the underlying psychology.

KEYWORDS

Circular supply chains, consumer behavior, lab experiments, multifunctional products, sustainable consumer psychology, sustainable consumer behavior

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1. Introduction

Many products today are multifunctional. For example, there are roughly 4.3 billion smartphones currently in use (Gartner, 2021), and each possesses the functionality of a phone, a computer, a web browser, a camera, a GPS device, a language translator, a scanner, etc. Scholars and journalists have suggested that the adoption of products with multifunctional capabilities should ultimately lead to more environmentally sustainable outcomes through dematerialization and reductions in raw material use and waste (O'Connell, 2013). Whereas consumers once needed a separate, dedicated product for each individual task in many cases, they can now rely on a single product to perform several different functions (Kasulaitis et al., 2021).

Despite the proliferation of multifunctional products, however, survey data suggests that instead of relying on one multifunctional product, consumers now rely on a community of multifunctional products, using them interchangeably to perform similar tasks (Ryen et al., 2015, 2014; Kasulaitis et al., 2021). For example, a consumer may start watching a drama series on her laptop, switch to her tablet, and eventually finish up an episode on her smartphone. Moreover, even though multifunctional products such as smartphones are by no means cheap, most smartphones are replaced more frequently than T-shirts, despite being in good working condition (Geyer & Blass, 2010; Wieser & Tröger, 2018; Makov & Fitzpatrick, 2021). Such consumption patterns stand in stark contrast to consumers' well-documented aversion towards waste (Arkes, 1996; Bolton & Alba, 2012;

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Sun & Trudel, 2017) . This raises the question, why are consumers willing to dispose of multifunctional products that still have some working capabilities and/or pay for functional redundancies?

In this paper we investigate one psychological antecedent of this phenomenon. Specifically, we propose that these costly consumption patterns are enabled by consumers' tendency to undervalue the individual capabilities of a multifunctional product (e.g., the phone, GPS, and camera on a smartphone) relative to those capabilities when performed by standalone products (e.g., a dedicated mobile phone, dedicated GPS, and dedicated camera). Put differently, we suggest that controlling for the absolute level of performance (e.g., the megapixels of the camera), consumers perceive the same functionality to be less valuable when it is performed by a multifunctional product (e.g., the camera on a smartphone) than by a single, dedicated product (an inexpensive digital camera). These differences in perceived value, may in turn, have important downstream consequences in terms of reuse and disposal, and may discourage consumers from considering older multifunctional products as reasonable substitutes for new, single-function products. For example, new parents may purchase a separate, dedicated baby monitor rather than use the working camera on a discarded smartphone that they already own.

Ignoring the potential to repurpose multifunctional products is costly for both consumers and the environment. Indeed, the macro-level implications of such behaviors are potentially very substantial as the fast replacement rate of multifunctional products and the purchase of multiple products with redundant functions increases the overall throughput of materials, energy, and waste. For example, the climate change impacts associated with a single iPhone 12 amount to 70kgCO2-eq (Apple, 2020), and each smartphone makes use of over 75 different elements of the periodic table, many of which have very low recycling and recovery rates (including a variety of precious, critical, and conflict minerals whose mining has been linked to civic unrest) (Reck & Graedel, 2012).

In sum, we suggest that despite the numerous environmental benefits that are afforded by multifunctional products and their sustainability benefits in terms of material reduction and reuse, there may be unforeseen psychological barriers which prevent consumers (and producers) from capitalizing on these benefits. We investigate this phenomenon across a series of four experiments which are aimed at documenting the basic effect and elucidating the underlying psychology.

2. Devaluing Multifunctionality

The existing literature in psychology and marketing identifies several converging explanations for why the same capabilities may be thought of as less valuable when performed by a multifunctional product versus a collection of single-function products. One mechanism stems from a phenomenon known as the "zero-sum" heuristic (Chernev, 2007). The basic notion is that consumers tend to assume that the resources which a firm uses to manufacture a product are fixed. As a result, product enhancements in one domain may be seen as detracting from benefits in another domain. For example, if a toothpaste is advertised to have enhanced tooth-whitening capabilities, consumers may infer that it is less good at cavity-protection.

To date, the zero-sum heuristic has been primarily documented in cases where a single product (like toothpaste) offers multiple benefits. However, Newman et al. (2014) found that such inferences may also persist in cases where the benefits are in different conceptual domains—e.g., making a cleaning product better for the environment may lead consumers to perceive it as less effective. Therefore, it may be that similar inferences extend to cases where a multifunctional product has different dedicated functions, such as a smartphone, or a 3-in-1 printer. Here, due to the "zero-sum" heuristic, consumers may perceive that each of the dedicated functions performed by a multifunctional product are less capable than the comparable functions of a single-function product, and as a result, may value the multifunctional product less than the sum of its single-function parts.

A second explanation is associated with the phenomenon of "mental accounting" (Thaler, 1985). In

brief, the idea mental accounting is that consumers tend to think of money differently depending on its intended use or source. In the context of multifunctional products, this may mean that damaged or outdated capabilities associated with one of the product's functions may "taint" the perceived capabilities of the product as a whole. For example, a consumer may replace a perfectly functioning smartphone with a newer model just because they perceive the camera to be out-of-date. Analogously, consumers may create distinct mental accounts which budget for the same capabilities across multiple products—a consumer may construe a mental budget for a smartphone very differently than a budget for a camera. As a result, consumers may be less likely to perceive functional redundancies across different mental accounts.

A third mechanism may be that consumers intuitively perceive a correlation between value and the amount of material stuff. In other words, a collection of single-function products are comprised of more physical material than a comparable multifunctional product, and as a result, consumers may perceive the collection of single-function products to be worth more.Thus, whereas multifunctional products have environmental benefits because they typically require fewer material inputs than single-function products, they may ironically be perceived as less valuable by consumers for the very same reason.

3. Overview of Studies

In studies 1 and 2 we compare consumer valuation of multifunctional products versus single-function products, both in terms of the amount of money they would be willing to sell their products for on the second-hand market (Willingness to Accept), and the amount of money they would be willing to pay for an upgrade (Willingness to Pay). Across both types of measures, we observe that the multifunctional products are valued less than standalone products preforming the same function. One consequence of this effect is that consumers may in turn show a greater willingness to replace multifunctional products and purchase redundant capabilities. Therefore, in studies 3 and 4, we examine how the devaluation of multifunctional products can lead to costly consumption patterns such as redundant purchases and premature replacement. We conclude with a discussion of our findings and suggestions for potential interventions.

3.1. Study 1

Our first study examines the basic hypothesis that consumers undervalue the individual capabilities contained on a multifunctional product relative to when those same functions are each performed by separate products. We tested this hypothesis by presenting participants with a scenario in which they were either asked to imagine that they owned a multifunctional device or instead, that they owned a collection of single-function devices. Following, participants were then asked to specify the least they would be willing to accept (WTA) to sell the device(s).

3.1.1. Subjects and Design

A total of 240 adult participants were recruited via Amazon's Mechanical Turk in exchange for $0.50 each. Participants who failed to answer a manipulation check and a comprehension check presented at the end of the experiment, or those who participated more than once (based on repeating IP addresses), were excluded from the study (N=52). The remaining 188 participants (54.8% male; Mage= 36.1), were randomly assigned to one of two between-subjects conditions: multifunctional product versus single-function products.

Specifically, participants were asked to imagine they had a home office, equipped with various devices. Half of the participants were told that their home office was equipped with a separate printer, copy machine, and fax machine (single-function condition), while the other half of participants read that their office had a 3-in-1 printer, photocopier and fax machine (multifunctional condition). Critically, in both conditions the original price paid for the three devices, or the 3-in-1 device, was the same ($275). All participants then read that the fax machine, which they used only occasionally, had stopped working (though the printer and photocopier worked fine).

Participants were then asked to state the lowest sum of money (in $US) they would be WTA to sell the equipment. No upper or lower limits were imposed, and participants were free to state their WTA as they

saw fit. Past work suggests that when selling products, consumers tend to specifically focus on what they are potentially giving up in the exchange (Carmon & Ariely, 2000). Hence, in this case, we expected that consumers' WTA would directly reflect their valuation of the photocopier and printer.

3.1.2. Results and Discussion

The results indicated that valuation of the multifunctional product (M= $116.8, SD=51.7) was significantly less than the single-function products (M=$138.6, SD=55.6), t(186)=-2.77, p=.006, d=0.4. These results indicate that the same remaining functions (i.e., printer and photocopier) were discounted when they were part of a multifunctional product compared to when they were part of a set of single-function products.

However, it may be that participants in Experiment 1 assumed that the fax machine was broken due to physical misuse, and that in the case of the multifunctional product, such an incident could also damage other functions. Therefore, in Study 2 we examined whether devaluation of multifunctional products can also bias utility perceptions of intact devices by examining consumers' Willingness to Pay (WTP) for a functional upgrade.

3.2. Study 2

In study 2 we sought to examine the present phenomenon in the context of replacement choices. As new product launches are frequent, especially when it comes to electronics, consumers are often presented with the opportunity to upgrade to newer models even though their current products are still in good working condition. From a normative perspective, consumer's willingness to pay (WTP) for an upgrade reflects the added utility they expect to gain from the new product, in comparison to what they currently own (Okada, 2006). As such, when the added benefits of upgrading are objectively similar (e.g. an increase from 16GB to 64GB of memory), consumer's WTP for upgrades should be similar. Hence, we would expect that WTP for an upgrade should be equal, regardless of whether it offers functional improvements to a set of single function products or to a multifunctional product.

3.2.1. Subjects and Design

We recruited 238 adults from Amazon's Mechanical Turk in exchange for $0.50 compensation. Individuals who participated in previous studies, those who participated more than once (based on repeating IP addresses), or those that failed to answer a manipulation check presented at the end of the experiment were disqualified (N=63). The remaining 175 eligible participants (66.9% male; Mage= 36.2) were randomly assigned to one of two between-subjects conditions: multifunctional product versus single-function products.

Half of the participants were asked to imagine that they owned an Apple iPod that included a MP3 player, a 6.0 Megapixel camera, and a GPS (multifunction condition), while the other half were asked to imagine they owned a functionally equivalent set of standalone products (i.e., a MP3 player, a 6.0 MP camera and a touchscreen GPS device; single-function condition).

Participants in both conditions were then presented with an upgraded multifunctional product (a newer model iPod with better camera resolution and more music storage) and were asked to state how much money they would be willing to pay for it in $US. Participants entered their answers into a text box. No upper or lower limits were imposed.

Since consumers in both conditions would gain the same functional benefits from the upgrade, WTP for the upgrade should be equal across the two conditions, or perhaps even greater when upgrading from the single-function products to the new multifunctional product, since the consumer is also gaining enhanced portability by reducing the total number of devices. However, in line with our previous results, we predicted that if consumers devalue multifunctional devices, the difference between the current multifunctional product and the upgraded multifunctional should be seen as greater than an upgrade from a collection of single-function devices to a multifunctional product. Thus, WTP for the upgrade should be greater in the multifunction condition than in the single-function condition.

3.2.2. Results and Discussion

The results indicated that WTP for the upgrade was significantly greater in the multifunction condition (M=$215.5, SD= 92.8) compared to the single-function condition (M=$180.5, SD= 95.9), t(173)=2.45 p=.016, d=0.37, even though participants in the single-function condition were potentially getting more out of the upgrade (enhanced portability).

Consistent with our previous findings, these results demonstrate that functionality is discounted when it is part of a multifunctional product compared to an equivalent set of standalone products. While the measures of valuation used in Experiments 1 and 2 suggest that multifunctional devices are valued less than their single-function counterparts, it remains unclear if this phenomenon would also affect replacement decisions. Past work documents a strong aversion towards waste. For example, if the functions themselves are valued less when they are part of a multifunctional device (versus single-function devices), then purchasing redundant functionality may be perceived as less wasteful for multifunctional devices, leading to greater purchase of redundant functionalities. Studies 3 and 4 examine whether consumers are indeed more likely to purchase redundant functionalities when they own a multifunctional product and whether this phenomenon is unique to electronic devices or persists in conventional low-tech products as well.

3.3. Study 3

Experiment 3 used a similar experimental design as the previous studies but asked about a non-tech product. Half of the participants imagined they owned standalone tools (single-function condition), while the other half imagined they owned a Swiss Army Knife (multi-function condition). In both conditions, participants read that one of the tools was broken and they were asked their willingness to purchase a new Swiss Army Knife (thereby acquiring redundant tools)

3.3.1. Subjects and Design

232 adults were recruited from the same online platform using the same compensation as Studies 1 and 2. Individuals who participated in previous studies, those who participated more than once (based on repeating IP addresses), or those that failed to answer two manipulation checks presented at the end of the experiment (see SI) were disqualified (N=39). The remaining 193 participants (56.0% male; Mage= 35.2; SD=12.3) were randomly assigned to one of two between-subjects conditions: multifunctional product versus single-function products.

All participants were asked to imagine a scenario in which they were going camping with friends and needed to bring utensils. Half of the participants read they usually take a set of standalone cutlery including a knife, spoon and fork (single-function condition), while the other half read that they usually use a dining Swiss Army Knife, which consisted of a knife, spoon and fork (multifunction condition). In both conditions, participants read that the fork was broken.

Next, all participants were asked to indicate how likely they were to purchase a new Swiss Army Knife (sold at a 40% discount for $17.50) on a 7-point scale, between extremely unlikely and extremely likely. The new Swiss Army Knife had all three utensils, thus, replacing the broken fork also meant acquiring redundant tools, namely, a redundant knife and spoon. We predicted that consumers would be more likely to discount the remaining functionality of the multifunctional product (spoon and knife) more so than the remaining functionality in the single-function condition, and thus, would be more likely to indicate they would purchase the new Swiss Army Knife in the multifunction condition than in the single-function condition.

3.3.2. Results and Discussion

Consistent with our predictions, participants in the multifunctional condition were significantly more likely to buy a new Swiss Army Knife (M=5.28, SD=1.65), compared to participants in the single-function condition (M=4.58; SD=1.94), t(191)=2.69 p=.008, d=0.39.

The results of Study 3 suggested that the devaluation of multifunctional products increases the likelihood of redundant purchases. However, as no standalone replacement was offered (e.g., a single fork), it is not clear whether participants in the multifunctional condition actually felt less waste aversion (Arkes, 1996; Bolton & Alba, 2012; Sun & Trudel, 2017) compared to those that owned a set of standalone items. Therefore,

in our final study we examined if multifunctional product owners were likely to duplicate functions even if a standalone substitute was available.

3.4. Study 4

The goal of study 4 was to specifically test our hypothesis that consumers are more likely to engage in redundant purchasing when they currently own multifunctional product compared to a set of single-function products. To this end we intentionally made participants' aware of their need for a specific functional capacity and asked only about their likelihood of duplicating that sole function as a single function versus a multifunctional product.

3.4.1. Subjects and Design

414 adults who were recruited from the same online platform using the same compensation as the previous studies. Individuals who participated in previous studies, those who participated more than once (based on repeating IP addresses), or those that failed to answer a manipulation check presented at the end of the experiment were disqualified (N=126). The remaining 288 eligible participants (56.6% male; Mage=34.8; SD=11.7) were randomly assigned to one of three between subject conditions: multifunction, single-function, or control.

Participants were asked to imagine a scenario in which they were going on a vacation where they would need to use a camera. Participants in the control condition read that they owned a smartphone (including a built-in cellphone, GPS and a 10 MP camera). Participants in the multifunction condition read that they owned a smartphone (including a built-in cellphone, GPS and a 10 MP camera), but that the camera was broken (scratched lens). Participants in the single-function condition read that they owned a travel kit that originally included a separate cellphone, 10MP camera, and a GPS, but that the camera was broken (scratched lens). Thus, in both multifunctional and single-function conditions the reason the camera did not work was explicitly stated to lower the chance that participants might think that other functions were directly affected by the camera malfunction.

Next, participants in all conditions were then asked to imagine that they were deciding between purchasing new smartphone (which contained a 12 MP camera) sold for $549 or purchasing a standalone 18 MP camera sold for $349. Thus, provided that the sole need was to replace the camera, the standalone camera was the superior option in terms of both cost and performance. Finally, participants indicated their preference for purchasing the smartphone or the camera using a binary choice response.

3.4.2. Results and Discussion

In line with our previous findings, participants in the multifunctional condition were significantly more likely to choose the smartphone (54.1% chose smartphone) compared to participants in the single-function condition (30.3% chose smartphone; $\chi 2$ (1) =10.7, p= .001). Interestingly, only 38.6% of participants in the control condition chose the smartphone, which rules out the possibility that participants with multifunctional products simply prefer to purchase other multifunctional products and indicates that the camera was indeed seen as the superior option $\chi 2$ (2) =11.4, p= .003).

Put differently, participants in the control condition chose to avoid waste and redundant functionalities (Arkes, 1996; Bolton & Alba, 2012). However, when there was a need for replacement, participants were more likely to duplicate functions when their existing possession was multifunctional versus when the same functions were contained on separate devices. This result is consistent with the hypothesis that the same functionalities are discounted when they are contained on multifunctional products versus standalone products.

4. General Discussion

Multifunctionality is often touted as the epitome of dematerialization—where once consumers needed many separate products, they can now rely on a single device to perform all tasks. Recent survey data, however, instead suggests that consumers now rely on a community of multifunctional devices rather than one multifunctional device to deliver a particular function. These costly consumption patterns may be aided by the devaluation of multifunctional products documented here. Moreover, this phenomenon is not

limited to technologic devices which might be more susceptible to perceived obsolescence (Makov et al., 2019) but also to low-tech products like a Swiss Army Knife.

We outlined several compatible explanations for this effect including zero-sum reasoning leading to reduced inferences about attribute performance, mental accounting and separate budgets for different devices, and the greater valuation of more material stuff. Indeed, we suspect that all these mechanisms may contribute to the effect. Future work could examine specific psychological mechanisms more directly. The fact, however, that we observe the effect for both high and low-tech products suggests that quality inferences alone are not driving the effect, since it is reasonable to assume that participants fully understood the functions of a cutlery set (Experiment 3).

In addition, the present studies suggest that the devaluation of multifunctional devices may discourage consumers from considering older multifunctional devices as reasonable substitutes for new, single-function products. Such patterns might be costly for both consumers and the environment. From an environmental perspective, reuse and repurposing are often preferable to remanufacturing or recycling since they do not require additional investment of materials and energy (Gutowski et al., 2011). Since it is common for consumers to keep older devices home in hibernation (e.g., unused in a spare kitchen drawer; (Wilson et al., 2017), designing products that highlight consumer's ability to repurpose their retired multifunctional devices could potentially help overcome the devaluation of multifunctional products and reduce overall consumption. For example, apps that enable consumers to easily transform a smartphone into a "nanny cam" could potentially make consumers see the value still remaining in their possessions and capitalize on it.

Furthermore, as we show here, the devaluation of multifunctional products might discourage consumers from repairing their existing multifunctional devices and encourage them to buy new ones instead. While advocacy and legislation for the right to repair is gaining force (Bloomberg, 2017; Koebler, 2017; European Parliament, 2022) consumers' biased evaluations might cause them to mistakenly think that their devices are not even worth repairing (Makov & Fitzpatrick, 2021; Sonego et al., 2022) . Similarly, consumers may be discouraged from reselling their devices in secondary markets, or hand them in for rebates since they may assume that the transaction costs are higher than the potential gains. Thus, while smartphones today hold more computational power than the super computers used by NASA to send a man to the moon (Kaku, 2011) , more often than not, once partially damaged or retired, these powerful and complex devices are often perceived as worthless by consumers.

Here we document how consumers may fail to appreciate the full capabilities of multifunctional products using a series of hypothetical scenarios. Though this methodology allows us to explore the phenomenon in isolation, it may fall short of describing the complex settings in which real life decisions take place (Kahan & Carpenter, 2017). Therefore, more research is needed to assess the extent of this phenomenon and its potential implications for sustainability. In addition to increased replacement rates, consumers misguided assumptions regarding the value of their old devices may also pose a major barrier for circular economy models that emphasize the recapture of materials and parts for reuse (Zink et al., 2014). As one example, one ton of cellphones today contains more gold than a ton of soil from a gold mine; failure to recirculate used multifunctional devices may severely limit the ability to recapture the precious materials they contain and reduce demand for virgin materials (Wilson et al., 2017; Glöser-Chahoud et al., 2019). In particular, future work should directly examine how the phenomenon documented here can be overcome through improved product design, messaging and targeted economic incentives.

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