Increasing the sustainable consumption of mainstream consumers through design and communication

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Increasing the sustainable consumption of mainstream consumers

through design and communication

Mirjam Visser

For my father, who taught me curiosity and perseverance

"When I first came here, this was all swamp. Everyone said I was daft to build a castle on a swamp, but I built it all the same, just to show them. It sank into the swamp. So, I built a second one. And that one sank into the swamp. So, I built a third. That burned down, fell over, and then sank into the swamp. But the fourth one stayed up. And that's what you're going to get, Son, the strongest castle in all of England." – King of the Swamp Castle

from "Monty Python and the Holy Grail"

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through design and communication

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Preface

Standing in a supermarket in Shanghai in 2009, I was aware of the unsustainable consumption I was about to commit by buying sparkling water. The Chinese do not drink sparkling water, so all available brands on the shelf were European. To limit my impact on the environment, should I buy a ¾ litre glass bottle from Italy or a 1.5 litre PET bottle from Belgium? I took the PET bottle and decided to Google an answer. Google knows all, right? Not that easy! It took days of research for such a simple product. When this was already so difficult, how hard is it for designers to add this to their design process? I started Design-4-Sustainability.com with the idea to help designers to design more sustainable products. One of the features of its website was a light version of a Life Cycle Analysis (LCA) tool to compare the environmental impact of alternatives. The LCA tool brought me in contact with Joost Vogtländer, the master of EcoValueRatio and EcoCost. Since I was already in so deep, it kindled the idea to start my PhD research. We know a lot already about what is (or is not) sustainable and how to make a product more sustainable, but with the many sustainable products already around, why is sustainable consumption growing so slowly? We obviously need to increase its value, but how? That was my quest.

My ideas about how to create value from sustainable consumption for mainstream consumers would never have materialized without both Joost Vogtländer, my daily supervisor, and Ab Stevels, my tireless companion, who both joined me from the start. Thanks as well to Nestor Coronado de Palma for opening every door and database for me at Philips Consumer Electronics and Royal Philips Electronics N.V. for sharing their sustainability strategy, data and processes.

I would never have finished, after eight rejections of the first article, without my co-writer, Valentin Gattol. Reluctant as Valentin was to be my co-writer of the first article at a distance of 900 kilometres away through Skype. He taught me to focus an article and to select my messages, and we became friends. Valentin also suggested Jan Schoormans as a promotor when I needed a new promotor after Han Brezet retired. Jan, thank you for taking this trip with me and for your guidance, dry humour and relentless patience to stick with me over the years! I would not like to be your first PhD candidate to not cross the finish line. Your retirement in half a year's time instead of over a year did create my burning platform to get me finish my PhD project.

And last, but not least, my family and friends! My father, from whom I inherited stubbornness and perseverance, and of course Christian, thank you for motivating me to continue. You can finally call yourself Herr Doktor Visser!
Thank you all for being there for me.

Summary

For over 50 years, green marketing has been attempting to increase sustainable consumption by promoting greener products to green consumers. Although most consumers promise to consume more sustainably, sustainable purchases are currently still in the lower percentages. To make a difference in global warming, and for resource scarcity and biodiversity, it is necessary to not only have the green consumer consume sustainably but also have the mainstream consumer do so as well. Therefore, this thesis examines mainstream consumers' behaviour in buying and using sustainable products. The focus of the thesis is on durables, as de-consumption is not likely for regularly or daily used durables that are a part of western society (e.g. household appliances or shoes). When broken beyond repair, these durables will be replaced. Therefore, this thesis examines mainstreams consumers behaviour in the buying and using of sustainable durables.

This thesis explores why some consumers buy sustainable options and others do not. As well as how this can be altered through targeted marketing communication and design. Sustainable intent is no guarantee for sustainable behaviour, but sustainable intent is also not a necessity for sustainable behaviour. It is the sustainable behaviour that counts. The reasons consumers buy energy-efficient vacuum cleaners makes this clear. Three out of four buyers of energy-efficient vacuum models did buy an energy-efficient vacuum cleaner for other reasons than environmental friendliness. They bought their energy efficient vacuum cleaner for the exact same reasons as those who bought an inefficient model. For neither shoes nor vacuum cleaners, sustainability is a primary buying criteria. On the contrary, there is a bias that sustainability comes at the cost of perceived quality, fashion image or performance. Only when all the main buying criteria are met, sustainability adds differentiation and value. This counts for both "feel" products (such as shoes and clothing) or "think" utilities (such as household appliances and utilities). The highest willingness to buy the sustainable shoe has been reported when the communicated benefit was on personal relevance combined with a green design.

Sustainability and the environmental impact of a product is, for most consumers, abstract and distal. More abstract than the present need which will be solved with the new acquisition. It is also hard, if not impossible, for a layman to compare the environmental costs of product alternatives. Results of comparisons are often context dependent and counter intuitive, which may reduce green trust. To make

sustainable products attractive to mainstream consumers, it is necessary, like in mainstream marketing, to focus communication and design on the consumers' main buying criteria. Deliver sustainability but focus the products' message and design on the general relevance and needs of the customer or user. Communicating sustainable products is most effective when personal benefits are combined with a linked sustainable benefit such as a health or energy cost reduction. Presenting the energy-efficiency of appliances as a result of broader technological advantages is more effective in creating sustainable purchases than emphasising the communication on the products' environmental friendliness.
Design should and can counter the bias and negative performance perceptions of sustainability. Consumers perceive the smaller energy-efficient motors in appliances often as less robust and powerful than energy-inefficient ones. Design can counter this perceived underperformance of sustainability with additional volume and weight which both have only a minor effect on the environmental cost. Sustainable utilities should perform as well and still look robust and powerful as less sustainable variants. Sustainable shoes without leather should be also just as comfortable, breathable and fashionable.

Unfortunately, the study after recommendations of buyers of sustainable vacuum cleaners showed sustainable buyers are less positive in their recommendations compared to those who bought unsustainable versions. This makes owners of energy-efficient appliances ineffective in promoting sustainable alternatives, increasing green trust or changing social norms. Differences in satisfaction ratings are not caused by the differences in the energy efficiency of the products but by the differences in the products' perceived performance, ease of use and value for money. These are all independent of the input power of vacuum cleaners. Additionally, irrespective of the energy efficiency of the vacuum cleaners, higher suction power and increased weight positively mediate the recommendations. Focusing design and communication on these aspects rather than on energy efficiency alone can reduce the perceived green risk and increase green trust in sustainable products.

For energy consuming durables, often the largest part of their environmental cost is realised during the use phase. Eco-design legislation to increase the energy efficiency of appliances and cars prescribes the use of eco-settings to reduce energy consumption. Most of the eco-settings usage is optional and, in most cases, defaults to the unsustainable settings after they are switched off. The washing machine study

shows only a few percentages of the theoretical energy savings from the eco-setting being realised. The focus of legislators has not been on user behaviour and the effectivity of these energy efficiency measures. The washing machine study shows energy inefficient users consume three times as much energy as energy efficient users (Chapter 5). The comparison of different design for sustainable behaviour interventions showed elimination of the unsustainable settings, combined with feedback on energy consumption to be far more effective in reducing energy consumption. Design interventions are cost efficient to implement and an effective addition to the technological innovations in motor adaptions and insulations. Feedback also teaches new behaviour.

Sustainability should be implicit and not explicit if it is not relevant for the products' performance or image. By focusing design and communication on consumer relevance and behaviour, this thesis highlights that it is possible to increase sustainable consumption among mainstream consumers.

Samenvatting

Duurzame marketing tracht al meer dan 50 jaar het aandeel van duurzame consumptie te vergroten door het promoten van 'groene' producten bij 'groene' consumenten. Hoewel de meeste consumenten op dit moment aangeven duurzamer te willen consumeren, omvat het aandeel duurzame aankopen nog steeds slechts enkele procenten. Om een zinvol verschil te kunnen maken in de strijd tegen klimaatopwarming, de schaarste van grondstoffen en de biodiversiteit is het noodzakelijk om niet alleen de 'groene' consumenten maar ook de 'doorsnee' consument te motiveren duurzaam te consumeren. In dit proefschrift is onderzocht hoe bij het meerendeel van de consumenten een gedragsverandering kan worden bereikt. Zowel tijdens het aanschaffen als het gebruik van producten. De aandacht is daarbij gericht op duurzame goederen. Goederen waarvan de levensduur langer dan een jaar is, zoals witgoed, meubels en schoenen. Dit zijn productcategorieën waarvoor stoppen met consumeren onwaarschijnlijk is. Wanneer producten niet langer gerepareerd kunnen worden zullen ze worden vervangen.
Dit proefschrift onderzoekt waarom sommige consumenten duurzame producten aanschaffen en anderen juist niet. Voorts wordt onderzocht of doelgerichte communicatie en ontwerp dit kan beïnvloeden. Het voornemen om duurzaam te consumeren blijkt geen garantie voor duurzaam gedrag maar is ook niet per se noodzakelijk. Alleen gedrag is van belang. De redenen die leiden tot de aanschaf van energie efficiënte stofzuigers maakt dat duidelijk. Drie van de vier consumenten koopt een energie efficiënt model om andere redenen dan milieuvriendelijkheid. Dezelfde redenen als door kopers van een inefficiënt model stofzuiger zijn aangegeven.

Voor consumenten van stofzuigers of schoenen is duurzaamheid geen belangrijk aankoopcriterium. In tegendeel, er is sprake van het vooroordeel dat duurzaamheid ten koste gaat van de waargenomen kwaliteit, modieusheid of prestatie van het product. Pas als aan alle belangrijkere aankoopcriteria is voldaan gaat duurzaamheid waarde toevoegen. Dit geldt voor zowel "gevoels"-producten als schoenen en kleding en "denk"-producten zoals gereedschap en huishoudelijke producten. De hoogste koopintentie voor duurzame schoenen werd gerapporteerd wanneer het benadrukte voordeel op persoonlijke relevantie werd gecombineerd met een groene lay-out.
Duurzaamheid en milieu zijn voor de meeste consumenten abstract, afstandelijk en daardoor moeilijk in te schatten dan of de aanschaf een oplossing biedt voor het

waargenomen probleem. Het beoordelen van het milieueffect van een alternatief is voor een leek moeilijk, zo niet onmogelijk te doen. Het resultaat van de overwegingen is vaak afhankelijk van de specifieke omstandigheden en is soms contra-intuïtief wat kan leiden tot verminderd vertrouwen in duurzaamheid. Om duurzame producten ook aantrekkelijk te maken voor de doorsnee consument is het van belang om de communicatie en het ontwerp te richten op het hoofdaankoop argument van de consument. Biedt duurzaamheid wel aan, maar richt de boodschap en het ontwerp op het nut en de behoeften van de klant of gebruiker. Communicatie over duurzame producten is het meest effectief wanneer de persoonlijke voordelen worden gecombineerd met een relevant duurzaam voordeel zoals gezondheid of besparing op energiekosten. Het blijkt echter effectiever om een energie efficiëntere stofzuiger te verkopen, door de boodschap te richten op de technologische vooruitgang die ook nog eens leidt tot energiebesparing, dan nadruk te leggen op milieuvriendelijkheid. Voor ontwerpers betekent dit dat negatieve vooroordelen en percepties van duurzaamheid moeten worden gecompenseerd in een ontwerp. Energie efficiëntere stofzuigermotoren zijn kleiner en lichter waardoor het eindproduct als minder krachtig en fragieler wordt waargenomen. Het ontwerp kan de waargenomen onder-prestatie compenseren met extra toegevoegd volume en gewicht. Duurzaam gereedschap en witgoed moeten net zo goed presteren en er net zo krachtig uitzien als de minder duurzame varianten. Duurzame schoenen zonder leer moeten net zo comfortabel, ademend en modieus zijn.

De studie naar de aanbevelingen van kopers van duurzame huishoudelijke apparaten laat zien dat de kopers van energie efficiënte stofzuigers minder positief zijn dan kopers die een minder energie efficiënte versie hebben aangeschaft. Dit maakt bezitters van energie efficiënte stofzuigers helaas minder effectief in het promoten van duurzame alternatieven, het vergroten van het vertrouwen in duurzaamheid en het veranderen van de sociale norm betreffende duurzaamheid. Het verschil in waardering tussen de energie efficiënte en inefficiënte stofzuigers wordt niet veroorzaakt door de energie efficiëntie maar door een verschil in de waargenomen zuigprestatie, gebruiksgemak en prijskwaliteitsverhouding. Het verhogen van de zuigkracht en het gewicht werken beide positief op de hoogte van de aanbevelingen en zijn beide onafhankelijk van het energieverbruik. Door reclame-uitingen en het ontwerp, anders dan op milieuvoordelen, te richten op de prestatie van het product en de voordelen voor de consument kan het waargenomen risico van duurzame

producten worden verminderd. Met als gevolg dat het vertrouwen in het duurzame product zal toenemen.
Voor energie verbruikende duurzame producten zoals witgoed wordt de grootste milieubelasting veroorzaakt tijdens het gebruiken van het product. Eco-design wetgeving en het invoeren van eco-standen heeft geleid tot hogere energie-efficiënte van apparaten en auto's. De meeste van deze eco-standen zijn echter optioneel te gebruiken en resetten zich in de energie-verslindende-stand nadat het apparaat is uitgezet. Met gevolg dat slechts een klein deel van de besparing wordt gerealiseerd.
De wasmachine studie toont aan dat slechts een paar procent van de theoretische energiebesparingen wordt gerealiseerd aangezien de eco-standen zelden worden gebruikt. De aandacht van de wetgevers is te weinig gericht op het consumentengedrag en de effectiviteit van de genomen maatregelen (regelgeving). De studie (hoofdstuk 5) toont een verschil in energiegebruik tussen de meest energiezuinige en -onzuinige consumenten van een factor drie. Een vergelijking tussen verschillende ontwerpinterventies die gericht zijn om duurzaam gedrag te sturen toont aan dat het forceren van energie-efficiëntie standen, in combinatie met feedback het meest effectief is in het reduceren van energieconsumptie. Deze interventies zijn bovendien kosteneffectief en tevens een effectieve toevoeging op technologische innovaties zoals bijvoorbeeld motorische aanpassingen en isolatie. Feedback leert bovendien nieuw gedrag aan.

Duurzaamheid moet impliciet en niet expliciet zijn indien duurzaamheid de hoofdredenen van aanschaf niet direct ondersteunt. Deze dissertatie toont aan dat door het ontwerp en de communicatie te richten op de noden en wensen van een bredere consumentgroep, het mogelijk is om het consumptief gedrag van de doorsnee consument ten verduurzamen.

Abbreviations

EU	European Union
DfS	Design for sustainability
DfSB	Design for sustainable behaviour
LCA	Life cycle analysis
NPS	Net promotor score
PBC	Perceived Behavioural Control
PhD	Doctor of philosophy
RQ	Research questions
SC	Sustainable consumption
TPB	Theory of planned behaviour
TU Delft	Delft University of Technology
UNEP	United Nation Environment Programme
VBN	Values-Beliefs-Norms theory

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1 Introduction: mainstreaming sustainable consumption

1.1 Problem background

For decades, the world recognises the need for sustainable consumption. The Club of Rome (Meadows et al., 1972) already warned of the effect of unsustainable growth in the 1970s; Planet Earth is unable to accommodate us if we continue the path of consumption beyond the limits of our resources. Legislation to increase resource and energy efficiency has been implemented around the world. Awareness of the environmental problems and its causes are high. In the EU 68% of consumers agree that their own consumption habits are affecting the environment in Europe and the rest of the world (European Commission, 2020). Four out of five consumers think industry is not doing enough to protect the environment. The respondents' top two perceived effective ways to tackle the problem are changing the way we produce and trade and changing the way we consume. This sounds promising; however, in 2021, the size of sustainable consumption was still in the lower percentages. More than four out of five Scandinavians are concerned about the environment, yet only 10–15% state they buy green products on a regular basis (Mont et al., 2014). In 2019, only 8% of all consumer product sales in Germany had an eco- or energy efficiency label (German environment agency, 2021). In 2020, only 11% of the sold cars in the EU were electric (European Environment Agency, 2021). Efforts to reduce the impact of products on the supply side through resource and energy efficiency have not been able to significantly reduce the footprint of consumption. Since 2010, the footprint of the EU has been growing by 4% (Sala & Sanye Mengual, 2022). According to a 2020 International Energy Agency report (IEA, 2020) on energy supply, the rest of the world is not progressing any better. By far, the largest part of Dutch consumers' environmental footprint is caused by the products they consume (Bergsma et al., 2020), as in Figure 1.1. Without a doubt, sustainable consumption is not growing fast enough.

Although the intent to consume more sustainably is there, sustainable behaviour is still relatively low and likely driven by green consumers. However, sustainable consumption of only a few green consumers is not enough to put a dent into the consumption footprint. More sustainable consumption patterns should be encouraged on the demand side. It would make a significant difference when the mainstream consumer, with the prevailing attitudes and values of society (definition mainstream from Merriam-Webster), would act on their intent to consume more

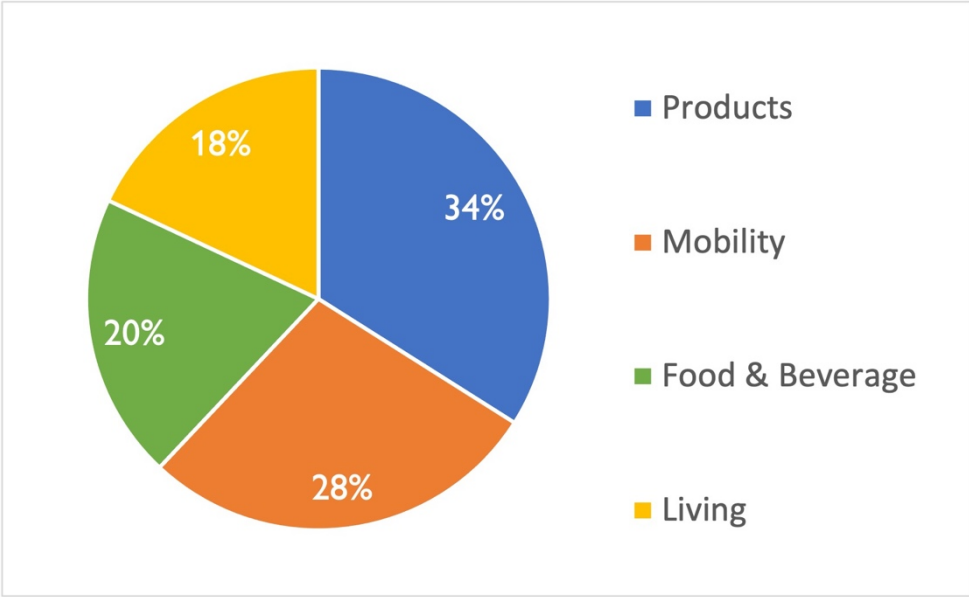

Figure 1.1: Sector share in the environmental footprint in the Netherlands

sustainably. Having the intent to consume more sustainably is not enough, so the main questions of this thesis are why mainstream consumers do not act on their intentions, and how can mainstream consumers be steered towards behaving more sustainably. This thesis addresses these questions in four separate studies.

This introductory chapter continues with a discussion on sustainable consumption and customer behaviour and the reasons for the intent–behaviour gap. Further, it discusses the status quo on research on marketing, communication and design in respect to increasing sustainable consumption. This chapter continues with the definition of the problem, the scope and the research questions and ends with an outline of the thesis.

1.2 Sustainable consumption

There are different definitions of sustainable consumption (SC) found in literature (Jackson, 2005; Mont & Plepys, 2008; Tunn et al., 2019; United Nations Environmental Programme, 2010). One line of scholars' views unsustainable consumption as a result of production problems, and they state the problems can be remedied by technological solutions and eco-efficiency of production systems. Other scholars concentrate the focus on the demand side and see greening the

market as a solution. Then, there is a line of literature that is convinced consumers would act more sustainable when they are better educated and informed by ecolabels, and there are scholars who promote reducing consumption and simpler lifestyles in developed countries as the only solution (Mont & Plepys, 2008). It can be expected that the last line of thinking (de-consumption) will not be an effective option for many durable products such as household appliances that, in developed countries, are considered a need rather than a want. This is shown by the inventory of the members of the consumer panel run by the TU Delft. In 2014, nearly all of the TU Delft's 1386 members owned a fridge, washing machine, vacuum cleaner, steam iron and coffee machine (Tan, 2014). An inventory by Cabeza et al. (2018) showed other countries from the US to China show similar penetrations. A workable definition of sustainable consumption is defined by Tunn et al. (2019) who defined sustainable consumption as satisfying consumer needs while reducing negative impacts caused during material extraction, production and consumption with the addition that this needs to be considered over the lifetime of the product or service including the end-of-life phase and material recovery.

Except for the option of reducing consumption, the thinking of industry is in line with the above ideas (WBCSD, 2008, 2021). Both industry and scholars have been mainly focusing on the supply side by reducing the impact of extraction, production, distribution, transport and end of life of products and services. This was done mainly by reducing the impact of products and services through energy and resource efficiency and technological and business model innovations (such as the circular and sharing economies).

Only recently is there more interest in the demand, or consumer, side of sustainable consumption. The low percentage of sustainable consumption suggests that, at present, sustainable alternatives are not perceived as attractive to potential customers. The goal of many industries is growth (Jackson, 2009); therefore, industry has been focusing on effective marketing and selling sustainable products. However, there seems to have been less interest in how products are used. A significant part of possible sustainable gains can only be realised when products are used in a sustainable manner. This thesis examines both sustainable buying and use.

1.2.1 Sustainable behaviour

Most consumers say they would prefer to consume sustainable products, so it seems the intent to buy more sustainable goods is there, but what is the value of that intent if it does not materialise in consumer behaviour? Environmental cost are often context dependent (Vogtlander et al., 2009), which makes it, for a typical customer in a specific situation, hard to judge what would be the most sustainable buying option available in the current situation. Further, consumers find the consequences of their behaviour on the future difficult to grasp (Carrington et al., 2010). This makes rational sustainable choices hard, if not impossible, to make when dealing with sustainable consumption. Models, such as the theory of planned behaviour (TPB) or the values-beliefs-norm (VBN), seem more promising in explaining how consumers buy either sustainable or unsustainable goods than the rationality model (Jackson, 2005; Williamson, 2018). Research's focus on behaviour is strongly influenced by the TPB (Ajzen, 1991), and it is also an often-used framework to research sustainable behaviour (Fishbein & Ajzen, 2009; Kalafatis et al., 1999; La Barbera & Ajzen, 2020; Rex & Baumann, 2007). The TPB as well as the reasoned action model (Fishbein & Ajzen, 2009) in Figure 1.2 suggest that the sustainable purchasing intentions of consumers are driven by their sustainable attitude and past behaviour, moral norms in their social environment, internal ethics, perceived behavioural control (PBC) and effectiveness of the sustainable action to take. Perceived behaviour control mediates the change from intent to

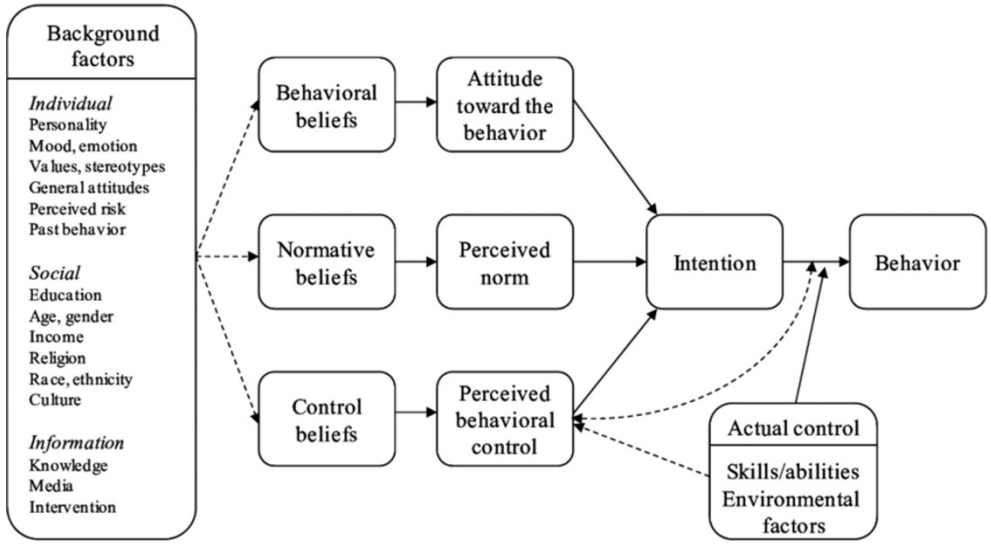

Figure 1.2: Schematic presentation of the reasoned action model

behaviour not only directly but also via actual control, skills and abilities and environmental factors. These experienced factors in their turn also influence PBC, thereby creating a loop that strengthens future sustainable behaviour in other situations and contexts (Whitmarsh & O'Neill, 2010). While testing intent to prevent food waste and reduce energy consumption, La Barbera and Ajzen (2020) found the predictive power of attitude in relation to intention increased with the PBC. When the PBC was low, subjective norms predicted intention better than when the PBC was high. Others found ethics are only considered as a selection criteria when the main criteria are met (Eckhardt et al., 2010).

The VBN theory (Stern et al., 1999) on the other hand posits that personal values influence consumers' awareness of the environmental consequences of consumption, which in turn impacts the sense of responsibility and the personal norms regarding the environment. This finally leads to more sustainable behaviour (Barbarossa et al., 2017). This theory is especially valuable in creating intent in the buying phase. Barbarossa et al. (2017) found that the intent to buy an electric car, a high-involvement product, directly influenced green self-identity as well as indirectly via teleological (functional) and deontological (moral) motives. Green self-identity itself was highly dependent on the individual values of self-transcendence, self-enhancement and conservation. To be effective in creating and promoting sustainable products, these values should be segmentised and communicated to the targeted consumers. Chen and Chang (2012) showed green perceived value increases green trust buying intention where green risk lowers them. Green trust also mediates green perceived value and risk. However, there is ample research that shows sustainability often comes at a perceived cost of performance, quality or price and at a perceived risk (Dangelico et al., 2021; Liobikienė & Bernatonienė, 2017; Rex & Baumann, 2007).

The above research has shown how to increase intent but has not delivered an explanation for how to change this intent into actual behaviour. The intent to buy sustainable goods is for most consumers not always a relevant factor because sustainability, like price, is seldom the main reason for consumers buying a product.

Literature indicates that consumers' motives for buying a specific product relate strongly to their reasons for buying. Ratchford and Vaughn (1989) described that products can be divided into a 'think' or 'feel' product category. The motivation to buy a 'think' product for utilitarian reasons to solve a problem or normal depletion

lies at the functional level rather than at the psychosocial consequences when buying 'feel' products (Claeys et al., 1995). Buying 'feel' products are motivated by a sensory gratification or triggered by adhering to social norms because the sustainable cost of a product choice is, for the average customer hard to judge since sustainability is considered a psychosocial attribute not only in 'feel' but also in 'think', or high-involvement, products. These decisions are fast, intuitive, automatic and emotional, whereas decisions regarding 'think' products and performance attributes are slow, controlled, deliberative and analytical (D. Kahneman, 2011). Consumers make ethical decisions on a more emotional than rational level, which might also explain why sustainable knowledge does not predict more sustainable behaviour (Ellen, 1994; Heeren et al., 2016).

There is a dissonance between cognitions about attitudes and cognitions about behaviour. Since it is harder to change cognitions about one's behaviour, cognitive dissonance theory (Festinger, 1957) would predict that people are more likely to seek to reduce cognitive dissonance through changing their ideas about their attitudes and finding excuses (McDonald et al., 2015).

When actions are frequent, they can become habits. Strong habits showed a barrier between intent and behaviour whereas weak habits are not (Verplanken et al., 1998). When the behaviour is sustainable, this is ideal news because the behaviour will persist; however, when the behaviour should change, this is a barrier. People are loss averse and reluctant to leave the status quo (D. Kahneman et al., 1991). An example of this are self-declared environmentalists who fly because they face competing norms (i.e. flying harms the environment versus flying is normal) (McDonald et al., 2015). Intervention to break habits can be the implementation and repeating of new habits to make them continue. This is a long-term effort, which can include policies such as education, taxes, incentives or restrictions (Verplanken & Wood, 2006).

The next two sections investigate sustainable behaviour in the buying phase and use phase, respectively. In energy consuming appliances, the use phase accounts to a major part of environmental cost.

1.2.2 Communicating sustainable products

Market researchers' first interest in sustainability dates from the 1970s when it was referred to as 'social marketing' or 'societal marketing' (Kotler & Zaltman, 1971).

Societal marketing came under criticism for being undemocratic because marketers did not have the right to decide what is in the public's best interest (Abratt, 1989). In 1990, a Roper study accounted consumers with an intention to purchase greener products at about 20% of the US market (Roper Organization, 1990). Therewith, sustainable consumers were seen as a niche large enough to be addressed as a separate consumer group. In the 1990s, most of market research's effort was focused on segmentation of the green consumer market to find these green consumers and learn how they behave (Rex & Baumann, 2007). The green marketing strategy to focus on only green consumers and focus advertisements on the products' green credentials has not been effective in growing sustainable consumption. Conventional marketing (Kotler, 1991) does not limit itself to addressing only current buyers. When introducing new products, like the first iPhone or Tesla, there is often no existing consumer base. Ottman (1993) was one the first people to recognise that more sustainable products are best sold when their selling points are based on factors other than their sustainable credentials. It would be more effective to communicate sustainable product on the personal benefits for the consumer, when possible, linked to the environmental benefits (Ottman et al., 2006). Currently, many products are being designed and produced with more attention on their environmental impacts. In most cases, however, the more sustainable products are marketed as niche products to greener consumers and are promoted explicitly on their sustainable credentials. Environmentally friendlier options are only slowly becoming more retail space in mainstream retail.

Considering the construal level of theory of psychological distance, sustainability is a higher construal attribute (Liberman & Trope, 1998). Sustainability is a solution to a problem that is perceived as distal in time and abstract compared to the imminent personal problem preceding the buying processs. Customers' beliefs that they are, as an individual, able to make a contribution through their actions is the best predictor for environmental conscious behaviour (Roberts, 1996). However, scepticism about sustainable attributes is high, which reduces consumer willingness to buy sustainable options (Jäger & Weber, 2020). This is also a reason why Testa et al. (2016) conclude that traditional green marketing campaigns aimed at shifting consumer behaviour from unsustainable practices towards more environmental friendly actions may be not so effective.

Besides traditional communication, word-of-mouth is an important information source used by consumers to make their buying decisions (Oates et al., 2008). It is

not clear yet whether more trustworthy sources like recommendations and worth of mouth from family, friends, peers or online influencers might be more effective than traditional communication. Paul et al. (2016) found consumers feel that the approval of family and friends is not that important of a factor for buying green products. Consumers perceive that adoption of green products may not be socially acceptable behaviour. Danner and Thøgersen (2021), however, found that the salience of a sustainable topic in social media (e-Word of Mouth or eWoM) steers the choice for the organic alternative; they recommend focusing communication on sustainability. They also recommend that this is best done when focusing on verifiable benefits such as biodiversity for organic food.

Dangelico and Vocalelli (2017) concluded from their study that an evolution of green marketing occurred, moving from being a marketing tool addressing specific problems to becoming a strategy affecting a whole company and considering global sustainability issues. In other words, integrating sustainability into production and products and communicating a broader product offering for a mainstream consumer base versus focussing exclusively on the green consumer exclusively.

1.2.3 Sustainable use

Compared to researchers' interest in sustainable buying, the interest in the use phase of sustainable consumption has been limited mostly to design and Life Cycle Analysis (LCA) researchers. LCA calculates the environmental cost over a product's life cycle from the cradle to the grave. Legislators and businesses have been focusing on reducing resources, energy consumption, hazardous and polluting substances of products and production processes. However, how energy-efficient and sustainable products are being used by consumers was less of a focus.

From toys and kitchen appliances to bicycles and cars, ever more products are consuming electricity when used. These products are often frequently or permanently used, which makes unsustainable habits a major issue. Modern appliances are more energy efficient, but, if a user leaves the television on continually or uses an energy label A washing machine or dishwasher at the highest temperatures, the benefits are limited.
Changing habits is difficult. People are loss and risk averse and rather persist with the familiar than adapt new habits (Daniel Kahneman et al., 2016). It is estimated that 45% of our daily actions are habitual (Jackson, 2005). When in similar context repeatedly similar actions are taken, that context will trigger an habitual reaction

(Steg & Vlek, 2009). Habits make choices easy in a world that is often complex and full of choices (Verplanken & Wood, 2006). On one hand, consumers are reluctant to break habits and adopt new ways of use. On the other hand, forced breaks in habits can change behaviour also in the long term. Fujii and Kitamura (2003) showed that car drivers presented with a free month ticket for public transport still more frequently used public transport a month after than before starting the test.

Design for sustainability is viewed as an potential tool to enable more sustainable use or discourage unsustainable use (Lilley et al., 2005). This will often equate to discouraging or undermining unsustainable behaviour. There are a few slightly different approaches (Bhamra et al., 2011; Lilley et al., 2005; Dan Lockton et al., 2008; D. Lockton et al., 2013; Wever et al., 2008); although they differ in detail, they have similarities in how they are realising sustainable behaviour through design interventions. The design behavioural intervention model (Tang, 2010) links the variable stages of design intervention with habitual change. The interventions are ranked from substantial consumer power to adjust the product to function more or less energy-efficient to leaving limited or no power for the consumer to adapt the product.

Examples of environmental interventions that leave power to the product user are the eco-buttons, energy-efficient defaults and eco-feedback. Eco-buttons are for instance used on dishwashers and washing machines. When the eco-buttons are used consumers reduced energy consumption by about 10% in cars and 40% in washing machines. An example of energy-efficient defaults is in cars that automatically switch the engine off when the car is stalling or reduces its acceleration. These defaults are most effective when the default is the energy-efficient setting and consumers can forget about it all together. Eco-feedback is a powerful design intervention to shape new behaviour since it saves decision time and the setting comes with the recommendation of the provider. In all three cases, the customer maintains their freedom to make other choices.

Among the interventions that leave no option for unsustainable use is coercion where unsustainable use is made impossible or sustainable use is integrated in ‘clever’ design. In this case, the product adjusts its settings automatically to the circumstances. For example, a sensor in the dishwasher measures the dirt level of the dishes and adjusts the temperature and duration accordingly. Scripting of use protocols guides the user towards sustainable use by combining the above options.

Bhamra et al. (2011) highlighted that there are no standard design rules, as each product demands different solutions. Also, what was is considered an acceptable intervention by the public might shift in time. There is a need for more research after the effectiveness of the design interventions.

1.2.4 Interventions for sustainable behaviour

The above literature and the work of White et al. (2019) presents possible interventions to change toward more sustainable behaviour in both the purchasing as well as in the use phase of consumption. These are summarised in Table 1.1 on the next page.

Table 1.1: Intervention options in purchasing and use phase per intended change

Intended change	Purchasing	Using
Changing the social norm	Positive word of mouth; recommendations; lead by example	Feedback on what peers do
Breaking habits-making new habits	Integrate sustainability in all available options by choice editing, incentives, prompting, technology innovation that makes the sustainable habit easier than the unsustainable one	Feedback on consumption or what peers do; scripting to support sustainable habit. Default is the new habit recommended by the provider
Making consequences of consumption visual	Eco- and energy labels; carbon tax	Feedback; gamification
Supporting maintaining sustainable choices	Positioning sustainable options front stage; make sustainable behaviour easiest; legislation and carbon pricing	Default the sustainable option; coerce sustainable use
Increasing relevance to the individual	Communicate sustainable options on personal benefits	Feedback on personal benefit
Increasing green trust and reduce risk	Design on performance of main buying criteria; consumer testing; word of mouth and recommendations	Feedback on cost; scripting for performance
Reducing temporal and spatial discounting	Communicate on the next generations; kids and grandchildren and benefits for the direct environment	Short loop feedback; script out unsustainable behaviour
Teaching new behaviour	Share comprehend information related to social norm, self-values, self-benefits and self-efficacy	Feedback; make links to comparable products and actions

1.3 Problem definition

Summarising Section 1.1, green marketing strategies have not been very effective in growing sustainable consumption beyond the minority of green consumers. For both future generations and the environment, mainstream consumers need to transform into sustainable consumers. Customers seem reluctant to accept the widely available sustainable options currently on the market. When customers should consume more sustainable than in the past, it makes sense to look at those moments in the value chain where the consumer had most influence on sustainable consumption (i.e. the buying and the using of the product). The use phase is especially important for the environmental cost of products that consume energy. The use phase of appliances can make up 75%–80% of the environmental cost during their life cycle. Another area of interest is whether current consumers of sustainable products are effective in word of mouth to convince others of the value of the more sustainable options. When sustainable consumers are at least as positive in their recommendations they would slow but steadily convince more people to consume like they do. This seems not to have been a research topic yet.

1.4 Research questions

Pertaining to Section 1.1. and the problem definition in Section 1.2, the central questions were how to increase sustainable buying and using among mainstream consumers, and how can design and communication contribute to this. There are a few moments in the value chain when consumers of durable products can be influenced in their consumption: buying and using products. The hypothesis is that sustainable consumption can be increased through more effective communication and targeted design to increase the consumer value of sustainable products both in the buying phase as in the use phase. This leads to the underlying research questions (RQ) of this thesis:

RQ1: How to communicate to increase trust in sustainable products and personal relevance for mainstream consumers?

RQ2: How to design to make energy-efficient options more relevant to mainstream buyers?

RQ3: Would recommendations from sustainable buyers be an effective tool in creating trust and changing the social norms towards more sustainable buying?

RQ4: How effective are design for sustainable behaviour interventions in steering sustainable appliance use?

1.5 Scope of the thesis

When the aim is to get more consumers to consume sustainable, it makes sense to focus on the following steps in the value chain;

1. Communicating the sustainable products' offerings.
2. The selection and buying of the sustainable product, when different offerings and recommendations are being weighted and a final choice is made.
3. Using the sustainable product in a sustainable manner
4. Recommending the sustainable product

Figure 1.3. gives a schematic overview of the scope of the research.

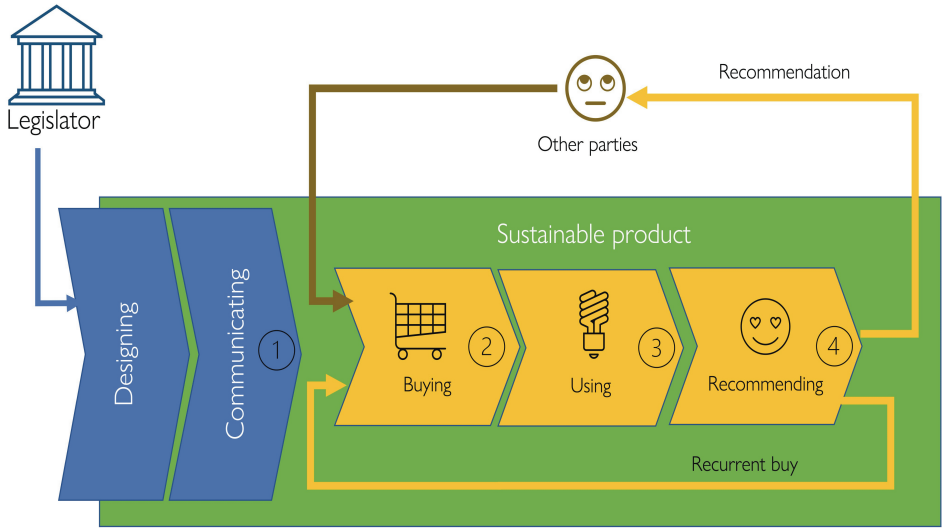

Figure 1.3: Scope of the research. The numbers refer to the articles

Although the product's end of life has an influence on the sustainable burden of a product, it is taken explicably out of the scope while recycling options are not only individually but also highly geographically dependent.

1.6 Method

In this research, different research methods are used: experimental and consumer survey data. To compare the effect of different independent variables in communication design (Chapter 2) and test the effect of different sustainable design interventions on energy consumption (Chapter 5), two experiments were conducted. For comparing the differences in buying criteria (Chapter 3) and recommendation (Chapter 4) between consumers of both energy-efficient and inefficient appliances, the consumer survey data of 888 Philips vacuum cleaner buyers is used. The buyers of the Philips products were asked to register their product for warranty; while doing so, they were also asked whether they would answer a few additional questions regarding their buying criteria. After three months, the same buyers were asked how likely they were to recommend the product to friends and family, and why.

1.7 Outline of the thesis

This first chapter described this thesis' topic, context, problem definition and RQs. Chapter 2 until Chapter 5 discusses integral texts from peer-reviewed publications. Each of the chapters begin with citations and end with a description of the contributor of this thesis and the other authors. The numbering of the sections is adapted to that of this thesis, and when additional text and figures are applied, this is made explicit.

Chapter 6 discusses the results from Chapter 2, Chapter 3, Chapter 4 and Chapter 5 in relation to the RQs, and it also presents recommendations for designers and marketers as well as recommendations for future research. Chapter 7 presents the conclusions of the research.

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2 Publication 1: Communicating sustainability

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2.1 Abstract

Traditionally marketing of sustainable products addresses green buyers, thus missing out on the mainstream consumers and volume necessary to cover the potentially higher cost of more sustainable materials. However, how to effectively communicate more sustainable products to mainstream consumers and to increase their buying intention is still underexplored. Combining personal and environmental benefits, called double benefit theory, is promoted as an effective green marketing strategy but so far not supported by quantitative research as being effective to reach mainstream consumers. We studied the effect of advertisement elements (layout colour, benefit type, and heritage) on the products' perceived sustainability, quality and fashion image, and buying intentions of mainstream consumers. Two hundred adults participated in a study that was based on a 2 (red vs. green layout) × 2 (personal vs. environmental benefit) × 2 (local vs. global heritage) between-subjects factorial design of a sustainable shoe advertisement. The impact of these independent variables on product image as well as on buying intention was analysed by means of three-way ANOVAs. In line with the double benefit theory, combining a personal benefit with a green layout led to the highest buying intention. Moreover, a mediation analysis revealed the effect of emphasizing a personal benefit on buying intention was mediated by fashion image but not by sustainability. Sustainability, however, did have a positive effect on buying intentions independent of benefit type.

Keywords: marketing of sustainable products; sustainability; double filter; buying decision; linked benefit; fashion; product image

2.2 Introduction

Green marketing (Ottman, 2011; Peattie & Crane, 2005) has been a research topic since over thirty years (Hartmann et al., 2005; Leonidou & Leonidou, 2011). Focusing mainly on developing marketing strategies to approach the green consumer population it was not meant or not able to attract the mainstream consumer. A study by the United Nations Environmental Programme (2005, p. p.

15) (UNEP) reports that only 4% of consumers actually buy sustainable products, this is in stark contrast with the 40% who stated that they were willing to buy more sustainable products. The Natural Marketing Institute published that although 16% of the consumers indicate that they are willing to pay 20% more for a product that is produced in a sustainable and environmentally friendly way (Natural Marketing Institute, 2012, page 4), in reality even fewer consumers deliver on that promise (Kalafatis et al., 1999). The market for greener products is under-exploited by marketers (Pickett-Baker & Ozaki, 2008). There appears to be a potentially much larger market for sustainable products if the mainstream consumer could be reached. This would make higher sales volumes possible, which are necessary to cover the potential extra cost to produce in a more sustainable and a more environmentally friendly way. Although there is extensive qualitative research in green marketing publicized (Hartmann et al., 2005; Leonidou & Leonidou, 2011), practical guidelines for the successful advertising of sustainable products substantiated by quantitative research are scarce, especially for marketing towards mainstream consumers. This makes effective advertising of sustainable products difficult.

We tried to bridge part of this knowledge gap with this research, performed as part of a project for the shoe manufacturer Bata Brands S.A. (further called "Bata") to develop the sustainable Bata shoe of tomorrow, targeting mainstream adults. Practical guidelines were needed to communicate the characteristics of the sustainable shoe collection in advertisements. The family-owned footwear retailer and manufacturer, founded in 1894 in the Czech Republic, operates on five continents. Striving to "think global, act local", the company designs, produces and sells most of its products in the emerging markets locally in addition to producing for the developed markets. Bata sells "value for money", serving in most countries the low and medium price segments of the market with a broad variety of shoes. Since its founding, the company has developed a heritage of being a socially responsible company; they have been building housing and schools for employees all over the world since many years. This long heritage on both a global and a local level is a unique feature among shoe producers. We took Bata as a case study to discover how to communicate a sustainable product effectively to the mainstream consumer. In our research we investigated how graphical and textual elements of an advertisement for sustainable shoes can influence the perceived product image and the buying intention of mainstream consumers.

2.3 Marketing and advertising of sustainable products

2.3.1 Green marketing evolves in marketing greener products

Since the 1970's green marketing has been the subject of many, mainly qualitative research papers (Leonidou & Leonidou, 2011). In the literature, the marketing of sustainable or environmentally friendly products is often mentioned in combination with the terms "disappointing consumer response" and "mistrust" (Peattie & Crane, 2005; Rex & Baumann, 2007). Researchers were holding the industry responsible because "some organisations appeared to exploit" consumers' increased environmental awareness without modifying their products or processes and committed "green washing" (i.e. providing disinformation disseminated so as to present an environmentally responsible public image). In response, the introduction of eco-labels was promoted as a solution to make it easier for consumers to differentiate environmentally friendly products from the rest (Mendleson & Polonsky, 1995), based on the idea that better-informed customers would change their buying behaviour (Ottman, 1993). Still, many of these measures did not live up to the expectations with disappointing increases in sales volume of sustainable products.

Peattie (2001) points out there is no such thing as a 'green consumer', there is only green purchasing behaviour; that is, only if products are otherwise equal most consumers would prefer the green option. Most consumers are purchasing both 'green' and 'grey' (without environmental benefits) based on trade-offs not only between conventional issues like price and availability but also between green credentials like organic or recycled content (McDonald et al., 2012). The view that there is no dedicated segment of green consumers is supported by Schuhwerk and Lefkoff-Hagius (1995) who found that both low and high level environmentally involved persons do not differ in purchase intent for green laundry detergent, regardless of whether the advertisement focused on cost-saving or on environmental attributes. Following this result, they concluded it unnecessary to separate advertising campaigns to target different segments of green consumers when selling sustainable products.

More recent publications therefore state that sustainable marketing should focus on the whole marketing mix (product, place, price and promotion) instead of on the products' sustainable specifications alone (Rex & Baumann, 2007). When customers enter a (web) store, they first look for products that meet their basic

needs, make them happy or feel attractive, taste good, perform well, and so on. When these qualities are met for the right price in the right place, consumers then seek products that best communicate their environmental beliefs to finalise their purchase decision. This layered decision-making process is described in the double filter theory (Vogtländer et al., 2002). In line with this theory, quantitative research on eco-fashion by Niinimäki (2010) showed eco-aspects can only add value to the product if the product is otherwise attractive, particularly in the fashion and luxury industry. Fashion is a challenging product category in sustainable marketing; consumers differ in their expectations and beliefs on how much impact their sustainable choice makes and how much effort their sustainable fashion shopping takes (McDonald & Oates, 2006). For instance, the effort it takes may differ depending on whether one shops for casual or business attire based simply on the fact that sustainable options are more readily available for the former than the latter. Also, the impact a more sustainable option has on the environment might be perceived differently in both cases.

Ottman et al. (2006) was one of the first to recognise people seldom buy sustainable products for the sake of sustainability alone and therefore suggested to highlight the added consumer value over and above sustainability both in product attributes and in marketing. This is later referred to as linked (Wever et al., 2009) or double benefit (Vogtländer et al., 2013), as in combining the sustainable product with personal benefits. Ottman named five typical personal benefits for sustainable products: efficiency and cost effectiveness; health and safety; performance; symbolism and status; and convenience.

The explanations and recommendations in the above-mentioned literature are valuable but abstract for practitioners in marketing, especially when marketing towards a larger mainstream consumer base rather than to green buyers exclusively. There is also little quantitative support that these theories lead to increased buying intentions, more sales, or higher prices, except for recent research on organic food (van Doorn & Verhoef, 2011, p. 172), which indicated that overall there is a significant willingness to pay on average 6% more for food products with an organic claim and that this percentage is higher for vice products (such as soft drinks and beer) than for virtue products (dairy, vegetables). This finding is in contrast with average demanded price premiums of 30% for virtue and 60% for vice organic food products.

The research reported in this paper addresses the question of how to more effectively communicate sustainable value and thereby raise interest in sustainable products. Specifically, how elements of print advertisements can be manipulated to alter perceived product images and to increase consumers' buying intentions.

2.3.2 Advertising sustainable products

Advertisement designs use diverse graphical and textual elements, and impact, interaction and dependency of these elements is complex. However, three elements are frequently mentioned in research regarding the advertisement of sustainable products and were selected as our independent variables: colour of the layout (red vs. green), communicated benefit (personal vs. environmental), heritage (local vs. global).

Colour of the advertisement layout

An American research report (Grail Research, 2011) published a list of brands perceived as sustainable by American consumers. The brands have one common feature: all use the colour green and natural graphics as a dominant graphical element in their advertisements. The use of abundant green vegetation and clear water is a universal standard in green advertising (Hartmann & Apaolaza-Ibáñez, 2013) and used to construct a positive sustainable brand image. However, the dominant colour in traditional Bata advertisements has always been red, aimed at creating a cosmopolitan brand image. Therefore, the first independent variable is the effect of the colour of an advertisement layout. Previous quantitative research by Hartmann et al. (2005) revealed a positive correlation between purchase intention and emotional (i.e., catering to the senses) green advertising. Thus we hypothesize;

H1: When advertisements are based on a "green layout" as opposed to a "red layout", participants will report higher buying intentions.

Environmental versus personal benefit

People seek benefits from the products they buy. For sustainable products these are likely both environmental (e.g., protect the environment) and personal. From the five suggested personal benefits related to sustainable products as suggested by Ottman et al. (2006), healthy feet appear to be the most applicable personal benefit for the low and medium segment-positioned Bata shoe brand. Because of the low importance given to the environment as a buying criterion for shoes (Vogtländer et

al., 2013), we expect people to rather buy shoes on personal benefit than on environmental benefit. Thus, we hypothesize:
H2a: When advertisements emphasize a personal benefit (e.g., "protects your foot health") as opposed to an environmental benefit (e.g., "protects the environment"), participants will report higher buying intentions.

One of the green marketing strategies mentioned in publications (Ottman et al., 2006; Vogtländer et al., 2013; Wever et al., 2009) is called the double-benefit strategy. This strategy proposes marketing of sustainable products to be more successful if the sustainability of the product (e.g. the green layout) is linked to primary personal benefits of individual consumers because the environmental benefit alone is seldom the main reason for buying a product. If the double-benefit strategy is valid, the buying intention will be highest when a green layout is combined with a personal benefit, thus addressing sustainability in an indirect way and the personal benefit directly. Thus, we expect:
H2b: Participants report the highest buying intentions when presented with the personal benefit combined with the green layout.

An important aspect of sustainable products is that consumers can have negative associations with sustainable products (Hartmann & Ibáñez, 2006); consumers are not easily convinced that sustainable products are of good quality regardless of whether the product is a sustainable tyre (Luchs et al., 2010) or food with an organic claim (van Doorn & Verhoef, 2011). Luchs et al. (2010) showed for tyres that emphasizing the sustainability claim could result in a negative quality image. The high relevance of quality in the buying process of tyres is similar to the high importance of the shoes' fashion image as a buying criterion for shoes (Vogtländer et al., 2013). Also, Meyer (Meyer, 2001) reported in his case studies (Coop NaturaLine organic cotton and Patagonia's Post-consumer recycled fleece) a lower perceived fashion image for eco-clothing. Thus, we expect:
H2c: When advertisements emphasize an environmental benefit (e.g., "protects the environment") as opposed to a personal benefit (e.g., "protects your foot health"), participants will rate the shoes lower in its perceived fashion image.

One of the elements seen as making green marketing successful is that customers need to be convinced of the product's environmental benefits and its superior sustainability image (Peattie, 2001) to consider buying it. The rationale of the emphasis on environmental benefit in green marketing is to help the consumer to

better recognise the sustainable value of products (Hartmann & Ibáñez, 2006). Thus we expect;
H2d: When advertisements emphasize an environmental benefit (e.g., "protects the environment") as opposed to a personal benefit (e.g., "protects your foot health"), participants will rate the shoes higher in its perceived sustainability image.

Global versus local heritage

Another phenomenon mentioned in the literature is the importance of heritage. According to Urde et al. (Urde et al., 2007, p. 5)(p.5) heritage is "a dimension of a brand's identity found in its track record, longevity, core values, use of symbols and particularly in an organisational belief that its history is important". "Consumers search for authentic brands with genuine history in an increasingly global and dynamic marketplace" (Wiedmann et al., 2011, p. 182). Alexander (2009) states "authenticity is enhanced by embedding the brand in a local culture". Bata has a heritage on both a local and a global level that, if correctly emphasized, might be a strong marketing instrument to increase buying intentions. Hustvedt and Dickson (Hustvedt & Dickson, 2009) found consumers of organic apparel also preferred to buy locally. Locally produce/production is a returning element in green marketing (Wilson, 2005). We therefore explore as a third independent variable the effect of emphasizing either local or global heritage. We follow Alexander's line of thinking and hypothesize:
H3: When advertisements emphasize local heritage as opposed to global heritage, participants will report higher buying intentions.

2.4 Methodology

To test our hypotheses, we designed an experiment in which we manipulated advertisements for shoes along three dimensions: colour of layout, communicated benefit and communicated heritage. Experiments allow for strict control over extraneous and unwanted variables and for cause and effect interpretations of results (Creswell, 2009; Wilson, 2005). At the same time, they come with the limitation of presenting the advertisements in a somewhat artificial setting. Nevertheless, former research (Bellman et al., 2010; Gibson, 1996) showed that even one-time exposure to advertisements in an experiment can be predictive of real life, in-market effects and an effective way to test the cause and effect relationships described in our hypotheses.

2.4.1 Participants

Six hundred university students received an invitation with a link to the online experiment. A total of 231 participants accepted the invitation (equalling a response rate of 38.5%) and were subsequently presented with one of the eight advertisements along with a questionnaire. Most participants were either master students or staff at a Dutch university. Thirty-one respondents were excluded due to incomplete answers. Consequently, the results of this study are based on the answers of 200 participants. The mean age was 24 years (SD_{age} = 9) of which 46% were women. Most of the participants (76%) were unfamiliar with Bata before the experiment. The participants did not receive any compensation, financial or otherwise.

2.4.2 Independent variables and stimuli

We designed a simple advertisement (see figure 2.1) based on a 2 (colour of layout: red vs. green) x 2 (communicated benefit: personal vs. environmental) x 2 (communicated heritage: local vs. global) experimental design that varied slightly for each factor combination (eight in total). The advertisements were designed as simple line drawings to avoid the confounding effects of style, material and colour of the products as much as possible. The same drawing, depicting a men's and a women's shoe, was used for each factor combination. The setup and amount of information (both visual and textual) were the same for all eight advertisements.
To test whether the independent variables were perceived as intended when reading the advertisement variants, we set up a pre-test questionnaire, which was also used as a manipulation check in the main experiment. The questionnaire was evaluated for validity by four experts (i.e., academics in the field of design for sustainability and marketing research) and filled in by 24 final year master students who were equally divided over the eight conditions (i.e., presented with one advertising variant per condition). The results of the pre-test mirror those of the manipulation checks reported in section 2.5.1, indicating that the participants perceived the independent variables as intended: The advertisement with the green layout was perceived as more sustainable, eco-conscious and natural than the one with the red layout. Participants who read about the personal benefit were more convinced that the advertisement communicated a benefit for the individual consumer than participants who read about the environmental benefit. Participants who read about the local heritage were more convinced that BATA is embedded in the Dutch culture than participants who read about the global heritage.

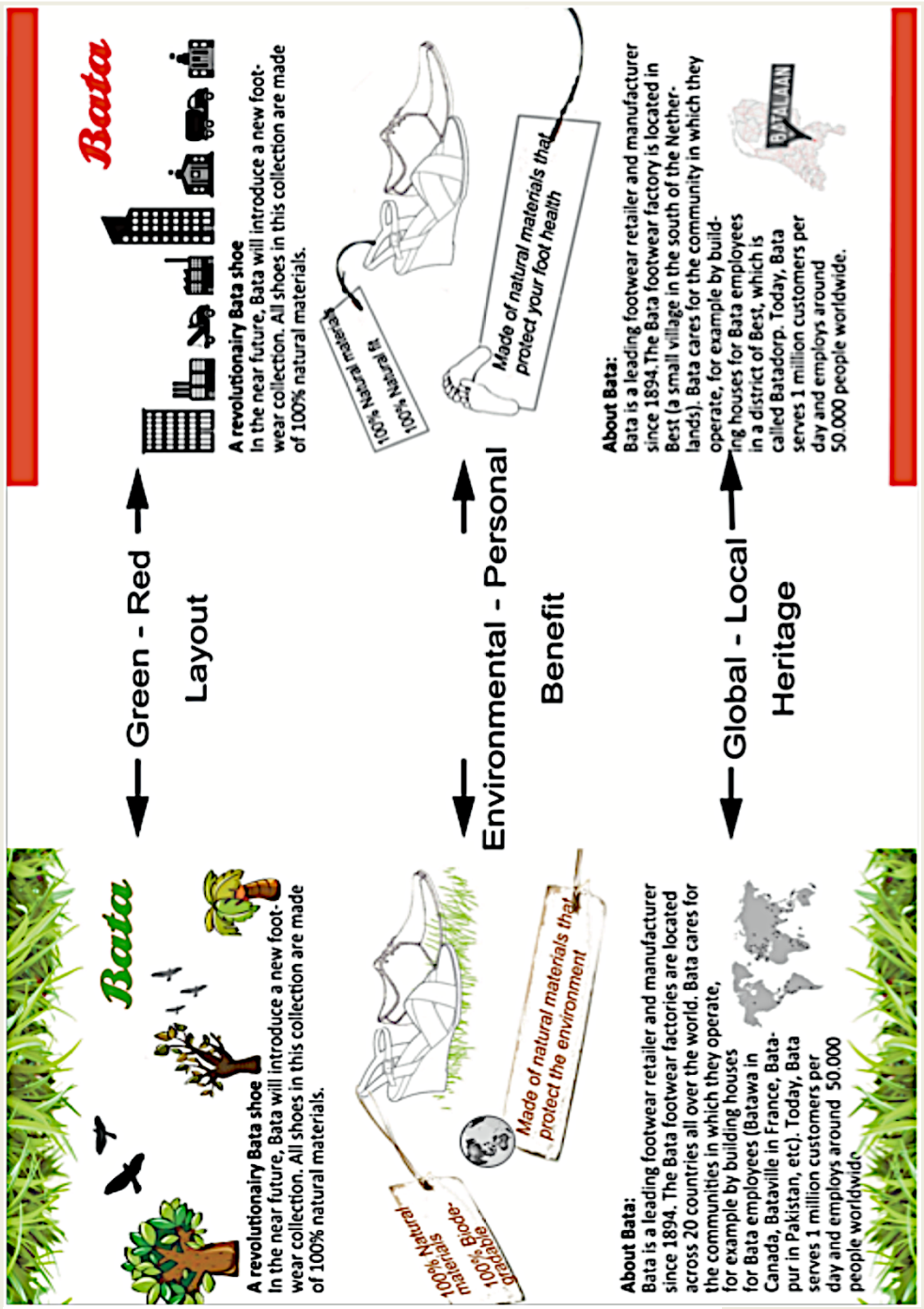

Figure 2.1: 2 x 2 x 2 between-subjects factorial design of a shoe advertisement

2.4.3 Dependent variables

Buying intention served as our main dependent variable for assessing the impact of the manipulations in the advertisements of our fictional sustainable shoe line. It was measured on a five-point scale, ranging from 1 = 'I will definitely not buy' to 5 = 'I will definitely buy these Bata shoes'.

To be able to explain the effects in more detail and to check for potential moderation and mediation, we included several additional dependent variables measuring the perceived product image regarding sustainability, quality and fashion. Based on literature we devised applicable scales to measure sustainability image (Hartmann et al., 2005; Luchs et al., 2010; Ottman, 2011; Ottman et al., 2006), quality image (Garvin, 1996; Luchs et al., 2010) and fashion image (Meyer, 2001; Niinimäki, 2010) of shoes. Four experts evaluated the scales in terms of face validity and provided feedback to assure their suitability for measuring the effect of the advertisement elements.

2.4.4 Procedure and design

The experiment was conducted online. Each of the respondents received an invitation to participate in the research via email that included instructions and a unique link to an online questionnaire. Participants were randomly assigned to a condition (i.e., one of the eight advertisements). Apart from the advertisements that different across conditions all participants received the same questionnaire, which was divided into four sections: (1) buying intention as the main dependent variable; (2) statements measuring the perceived sustainability, quality and fashion image of the product; (3) questions to check whether our manipulations of the independent variables were successful (see section 3.3); and (4) Demographics such as the participants' age in years, yearly shoe budget in EUR, number of shoes owned and prior familiarity with Bata.

2.5 Results

The results are presented in four sub-sections. In section 2.5.1 we present the results of the manipulation checks. In section 2.5.2 we present the results of a three-way ANOVA regarding the impact of layout, benefit type and heritage on buying intention. In section 2.5.3 we present the results regarding the impact of the same variables on fashion image. In section 2.5.4 we present the results of a mediation analysis in which we investigated fashion image and sustainability as potential mediators between benefit type and buying intention.

2.5.1 Manipulation checks

Before testing our hypotheses, we checked whether our manipulations of the advertisements were successful (i.e., whether they really differed as intended according to the three factors sustainability of layout, communicated benefit and heritage).

Sustainability of the layout

Perceived sustainability of the advertisements was measured with the following three items (on seven-point Likert scales, ranging from 1 = 'strongly disagree' to 7 = 'strongly agree'): "The graphical design of the advertisements emphasizes sustainability / communicates eco-consciousness / looks natural". The three items were combined (i.e., averaged) to form an index score after checking their one-dimensionality (all Principle Component Analysis (PCA) factor loadings > .87) and reliability (Cronbach's α = .90). The results revealed that our manipulation of sustainability based on the colour used in the layout was successful: respondents perceived the green layout to be more sustainable than the red layout (M_{green} = 4.77 vs. M_{red} = 2.85, t(180) = 9.56, p < .001).

Communicated benefit

The communicated benefit of the advertisements was measured with the following three items (again on the same seven-point Likert scales): "The advertisement emphasizes a personal benefit for the customer / communicates a benefit for the environment (reverse coded) / emphasizes foot health" (communicated benefit). As before, the three items were combined to an index score after checking their one-dimensionality (all PCA factor loadings > .84) and reliability (Cronbach's α = .91). The results revealed that our manipulation of the communicated benefit was successful: respondents receiving the advertisements with the personal benefit perceived the advertisement to be significantly more about communicating a benefit for the individual consumer compared the those being presented with the environmental benefit ($M_{personal}$ = 4.12 vs. $M_{environment}$ = 2.78, t(177) = 7.45, p <.001).

Communicated heritage

Finally, the type of heritage respondents ascribed to the advertisements was measured with the following item (on a seven-point Likert scale): "Bata is a company of Dutch heritage". Also here the results revealed that our manipulation was successful: respondents reading about the local heritage were more convinced

of Bata's local Dutch origins than respondents reading about the global heritage (M_{local} = 4.95 vs. M_{gobal} = 3.11, t(180) = 7.68, p <.001).

2.5.2 The Impact of layout, benefit type and heritage on buying intention

The results of the three-way ANOVA revealed a marginally significant main effect for the type of benefit used in the advertisements, F(1, 179) = 3.06, p = .07. Buying intentions were higher for respondents presented with the personal benefit ($M_{personal}$ = 2.36, SD = .84) compared to those presented with the environmental benefit ($M_{environmental}$ = 2.16, SD = .75). No main effects were found for the other two independent variables, the type of layout and heritage used in the advertisements, F(1, 179) = 1.07, p = .30 and F(1, 179) = .11, p = .75, respectively. Moreover, the ANOVA revealed a significant interaction effect between the benefit and the layout in the advertisements, F(1, 179) = 5.82, p = .02. Figure 2.2 shows that when the green layout was combined with the personal benefit rather than the environmental benefit, buying intentions were significantly higher, 2.43 (SD = .76) vs. 1.95 (SD = .65), whereas no such effect was found for the red layout, 2.29 (SD = .92) vs. 2.36 (SD = .79).

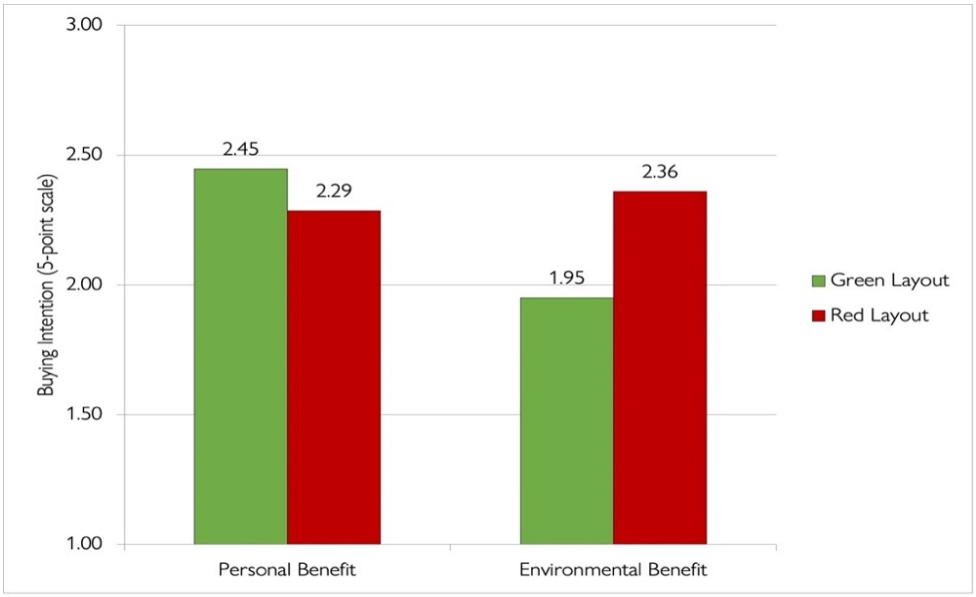

Figure 2.2: Interaction between independent variables "benefit" and "layout"

2.5.3 The impact of layout, benefit type and heritage on fashion image and sustainability image

Perceived fashion image of the product was measured with the following three items (on seven-point Likert scales, ranging from 1 = 'strongly disagree' to 7 = 'strongly agree'): "Shoes of the Bata footwear collection are fashionable / cool / a must-have." After checking their one-dimensionality (all PCA factor loadings > .82) and reliability (Cronbach's α = .83), they were combined to an index score.
The results of the three-way ANOVA revealed a significant main effect for type of benefit used, $F(1, 174) = 4.33$, $p = .04$. Respondents presented with an advertisement emphasizing a personal benefit rated the fashion image higher ($M_{personal} = 3.46$, $SD = 1.08$) than respondents presented with the environmental benefit ($M_{environmental} = 3.09$, $SD = 1.17$). No main effects were found for colour of layout, $F(1, 174) = 2.41$, $p = .12$, and heritage, $F(1, 174) = .42$, $p = .52$.
The following three items were used to measure the perceived sustainability image of the product (on seven-point Likert scales): "Shoes of the new Bata footwear collection are sustainable / do not harm the environment / protect the earth." The items were combined to an index score after checking their one-dimensionality (all PCA factor loadings > .74) and reliability (Cronbach's α = .72). The results of the three-way ANOVA revealed no significant main effects, neither for type of benefit nor for colour of layout nor for heritage.

2.5.4 Mediation by fashion image and sustainability image

For checking possible mediation effects through fashion image and sustainability image, we conducted an ordinary least squares path analysis (using Preachers' SPSS Process script (Hayes, 2013) Model 4). The analysis revealed a significant indirect effect of benefit type on buying intention through fashion image ($c = -.09$, CI [-.20, -.02]). Participants presented with the personal benefit rated fashion image higher than those presented with the environmental benefit (95% CI [-.7300, -.0731]). The analysis revealed no significant indirect effect of benefit type on buying intention through sustainability image, due to a non-significant direct effect of benefit type on perceived sustainability image ($a = -.19$, $t = -.38$, $p = .70$), as was shown already in the results from the three-way ANOVA (see section 3.2). However, we found a significant positive impact of sustainability image on buying intention ($b = .113$, $t = 2.322$, $p = .0214$) that was independent of the communicated benefit type.

The mediation model presented in Figure 2.3 shows that benefit type did not directly impact buying intention but that it did so indirectly through fashion image. The model explains 20% of the variation in buying intention.

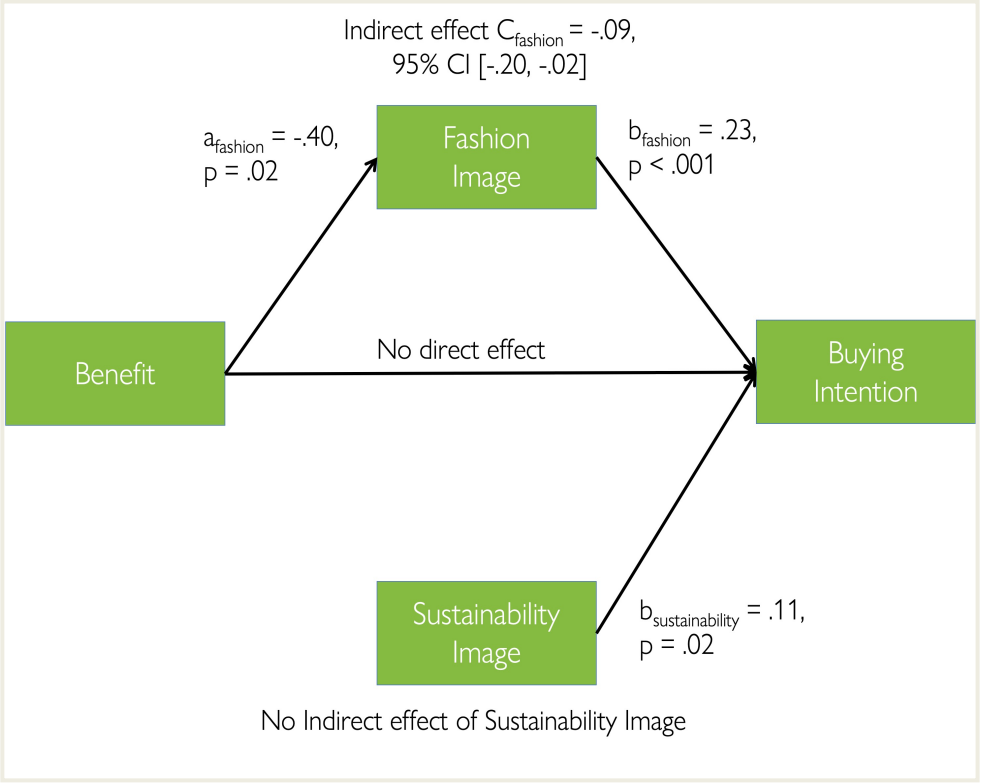

Figure 2.3: Model of benefit type as predictor of buying intention, mediated by fashion and sustainable image

2.6 Discussion

In this section we first discuss the results and theoretical implications pertaining to our hypotheses from section 2.3.3., followed by limitations and further research and a discussion of implications for marketers.

2.6.1 Impact of the colour of the layout on buying intention

Previous research by Hartmann et al.(Hartmann et al., 2005) showed purchase intention to correlate both with what they called emotional (i.e., catering to the senses) and functional (i.e., catering to the rational mind) green advertising

strategies. Specifically, in their research they manipulated a print advertisement of a low emission car either by placing it pictorially against the backdrop of pristine nature (in line with an emotional positioning strategy) or by including a tagline emphasizing its low CO_2 emission levels (in line with a functional positioning strategy). We found no support for Hartmann's conclusion that buying intention for sustainable products is increased using an emotional advertising strategy, in our case a green layout. Buying intention was similar for respondents presented with the green and the red layout, even though only the green layout was associated as standing for sustainability in the manipulation checks. H1 therefore was not supported by our results. The lack of effect from the green layout may be explained by the low importance sustainability tends to receive as a buying criterion (Niinimäki, 2010; Vogtländer et al., 2013) for clothing.

2.6.2 Impact of the communicated benefit on buying intention

Our results further showed a marginally significant effect of our second factor, benefit type, on buying intention. Participants being presented with the personal benefit reported higher buying intentions than those being presented with the environmental benefit, thus showing some support for H2a. An environmental benefit is a less important buying criterion than a personal benefit and likely the cause for the lower buying intention (Vogtländer et al., 2013). However, the effect on buying intention by the personal benefit used in the advertisements (i.e., "these shoes protect foot health") was relatively low in absolute terms (i.e., slightly under the mid-point of the five-point Likert-scale, $M_{personal}$ = 2.36, SD = .84). Apparently, "healthy feet", despite being more important than an environmentally framed benefit, is not that relevant as a buying criterion among our relatively young respondents. We expect references like "make you look good", "latest fashion", "good for dancing" would have led to even higher buying intentions. As shown by the significant mediation, emphasizing an environmental benefit negatively affected the buying intention through a lower perceived fashion image of the product; this coincides with the conclusions Meyer (Meyer, 2001) drew from his case studies in which eco-fashion was perceived less fashionable.

2.6.3 Interaction between colour of layout and communicated benefit

Previous research (Ottman, 1993; Wever et al., 2009) suggested that buying intention for sustainable products might be higher when both environmental and functional benefits are combined. We found this proposed interaction, in our case between the independent variables 'layout' and 'benefit type', to be significant: buying intention was highest when combining either the personal benefit with the

green layout or the environmental benefit with the red layout. Combining the environmental benefit with the green layout led to the lowest buying intention, 20% lower than in the highest rated combination of personal benefit with a green layout. Our findings thus support H2b and substantiate the claimed effectiveness of the double benefit theory (Ottman, 1993; Wever et al., 2009) as a strategy in increasing interest for sustainable products. According to the double benefit theory it is best to sell sustainable products on personal benefit and to combine it with an environmental message catering to the senses, in our case the green layout.

2.6.4 Impact of the communicated heritage on buying intention

We expected that respondents presented with an advertisement emphasizing local heritage as opposed to global heritage to report higher buying intentions. Based on our results, we found no significant difference in buying intentions due to heritage and thus no support for H3. This finding contradicts other research (Urde et al., 2007; Wiedmann et al., 2011) that found consumers of sustainable products to prefer locally produced products over globally produced ones. We suspect that this might have to the do with the product category of shoes, where local heritage might not be of similar importance, either in general or for our relatively young respondents. Other heritage elements like the historical aura surrounding the brand or references to social responsibility might give other results. Another factor why heritage revealed no differences might be due to unfamiliarity with the brand—our results showed that only one out of four respondents was familiar with BATA. Given that heritage requires deeper knowledge about the brand, results might be different for a well-known brand.

2.6.5 Impact of communicated benefit on fashion and sustainability image

Fashion appeal is the most important criterion when buying shoes, comparable to the importance of quality in buying tyres (Luchs et al., 2010). We therefore expected fashion image to be negatively impacted by an emphasis on environmental benefits (see H2c), just like an emphasis on sustainability negatively impacts the perceived quality of car tyres. The results support this hypothesis: emphasizing the environmental benefit resulted in a significantly lower perceived fashion image compared to emphasizing the personal benefit. This is in line with the reported lower fashion image of eco-clothing in Meyers' case studies (Meyer, 2001).

We expected that communicating an environmental as opposed to a personal benefit would lead to a higher sustainability image of the product (see H2d). We found no support for this hypothesis in our results. This suggests either the direct

environmental benefit claim was not believed or not considered important for the product category of shoes. The first explanation can be ruled out by our manipulation checks, which clearly showed that respondents who received the advertisements with the environmental benefit claim also perceived it to be significantly more about communicating a benefit for the environment than for the individual consumer (and vice versa for those who received the advertisement with the environmental benefit claim). The second explanation seems more likely as sustainability has previously been identified as being of low importance as a buying criterion for the product category of shoes (Vogtländer et al., 2013).

2.6.6 Mediation of fashion image and sustainability image on buying intention

Based on previous research that found the appearance of the shoe to be the most important buying criterion when buying shoes (Vogtländer et al., 2013) and clothing (Niinimäki, 2010), we expected that our dependent variable fashion image would exert a great influence on buying intention. By the same token, as environmental concerns are typically not the most important buying criterion when buying shoes (Niinimäki, 2010; Vogtländer et al., 2013), we expected a lower influence on buying intention through sustainability image of the shoe. The results from the mediation analysis support this and further our understanding of the mechanisms involved in raising consumers' interest in sustainable shoes through the communicated benefit. Our model could account for 20% of the variation in buying intention, even though the drawings presented to the respondents remained rather sketchy. It is quite possible that the added richness in detail of a photograph or of seeing the actual shoes in front of you would influence buying intentions even stronger.

The fact that sustainability image has a direct effect on buying intention independent of the communicated benefit suggests consumers apply a double filter (Vogtländer et al., 2013). The more important buying criteria must be satisfied first, in our case fashion image but also price and brand. When more buying options remain, only then sustainability comes into the equation and increases the buying intention of the sustainable option. Our data unfortunately offer no answer on how to create a sustainability image. Sustainability image was neither significantly impacted by layout nor benefit nor heritage.

2.6.7 Limitations and further research

Although previous research (Bellman et al., 2010; Gibson, 1996) showed that even one-time exposures in a controlled environment can be predictive of in-market

effects in real life people, additional testing in a more natural environment is advised to validate the cause and effects relationships found in our controlled experiments. In real life people usually are exposed much briefer to advertisements. Therefore, one should not conclude that one exposure in real life would be enough to create the same effects, especially as people might attend to the advertisements differently (e.g., less consciously when distracted by another task carried out simultaneously). This research focused on shoes, a product category where sustainability is of low importance among other buying criteria (Vogtländer et al., 2013). However, for other products such as food or baby nutrition, where the environmental benefit is more directly connected to health, sustainability is of higher importance, and can increase willingness to pay as shown by van Doorn and Verhoef (2011).

As the respondents recruited for this research were mainly master students at a University in the Netherlands, they were relatively young. It is thus unclear whether an older population would show the same results; the literature differs in the effect of age on sustainable behaviour and consumption (Roberts, 1996). In particular, brand familiarity with Bata was relatively low among our young respondents. A well-known brand for this younger cohort might show different results, given the more readily available associations of its (sustainable) brand image.

Furthermore, the interpretation of advertisements—e.g. how colour is linked to perceptions of sustainability—is assumed to depend on culture (Albers-Miller & Royne Stafford, 1999) and/or region; thus, caution should be used when implementing the findings on a global scale. Certainly, in further research it would be interesting to investigate the impact of geography and culture on the importance and perception of sustainability in products or brands.

People seek different benefits by products. We selected "foot health" as the personal benefit; however, other personal benefits might have stronger effects on the evaluation of a brand and product. For instance, emphasizing a fashionable image as a personal benefit might have a more noticeable impact on buying intention. After all, the looks of the shoe are likely the most important criterion when buying shoes. How to effectively use different personal benefits to increase buying intention of sustainable products asks for further research. Our mediation results provide new ideas for further research and marketing theory development on how to create value with sustainable products for mainstream consumers.

An avenue for further research is also the question of how to create a sustainable image. We showed a direct effect of sustainable image on buying intention but were not able to pinpoint what created the sustainability image of the shoe. A specific

mentioning of the environmental benefits would lead to a lower buying intention through fashion image. A potential answer might be found in the interaction between layout and benefit.

2.6.8 Implications for marketers

The results of our analysis offer interesting insights into how to increase the buying intention of mainstream consumers for sustainable shoes, as well as how to avoid alienating mainstream consumers when bringing sustainable products to the market.

Advertisements for sustainable products typically feature green colours and abundant natural sceneries (Grail Research, 2011). Our results showed that although people perceived our green natural layout as standing for sustainability, this did not result in a more sustainable product image of our shoe compared to the red cosmopolitan version. On the contrary, when combining a green layout and communication about environmental benefits in the advertisement, buying intentions were significantly lower. This shows overemphasizing the sustainability of sustainable products can easily become too much of a good thing.

Focusing the communication on personal benefits and embedding this in a green layout, as proposed by the double benefit theory (Ottman et al., 2006; Vogtländer et al., 2013; Wever et al., 2009), resulted in higher buying intentions. This is owed to a third variable, namely fashion image, which mediates between the (communicated) benefit claim and buying intentions. That is, emphasizing an environmental benefit, instead of a personal benefit, reduced fashion image, which in turn reduced buying intentions. This result is interesting since we communicated foot health as a personal benefit and did not mention or refer to fashion in our advertisement. By communicating on personal benefit, it is thus possible to increase buying intention through fashion image.

Moreover, even though the type of benefit—personal versus environmental—did not influence sustainability image, the latter is still relevant as it directly influences buying intentions. However, given that the effect of sustainability image is smaller than the effect based on the communicated benefit through fashion image, sustainability image should not be prioritized at the expense of more important buying criteria such as fashion appeal and health benefits.

2.7 Conclusions

Our research found it is possible to effectively communicate sustainable products to mainstream consumers. Based on our results, and other than suggested by the widespread use of green layouts to communicate sustainable products, using a green layout was not effective in increasing buying intention of shoes. Focusing communication on personal benefits led to a higher buying intention as opposed to focusing on environmental benefits. Moreover, combining a personal benefit with a green layout led to the highest buying intention. Thus, our results provide previously missing empirical evidence in support for the double benefit theory (Ottman et al., 2006; Vogtländer et al., 2013; Wever et al., 2009) as an effective strategy to increase consumers' interest in sustainable products.

Furthermore, a mediation analysis revealed the effect of emphasizing a personal benefit on buying intention was mediated by fashion image but not by sustainability image. Sustainability image, however, did have a positive effect on buying intentions independent of benefit type.

2.8 Author contributions

Rosan van der Helm conceived and performed the experiments as a graduation project for her M.Sc Engineering Industrial Design at Delft University of Technology; Rosan van der Helm and Valentin Gattol designed the experiment. Mirjam Visser and Valentin Gattol analyzed the data again for this paper; Mirjam Visser was first author and Valentin Gattol co-author of this paper.

The authors declare no conflict of interest.

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3 Publication 2: Consumer buying behaviour of sustainable appliances

Visser, M., Schoormans, J., Vogtländer, J. (2018). Consumer buying behaviour of sustainable vacuum cleaners - Consequences for design and marketing. Journal of Cleaner Production,195, 664-673.

3.1 Abstract

Although most people claim to prefer a more sustainable product, only a limited number of 'green buyers' act on their words when making a purchase. To find out how to get mainstream buyers to buy more sustainable products, we used data on 950 Western European buyers of 32 different vacuum cleaner models. The issue was why three out of four consumers bought a less sustainable high input power model when an energy-efficient model with equal specifications was also on offer at the same price. Only 6% of buyers bought their vacuum cleaner for environmental reasons. The remaining 94% of buyers stated that their purchase decision was mainly based on reliability, durability, key features, the brand and value for money, regardless of whether they bought an energy-efficient or -inefficient model. The 73% who bought energy-inefficient vacuum cleaners opted for heavier models (perceived as more robust) featuring bags for dust collection and were more sensitive to messages addressing technological innovation. Beside energy efficiency legislation, we see two options to encourage mainstream consumers to buy more energy-efficient products: (1) link technical advancement in innovation to lower power ('we can create more suction with less energy') in product branding, and (2) seduce mainstream consumers with models that are redesigned for performance, robustness and durability. With this quantitative consumer research, we add both to the knowledge of buying behaviour in terms of sustainability as well as to the knowledge on how to redesign and market green products in mainstream markets.

3.2 Introduction

To ensure sustainable consumption it is necessary to attract mainstream consumers with sustainable and energy-efficient products (Mont and Plepys, 2008). A majority of consumers indicate they prefer more environmentally friendly products; however, only a minority (5-10% depending on the product category) of those same consumers act on their promise to buy more sustainable products (United Nations

Environmental Programme, 2005). As a result, in the present market, most sustainable products are not able to attract large segments of customers.
Most literature studies on sustainable consumption (Dangelico & Vocalelli, 2017; McDonald et al., 2012; Mont & Plepys, 2008; Mont & Power, 2010; Rex & Baumann, 2007) assume that a preference of sustainable products is a predictor for sustainable buying, based on the theory of planned behaviour (Ajzen, 1991). However, the intention to buy in a sustainable way is most often not followed by a sustainable consumer choice. The existence of this gap between 'sustainable intention' and 'behaviour' (Auger & Devinney, 2007; Carrington et al., 2010; Liobikienė et al., 2016; United Nations Environmental Programme, 2005) indicates that, consumer behaviour is far more complex than being driven by rational decisions alone.

This paper deals with two issues: (1) the preferences of people while purchasing, i.e., why do most buyers refrain from buying more sustainable options, and (2) the consequences of these consumer preferences regarding the design and the marketing of green products.

In the literature review of Section 2, we will summarise the latest views of researchers in sustainable consumption and will define our research questions. In this section, we will also explain why we have chosen vacuum cleaners as the subject of our research. In Section 3, we will describe our research method, the source of data, the respondents, and the specifications of the vacuum cleaners. In Section 4, we present the results of the data analyses. In Section 5, we discuss the theoretical, managerial (marketing and redesign), and policy implications, as well as the limitations of our research. We will finalise this paper with Section 6, in which we will draw our conclusions.

3.3 Literature on sustainable consumption

3.3.1 Consumer preferences for sustainable products

Several reasons have been reported for why consumers do not show preferences for sustainable products in the shop. The first reason is that environmental products often come with negative perceptions; consumers perceive such products as being more expensive (van Doorn & Verhoef, 2011), less fashionable (Visser et al., 2015) or lower in quality (Luchs et al., 2010). The second reason is that the buying of a product is the fulfilment of a need, wish or emotion, in a trade off with sustainability (Hüttel et al., 2018). The environmental attributes of products are

often of lower importance than other attributes (Niinimäki, 2010; Visser et al., 2015; Vogtländer et al., 2013), and only come into play when other more important attributes do not lead to a final choice (Vogtländer et al., 2002). The third reason is that consumers might perceive lower energy consumption to be related to performance, an experience attribute that will only be understood after prolonged use of the product. During the buying process, the evaluation of a new product is based on experiences with prior products (Mariëlle E. H. Creusen & Schoormans, 2005). The fourth reason is that the ecological burden (i.e. impact of material and energy consumption) is very difficult to understand and judge, even for sustainability conscious consumers (Ellen, 1994). This leaves people with limited decision-making abilities (Brown, 2015).

In contrast, a limited number of, mostly, experimental studies show that consumers do react positively towards sustainable products. De Angelis et al. (2017), for example, show that green luxury fashion products are preferred if the design of these fashion products is not dissimilar to the design of traditional non-green products. Magnier and Schoormans (2015) show, that the use of sustainable material in packaging increases the sustainable products' credibility for consumers. Although all these experimental results are promising, intentions are not actions, and studies researching consumer behaviour in the marketplace might show different results. So far, there is limited quantitative consumer research on marketing of green products (Baumann et al., 2002; Carrington et al., 2010; Dangelico & Vocalelli, 2017); this is especially the case when it comes to durables or addressing those who are not green buyers or self-proclaimed green consumers (McDonald & Oates, 2006). McDonald et al. (2009) point out that the brand is by far the most important decision-making criterion for small electronic appliances, and that sustainability criteria are rarely used in relation to these purchases, even by very green consumers. Most quantitative empirical studies focus on food (Tanner & Kast, 2003), textiles, packaging or tourism. On durables we found quantitative research only on electronic and alternative fuel vehicles (Jansson et al., 2017) and solar systems (Elmustapha et al., 2018), which both concluded that the visibility of sustainability is an important factor in sustainable buying.

3.3.2 Buying behaviour insights

Findings from social science studies on consumers and consumption behaviour demonstrate that consumption behaviour is not merely rational, and influenced by a wide range of individual, social and institutional factors (Power & Mont, 2010).

Individual customers show biases that may potentially interfere with sustainable consumption. They tend to stick to: (1) the status quo or their, often unsustainable, default choice; (2) satisfice instead of go for the best solution; (3) are loss averse; (4) are risk averse; (5) recover their sunken cost; (6) perceive things as less valuable or significant if further away in time; and (7) act in conformity with social norms (Frederiks et al., 2015). These biases might explain why consumers who say they would prefer environmentally friendlier products do not actually buy such products. Lorek and Spangenberg (2014) think biases are difficult to overcome with mainstream economic business thinking and therefore call for governmental leadership to strengthen social innovation by means of carrots and sticks.

Policymakers have used behavioural insights and biases to nudge consumers towards more sustainable behaviour and the industry towards sustainable innovations (Sousa Lourenco et al., 2016). To curb the growing share of European household energy consumption accounted for by electrical appliances (Odyssee-Mure, 2017), the European Commission decided to implement legislation to limit the maximum input power of consumer electronics. Since September 2015 (after the collection of data for this paper), the maximum input power of vacuum cleaners in the European market is limited to 1600 W (European Union, 2013), which will be limited even further to 900 W. This legislation met with consumer and consumer group resistance, and was even challenged in court (The week, 2015).

3.3.3 Research questions

A few conclusions can be drawn from the literature. For one, there is hardly any quantitative empirical research published on consumer buying of durables. While durables like household appliances might not be bought primarily because of their sustainability attributes, they significantly contribute to (un-)sustainable consumption and their contribution to total household energy consumption is rising (Odyssee-Mure, 2017). As 75%-80% of the environmental burden of appliance life cycles is caused by energy consumption during use (Coronado Palma & Visser, 2012), the choice of power input of these appliances has a major impact on sustainable consumption. Secondly, there is reason to believe that buying intention cannot be interpreted as buying behaviour. To understand consumer behaviour and eventually change it towards sustainable consumption, it is vital to research sustainable product choices in the marketplace. The use of real market data, however, is not without problems. To arrive at valid results, we need both to find a marketplace in which a comparison can be made between products that differ

only in terms of the product attribute 'sustainability' and substantial consumer choice data need to be available.
For this study, we searched for a durable where sustainable consumption is not related to other product attributes and people's product preferences could be met with both a sustainable and a less sustainable choice. Vacuum cleaners are an excellent product category to research why consumers are not acting on their promises to choose the greener option when all other product specifications are equal. First of all, because of the utilitarian nature of a vacuum cleaner (M.E.H. Creusen, 1998), its product specifications – such as energy use, suction power, weight and price – are considered critical in the buying decision and can be measured in a both objective and nominal way. Secondly, vacuum cleaners of all input powers are available within a broad line of other attributes, making it possible to meet the requirements of every customer with both an energy-efficient and -inefficient version (Heiskanen et al., 2010). Furthermore, the European Union has in its energy efficiency policies defined what constitutes a sustainable vacuum cleaner i.e., one of less than 1600W.

For this paper, we were able to use an extensive data set that was collected by the Philips Consumer Electronics Consumer Lifestyle division. This data shows the actual buying behaviour of 950 consumers of both energy-efficient and -inefficient vacuum cleaners of equal specifications that were sold by Philips in 2010. Buyers indicated one of ten reasons why they bought one of 32 specific product models. This consumer data was combined with the specifications of the bought product, the used communication focus and its recommended retail price. For all vacuum cleaners with an input power of less than 1600 W, Philips used communication messages promoting the environmental benefits, such as 'this is an energy-efficient product'. For other models, the packaging or leaflets might refer to their 'technologically advanced' product features.

The vacuum cleaners included in this study showed a wide spread of specifications in terms of suction power, weight, bag or bagless dust collection, price and communication focus. For every attribute, a model was available in both the low and high input power categories, and therefore a lower or higher level of sustainability for every preference in specification attributes. Philips' broad product portfolio gave us the possibility to research why most people buy a non-sustainable model when a more energy-efficient model of equal specification and price is available.

Based on the above, we defined our research questions as:

1. How many people bought an energy-efficient vacuum cleaner in this survey?
2. Are there differences in the reasons for buying either an energy-efficient or -inefficient vacuum cleaner?
3. How are the reasons to buy and the attributes of the bought vacuum cleaners related to input power?
4. What is the difference between the preferences of the buyers of energy-efficient and -inefficient vacuum cleaners?

3.4 Methods and materials

3.4.1 The data set

The analysis of this paper is based on the consumer research database of Philips Consumer Lifestyle. Philips collected this data to analyse the reasons why a specific customer bought a specific vacuum cleaner as well as to measure the satisfaction of buyers with their newly bought product.
Philips used a specific procedure to determine the preferences of their customers. Buyers of Philips products were invited by a warranty leaflet in the packaging of the vacuum cleaner to promptly register their product on the Philips website in exchange for an extra year of warranty. Upon registration of their product (by registering article and serial number) customers are asked to provide their demographics (sex, age, education, family composition, country, city, etcetera) and buying behaviour (market channel, reason to buy) and contact details. It is obvious that not all buyers register their product, but the data of this study cover 951 European consumers who bought one of the 32 different vacuum cleaners in 2010. Given the fact that the vacuum cleaner models as well as preferences and buying behaviours differ between regions (Coronado Palma & Visser, 2012) and cannot be compared as such, we concentrated our tests on European consumers.

Buyers were asked to indicate one out of 10 reasons (see Appendix A, Table A.1. for Reason to Buy list and definitions) as their primary reason to buy their specific vacuum cleaner. The 10 reasons were: brand reputation; key features (the vacuum cleaner's key features, such as dust chamber size, accessories, filter(s), performance, cord length, etcetera); service; design and looks; ease of use (manoeuvrability, easy to store); environment; warranty; value for money; reliability & durability; none of these. These data of a specific buyer is combined with the specifications of the

bought vacuum cleaner that were available to the consumer either on the product leaflets, at Philips.com and/or on its packaging.

3.4.2 Specifications of the vacuum cleaners

The specification attributes of the 32 vacuum cleaner models in the data set are input power (W), suction (W), noise (dB), weight (kg) and whether they have a bag (69.3%) or not (30.7%), the communication focus on technology innovation (in 57.7% of the cases, all for high input power versions) or environment (in 26.2% of the cases all for low input power versions) and recommended retail price in Euros (collected from the Philips.com webstore). As indicated before we use vacuum cleaners as a product category because their attributes have no or a low correlation with input power. There would thus be no reason for customers to select an energy-inefficient model other than the fact that it has more input power. Of the different attributes, only suction is significantly correlated with input power ($p = .001$), with a medium-size effect ($R2 = .30$). Figure 3.1 shows in most cases, lower input power versions offer somewhat lower suction for the existing designs, e.g. 300-400 W compared with 300-500 W in the high input versions.

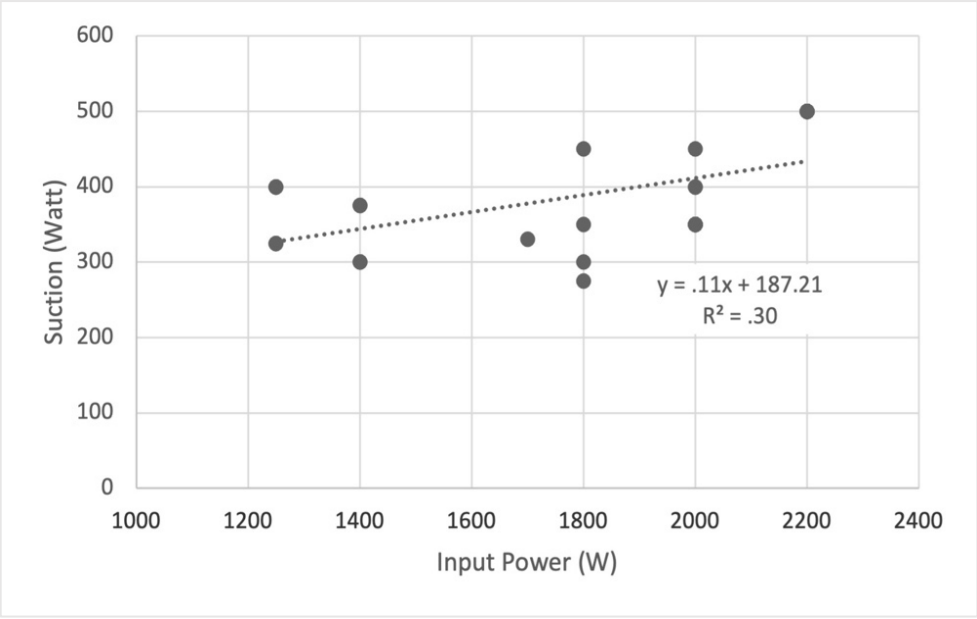

Figure 3.1: Scatterplot Suction versus Input Power (N=32)

The correlations between other attributes and input power were all low (price R^2 = .02, weight R^2 =.05, noise R^2 =.05, and all input powers were on offer with and without a bag R^2 = .01). These correlations confirm that the attributes of vacuum cleaners are independent of their input power and sustainable vacuum cleaners do not differ from non-sustainable ones in terms of their specifications. Both the correlation table (Table A.3) and scatterplots (Figures A.1 to A.4) are presented in Appendix A.

3.4.3 Respondents

The 951 respondents in the analysed dataset comprise buyers from Austria, Belgium, Switzerland, Germany, France, Ireland, Italy and the Netherlands. In line with the regulations of the European Union (European Union, 2013) that limit the maximum input power of vacuum cleaners to 1600 W, we split the consumers into two groups: those who bought, a vacuum cleaner with input power of 1600 W or less, and one group of those who bought one rated above 1600 W.

Table 3.1: Respondents by input power (Wattage) of the vacuum cleaner they bought (N=951)

	Wattage	Frequency	Percent	Cumulative percent
Low input power <1600 Watt	1250	78	8.2	8.2
	1400	177	18.6	26.8
High input power >1600 Watt	1700/1800	94	9.9	36.7
	2000	356	37.4	74.1
	2200	246	25.9	100.0
	Total	951	100.0	

See Table 3.1 for the respondent groups by the input wattage of their vacuum cleaners.

3.5 Data analysis and results

3.5.1 The sustainable buyers

Our first research question is how many people are buying an energy-efficient vacuum cleaner? The answer to this question is found in Table 3.1. It shows that only 27% (N=255) of buyers bought a low power energy-efficient vacuum cleaner

with less than 1600 W input power. A large group of 73% buyers (N=696) bought an energy-inefficient model.

3.5.2 Consumers' reason to buy in relation to energy efficiency

To answer the second research question concerning the reason why consumers buy a vacuum cleaner, we analysed the self-reported main reasons for buying. The indicated reasons for buying in both consumer groups are presented in Figure 3.2, which shows reliability & durability, key features, value for money and brand reputation as the main reasons to select a certain vacuum cleaner model for 74% of all consumers (68% of all buyers <1600 W and 79% of all buyers >1600 W).
An independent t-test showed no significant difference in scores between the two groups on reliability & durability (t (494) = -1.33, p. = .20, two-tailed), key features (t (494) = -.55, p. = .58, two-tailed), value for money (t (494) =.75, p. = .46, two-tailed) or brand reputation (t (494) = -1.96, p. = .05, two-tailed).

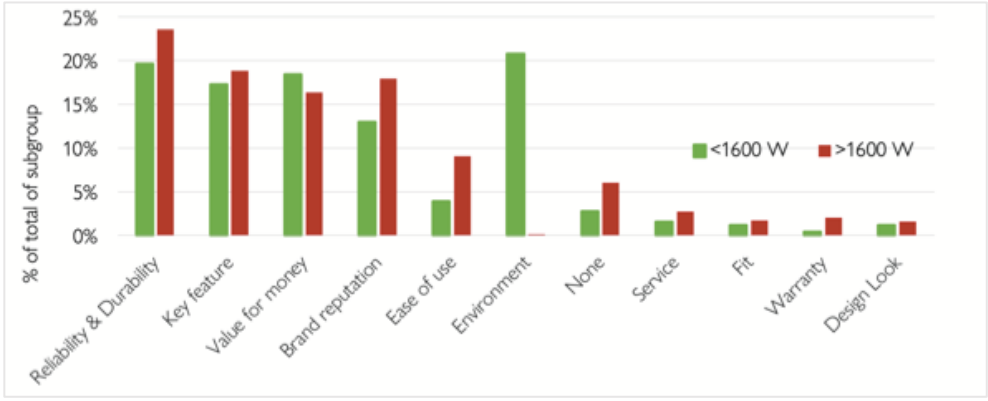

Figure 3.2: Main reasons to buy in order of frequency per customer group

There was a significant difference between buyers of lower and higher input power versions on ease of use (t (494) -3.14, p. = .01, two-tailed), which was however only slightly more important (Eta squared = .01) to buyers of energy-inefficient vacuum cleaners. Environmental friendliness is, as expected, only important to buyers of energy-efficient vacuum cleaners (t (494) 8.09, p < .001, two-tailed). There is a large

difference between them and energy-inefficient buyers in terms of environmental friendliness as a reason to buy (Eta squared = .2).
74% of the buyers did not differ in their preferences, irrespective of their choice of an energy-efficient or -inefficient vacuum cleaner. On the other hand, although all low power vacuum cleaners were advertised as such, only 21% of the buyers of energy-efficient models said they bought one for environmental reasons. These 'green buyers' account for only 6% of all respondents. In contrast, nearly 80% of the low input power buyers made their selection for other reasons and their preferences hardly differ from those of buyers of energy-inefficient models.

3.5.3 Reasons to buy in relation to the product attributes

To answer our third research question (how the reasons to buy and the attributes of the bought vacuum cleaners are related) we performed a correlation analysis (Appendix A, Table A.3). A summary of relevant correlations between the product attributes of the 952 bought vacuum cleaners and the two input power groups is given in Table 3.2.

Table 3.2: Correlation between the bought product attributes and low/high power (906<N<951).

Product Specification		Power low/ high Buyers
Price RPP/ NL EURO	Pearson Cor.	-.00
	Sig. (2-tail)	.924
Message Technology	Pearson Cor.	.36**
	Sig. (2-tail)	.000
Weight (kg)	Pearson Cor.	.33**
	Sig. (2-tail)	.000
Noise level (dB)	Pearson Cor.	-.09**
	Sig. (2-tail)	.004
Suction (watt)	Pearson Cor.	.55**
	Sig. (2-tail)	.000
Bag less/Bag	Pearson Cor.	.42**
	Sig. (2-tail)	.000

** Correlation is significant at the 0.01 level (2-tailed).

In Section 3.4.2, we showed that there were no correlations between the factual, measured, product attributes and input power of the 32 vacuum cleaner models,

except for suction power. In contrast to this, Table 3.2 shows significant (p. <.01) correlations between low/high power and all attributes except for price. The differences between the factual vacuum cleaner attributes and the bought attributes seem to arise from a difference between fact and perception, which might be caused by bias or interaction and mediation among attributes and preferences.

The correlation of low/high power with noise level is small (Pearson correlation <.3) but correlation is large with suction, and medium with bagless/bag and weight. Price is not correlated with low/high input power, but it is, to a great extent (Pearson >.5), with suction, noise and weight as well as message technology, signalling willingness to pay for more suction and weight and for less noise. Since price is not related to input power, this opens possibilities to create more consumer value with low input power machines.
There are no significant correlations between the consumers' reason to buy and input power (Appendix A Table A.3), except for a small effect of ease of use as a preference for high power input buyers and the environment as a reason to buy, medium in size, as a preference for low input buyers. These are in line with the results of 3.5.2. Environmental preference is slightly negatively correlated (Pearson -.25) with suction power, which would indicate that green buyers seem willing to accept somewhat lower suction performance for greater environmental benefits.
Customers' preference for either low or high input power vacuum cleaners
A discriminant analysis was conducted to predict whether people would buy a low or high input power vacuum cleaner. To avoid both singularity and multicollinearity we selected as our predictor variables those variables that showed (Appendix A) a significant Pearson's relation with input power between .3 and .8. Suction as a predictor with a large effect created singularity due to its similar importance for both low and high input categories. We found that the differentiating predictor variables were environment, weight, technology message, and bagless/bag. For detailed results of the discriminant analysis see Appendix A (Table A.4). The means of the groups are shown in Table 3.3.

The Box's Test showed that, although there were similar log determinants per group, the assumption of equality of covariance was violated (p <.001). Tabachnick and Fidell (2013), however, suggest that if the samples are large, as in this case, the probability values will be conservative and can be trusted. The discriminant function revealed a significant relation between the two groups and the four variables and accounted for 31% of all variations between the groups.

The canonical discriminant function (Table 3.4) results in two groups centroids with means of -1.097 for low input power buyers and .400 for high input power buyers.

Table 3.3: Group means of variables per high/low power

Power low/high	Variables	Mean	Std. Deviation	N
low <1600 Watt	Weight (kg)	5.832	.568	243
	Message Technology	.272	.446	243
	Bagless/Bag	.383	.481	243
	RS7 Environment	.202	.402	243
high >1600 Watt	Weight (kg)	6.196	.422	666
	Message Technology	.703	.457	666
	Bagless/Bag	.800	.400	666
	RS7 Environment	.002	.039	666
Total	Weight (kg)	6.099	.492	909
	Message Technology	.587	.493	909
	Bagless/Bag	.689	.463	909
	RS7 Environment	.055	.228	909

Table 3.4: Canonical Discriminant Function coefficients

Function Coefficients	Function 1
Weight (kg)	1.212
Message Technology	-.300
Bagless/Bag	1.533
RS7 Environment	-2.720
(Constant)	-8.119

This model correctly classified 67% of the low input buyers and 100% of the high input buyers (91% of the cases in total). These results show the high impact of weight and bags for dust collection on the decisions made by buyers of energy-inefficient machines. Unsurprisingly, they are less focused on the environmental impact. Addressing environmental benefits might even lead to rejection due to negative associations.

3.6 Discussion

3.6.1 Consumer preferences for sustainable products

In line with most literature (McDonald et al., 2009; United Nations Environmental Programme, 2005) the percentage of people who base their purchases on environmental preferences is small in our case, just 6% (see 3.5.1). These 'green buyers' seem willing to accept lower performance if their sustainable preferences are satisfied. This is different from the other 80% of the consumers of energy-efficient vacuum cleaners who based their purchase decision on non-environmental reasons. Their top four preferences – reliability and durability, key features, value for money or brand reputation – are not different from those of the 73% of customers who bought energy-inefficient vacuum cleaners. Brand reputation was not decisive in their choice for energy (in)efficiency, unlike as suggested by McDonald et al. (2009) for household appliances. Many researchers researching sustainable consumption (Dangelico & Vocalelli, 2017; Lorek & Spangenberg, 2014; Peattie, 2001) focus on the green consumer. We showed that a focus on the green consumer is not the most effective approach to encourage sustainable consumption or development, as most consumers do not show a commitment to sustainable appliances in our study.

The consumer research performed on sustainable durables and preferences, alternative energy cars (Jansson et al., 2017) and solar systems (Elmustapha et al., 2018) has shown that visible evidence of sustainability is an important factor in the buying process. We did not find support for this. Which might be because household appliances like vacuum cleaners are usually not used in front of third parties.

3.6.2 Buying behaviour insights

Although the product preferences of most consumers are the same, most (73% in our case) buy energy-inefficient vacuum cleaners even when a more efficient model with the same specifications and price is on offer. Even self-pronounced green consumers often do not act on their promises (McDonald & Oates, 2006). We showed that there are differences between the factual product attributes and how these attributes are perceived in the buying process (see 3.5.2). Due to biases (Frederiks et al., 2015), consumers expect the energy-inefficient vacuum cleaner to provide better performance and offer a more reliable and durable product. Especially the buyers of energy-inefficient vacuum cleaners value technology and perceive high weight to be related to high quality (durability). People probably avoid

the potential risk that a more energy-efficient model might provide lower performance and instead hang on to their default option: their last, probably energy-inefficient, vacuum cleaner. This is comparable to the results of research by Luchs et al. (2010) who found that the performance of tyres, also a low involvement product, is negatively affected by sustainable attributes.

3.6.3 Managerial implications

In this section we will provide guidelines to meet the preferences of mainstream, non-green consumers with sustainable, energy-efficient products.

3.6.4 Communication and branding

'Green' is the primary buying reason for only 6% of the buyers in our study. These buyers are so different from the rest of the buyers that our research suggests they would even be willing to accept somewhat lower performance if their environmental preferences are met. On the other hand, current buyers of high input power machines were even put off by the environmental benefits, or at least were indifferent to the promotion of energy efficiency. The two groups are so different that it would be best to address them separately. It is well documented that 'green' does not have positive connotations for everybody in the retail shop: 'green' is perceived as being either less reliable (Luchs et al., 2010) or more expensive (Niinimäki, 2010; Visser et al., 2015). A study on sustainable packaging and environmental messages also concluded that people with low environmental consciousness are more successfully reached with packaging without an environmental claim (Magnier & Schoormans, 2015). In addressing non-green buyers, combining communication with an environmental visual image seems to hurt both the brand and product. Ottman (1995) was one of the first researcher to have realised the dilemmas of green marketing, and introduced the idea of 'personal benefit', which is predominant in the retail phase, and the 'environmental benefit', which has long-term importance for the same buyers. The benefits of radical designs, in this case higher performance with lower input power through technologically advanced design, should be actively marketed in communications and promotions (Mugge & Dahl, 2013). Vogtlander et al. (2014, Section 8) describe the consequences: create a green brand and deliver sustainable products and services but emphasize their high performance (personal benefit) to counteract the negative connotations of green at the moment of purchase. This is supported by our results (3.5.2 and 3.5.3), which showed that the preferences of 'non-green' buyers do not differ from each other and are focused on performance. To these buyers, lower energy consumption should be promoted in the form of superior

performance through technological innovation, while an emphasis on environmental benefits should be avoided in product communications. This contrasts with the communications used by Philips for the vacuum cleaners in our dataset, where all energy-efficient vacuum cleaners were promoted in terms of environmental benefits. Their communication focused purely on the few 'green' buyers.

3.6.5 Redesign

To attract mainstream buyers with energy-efficient products, innovative redesign is required. To satisfy customers, the actual suction performance of energy-efficient vacuum cleaners should be at least as good as that of less energy-efficient models. Heiskanen et al. (2010) provided several technical solutions to this. At the moment of purchasing, the perceived power is even more critical than the actual input power. Product design can counter the biases and incorrect perceptions of consumers that high input power stands for high performance and low input power means an inferior product. In fact, the current high power buyers should be seduced to buy low power innovations. Mugge et al. (2017) provided guidelines for influencing consumer perceptions of durable products. The redesign of low input power vacuum cleaners must be fine-tuned to the specific requirements of high-performance buyers. It should show robustness (including weight) and suction power and be equipped with a bag. Extra weight and bags for dust collection will add some additional environmental cost but, since 75-80% of the environmental cost is caused by energy consumption, this will be more than offset by moving mainstream buyers over to buy energy-efficient models. The additional weight can be used for value-adding features such as higher perceived performance and quality, additional soundproofing to reduce noise or heavier filters for cleaner air.

It is important to mention that buyers of vacuum cleaners do not base their decisions solely on price and technical specifications. Most of the consumer preferences in Figure 2 concern emotions, biases and perceptions, not facts. The perceived customer value (i.e., the utility and fun the customer expects after the purchase) is mainly determined by their preferences in the retail channel and are similar among nearly all buyers: reliability & durability, key features, value for money and the reputation of the brand. Most of the specifications are irrelevant to preferences for either a low or high input power version (in 3.5.2.) and are not functionally linked to performance. This is an advantage, since exactly these product attributes can be used to reinforce perceptions of performance and reliability without compromising either performance or energy consumption.

We believe that these recommendations to counter the perceived reduced performance of energy efficiency could be applied to other energy-efficient appliances as well. Mugge and Schoormans (2012) have already shown this for washing machines and cameras.

3.6.6 Policy implications

Our research showed that three out of four of our buyers opted for an energy-inefficient vacuum cleaner although an equal energy-efficient model was on offer. We view the implementation of energy efficiency legislation as an effective tool to foster sustainable consumption. It instantly forced the majority, roughly 73% of the consumers in our consumer database, towards more energy-efficient consumption. This was likely much quicker (Brown, 2015; Koomey, 1994) than convincing the majority of consumers through marketing and education. Legislation also forces manufacturers to develop energy-efficient technologies to meet mainstream customer needs and wishes. Lorek and Spangenberg (2014) pointed out that sustainable economies do not match the mainstream economic business models and can never be a driver for sustainable development without governmental intervention. Legislation also has limitations as it has no or limited impact outside the European Union and should not be seen as a silver bullet (Lehner et al., 2016; Sousa Lourenco et al., 2016). Redesigns of products and communication are therefore needed to address the needs and perceptions of buyers outside the EU.

3.6.7 Limitations of the dataset

The advantage of using the Philips dataset is that it is sufficiently large to do statistical analysis. The disadvantage is that the consumer preferences part falls short on details. The quality of the analysis could have been better if (1) the consumer preferences had been asked using a scale per aspect, rather than by asking for one primary reason, because it could be that different preferences are related and would yield more insight into individual biases, and (2) the reason for the choice related to the product specifications had been asked as well. There is thus room for improvement in future measurements.

Another issue is that the analysis was restricted to Western European consumers, because the data on other regions of the world were both smaller in quantity and the model offerings differ too much over regions. Extrapolation of conclusions to other regions of the world must be done with great care due to cultural differences, especially since consumers in other regions such as China and Brazil prefer and buy smaller input power machines with lower weight and size (Coronado Palma & Visser, 2012) to start with.

3.6.8 Future research

Our research provided support for the biases against sustainable and energy-efficient products (Frederiks et al., 2015). Further research is needed to show the relevance for other product categories like food, cosmetics or fashion. Preferences play an important role in sustainable consumption, as other research has pointed out (Auger & Devinney, 2007; Carrington et al., 2010; Luchs et al., 2010; Rex & Baumann, 2007). However, most of this research is focused on green consumers rather than the mainstream. We would like to encourage our colleagues to add to our work and adapt the models to include mainstream buyers in sustainable consumption.

3.7 Conclusions

In our research, we see basically three types of buyers of appliances: (1) a small minority (here 6%) of green buyers that regard the environment as a primary selection criterion, (2) the majority (here 73%) of buyers who think that only high input power cleaners provide the best performance and reliability & durability and (3) buyers (21%) who prefer low power cleaners because they either consider other specifications not discriminating enough and base their final choice on environmental aspects, or consider energy efficiency as a no-brainer and base their decision on other aspects. Except for environmental buyers, most buyers have the same primary preferences: reliability/durability, key features, value for money or brand reputation. All these preferences could be equally realised with an energy-efficient model.

We showed that perception and biases are major obstacles to sustainable consumption of durables. The people who did not buy energy-efficient vacuum cleaners did so because they, incorrectly, perceived that higher input power stands for higher performance and value. Getting this group of buyers to buy energy-efficient products has been a difficult and slow process. European legislation instantly more than tripled sales of energy-efficient vacuum cleaners and is regarded by us as both an efficient way to increase sustainable consumption and to put pressure on the industry to innovate towards sustainable consumption. We think that with this research we open possibilities to increase consumer acceptance and enthusiasm for energy-efficient consumer electronics. By applying this knowledge to future product design and communications of household appliances and consumer electronics in general, it would be possible to deliver low power versions with a higher perceived consumer value than that of the high-power versions, while also being energy efficient. These innovative energy-efficient designs must be

marketed as providing high performance thanks to their high technology, low noise and robustness.
In general, one should realise that although environmental benefits are, for most consumers, seen as important for the long-term transition towards a sustainable society, while purchasing the personal benefit dominates the mainstream buyers' choice. Consequently, communication of product attributes must be done with great care: (1) direct communication of the energy efficiency of products must always go hand in hand with a message of technological advancement, since 'less energy' is perceived as coming at the cost of 'lower performance' and (2) the mainstream consumer must be seduced at the moment of purchase to buy the energy-efficient product by relying on benefits other than 'less energy'. Such a double approach requires a high level of integration of design and marketing.

3.8 Author contributions

The project design and complete analysis and text was largely the contribution of ir. Mirjam Visser. Prof. Jan Schoormans and dr.ir. Joost Vogtländer offered textual input and feedback.

We thank Philips NV for sharing its consumer data for this research. They did not have influence on the analysis, results or conclusions.
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4 Publication 3: Recommendations of buyers of energy-efficient and inefficient appliances

Visser, M., Stevels, A., Schoormans, J. (2021). Comparing the Recommendations of Buyers of Energy-Efficient and Inefficient Vacuum Cleaners. Sustainability; 13(23):12988.

4.1 Abstract

Although environmental awareness is increasing every year, and most people say they prefer to buy more sustainable products, many still do not act on their promise at the cash counter. Sustainable products are often still perceived to have lower quality or reduced performance. Recommendations of sustainable buyers might reduce this perceived risk of sustainability. In this research, the Net-Promotor-Scores (NPS) and the underlying reasons for such recommendations of 888 vacuum cleaner buyers were analysed. The buyers of energy-efficient vacuum cleaners were found to be significantly less positive about their purchase. A difference in scores is, however, not caused by the difference in the energy efficiency of the products, but by differences in other drivers to recommend a product, such as perceived cleaning performance, ease of use and value for money. Additionally, higher suction power and increased weight positively mediated NPS ratings, irrespective of energy efficiency. Focusing design and communication on these aspects rather than on energy efficiency alone can be used to reduce the perceived green risk and increase trust in sustainable products. In this way, recommendations of buyers of energy-efficient appliances can be an effective additional tool in increasing sustainable consumption.

4.2 Introduction

Green marketing has been researched since the 1970s. The development of the theory has mostly been focused on green consumers and how to target those who would be willing to pay more for greener options (Dangelico & Vocalelli, 2017; Peattie & Crane, 2005; Straughan, 1999). Although most people say they would prefer to buy a more sustainable product providing the performance, quality and price are the same (Vogtländer et al., 2013), only a small minority actually buys sustainable products. To attract only the minority of consumers is, however, not enough to change the impact consumption has on the environment. It is necessary to urge more consumers to act on their promise to buy more sustainable products. "Sustainability" might offer additional customer value but is still seldom the main

reason to buy. At the cash counter, superseding issues, such as performance or image, prevail. Research of different product categories found that people often perceive sustainable products as having a higher cost of ownership. Cost is regarded not only in terms of money but even more so in terms of perceived lower performance or quality; for instance, sustainable shoes are seen as less fashionable (Visser et al., 2015), refurbished tyres perceived as being of lower quality (Luchs et al., 2016), and energy-efficient appliances as underperforming less sustainable options (Visser et al., 2018). People need to be assured that more sustainable or energy-efficient products do not necessarily come at the cost of other buying criteria. There is a need to communicate the value of sustainability in a more integrated manner with other product values. Experiences and recommendations of more environmental friendly products from customers are effective in confirming sustainable value and creating recurring sales (D'Souza et al., 2006). This research seeks answers on whether the recommendations of buyers of energy-efficient vacuum cleaners can potentially increase the consumption of energy-efficient models.

The theoretical background regarding sustainable consumption is addressed in the next paragraph. Then, the research on the quantitative measurement of customer satisfaction and recommendations is addressed. Before concluding with the research questions, we introduce vacuum cleaners as our research topic.

4.2.1 Sustainable consumption

Recent literature studies on green marketing (Dangelico & Vocalelli, 2017) and green consumption (Testa et al., 2021) show that green marketing strategies and research on sustainable consumption are increasingly moving away from mainly targeting green consumers with green products. Rex and Baumann (Rex & Baumann, 2007) recommended broadening the targeted population with more mainstream consumers and including green features in conventional products. They also highlighted that the customer perceived increased risks of sustainable buying as a critical issue that needs to be addressed. Empirical research verified that reducing green perceived risk can not only increase green trust, but can also raise green purchase intentions (Chen & Chang, 2012). Dangelico et al. (Dangelico et al., 2021) found that there are positive roles for functional value and value for money in driving green purchase behaviour and highlighted that product characteristics, related to quality, performance and price, are key for green product success. Marketeers should avoid green marketing myopia mistakes (Ottman et al., 2006) by including products' environmental attributes as additional benefits and carefully

integrating them, in both design and communication, with other superseding attributes, such as performance, quality and image.
When addressing mainstream consumers, it is more effective to focus on personal benefits, e.g., health, fun, ease of use or image, instead(Ottman, 1995). Environmental benefits are perceived as more abstract than, for instance, caring for family, personal image or health. Environmental issues are considered less urgent, more distant, and solvable in the future, unlike more personal problems (Liberman & Trope, 1998).
Another issue to address to drive sustainable consumption is consumer behaviour and habits (Testa et al., 2021). Most people tend to stick to past behaviour. If they adopt more sustainable behaviour and consumption, they will tend to stick to it.

4.2.2 Product recommendations

Overall product satisfaction is a prerequisite for recurring behaviour and sales, as well as for recommendations to convince others of the quality and value of more sustainable products. Dangelico et al. (Dangelico et al., 2021) showed the mediating effect of green purchase satisfaction on the links between personal norms and green purchase frequency. They highlighted the relevance of considering purchase satisfaction when studying green purchase behaviour, although this has received limited attention in the past.
Satisfaction can be viewed as a positive post-purchase customer perceived value. Perceived value involves more than one aspect of value simultaneously (Zeithaml, 2020), e.g., functional value, economic value, social value, hedonic value, and altruistic value. There is consensus that this depends on the individual attitudes, the context and the product/service itself. There is, however, less consensus on how to measure satisfaction. This can be either performed on multiple of the abovementioned aspects or on only one dimension, as proposed in the Net-Promotor-Score (NPS).
Reichheld proposed the NPS with the slogan "the one number you need to grow" (Reichheld, 2003). NPS basically condensed the measurement of satisfaction into one dimension by asking customers (on a scale of zero to ten) how likely it is that they would recommend the product or service to their family or friends. This was based on the idea that willingness to promote a company or product is a strong indicator of perceived quality and value. When customers recommend a product, they are putting their own reputations on the line. Consumers would only take that risk if they were intensely loyal. The NPS is not without criticism (Keiningham et al., 2008; Kristensen & Eskildsen, 2014; van Doorn et al., 2013). It proved not to be

a reliable predictor of future sales growth, as claimed by Reichheld. The validity of the NPS as a measurement of satisfaction, however, is neither inferior nor superior to more dimensional methods to measure satisfaction (van Doorn et al., 2013). The benefit of the NPS is that it asks only one simple question: would you recommend this product to your family and friends? The question is easily understood and quick to answer. A second reason for the use of the NPS is that recommendations and word of mouth are playing a major role in influencing customers. Consumers would only take that risk if they were intensely loyal. The NPS is not without critics (Keiningham et al., 2008; Kristensen & Eskildsen, 2014; van Doorn et al., 2013). Allen and Spialek (Allen & Spialek, 2018) showed that sustainable food buyers are more likely to provide word of mouth recommendations than those who bought less sustainable food. They predict that green WoM will increasingly become a strategic business concern. Not only word of mouth (WoM) from family, friends and colleagues, as measured by the NPS, is gaining interest, but also eWoM by influencers on social media. Ismagilova et al. (Ismagilova et al., 2020) found that for people to be willing to buy based on a recommendation, the credibility and similarity (homophily) of the source is highly important. This explains why friends and family are seen as trusted sources; they know each other. On the other hand, people tend to advise their loved ones to perform less risky behaviour compared to the risks they would take themselves (Helfinstein et al., 2015). As highlighted in the last paragraph, sustainable consumption is still perceived as riskier than buying less sustainable options.

4.2.3 Vacuum cleaners

For this research, extensive NPS data from Philips Consumer Electronics on consumers of vacuum cleaners were used. Vacuum cleaners are an ideal product category for research on sustainable consumption.

First, vacuum cleaning is a well-researched and described product category in respect to sustainability. Furthermore, 75% of the environmental cost over the life cycle (calculated by Life Cycle Analysis) of a vacuum cleaner is caused by its energy consumption (Mälkki et al., 2010). Reduced input power is, therefore, essential for more sustainable consumption. Input power had no significant association with weight or price but also not with suction power. Suction power is the factor that defines the quality of vacuuming to a large extent. Other research (Visser et al., 2018) on the reasons for buying either energy-efficient or -inefficient vacuum cleaners found no significant difference in the reasons to buy between buyers of either low- or high-input models, except for 6% of the buyers who bought a low-

input model for its environment friendliness. This last group, buyers of low-input power for reasons of environmental friendliness, was defined as green buyers. Obviously, no customers bought energy-inefficient vacuum cleaners for reasons of environmental friendliness.

Second, in 2016, the European Union implemented new legislation that maximized the allowable input wattage of vacuum cleaners at 1600 Watt (European Union, 2013), thus effectively defining the border between energy-efficient and -inefficient vacuum cleaners at 1600 Watt. In 2011, there was an approximately equal number of vacuum cleaner models above and under 1600 Watt on the European market. This makes it possible to compare both energy-efficient and -inefficient models. Both low- and high-input power models were available with similar specifications in suction power, weight and price (Visser et al., 2018). All the vacuum cleaners under 1600 Watt were promoted as energy efficient and better for the environment.

Finally, Philips' product portfolio covered the complete spectrum of vacuum cleaner products offered to the market. It aimed to cater to the complete range of prospective buyers and as such covers all products, from high to low end, targeting both mainstream and green buyers. Since all specifications in suction power, weight and price were available in both low- and high-input power models (Visser et al., 2018) and input power has no correlation with performance (Mälkki et al., 2010), no difference was expected in recommendations between buyers of high- and low-input power models after experiencing product use.

4.2.4 Research questions

Based on the previous paragraphs, we deduce that sustainable consumption can be encouraged by reducing the perceived risk of sustainable consumption. Previous research (Chen & Chang, 2012; Dangelico et al., 2021) concludes that this can be achieved by increasing satisfaction with and trust in sustainable products both directly by product use and indirectly by product recommendations. This research explores whether recommendations of sustainable consumers might be effective in increasing sustainable consumption. In this regard, it is essential that the customers of energy-efficient models report higher or at least the same NPS ratings as those who bought a less energy-efficient vacuum cleaner from an otherwise comparable specification. This leads to our four underlying research questions.

(RQ1) Are buyers of low-input power vacuum cleaners as positive in their NPS as those who bought high-input power models?

Both low- and high-input power vacuum cleaners were available in comparable product specifications (suction power, weight, and price) and comparable

performance. Since the vacuum cleaners are, except for input power, comparable, we also expected NPS levels between the consumer groups to be comparable.

Most low-input buyers bought their vacuum cleaners for the same reasons as high-input buyers, except for those who bought an energy-efficient model for the main reason that it is energy efficient. We expect the same difference to be reflected in the NPS ratings between the three consumer groups.
(RQ2) Do consumers of low- or high-energy models recommend for different reasons?

Since high input powered versions are not bought for reasons of environmental friendliness, and they are scientifically not environmentally friendly we expect a difference between the two groups.
(RQ3) Are the specifications of buyers of low- and high-input power vacuum cleaners comparable besides their input power?

All specifications in weight, suction power and price were available in both low- and high-input versions (Visser et al., 2018). The reason for this might be that the buyers of low-energy versions bought different specifications in weight, suction power or price than those who bought high-power vacuum cleaners.
(RQ4) Are there different mediation effects for buyers of low/high-input power vacuum cleaners on NPS rating?

We expected specifications such as suction power and weight and some of the main reasons to recommend mediating NPS ratings.

In section 4.3, the 'Materials and Methods' describe how the NPS data from the vacuum cleaner buyers were collected. In section 4.4, results are reported. Section 4.5 discusses the results and highlights academic and managerial implications of this research. This section also describes the limitations of this research and provides directions for further research. Chapter 4.6 summarises the conclusions.

4.3 Material and methods

In this research, Net Promotor Score (NPS) data of vacuum cleaner customers obtained from Philips Consumer Electronics were used. Buyers who registered their vacuum cleaners for warranty answered questions regarding their

demographics (age, country of living, household, and sex) as well as reason to buy and article number. These data were combined with the procured product specifications, i.e., input power (Watt), weight (kg), suction (Watt) and price (EUR). After three months, and ample time to experience and judge their product, they received an email with a link to answer several questions. Owners were asked to rank on a 11-point scale of zero (very unlikely) to ten (very likely) how likely it is that they would recommend the procured article to family or friends. They were also asked to pick one out of 12 reasons of recommendation (accessories, brand & reputation, cleaning performance, customer support, design & look, ease of use, environmental friendliness, noise & emissions, price, product features, reliability/durability, and others). In total, 888 customers answered the additional questionnaire. Sufficient answers were obtained to allow meaningful conclusions (see Appendix B.1. for the number of respondents per customer group and a further numerical specification of their reactions).

Only data of European customers were used, as the vacuum cleaners' specifications as well as regulation and legislation are identical across the continent. The respondents were split in line with the future energy efficiency legislation for vacuum cleaners by the European Union (European Union, 2013) in less or more than 1600 Watt input power. Previous research (Visser et al., 2018) showed that the buying reasons of most low-energy buyers do not differ much from those of the high-energy buyers, except for a smaller group buying a low-energy vacuum cleaner due to its environmental friendliness.

Therefore, it was decided to start this research with the same 3 buyer groups: buyers (N = 244 or 27% of the total population) who bought low-input power versions (including 53 green buyers who bought a model for its environmental friendliness, 6% of the total population) and buyers of high-input power versions (N = 644 or 73% of the total population), as shown in Figure 4.1.

To analyse the data, several tests were performed by using SPSS as a software tool. For normality, skewness (the symmetry of the distribution) and kurtosis (tailedness, which would be three in case of normal distribution) were calculated. To test for differences between groups, Analysis of Variance (ANOVA), specifically the "one-way-between-groups" version, was used to test for differences between groups. Due to non-normal distributions, the Welch and Brown–Forsyth F test based on the deviations of the group data from their individual medians was used.

This is valid considering the large sample size (Field, 2018). A mediation analysis was used to determine the interactions of attributes and reasons for satisfaction in NPS ratings. Mediation occurs if the strength of the relation between the predictor (in our case, the input power) and outcome (NPS ratings) is reduced or increased by including a mediator. To estimate the model the PROCESS-macro for SPSS by Andrew Hayes (Hayes, 2013).

Figure 4.1: Spread of consumers over low and high power (N=888)

4.4 Results

4.4.1 Are buyers of low-input power vacuum cleaners as positive in their NPS ratings as those who bought high-input power models?

In Figure 4.2, the NPS scores for each customer group are shown (see also the corresponding cross table in Appendix B Table B2). As described in section 4.3, there is a clear positive bias shown in the asymmetry (skewness of −1.81) towards higher recommendations.

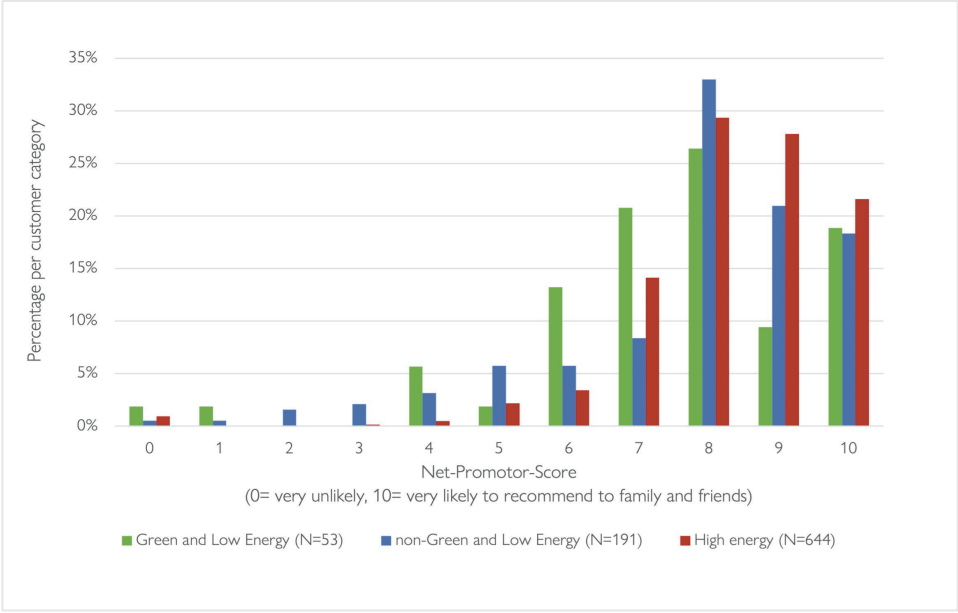


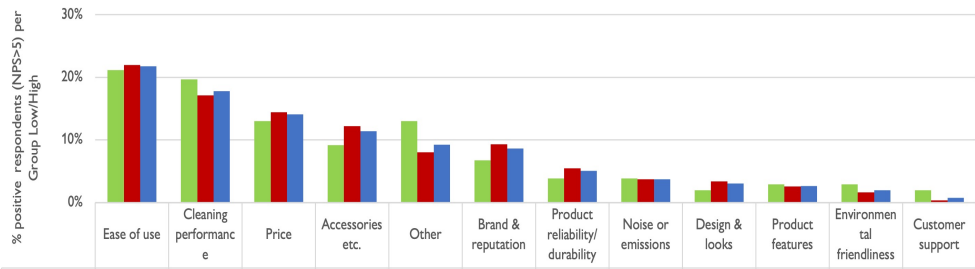
Figure 4.2: NPS scores of 888 respondents

(0=very unlikely to 10 = very likely to recommend this product to family and friends)

The high-power buyers are significantly more positive in their recommendations than the low-energy buyers; the difference in the NPS means between high and low energy is 0.62 compared to the mean of the total sample (8.17). Considering the skewness of the data, this is a considerable effect. Therefore, energy efficiency comes at a cost to customer perceived value of the vacuum cleaners. No significant difference was observed in NPS ratings between green buyers and non-green buyers of low-energy models.

4.4.2 Do consumers of low- or high-energy models recommend for different reasons?

To determine whether low and high buyers differ in their reasons to promote, we only considered satisfied buyers (NPS rating higher than five).
Figure 4.3. shows the reasons for recommendation of the positive customers, also presented from high frequency to low frequency. The customers named ease of use, cleaning performance, price, accessories, other, and brand and reputation as the main reasons for promoting, as these attributes account for more than 80% of the reasons to buy. For all customer groups, environmental friendliness is a reason to promote in only 2–3% of the cases. The distribution is further strongly tailed with only 6.3% of the customers rating negative (a score of a five or less). All three groups show a median of 8.



	Ease of use	Cleaning performance	Price	Accessories etc.	Other	Brand & reputation	Product reliability/ durability	Noise or emissions	Design & looks	Product features	Environmental friendliness	Customer support
Low Energy %	21%	20%	13%	9%	13%	7%	4%	4%	2%	3%	3%	2%
High Energy %	22%	17%	14%	12%	8%	9%	5%	4%	3%	3%	2%	0%
ALL %	22%	18%	14%	11%	9%	9%	5%	4%	3%	3%	2%	1%

Figure 4.3: Percentage of the positive customers (NPS rating>5, N=832)
per low/high power customer groups reporting one of 12 main reasons for recommendation

The NPS scores of the three independent customer groups in Figure 4.2 show that the high-energy buyers ($Mean_{HE}$ = 8.33, Std. $Deviation_{HE}$ = 1.49) are most positive in their recommendations. More importantly, green low-energy buyers ($Mean_{GL}$ = 7.43, $S.D._{GL}$ = 2.14) are those who are the least positive. The non-green low-energy buyers are found in between ($Mean_{nGL}$ = 7.80, $S.D._{nGL}$ = 1.99). A one-way between-group analysis of variance (descriptions in Appendix A Table A3) was conducted to explore whether the three independent customer groups differ significantly in their level of recommendation. The Welch and Brown–Forsyth test, to test if the groups

are different from one another, is significant ($p < 0.001$), which makes it unlikely that the differences observed are due to random sampling. It showed a difference between at least two of the groups ($F(2, 885) = 13.21$, $p < 0.001$). The post-hoc test showed that there was no significant difference ($p = 0.391$) between the low-energy buying groups but a significant difference ($p < 0.001$) between high-energy and green low-energy buyers (95% confidence interval (C.I.) = [0.34, 1.46]) as well as between the high-energy and non-green low energy buyers (95% C.I. = [0.21, 0.86]). Since there is no significant difference between the low energy buying groups, these groups were combined in the further analysis.

To check whether the reasons for recommendation are related to the NPS rating or to the (in)efficiency of the vacuum cleaners, Pearson Chi-square tests (Field, 2018) were performed. The tests showed that there was a significant association between the NPS rating and the main reason for recommendation (X^2 (11, N = 888) = 28.72, $p = 0.003$).

There was, however, no significant association between low or high power and the main reasons for recommendation, X^2 (11, N = 888) = 17.09, $p = 0.105$.
Low- and high-energy buyers are not significantly different in their reasons for recommendation. The NPS rating comes from their reasons for the NPS and not from whether their vacuum cleaner is energy efficient or not. This raises an additional research question as to whether their perception is steered by specification attributes other than input power, i.e., suction power, weight or price, which were all found to be input power-independent (Visser et al., 2018) attributes. Both efficient and inefficient models were available with comparable specifications, except for input power, but the bought models might have had a different spread.

4.4.3 Do the Specifications of Vacuum Cleaners Bought by Promotors Differ between Low- and High-Power Models?

To test whether the low- and high-powered vacuum cleaners bought by positive recommending owners had significantly different specifications, a one-way analysis of variance was performed. The means and standard deviations, as well as the significances, are presented in Table 4.1. The price in EUR between the low- and high-powered vacuum cleaners of the promoting customers is not significantly different, although price, i.e., value for money, is an important reason to promote. Both suction power ($F (1, 540) = 447.03$) and weight ($F (1, 371) = 14,261$) are

significantly (both $p < 0.001$) different between the two groups of owners. Energy-efficient buyers bought vacuum cleaners with significantly less suction power and weight, although models with a higher suction power and weight were available. Suction power and weight are also attributes that are not related to input power wattage.

Table 4.1: Means and standard deviations of suction power (W), weight (kg) and Price (EUR)

	Low energy <1600W (N = 208)		High energy >1600W (N = 624)		Total (N = 832)		Sign. (2-tailed)
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	
Suction power (W)	335.8	44.5	422.5	67.4	400.8	72.9	p <.001
Weight (kg)	5.91	0.63	6.52	0.66	6.36	0.70	p <.001
Price (Eur)	153.3	54.7	151.1	32.1	151.68	39.0	p = .59

4.4.4 Mediation effects on NPS ratings of promotors

Due to the results presented in sections 4.4.1, 4.4.2 and 4.4.3, weight, suction power and one or more of the reasons for the NPS rating might explain NPS ratings. This effect is called mediation. To find the indirect effect of the variables on NPS ratings, an ordinary least squares path analysis (using Preachers' SPSS Process script (Hayes, 2013) Model 4) was conducted on the data of the promotors (NPS>5). The direct effect from input power on NPS ratings was not significant ($p = 0.48$). This is very important and means that input power alone has no impact on NPS ratings, and it also confirms the outcomes of 5.4.2; the choice for low- or high-input power is not significant for the NPS rating. The indirect effects of weight and suction, often mentioned by buyers as a major buying criterion, were neglectable (effect 0.002).

Four reasons to promote had a significant (all $p < 0.002$) direct effect on NPS ratings independent from input power: brand and reputation ($b = 0.64$, $t = 4.47$), cleaning performance ($b = 1.14$, $t = 10.14$), ease of use ($b = 0.60$, $t = 5.70$), and perceived price ($b = 0.50$, $t = 4.17$). Promotors who promoted their purchase based on these aspects were more positive in their recommendations, whether they bought an energy-efficient vacuum cleaner or not.

4.5 Discussion

The main question of this paper is to what degree buyers of energy-efficient vacuum cleaners are effective in promoting sustainable products. As shown in 4.4.1., buyers of energy-inefficient models are much more positive in their recommendations compared to the buyers of energy-efficient models. Here, it should be taken into account that the low- and high-energy models on the European market showed, in contrast to the input power, no significant differences in specification (Visser et al., 2018), so in the first instance, no difference between customer groups was expected. Furthermore, 4.4.2. and 4.4.4. showed that input power is not the reason for the lower NPS ratings or being satisfied or not.

Persons who bought an energy-efficient model bought a model with significantly lower suction power and weight (Table 4.1) compared to those who bought inefficient vacuum cleaners (in 4.4.3.). This is interesting as higher specifications were also available in energy-efficient models. All energy-efficient models were sold with communication focusing on energy efficiency, which might have put the energy-efficient models into a one-sided environmental perspective, at the cost of more important attributes, such as cleaning performance which is related to suction power (Mälkki et al., 2010; Visser et al., 2018). This is potentially penalized with lower NPS ratings. As recommended by different researchers [7,10,14], the primary focus in the design and communication of sustainable products should be on conventional criteria such as performance and personal benefits. The environmental performance should be an integral part of the design but not a focal point of communication to avoid backlash in reduced trust and increased risk.
S
atisfaction is determined by people's reasons for the NPS and not from whether their vacuum cleaner is energy efficient or not. Low-energy buyers find other aspects important compared to high-energy buyers and, therefore, judge on other criteria, which are not directly related to energy efficiency (4.4.2). This is supported by the results from 4.4.4., which show that the direct effect of input power on NPS ratings is neglectable. One needs to consider that specifications such as suction power, weight and price are not significantly associated with the height of input power. They do, however, impact the perceived performance, e.g., perceived cleaning performance, perceived ease of use and perceived value for money (Luchs et al., 2010; Visser et al., 2018). These performance-related perceptions do have a direct effect on NPS levels. However, these are independent of input power.

It should be considered that recommendations, especially those coming from close personal relations, are coloured by the knowledge of the person in mind. People recommend lower risks to people they know than risks they would take themselves (Helfinstein et al., 2015). Considering that most people bought energy-inefficient vacuum cleaners, some still might perceive a sustainable choice to carry more risk in the short term. The environmental benefit is also much more abstract compared to the perceived personal benefit, e.g., a clean floor for children to play on.

4.6 Conclusions

4.6.1 Academic implications

The most important academic implication of this research is the support for research recommending targeting a broader population with sustainable products and energy-efficient appliances rather than targeting only green consumers who buy mainly based on environmental credentials. Figure 5.2 and the supporting one-way between-group analysis of variance showed no difference in satisfaction between the green and non-green energy-efficient buyers. This is support for the recommendations of Rex and Baumann (2007) and Ottman (2011) to target consumers for sustainable products much broader than only green consumers. Sustainability should be an integrated aspect of products. Product communication should be focused on personal benefits and performance rather than on environmental benefits. The results of the mediation show that functional value, quality and performance are key for green product success, as suggested Dangelico et al. (Dangelico et al., 2021).

This research showed that energy-efficient buyers are less effective promotors compared to buyers of energy-inefficient vacuum cleaners. This makes them, at the moment, ineffective in reducing the perceived risk of sustainability or increasing trust in sustainable products, as proposed by Chen and Chang (Chen & Chang, 2012). The present research showed lower value or satisfaction ratings for energy-efficient buyers. A difference might be caused by the fact that the present research tested, unlike in the case of Chen and Chang, actual purchases. We suspect the recommendations of sustainable products measured by the NPS based on recommendations to relatives might be somewhat more negatively biased than the methods used by Chen and Chang, which measured the perceptions of respondents. Helfinstein et al. (Helfinstein et al., 2015) suggest that recommendations to close relatives might be risk avoiding. Although we found that

energy efficiency was not the direct reason for lower NPS ratings, the input power might have coloured the attributes that were reasons to recommend.

4.6.2 Managerial implications for design and communication of sustainable products

This research showed that buyers of energy-efficient vacuum cleaners are not effective in recommending sustainable products. It also showed that energy efficiency itself is not the cause for this. There are a few options available to reduce the perceived risk of sustainability through a combination of improved design, up to date technology (IT and sensor-assisted energy management) and a linked benefit communication strategy (Ottman et al., 2006). Possible options can be found in the following:

Design focused on (perceived) performance: for example, focus the design of energy-efficient vacuum cleaners on increasing ease of use and cleaning performance. As shown in 4.4.4., both are reasons that lead to higher NPS levels. Technically, this is feasible. Modern 900 Watt vacuum cleaners show better cleaning performance and increased suction via more airflow effective accessories and connectors (Consumentenbond, 2021). Make designs look powerful and robust to increase the perceived performance and quality (Mugge et al., 2017). Focusing product design and specification on reliability and durability, cleaning performance and ease of use can additionally improve satisfaction ratings independently from energy efficiency.

Focus product communication predominantly on personal benefits, such as clean floors, reduced time to clean, and ease to handle. When communicating environmental benefits, this should be linked to benefits (Ottman et al., 2006) such as reduced cost, longer lifetime, and higher quality.

4.6.3 Legislative Implications

In 3.1, it is shown that, at present, buyers of energy-efficient vacuum cleaners are not effective promotors. If energy efficiency is not promoted by customers and continues to be perceived as a risk to performance producers are encouraged to sell energy-inefficient instead of energy-efficient models. Unfortunately, the event after Dyson successfully challenged the eco-design directives for vacuum cleaners in court (General Court of the European Union, 2018) proofed this. Awaiting reformulated directives, scheduled for 2023, many producers directly took the opportunity to temporary reintroduce high-power models, undermining their own

messages in recent years that energy efficiency does not come at the cost of performance, an effect already observed more than 20 years ago for TVs and audio equipment (Stevels, 2007). Producers were not able to disseminate messages about energy saving in a way that results in a significant shift toward low-energy models. This makes it legitimate and unavoidable to implement energy consumption-reducing legislation, effectively taking energy efficiency out of the buying decision-making process. The market will not likely move by itself as long as there are energy-inefficient models on the market. When design and communication are not applied appropriately and satisfactorily, this will make implementing energy efficiency legislation, such as that of the European Commission (European Union, 2013), unavoidable. Awaiting EU legislation in 2023 to reduce the maximum input power even further to 900 Watt has stimulated innovation in energy efficiency enormously. At present, the top 20 vacuum cleaners with the highest performance rating have lower than 900 Watt input power (Consumentenbond, 2021; Rames et al., 2019).

4.6.4 Limitations and Further Research

This research has some limitations. One is the concise character of the NPS as a measurement instrument. NPS has been used by multiple for profit and not for profit organizations in multiple branches. Although the NPS by scholars is not viewed as a valid predictor for business success or future behaviour (Keiningham et al., 2008), the validity of a one-dimensional measure for satisfaction is acceptable (Zeithaml, 2020). Although the one-dimensional question "how likely are you to recommend?" has validity, it is lacking details in the reasons for satisfaction. This is overcome by asking customers to pick a reason for their rating as well. Customers could select only one chief reason and one second reason for their rating. The latter were hardly reported and, therefore, omitted from the analysis. More interesting and useful data would have been collected when more comprehensive Likert scores were used and customers were asked to rate the degree to which each attribute affected their satisfaction rating.

Only one product category was researched, and the results might be different for other white goods, which, for instance, have a stronger emotional effect on people, such as espresso machines, cars or music appliances. Additionally, products with stronger personal or health benefits, such as organic produce, might provide different results. On the other hand, the results are in line with those for televisions (Stevels, 2007), although this relates to a study of approximately 20 years ago.

European consumer data were used as the models sold had the same specification. In other regions, the specifications and likely also the results might differ. The sold vacuum cleaners in countries such as Brazil, China and India have different specifications and are most often smaller and lighter with lower watt engines. Use patterns, flooring and cleaning practices in other regions might also be different and lead to other outcomes. It might be interesting to repeat this study for those customers.

4.7 Conclusions

Buyers of more energy-efficient vacuum cleaners make poor promotors compared to those who bought energy-inefficient models. A difference in satisfaction comes from the different reasons for the satisfaction of energy-efficient buyers rather than from the energy efficiency itself. Objectively, there is no reason for such a negative perception; there is no difference in the technical performance between energy-efficient models and inefficient models (Mälkki et al., 2010; Visser et al., 2018). Apparently, large parts of the buying public have a subjective perception that the performance of the energy-efficient models is lower, even if this objectively is not the case. This strongly suggests that the communication about energy efficiency must be improved drastically. This can be achieved by taking energy efficiency out of a specific environmental context and taking energy independent attributes into account. Many consumers see sustainability as of great societal interest but not as the most important or discriminating attribute of their product. Environmental benefits should be positively linked to product attributes that are perceived to be of primary interest, both in design as well as in communication. For vacuum cleaners, these are suction performance, accessories, ease of use and value for money. With designs that better balance airflow among motors, hoses and suction heads and application of the latest technology (IT and sensors), the technical performance, including the environmental performance, can be further improved. When communicated well, this can also contribute substantially to the perceived performance and reduce the perceived risk of sustainable consumption. This might even prove to be successful in attracting currently inefficient buying customers.

Since energy efficiency comes at the cost of the perceived customer value and additional perceived risk, producers proved to be reluctant to switch to energy efficiency as long as there are energy-inefficient models with higher perceived consumer value on the market. If this issue is not satisfactorily addressed, energy-

reducing legislation is unavoidable and yields faster reductions in energy consumption. (Vacuum) cleaning has a large cultural element and is performed differently in different cultures. It seems that the perception problems regarding energy efficiency are also, to a large extent, Western ones. In Asia and Brazil, vacuum cleaners with lower energy consumption on average are sold in large quantities. This demonstrates that the present design and knowledge, and changed communication, offer a wide range of improvement options.

Recommendations and (e-) word of mouth of sustainable and energy-efficient customers can grow trust in a company's communication regarding issues that cannot be supported with hard figures or have a strong emotional component, such as the environment or sustainability. It should be noted that positive emotions play an important role in the value perception of customers. Increasing the positive recommendations and word of mouth of sustainable buyers can be an additional tool to increase sustainable consumption beyond the greenest consumers.

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5 Publication 4: Sustainable use of appliances

This article is submitted to Journal of Cleaner and Responsible Consumption and in the rebuttal phase.

Visser, M., Schoormans, J., Get rid of the eco-button! Design interventions to steer sustainable use of washing machines

5.1 Abstract

To reduce energy consumption of households, many appliances contain eco-settings, which when used, reduce energy consumption. However, the effectivity of the eco-settings in reducing energy consumption is hardly tested. Other design for sustainable behaviour strategies like coercion and feedback might be more effective. To test the effectivity of these three design for sustainable behaviour strategies in reducing the energy consumption of washing machines a 2x2 factorial design experiment is conducted. A total of 779 European washing machine users were asked to set washing machine controls for three laundry baskets on one of four control panels. The results showed that eco-settings of the washing machines were used for only 26 % of the laundry baskets. Respondent presented with coercion or feedback controls consumed 15% less energy compared to those who were allowed to decide whether to use eco-settings. Few people understood the relation of water temperature and the duration of washing machine programs on energy consumption. Feedback can support their decision processes and prevent unintentional and unsustainable settings. Our research shows that even washing machines with an energy label A are not necessarily leading to energy reductions because eco-settings are only used in a minority of cases. In this survey, only 6% of the potential 44% savings by using eco-settings was realised. The results suggest it would be more effective to always use energy efficient settings, preferably together with feedback and scripting of program menus that solicit the use of short cold cycles. This research shows that for energy efficiency to be effective, a product must be designed for sustainable behaviour of the user.

5.2 Introduction

In 2019, households represented 26.3% of the total energy consumption of the European Union (EU), of which 14% was used by household appliances (Eurostat,

2021). To reduce this consumption, the EU implemented increasingly challenging eco-design legislation to force producers of household appliances to innovate and attain increasingly higher energy efficiency. Eco-settings and -programs that provide users with an optional button, switch, or program to run appliances in a more energy efficient mode are familiar features in this quest. This higher energy efficiency when running in eco-mode usually comes to some kind of performance loss, like the increased durations of washing cycles in washing machines or somewhat less acceleration in cars. After finishing the washing cycle or switching off the engine of a car, the eco-settings are usually resetting to a start or defaulted mode that is less energy efficient or not "eco". The next time the appliance will be used again, it requires a conscious action on the part of the user for the eco-mode to be activated. From a sustainable point of view however, it is important that consumers use the included eco-modes otherwise the energy savings of energy efficient appliances will not be realized to their fullest intentions.
Appliances are becoming more energy efficient, but also more complicated. The way they are set and used becomes a critical determent of their real-life energy consumption, which can vary greatly depending on a single initial setting or usage routine. Irrational or poorly informed behaviour with respect to appliance energy consumption may be a tangible setback in the path towards a more energy efficient world. This is an area of interest and concern for legislators who seek energy savings (Sivitos et al., 2015). Most eco-design legislation and producer responses have focussed on technological innovation and not on how the consumer uses the appliances. When about 80% of the appliance environmental load is realised in the use phase for both irons and vacuum cleaners (Visser et al., 2018) as well as washing machines (BSR, 2009; Van Der Velden et al., 2014) the behaviour of the user is of utmost importance. This is also the case in pay-by-use models (Bocken et al., 2018) which offer feedback in charging lower fees for lower temperature cycles or for laundry services. Thus, if eco-design features in appliances are not being used, not all potential of energy efficiency and other eco-design targets will be realised.

This research aims to contribute to understanding how design for behaviour in product designs can be applied to reduce energy consumption in the current washing machines that, in the EU, are equipped with eco-programs.

5.2.1 Product design for sustainable behaviour

Many of the daily actions people take are habitual, automated actions that are difficult to change (Godin et al., 2020) and are considered a major factor in the sustainable awareness-intention-behaviour gap and a mediating factor in behavioural change (Bhamra et al., 2011; Shove, 2003). Design research has defined several design strategies to promote sustainable behaviour (Bhamra et al., 2011; Boks, 2012; Lilley, 2009). Design for sustainable behaviour aims to break habitual behaviour and, in some cases, teach new more sustainable behaviour. Possible strategies can be categorized in order from product in control towards user in control. When the product is in control, the product determines behaviour, for instance, by using 'intelligent systems' that use sensors and automatically use the most sustainable settings, or it coerces behaviour by offering no option to make a mistake or act unsustainably. With the product in control, products can be optimized to deliver the most sustainable performance. Defaults, the path of least resistance, proved to be an effective strategy to steer behaviour in many different settings (Hankammer et al., 2021). It is assumed that a default set to the intended choice is more effective because people tend to stick to the status quo because of inertia. Change incurs cost in money, time or effort. People, therefore, often only adjust product settings if prompted to do so. When machines offer no or few adjustment options, people make less mistakes, but without feedback they miss learning effects that might lead to more sustainable behaviour in other situations or with other products (Bhamra et al., 2011; Wever et al., 2008). Legislators and producers are reluctant to use coercion to reduce energy consumption (Varone & Aebischer, 2001). Indeed, many consumers prefer products that give them some freedom of choice. At the other end of the spectrum, where the user is in control, a product shares information and/or feedback to enable users to make a free choice. One example is a feedback system that teaches users the dynamics of the control system. Feedback systems are more effective if they work in the moment and are accessible and easy to understand (Kobus et al., 2015). However, even monthly feedback that reported cost of laundering resulted in people using less washing cycles and lower washing temperatures after three months (Bocken et al., 2018). A strategy that offers the best of both sides combines persuasion with eco-choices supported by scripting. Sustainable scripting is defined as the design of a product layout guiding the user, in a more or less forceful way, to sustainable behaviour (Jelsma & Knot, 2002). In these strategies, the design makes sustainable use easier and unsustainable use more difficult or even impossible. Feedback can be one element in the script to prevent users from skipping a sustainable benchmark or

option for other than sustainability reasons. For scripting to be effective, it should be easy, fun and intuitive to use and difficult to misuse.

5.2.2 Washing machines

This study uses washing machines that are sold in Europe. Washing machines is a good product category for testing the usage of eco-settings and the effectivity of coercion and feedback on energy consumption of a household appliance. If used in a sustainable manner, by washing more often on energy efficient settings, energy consumption of a washing cycle could even be halved. Washing machines are found in nearly every household in Europe. The different models washing machines on the European market have similar functionality, need to be produced according to eco design regulations (European Commission, 2019) and offer options for more sustainable behaviour like eco-settings, short cold cycles and temperature control. Clean washing results are the product of water temperature, duration of the washing machine cycle (including washing, rinsing and spinning), water consumption as well as mechanical and chemical action (Boyano Larriba et al., 2017). To increase energy saving, motors and insulation are improved. However, most of the energy efficiency comes from eco-programs that use reduced water temperatures and increased duration of the washing programs. When operation in a sustainable way, modern energy efficient washing machines use 30-60 minutes longer washing cycles at around 10℃ lower temperatures. Modern washing machines with an EU energy label A consume on "Eco 40-60" less than 50 kWh per 100 cycles. When both low temperatures and eco-settings are used, the washing machines are even more energy efficient. For example, using the same reference washing machine (Miele, 2021), 8kg cotton laundry consumes on eco (40-60℃) 0.75 kWh (for the data seen Table A.1. in Appendix A). When washing the same load on eco at 20℃ it would only consume 0.35kWh, a saving of 53%.

5.2.3 Sustainability and doing the laundry

As indicated above, the behaviour of users is crucial in realizing the intended benefits of energy efficient washing machines. About 80% of washing machines environmental load is realised in the use phase and the result of energy consumption and detergents.

The environmental burden of washing laundry depends largely how and how often the consumer does his or her laundry. This has been a topic of many researchers worldwide. (Farnaz Alborzi et al., 2017; F. Alborzi et al., 2017; Boyano Larriba et al., 2017; Pakula & Stamminger, 2010; Shove, 2003; Sohn et al., 2021; Yates & Evans,

2016). Washing rituals differ over countries (Farnaz Alborzi et al., 2017; Boyano Larriba et al., 2017), not only within Europe where most household own a washing machines but also over the rest of the world. Some wash by hand, others cold or hot, in top loader or front loader. Some wash at home other use coin services or use a laundry service.

Further, social norms are differing over countries and play a major role in standards of cleanliness and which washing method is considered giving the cleanest results (Shove, 2003). In some countries this will be by washing by hand, in others by using the most technologically advanced washing machine (Klint et al., 2022).

The environmental burden of washing depends largely on personal decisions. Is an item considered dirty or not? When is the machine full enough to be switched on? Which program should be used? These all affect the final energy consumption of households. The most effective reduction in energy consumption would come from doing the laundry less often or wash cold(er) as was recommended by (Yates & Evans, 2016). But social norms and habits are notoriously hard to change (Shove, 2003; Yates & Evans, 2016). Klint et al. (2022) suggest technology can play a role in changing the laundry habits by steering towards more sustainable behaviour and choices.

5.2.4 Washing machines features and product design for sustainable behaviour strategies

Currently the washing machines in Europe are obliged to have an eco-washing program for 40-60°C programs or an eco-switch or -button to gain market access. Eco-buttons are therefore a familiar feature in washing machines nowadays. However, the effectivity in energy reduction of washing machines succeeds or fails with the choice of users to use these eco-settings. There might be other washing machine features or product design strategies to steer more users towards sustainable behaviour. Based on the design for sustainable behaviour strategies research of several authors (Bhamra et al., 2011; Lilley, 2009; Tang & Bhamra, 2012; Wever et al., 2008) we expect two washing machines features to be promising alternatives to eco-settings.

The first feature is coercion. If users would always wash on eco and/or lower temperatures, there might be an even greater potential reduction of energy than will be realized by eco-settings which need to be set intentionally. By using coercion, as a method to reduce energy consumption in washing machines, all laundry is washed as if the eco-button is selected. Coercion as a feature is currently not available on the European market. Such a feature would run every washing program

in the eco-mode. In that case the eco-button is omitted while there is no option to run in any other mode than eco.
The second feature is feedback. A product feature that shows feedback is offered in some current washing machines. However, in most cases they only report the (remaining) duration of the selected program cycle. Bocken et al. (2018) included in their pay-by-use washing machine feedback in the monetary cost of a cycle and in a monthly bill with a report per program setting. They reported changes in habits like a 30% lower number of washing cycles and reduced temperatures. Feedback on energy use is further known to result in the consumer's reduction of energy consumption in both household energy monitoring systems (van Dam et al., 2010) and cars (Allison & Stanton, 2019). To use feedback to steer to energy efficient washing, every setting could show the difference in energy reduction between the user and machine settings. The presentation of the difference could be either absolute or relative. Energy consumption on one cycle is less than 1 kWh or less than 25ct. Most users would estimate the impact of one washing cycle both on their yearly energy bill and the environment as low. Thus, a relative comparison makes more sense, in other words, save x% on your consumption is shown on the control panel.

In this survey we test the effectiveness of present eco-buttons as well as the product design for sustainable behaviour strategies of coercion and feedback in reducing energy efficiency in washing machines. In this study, the product feature coercion offers no other option than to use the energy-efficient programs as opposed to the freedom of choice when an eco-setting is available. The product feature feedback shows the percentage energy consumption saved or gained during a program cycle by using or not using the eco-settings.

Section 2, Methods and materials, describes the used methods, stimuli and experiment design. Section 3 describes the results, which are discussed in Section 4. Section 5 presents the conclusions.

5.3 Methods and materials

To test the effect of design for sustainable behaviour strategies "coercion", and "feedback" on energy consumption of washing machines, a 2 (no coercion/coercion) x 2 (no feedback/feedback) factorial design of a washing machine control panel was used. Four control panels were tested in this experiment. Each

control panel version was presented to 200 European washing machine users who all set three standardized laundry baskets. The effect of the independent variables "coercion" and "feedback" on the dependent variable energy consumption was measured.
The experiment was conducted via the internet. The questionnaire was designed in Qualtrics. The respondents were selected via the British survey platform Prolific. The respondents answered the questionnaire in Prolific. After finishing the questionnaire, the data was collected in Qualtrics. Analysis of the data was performed in SPSS.

5.3.1 Stimuli design

The four designs of the control panels were made, based on the settings of an Energy Label A Miele WEF 375 WPS washing machine with a capacity of 8kg (Miele, 2021). Washing machine producers are obliged to calculate and present their energy consumptions for standard settings according to the EU Energy Label Regulations (European Commision, 2019). This washing machine was tested best-in-class by the Dutch consumer organisation (Consumentenbond, 2020). The program temperatures/duration combinations and the resulting energy consumptions of its manual were used and extrapolated for the remaining settings in the four control panels. Appendix A presents all potential different settings per model and fabric with their responding program length (in hours and minutes) and both absolute as relative energy consumption (in kWh). Washing machines using eco-settings, not only of the reference washing machines but also by other brands, are washing at around 10℃ lower than presented on control panels. In this research, both coercion and no coercion with chosen eco-settings are calculated using the same energy efficient, 10℃ lower, settings.
The eco-setting was interpreted as "no-coercion"; users have the option to use or not to use an energy efficient setting for their selected washing program. After each washing cycle, the setting returns to the defaulted "no eco" as is practice in most eco-button options in washing machines, other appliances and cars. The no-eco setting resulted in proposed washing machine settings at 40℃ for cotton and 30℃ for all other fabrics with applicable durations according to the reference Miele washing machine.
The coercion version had the same program settings as no-coercion but with the difference that all program cycles in the coercion version were performed on eco. Both coercion and no-coercion set at eco proposed 20℃ washing cycles with

durations that depended on the selected fabric program. Respondents could still make temperature adjustments or use short cycles.
Feedback was presented as the relative difference in energy consumption (in kWh) between the user's (optional) choice and the proposed standard machine setting for the fabric program. For the coercion model with feedback, the machine-suggested setting of 20℃ for all programs is so low in energy consumption that the feedback on other options users can make are nearly always negative, except for short programs, which are even lower in energy consumption. All models offered the option of a short cold cycle. They are the same for each fabric program with 20 minutes at 30℃ consuming .33 kWh. Obviously, models which did not include feedback showed no feedback on the energy consumption of the washing cycle.
The machine controls were designed for the three most often used settings for fabrics (Boyano Larriba et al., 2017): cotton, handwash/wool/silk and synthetic/mix. The 2x2 control panels were simplified designs (Figure 1) with just the three fabric program settings, an option to choose a short program and an option to adjust the temperature. This would keep the process of setting the control panels brief (around 60 seconds per cycle), and easily understandable what is relevant to guarantee more validity.

Figure 5.1 shows the control panels used in the four different experimental cells as they were presented at the start of the experiment.

Different types of laundry require different washing machine settings, for example, the setting for washing towels is different from the setting for washing underwear. Therefore, three different laundry baskets were defined for the study. Participants were asked to indicate the washing machine settings (in random order to avoid learning effects) for the following three laundry baskets:

- Coloured bedsheets and towels
- Freshen-up t-shirts, blouses and men shirts
- T-shirts, underwear, sportswear and jeans.

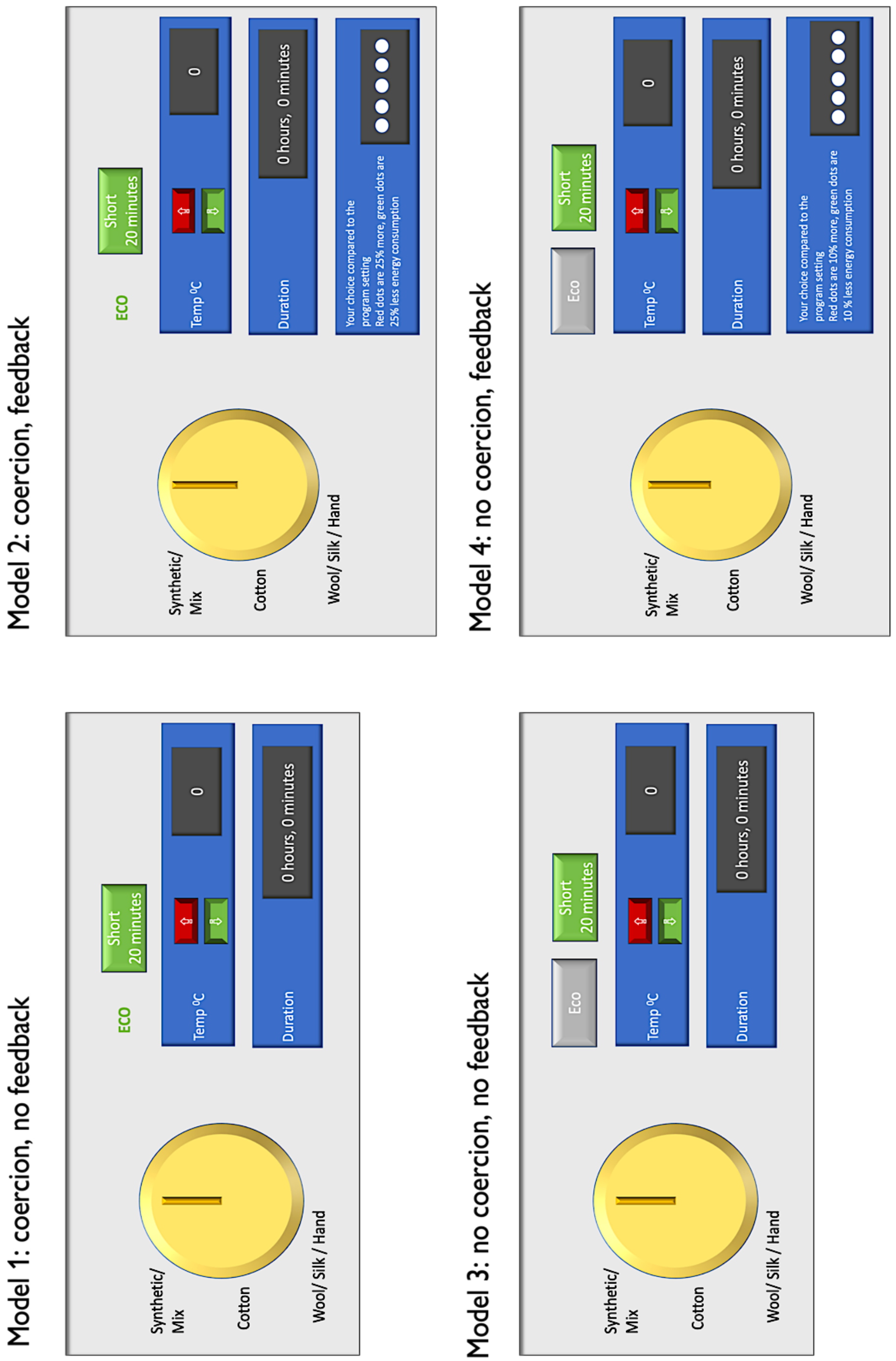

Figure 5.1: Stimuli 2x2; no coercion/coercion, no feedback/feedback

5.3.2 Instruction to the respondents

Each respondent was first given a summary of the experiment and asked for their consent to use their data for this and future research and education purposes. They also confirmed they are regular washing machine users. Thereafter, they answered a few control questions to verify that they were English speaking, between 28 and 75 years old and European citizens. Next, they were asked to indicate the number of people in their household and how many children under 18 years were part of their household.

Next, each respondent was presented, in random order, with the three laundry baskets and was asked to set the washing machine for each of the laundry baskets according to the following script (Appendix B presents an example for Model 2 coercion/feedback);

1. Please select a program for the laundry basket mentioned below (cotton, handwash or synthetic).
2. For this laundry basket, do you select "Short 20 minutes at 30 degrees"? (Yes/No) (if feedback was included in the assigned model, then feedback was presented for both options in this and all following questions).
3. For no-coercion only: Please select whether you like to use the eco-setting or not for this laundry. You can adjust the laundry temperature in the next step. (Yes/No).
4. You see your control panel: do you want to select another temperature and duration? A temperature/duration combination is chosen.

Respondents might make choices based on an incorrect assumption about the effect of certain control settings, especially related to the relation between temperature, duration and energy use. Therefore, after setting the control panel for all three laundry baskets, respondents were asked to answer two control questions to determine whether they understand the relationship of temperatures and duration to energy consumption:

1. Put in order from least energy consuming to most energy consuming (in random order presented 40, 30, 50, 20 degrees)

2. Put in order from least energy consuming to most energy consuming (in random order presented; five different combinations of eco/no-eco, temperature and duration.

5.3.3 Data collection

The questionnaire was programmed in Qualtrics for each of the four models. The British survey platform Prolific provided 800 respondents. The respondents were pre-screened according to age (28 to 75 years old), country of residence (all European countries), gender (female, male, other), fluency in English and only frequent users of washing machines were selected. Because the respondent base of Prolific leans heavily on respondents from the United Kingdom (UK), respondents from the UK were limited to 25% per experimental cell. Each of the four cells was presented to 200 respondents. After giving consent and completing the questionnaire, each response was loaded into Qualtrics. Each respondent earned 0.75£ to complete the questionnaire, which took about 4 minutes ($M_{response}$ = 248 seconds, $SD_{response}$ =134).

5.3.4 The demographics

It was expected that it would take at least 60 seconds to perform the task in a reliable way. Next it was expected that people who took a very long time to do so (over 1000 seconds) probably where not understanding or not focusing on the task at hand. Therefore, we decided to exclude the 21 respondents who were using less than 60 seconds or more then 1000 seconds to complete the questionnaire. After this excluding, the sample included 779 persons with the following spread:
Age: $Mean_{Age}$ = 37.6 years old, SD_{Age} = 9.8.
Gender; 50.0% female, 49.9% male and 0.1% other.
Country: UK 25%, Portugal 19%, Italy 13%, Poland 12%, Spain 7%, Greece 5%, France 4%, Germany 3% and the remaining respondents spread across the remaining European countries.
Household size; $Mean_{\#persons}$ = 2.7, $SD_{\#persons}$ = 1.3. Largest groups; 2-person household (35%); 3-person household (27%), 4-persons (18%), 1-person (14%).
Number of children under 18 years in household: 0 (69%), 1 (16%), 2 (11%), >2 (4%), $Mean_{\#kids}$ = .49, $SD_{\#kids}$ = .85.

5.4 Results

5.4.1 Effects of coercion and feedback on energy use

A two-way between-groups analysis of variance was conducted to examine the impact of coercion and feedback on energy consumption (in kWh).

Coercion showed a significant positive effect on reducing energy consumption by 11.0% ($F(1, 779) = 43.7$, $p < .001$).
Feedback also had a significant positive effect and reduced energy consumption by 5.3% ($F(1, 779) = 8.7$, $p = .003$).
Figure 5.2 shows the estimated marginal means of the different models. Model 3, (no coercion and no feedback), is comparable to both the reference washing

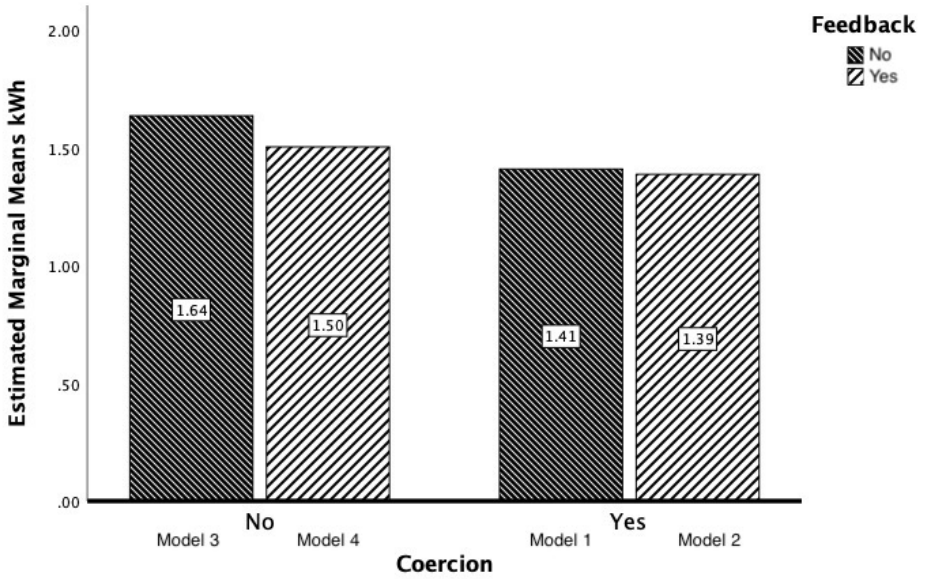

Figure 5.2: Estimated Marginal Means in kWh energy consumption for all Models

Model 1 (N= 193, Mean 1.41, SD .03), Model 2 (N= 198, Mean 1.39, SD .03), Model 3 (N= 192, Mean 1.64, SD .03) and Model 4 (N=196, Mean 1.50, SD .03). Covariates appearing in the model are evaluated at the following values: Age = 37.61, Gender = .50, Country Coded = 15.55, Household size = 2.72, # of Kids = .49, Short total = 1.43

machine and most recent commercial models on the market. It has the highest energy consumption ($M_3 = 1.64$ kWh, $SD_3 = .03$) for washing three laundry baskets. The effect size, measured in difference between the means, with Model 1 is 14.0%, with Model 2 is 15.2% and with Model 4 is 8.5%.
There is a significant interaction observed between coercion and feedback ($F(1, 779) = 4.4$, $p = .035$). The positive effect of feedback in reducing energy consumption is larger for the no-coercion cells (8.5% reduction) than for the coercion cells (1.4% reduction).

The use of short cycles had a significant and large positive effect on reducing energy consumption ($F(1, 779) = 487$, $p < .001$). Using three short cycles reduced the energy consumption by 50% compared to washing without using short cycles.

There was a significant main effect on energy consumption found for country ($F(1, 779) = 8.6$, $p = .004$). Moreover, a significant main effect was observed for number of under-18-year-old persons in the household ($F(1, 779) = 10.7$, $p = .001$), families with children under 18 years washed less energy-efficiently. No significant main effects on energy consumption were found for gender (p. =.37), age (p =.04, Eta .006) or household size (p =.36).

Eco-settings usage

In two cells (Cell 3, no feedback on energy consumption and Cell 4, feedback on energy consumption) an eco-button was present. A total of 31.5% of the respondents chose the eco setting at least once out of the three laundry baskets – 26.3% of those in the no-feedback cell and 37.1% of those in the feedback cell. A Chi-square test for independence (with continuity correction) indicated a significant relation between eco-settings and feedback cells (χ^2 (1, n = 445) = 5.51, $p.$ < .001, eta .12) meaning that feedback encourages more people to select at least once the eco-setting however with a small effect size.

A total of 14.5% of the laundry baskets within the no-coercion cells were washed with the use of the eco-button. No significant difference was observed on eco-setting usage ($p.$ =.46) between feedback type.

Temperature settings and short programs

For only 14% of the laundry baskets, the proposed washing temperature setting was accepted and no change in the programs setting, either in temperature or wash at the short program, was applied (Table 5.1).

A Chi-square test for independence showed a significant association between temperature adjustments and the coercion and feedback cells (χ^2 (18, n = 2340) = 531, $p.$ <.001) and the effect size was large (Cramer's V = .28). When using coercion to use 20°C as a proposed washing temperature only 7.3% of the respondents accepted the proposed temperature setting. Without using coercion more people used the proposed programs settings.

The significant effect of coercion on temperature setting is large (χ^2 (6, n = 2340) = 350, $p.$ <.001, Cramer's V = .39). The significant effect of feedback on temperature settings is medium (χ^2 (12, n = 2340) = 194, $p.$ <.001, Cramer's V = .20).

Table 5.1: Percentage of respondents making temperature adjustments

from the proposed starting temperature per washing cycle (Model 1 (N=579), Model 2 (N= 594), Model 3 (N=576) and Model 4 (N=591)

Model #	Coercion	Feedback	Program Starting temp	-20 °C	-10 °C	No change	Short program	+10 °C	+20 °C	+30 °C	+40 °C	Total
1	Yes	No	20 °C	0%	0%	8%	28%	22%	30%	2%	10%	100%
2		Yes		0%	0%	6%	63%	14%	10%	1%	6%	100%
3	No	No	Cotton 40 °C, others 30 °C	0%	5%	19%	60%	8%	8%	0%	1%	100%
4		Yes		1%	3%	20%	64%	7%	4 %	0%	0%	100%
% total				0%	2%	14%	54%	13%	13%	1%	4%	100%

Short programs were popular, 53.8% of all set programs was a short program ($F(3, n = 2340) = 206$, $p. <.00$) the effect size is large (Cramer's V =.30). However, offering coercion without feedback led to about half the number of people selecting short cycles compared to the other models.

The interaction's effect between coercion and the number of short cycles ($F(3, 779) = 11.5$, $p. <.001$) on energy consumption is significant. Respondents in the no coercion cells ($M_{coercion}$ 1.45, $SD_{coercion}$ .05) more often selected short cycles than those in the coercion cells ($M_{nocoercion}$ 1.40, $SD_{coercion}$ .05), a small mean difference of 3.9%.

Offering feedback to respondents had a significant and medium sized positive effect on the use of short programs ($F(1, n = 2340) = 90$, $p. <.001$, Cramer's V =.20).

There is no significant interaction effect between feedback and the frequency of short cycles ($p. =.60$).

5.5 Discussion

5.5.1 The effectivity of coercion and feedback on energy consumption

As demonstrated in Section 5.4.1. both coercion and feedback show more potential to reduce the energy consumption of washing machines than using eco-settings which were only selected in 26% of laundry baskets. Model 3 (with an eco-button but without feedback) is a simplified version of the reference machine. In this model,

the three laundry baskets together consumed about 1.64 kWh. All other models had better energy performance; Model 1 showed a additional reduction of 14.0%, Model 2 an additional reduction of 15.2% and Model 4 an additional reduction of 8.5% compared to Model 3. One needs to consider that Model 3 had energy reductions from eco-settings but also from the energy saving from short-cycle usage; 59.7% of the laundry baskets on Model 3 was washed on a short cycle, but an eco-setting was applied for only 26.3% of the laundry baskets. While energy consumption in short programs are so low most of the energy savings of Models 2, 3 and 4 would have been realized from the short cycles.

Using coercion in washing machines showed an average reduction of 11.0% on energy consumption compared to models with eco-settings. It should be noted that coercion as well as eco setting in no-coercion cells, for all cycles other than the short ones, effectively washed at 10℃ lower than was communicated. A cotton wash at eco 40℃ is washed 10℃ lower than a 40℃-cotton wash without an eco-setting. This is common in washing machines with eco-settings. Users, however, are not always aware of this, as they generally do not read manuals or they skip content (Mehlenbacher et al., 2002). The 14.6% difference in energy consumption between Models 1 and 3 results from the 10℃ difference between the temperature on the control panel and the actual washing temperature when using coercion or an eco-setting. According to manuals, the control panel shows the maximum allowable temperature on labels instead of washing temperatures, as is commonly interpreted by consumers (Consumentenbond, 2020). This research strongly supports the tactic of focussing communication on the performance, in this case clean and save clothing, to overcome the negative bias of some consumers that laundry does not come clean at lower temperatures. This tactic is already in use in most of the washing machines currently available on the European market. That users are not aware of this might lead to unintentional effects for those who want to use low temperatures; they might set their washing program to too low temperatures and, as a result, not receive the expected washing results.

Feedback showed a significant effect. Using feedback reduced the energy consumption by 5.3%. While it is somewhat lower than with coercion, feedback has the additional advantage that it teaches people how to save energy, which might influence behaviour when using other products (Wever et al., 2008).

The control questions of this research showed that most respondents do not understand the dynamics of energy consumption. Only one out of five respondents ranked combinations of temperature and durations correctly from low to high energy consumption. Other research also noted that users have difficulty

comparing the energy consumption of different washing programs (F. Alborzi et al., 2017). Using feedback can remedy this and guide the user towards correct, fact-based settings in washing programs.

Potential additional reductions in energy consumption compared to eco-settings of between 5 and 15% by implementing coercion and/or feedback systems are impressive numbers because they are mainly a graphical design change. Scripting by including coercion to make washing energy efficient and include feedback and menu-sequencing to solicit the use of short cold cycles would, as this results support, be likely far more effective than the current optional use of eco-settings. Further, the changes can be realized without much effort, investment in innovation or major technical changes in washing machines which makes it worthwhile to try it out in pilot series with little risk.

5.5.2 Eco-settings usage

The default choice of the eco-setting was, as in most washing machines on the market, "no-eco". In the experiment, the choice to set the program to "eco" was asked directly after people rejected the option of a short program. At that point, they were shown the consequences of choices on temperature and duration, and when feedback was a feature, also on the relative effect on energy consumption. Optional eco-settings were only used on one out of seven washing cycles (Section 5.4.2). Thus, from the reference Miele washing machine, the 44% reduction between eco 40-60 (0.75 kWh) and 60°C (1.35 kWh) is likely not fully realized, but only 1/7th which accounts for a mere 6.2% of energy savings. In practice, it is probably even less since only 8% of the laundry baskets was washed at temperatures higher than 40°C. If the default were set to "eco", this would probably have been about double, as is similar to the effect shown in research on green/grey energy (Pichert & Katsikopoulos, 2008). In their study, respondents less frequently switched to unsustainable options when presented with an eco-friendly default. Thaler and Sunstein (2021) recommend using the preferred setting as the default because users tend to accept the default unless prompted to act.

The results in Sections 5.4.1. and 5.4.2. support the advice to use the sustainable solution as the default setting.

5.5.3 Use of proposed temperature settings and short programs

Less than 14% of all respondents accepted the proposed setting of the fabric program (Section 3.3). Especially when using the coercion models (Model 1 without

feedback and Model 2 with feedback), this a low 8% and 6%, respectively, which is significantly lower than for the respondents who were offered the no-coercion models with an eco-button (respectively, 19 % for Model 3 without feedback and 20% for Model 4 with feedback). The difference can be explained by the difference in starting temperature between coercion models (all fabrics at 20°C) and no-coercion models (cotton 40°C, both other programs at 30°C). It appears that many people perceive 20°C as too low to guarantee a clean result. Literature on nudging (Hummel & Maedche, 2019; Lehner et al., 2016; Schubert, 2017; Thaler & Sunstein, 2021) mentions that low settings can nudge people towards preferred behaviour. Users do not change their behaviour unless they are prompted. The proposed 20°C in combination with the long program might be such a prompt. F. Alborzi et al. (2017) found that European consumers are willing to save water and energy in a laundry washing but are reluctant to use long program cycles since they do not believe that the long cycles could be energy-saving. This might explain why short cycles showed so popular in our survey.

The short program was a popular setting, and 53.8% (Table 5.1) of all laundry baskets were washed using a short cycle. Research published in 2017 (F. Alborzi et al., 2017) showed about 18% of the laundry in new machines was washed in a short cycle. Alborzi et al. surveyed actual washing machine usage over a period. Their respondents also washed laundry baskets that are not represented in the three laundry baskets defined in the current study. Short programs on low temperature, in our case 30°C, are one of the most energy efficient program settings. In this research, as with that of the reference Miele machine, only .33 kWh per cycle was used, which is a reduction of 30% on the mean of .49 kWh per cycle. Many people appear to accept that short programs with low temperatures will be effective, especially when laundry is not too dirty, as in the second laundry basket that merely needed to "freshen up t-shirts, blouses and shirts" when 66% of all customers chose to use the short program. However, even 29% of the basket "washing bedlinen and towels" was washed with a short program. Short cold cycles are even more often used when no coercion is applied. In that case it accounts for an additional 4% of short cycles. The higher starting temperature settings in no-coercion models also result in greater reduction than in coercion models. One can consider short cycles an alternative to eco-buttons. Scripting to steer to promote the use of short cycles can be applied in combination with coercion and feedback systems.

The control questions indicate that 83% of the respondents ranked temperatures correctly in the right order from low to high energy consumption. However, when presented with both temperature and duration, only 20% of the respondents

ranked the settings in the correct order. Boyano Larriba et al. (2017) suggest it would be ideal if customers understood the relation between temperature and duration on washing performance and energy consumption, but surveys indicate that it is currently not understood. Feedback might solve this problem, but practice shows that behaviour change remains difficult (F. Alborzi et al., 2017; Klint et al., 2022).

5.5.4 Energy efficiency due to demographic differences

In our experiment, only one out of seven laundry baskets on eco-setting machines were washed with an activated eco-setting, which resulted in realizing only 6% instead of the 44% calculated energy saving from our reference best in class Label A washing machine. Energy efficiency is an important factor reducing energy consumption but if in practice also hardly any laundry is washed with the energy efficiency program, it is not effective in reducing energy consumption. Far more effective in energy reduction would be to remove the eco-settings and use coercion with low standard eco settings as a baseline. If it is possible, as is promoted by producers, to wash more energy-efficiently and achieve the same washing result, why offer the option of reduced energy efficiency? The fact that the program offers the option to not use eco-settings suggests that eco-settings offer lower performance. Washing machines are utilities and consumers buying criteria, sustainable usage and satisfaction depend highly on their perceived performance (Visser et al., 2015). The option of not using an eco-setting will likely encourage people to, unnecessary and unsustainable behaviour. This research's results suggest removing the eco-settings and always offering coercion combined with feedback and scripting, which will probably encourage users to use short cold cycles.

5.5.5 Implication for legislation

This research showed that only one out of seven laundry baskets were washed with an eco-setting used, which resulted in realising only 6% instead of the 44% calculated energy saving from using an eco 40-60 program of the EU eco-design legislation (European Commission, 2019). Energy efficiency is an important factor but if hardly any laundry is washed with the energy efficiency program, it is not effective in reducing energy consumption. Far more effective in energy reduction would be to remove the eco-settings and use coercion with low standard eco-settings as a baseline. If it is possible to wash more energy efficiently and achieve the same washing result, why offer the option of reduced energy efficiency? The fact that the

program offers the option to not use eco-settings suggests that eco-settings offer lower performance. Sustainable behaviour is closely correlated with perception (Visser et al., 2015). The option of not using an eco-setting will encourage people to, unnecessary and unsustainable behaviour. This research's results suggest removing the eco-settings and always offering coercion combined with feedback and scripting, which will encourage users to use short cold cycles.

5.5.6 Implications for designers and producers

The combination of modern washing machines and detergent is suitable for cleaning laundry at low temperatures of a maximal 30°C (Laitala et al., 2011). However, many consumers still do not seem to trust this advice. Laitala et al. suggested that the energy efficiency potential of current washing machine technologies remains unused. As is supported by this research, which showed only one out of seven laundry baskets was washed by use of the eco-setting. Furthermore, it showed that coercion, feedback as well as the use of short cold cycles in machines are likely more effective tools to reduce the energy consumption of washing machines, even independently of technological improvements.

This research also showed that only one out of five people understands the relationship between temperature and duration on energy consumption, and even fewer understand the effects on washing performance. This is supported by Boyano Larriba et al. (2017). Feedback can be used to guide consumers to the best setting for their laundry basket at hand. The results of this research show that coercion and feedback together with menu scripting that encourages users to use short cold cycles is more effective to reduce energy consumption than the current eco-setting option. It would also make setting a program easier.

Feedback might even teach users sustainable behaviour beyond the washing machine. This research supports the effectivity of design for sustainable behaviour strategies, such as coercion, feedback and scripting, to increase the sustainable usage of washing machines. While it is ideal to have a design tool for sustainable behaviour interventions, these interventions are difficult to standardize and must be tested, prototyped and fine-tuned to avoid unwanted behavioural effects, as was also noted by Bhamra et al. (2011).

5.5.7 Limitations of the dataset

The spread of the respondents over Europe was not heterogeneous. The British research platform Prolific provided the respondents. Their pool of respondents

living in the United Kingdom is about four times as large as those who live in continental Europe. The size of the respondent group from the United Kingdom was fixed at 25% but is still significant compared to the population in the rest of Europe. The spread of respondents in continental Europe is not equal to the population spread of those countries either. For example, France and Germany are underrepresented, whereas Portugal and Poland are overrepresented. This is solved by controlling for country of residence in the analysis but this might shift results when a larger sample with a different mix is selected. However, this heterogeneity is considered acceptable due to the large sample size of about 800 respondents.

The 30% difference in energy consumption between the respondents of different countries suggests this might arises from culture and historical washing habits and social norms (Klint et al., 2022). One should be careful to apply the results directly to regions outside of Europe which might have even different habits and norms.

The washing machines available on the European market are all front loaders and designed and produced according to European eco-design legislation (European Commission, 2019). The conclusions of this research will likely not apply to top-loader machines or be the most effective way to reduce energy consumption in top loaders which are often washing on cold temperatures but are using more water and detergents (Amasawa et al., 2018).

5.5.8 Implications for research

This research did not address the cultural and historic influences on washing habits. Our results showed a difference of up to 30% between countries within Europe. By understanding and addressing cultural and habitual processes there is, in some countries, much to be gained if the reason for the differences in energy consumption is better understood.

The difference among countries might also be a result of differences in energy prices between countries. Low energy prices might encourage users to wash on less energy-efficient settings. This is another potential avenue for research.

It is even better for the environment to avoid washing the laundry as much as possible but cleanliness standards (Shove, 2003) and washing habits turn out to be sticky and social norms hard to change (Godin et al., 2020). Feedback potentially makes a difference when it is designed in such a manner that the cost of a choice or laundry cycle is made visible. As this was shown by (Bocken et al., 2018) but in their case the feedback was given by presenting the cost in monthly bills. A month

feedback time might be less effective compared to direct feedback on a control panel.
The effectiveness of design for sustainable behaviour strategies must still be tested for a wide range of other product categories and even services. As is also suggested by Bhamra et al. (2011)
Eco-settings as a default are used not only for washing machines but also for other appliances and cars. Currently, most eco-buttons have a default setting for "no-eco" and reset automatically to this after each use. Frequent users of the eco-setting in cars probably do not always think about setting the car in energy efficiency mode every time they drive. Defaulting towards "eco" would likely lead to more energy savings but needs to be tested.

5.6 Conclusions

This research showed that the effect of legislation to increase energy efficiency is highly depending on the users behaviour and use of the optional eco-settings. Energy efficiency necessarily results in energy reduction. It is likely that, in practice, only a small part of the intended energy savings of the EU Eco-design legislation for washing machines will actually be realised.
Of the three tested design for sustainable behaviour strategies the familiar eco-settings showed to be the least effective in reducing energy consumption. That eco-settings after a washing cycle default to the less energy efficient settings might be a major reason for low effectivity in reducing energy consumption.
Few respondents understood the relationship between programs and energy consumption, and even fewer understood the link between programs and washing results. Adjustments will often not lead to the intended results. Whether users made these adjustments for the sake of cleaner laundry or energy efficiency. There seems to be a need for feedback systems to remedy this and encourage users to more often make energy reducing choices, potentially even beyond the operation of a washing machine.
This research also showed the potential of product design for sustainable behaviour strategies like coercion, feedback and scripting to reduce the energy consumption of even the most energy efficient washing machines on the market. Offering washing machines with coercion and feedback systems and scripting to seduce people to use short cold cycles might to be far more effective in reducing energy consumption than offering eco-setting which default on less energy efficient settings.
The main conclusion of this paper is therefor: Get rid of those eco-buttons!

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6 Discussion

To realise sustainable consumption, sustainable consumption needs to go mainstream with more people than only green consumers consuming sustainable products.
In this thesis, I study the sustainable consumption of durables from a consumer's perspective. In this chapter, I discuss the findings of the studies. The findings provide answers to the following main questions: how to increase sustainable buying and using among mainstream consumers, and how can design and communication contribute to this?

After presenting the main findings, I present the implications for theory and practice including the limitations of the studies and avenues for further research. In the last section of this chapter, I discuss the implications for the practice.

6.1 Main findings

The first two studies (Chapter 2 and Chapter 3) investigated how consumers chose to buy sustainable or unsustainable products. The first study (Chapter 2) researched the impact of three different communication variables on the consumers' willingness to buy sustainable shoes. The study found that emphasising environmental benefits results in lower consumer willingness to buy, while focusing communication on the benefits for the environment lowers the perceived fashion image of the shoe. Sustainability does add value but only after all the consumers' main criteria are met; this is independent of whether the communicated benefit is environmental or personal. There is a significant interaction between the communicated benefit and the colour of the layout. Communicating an environmental benefit combined with a green coloured layout reduced the consumers' willingness to buy by 20%. Conversely, a personal benefit combined with a green layout showed the highest consumer willingness to buy.

The second study (Chapter 3) compared the buying criteria between buyers of energy-efficient vacuum cleaners and buyers of energy-inefficient vacuum cleaners. One out of four consumers bought an energy-efficient model. Three out of four of those did so for other reasons than the vacuum cleaner's environmental friendliness. Like the first study, emphasising sustainable benefits reduced sales. Most consumers did not buy durables primarily for their environmental friendliness. The buyers of energy-inefficient vacuum cleaners bought models with more weight

for their perceived robustness. Consumers are also more sensitive to messages emphasising the technological advancements in their vacuum cleaners. Both attributes that are independent of input power and easily to be realised within energy-efficient models.
In general, consumer trust in sustainable products is low.

The third study (Chapter 4), therefore, investigated whether sustainable product users can convince those who do not buy sustainable products that sustainable products are trustworthy. The results of the study show owners of energy-efficient vacuum cleaners, although positive, are not as positive in their recommendations as those who own energy-inefficient vacuum cleaners. This implies owners of energy-efficient appliances are not effective in increasing trust or changing the social norm. A difference in scores is, however, not caused by the difference in the energy efficiency among the products, but by differences in other factors, such as perceived cleaning performance, ease of use and value for money. All these factors are independent of the amount of Watts input power. Additionally, irrespective of energy efficiency, higher suction power and weight positively mediated the recommendations. Focusing design and communication on these aspects rather than on energy efficiency alone can reduce the perceived green risk and increase trust in sustainable products.

The fourth study (Chapter 5) tested whether consumers used the energy efficiency options available on energy-efficient (energy label A) washing machines. The study also compared the effectivity of different design interventions on energy consumption. Only 15% of the laundry baskets were washed with the eco-settings switched on even after respondents were actively prompted to make a choice. This results in only 6% being realised of the calculated 44% reduction of the energy label A washing machines energy savings. Taking all respondents into account, 10% of the most energy-efficient respondents were able to reduce their average energy consumption by 37%. The 10% of the most inefficient respondents needed 63% more than the average energy consumption. This is, by all means, a large individual difference among users of the same washing machines. Combining coercion and feedback is most effective in reducing the energy consumption of washing machines. This demonstrates that there is more sustainable consumption potential when technological improvements of energy efficiency are combined with interventions to steer sustainable behaviour.

6.1.1 Using communication to increase consumer preference for sustainable durables

A major part of the buying process is based on perceptions and expectations. All respondents in the shoe study (Chapter 2) saw identical shoes. However, when the shoes accompanied an environmental message, respondents perceived the shoes less fashionable than when the shoe came with a personal message. Indeed, sustainability comes with negative expectations, be it via the fashion image of shoes or cleaning performance of vacuum cleaners. Besides, three out of four buyers of energy-efficient vacuum cleaners bought their model for other reasons than the environment. Not unlike the buying reasons of the consumers who bought an energy inefficient vacuum cleaner. This demonstrates again that sustainability is, for most consumers, not a main buying criterion.

Communication is an important marketing tool. Consumers use this information to prepare themselves for their decision-making. Product communication emphasising sustainable benefits reduces trust and increases the perceived risk of sustainable consumption. However, as the vacuum cleaner study (Chapter 3) shows, messages communicating technological improvements as a reason for both additional performance as well as increased energy efficiency increase trust. Combining communication on personal benefits with a green layout is most effective. Sustainability adds value but does so only after other, more prevailing, criteria are met.

6.1.2 Using recommendation of users to promote sustainable products

Consumer trust in sustainable features is low, and consumers are sceptic about the environmental claims companies make. Therefore, study three (Chapter 4) investigated whether positive recommendations from friends and relatives could convince those who currently do not consume sustainably. The results of the study shows that those who buy energy-efficient vacuum cleaners are less positive in their recommendations than those who buy energy-inefficient models, which suggests that sustainable consumers are not very effective promotors of sustainable products. The lower ratings are caused rather from the chosen reasons to recommend then from the fact that they bought a model with lower input power. It is also interesting that, even though higher specifications in suction power and weight were available for energy-efficient vacuum cleaners, energy-efficient buyers seemed, while purchasing, satisfied with lower specifications than those who bought an energy inefficient model. The experiences of the energy efficient buyers, and

their corresponding recommendations, might be directly reduced by those lower specifications. Especially for buyers who bought energy-inefficient vacuum cleaners, suction power and weight are important attributes that relate to the vacuum cleaner's performance and ease of use. The lower recommendations seemed to be a direct effect from bringing energy-efficient models with reduced weight and suction power onto the market. Since the vacuum cleaners' specifications are largely independent of their input power, equalizing the specifications of the energy-efficient models (other than energy efficiency) to the level of the energy-inefficient models may address this reason for lower recommendations ratings.
Another possible reason that energy-efficient buyers are more tempered in their recommendations to their relatives and friends is because they adapt their recommendation to the social or personal norms of their relatives. Distrust in sustainability or lack of a sustainable social norm among relatives and friends might make owners of sustainable products more conservative in their recommendations to sceptics.

6.1.3 Using design to increase sustainable buying of durables

Since product choice is largely based on perceptions and assumptions, these could also be altered to the benefit of sustainable products. Product design could counter the perception of low performance with designs that allows the product to convey high performance, relevance and quality. For example, energy-efficient vacuum cleaner motors are smaller and need less insultation, which not only makes a vacuum cleaner smaller and lighter but also appear less powerful. Product design can make the vacuum cleaner look like it has more motor volume than it really does and use the additional volume and weight to accommodate an increased bag volume and improved ease of use. Even if this means that additional material is needed in the body to do so, it will lead to a sustainability gain, since about 80% of a vacuum cleaner's environmental cost is caused by its energy consumption. The sustainable product design should focus on meeting the main buying criteria in a sustainable way and radiate quality and trust to buyers.

6.1.4 Using design to realise sustainable use

Energy efficiency has been a focus of legislators, industry professionals and scholars. Currently, many appliances and cars have eco-settings that can optionally be used to reduce energy consumption but, in most cases, are paid with somewhat lower performance. Cars accelerate a bit slower and washing machine programs take slightly longer when their energy consumption is reduced. The effectivity of these interventions, however, has been discussed rarely. The last study (Chapter 5) of

the thesis, therefore, tested the effectivity of design for sustainable behaviour interventions in reducing the energy consumption of washing machines. The study showed that the current eco-efficient settings in washing machines are only used one out of seven laundry cycles. Consequently, only 15% of the energy saving potential is realised. In the study, the respondents were even prompted to make a choice to use the machine's eco-settings. Doing their laundry without being prompted to use an eco-setting, they would probably forget, at least sometimes, to switch the eco-button on, which would result likely in even less energy savings. The result of this study shows that there is an urgent need to reconsider the currently implemented design interventions. To make it easier to maintain sustainable behaviour, machine settings for the sake of energy efficiency should default to its eco-setting. That this seldom seems to be the case at present is not comprehensible.

The potential of a well-selected design for sustainable use interventions that wash energy efficiently and provide feedback on intended settings is significant with an energy potential of 35%–50% on the (currently not realised) calculated average of eco-programs, which is four times more effective in reducing energy consumption compared to the current eco-settings in the EU. When using feedback systems, users have control over both the machine's performance and energy consumption. The awareness of users for energy efficiency might be increased also for other appliances.

Most users alter settings because they think either the standard setting for a task is resulting in a too high performance and consuming too much energy or just the opposite. Since few users understand the dynamics of the appliances' processes and the implications of choices, it is likely that many users make unintended changes. This is a clear call for feedback systems not only for reasons for energy efficiency but also for better washing performance. Scripting the intended use into the appliances' handling not only makes using the appliances more sustainable but also reduces the complexity and risk of unintended unsustainable behaviour. Finally, these design interventions are not only effective but also inexpensive, quick to implement and a valuable addition to technological innovations.

6.2 Implications for theory

In this section, I outline the value of the findings of this thesis and the implications of its theory. First, I present and discuss the contributions to the theory in the context of the literature. Then, I present the limitations of the studies and avenues for further research.

6.2.1 Contribution to theory

Focus on consumer behaviour instead of intent

Although several authors criticised the lack of focus on consumer behaviour (Nita et al.; Tang & Bhamra, 2012), there is currently less focus on the consumer side than on the production side of sustainable consumption. Resource and energy efficiency are not effective if the products are neither accepted nor used as intended. The research from this thesis shows how a mainstream consumer's perspective on sustainable consumption has potential to significantly grow sustainable consumption through buying decisions and using appliances and utilities.

Traditionally, the focus of authors studying sustainable consumption is on buyers with green intent (Carrington et al., 2010; Chen & Chang, 2012; Hartmann & Apaolaza-Ibáñez, 2012; Lam et al., 2016; Leonidou & Skarmeas, 2017; Paul et al., 2016). The studies in this thesis show that a focus on intent is not effective when so little of sustainable intent is materialised in consumer behaviour. The study of Chapter 3 shows that 75% of the buyers of energy-efficient vacuum cleaners did not do so for the products' environmental friendliness. Although they did not buy the product for environmental reasons, they were convinced that the product offering meets their needs at an acceptable quality and price. This demonstrates that sustainable intent is not only not a necessity for sustainable consumption but also it questions the importance of sustainable intent as a predictor of sustainable behaviour as is suggested by TPB (Ajzen, 1991; Ghose & Chandra, 2019; La Barbera & Ajzen, 2020).

Several authors have pointed to the sustainable intent–behaviour gap (Biswas, 2017; Carrington et al., 2010; Park & Lin, 2020; Vermeir & Verbeke, 2006). When asking consumers whether they would prefer to buy sustainable products or find sustainable use important, one will likely get politically correct answers. Of course, most consumers say they would prefer more sustainable products when quality and price are similar to unsustainable products. Their answers have no direct consequences unless when they buy the product. At the same time, most people seem to maintain and protect their current unsustainable behaviour. If they doubt the sustainable option will deliver performance, quality or sensual satisfaction, a less sustainable version is bought. More prioritised criteria and needs other than sustainability prevail in the store. This is in line with Barbarossa et al. (2017) who showed the buying intentions of electric cars were less than those who found values other than sustainability important.

Sustainability may not be an Unique Selling Point but it is certainly no disclaimer. Most of the buyers of energy-efficient vacuum cleaners bought their model for non-environmental reasons. Suction power, rather than sustainability, cleans the floor. Rather, sustainability is an, sometimes indirect or unaimed, effect of sustainable consumption. Some customers seek sustainability, other do not but would not oppose to a more sustainable solution as long as the performance, the quality and price of the product is satisfying. Most scholars focus on increasing green intent to steer consumers toward sustainable consumption. Focusing more on the broader need of and value for customers while delivering sustainability would counter many of the negative perceptions identified in literature (Dangelico et al., 2021; Fischer et al., 2017; Mont et al., 2014; Quoquab & Mohammad, 2020; Rex & Baumann, 2007).

Because sustainable intent is neither a strong predictor nor a necessity for sustainable behaviour, the TPB offers little guidance in explaining how to achieve more sustainable consumption. The VBN theory (Stern et al., 1999), proposing that after values, beliefs and personal norms become more sustainable, they lead to more sustainable behaviour. The VBN theory offers more guidance in explaining how buyers are consuming either unsustainable or sustainable products.

Communicate sustainable products on the benefits for the consumer

The first two studies (Chapter 2 and 3) show the main product communication should be concentrated on personal benefits, relevance and needs instead of on sustainable benefits. The studies confirm the value of the double benefit theory (Ottman, 1993; R. Wever et al., 2009). The double benefit theory proposes to communicate sustainable products (Section 1.2.2), first, on their benefit and relevance for the customer and, second, link the environmental benefit to a personal benefit. Such a personal benefit might be a reduction in energy costs or waste, better health or an improvement in the welfare to the wider group. The double benefit theory works for shoes, a 'feel' product, as well as appliances such as vacuum cleaners that are 'think' products (Claeys et al., 1995).

Product sustainability is distal and abstract, which makes it a 'feel' attribute in both product categories as well as in likely most other durable product categories. Sustainable claims are by the average consumer hard to validate and thus judged on instincts. Sustainable claims should be plausible or easily validated by consumers to avoid distrust. Above all, focus should be on the consumer's personal relevance and main buying criteria.

Green trust and risks

Green trust is seen as a precursor for sustainable consumption and satisfaction (Chen, 2010; Gil & Jacob, 2018; Gupta & Ogden, 2009). However, as most literature point points out, the trust in green products is low (Park & Lin, 2020). The three first studies (Chapter 2, 3 and 4) in this thesis also show support that green trust is low. On the other hand, three times as many buyers bought an energy-efficient vacuum cleaner for reasons other than for environmental reasons. Evidently, a significant portion of the buyers were convinced an energy-efficient model would be able to deliver performance. In their case, the energy efficiency was considered an additional performance attribute.

In social circles where the norm is not to be sustainable, sustainable buyers might feel reluctant to promote their sustainable acquisitions (Chapter 5). Trust in and value from sustainable products relies on perception and assumptions. This thesis shows options and strategies to remedy low consumer trust via product design and communication to change the mainstream consumer's perceived performance of sustainable products. To reach the mainstream consumers with more sustainable product options, the focus should be on delivering performance for more relevant criteria and attributes. The product should, at the same time, be delivered within a sustainable solution. Sustainability, for many buyers, has a perceived cost of lower product performance. Especially with 'think' products such as appliances or other utilities like reconditioned tyres, green trust and satisfaction from mainstream consumers are not easy to realise. Sustainable products need to deliver, at least the same, personal benefits and performance as less sustainable product options; otherwise, the product will not receive consumer trust. The third research (Chapter 3) shows that sustainable buyers are less positive, or more conservative, in their word-of-mouth recommendations compared to the unsustainable buyers. One of the reasons might be that promoting sustainable performance products is considered risky, especially when the social norm is not that sustainable. Danner and Thøgersen (2021) showed that the sales of sustainable products benefit when the relevant sustainable topic is salient online; this means that it is likely that when saving energy becomes a recommendations from owners of energy-efficient appliances may become both more positive and valued.

The power of design for sustainable behaviour interventions

This thesis illustrates how the negative perceptions of sustainability can be countered by attractive designs and communications to seduce mainstream buyers

to buy more sustainable products. Design is not only a powerful tool in the buying phase, but it can also steer or enforce sustainable behaviour more salient topic, the in the use phase. The fourth study (Chapter 5) shows the potential to halve the energy consumption of modern energy-efficient energy label A appliances. Feedback proved to be a very effective intervention in steering sustainable behaviour. This supports the suggestions of several authors (Allison & Stanton, 2019; Günther et al., 2020; Kobus et al., 2015; Renee Wever et al., 2008).

Are interventions like coercion in the washing machine study ethical? People were not made aware that the unsustainable option was cancelled. Conversely, unsustainable products never communicate their extensive energy consumption. Why would anyone need an option for inefficient performance? Unsustainable settings would lead to a slower reduction of global warming, which would be very unethical especially for all who do not consume, either because they cannot afford consumption or do not want to consume. Besides, it is still possible to adjust settings since the temperatures and duration of the washing machine can still be adapted. The machine's limitations are protecting both the laundry and the environment from any unintended damaging effects similar to the seat belt we all use nowadays without giving it a second thought.

6.2.2 Limitations of the studies

This thesis investigates consumer behaviour when buying durables. Other product categories, like consumables such as food and beverages, that are bought, consumed and replenished in short cycles may have different outcomes. Habitual buying is likely stronger in short product life cycles which are more often replenished. On the other hand, consumers could be more easily encouraged to trial sustainable alternatives. Sustainable food and beverages may also be perceived as having impact on health, which is, for many consumers, an important buying criterion. This will count specially for products such as baby nutrition, where the environmental benefit is more directly connected to health, in this case sustainability is of higher importance, and can increase willingness to pay as shown by van Doorn and Verhoef (2011).
Also, 'feel' services such as sustainable hospitality services might have other dynamics. Product service systems will likely show different effects particularly when pay-per-use charges are applied, which are feedback systems by nature.

The thesis' studies were all conducted in Europe. Different regions show different consumer reactions to the importance of sustainability (De Silva et al., 2021; Spencer et al., 2015). The washing machine study of this thesis (Chapter 5) showed even differences in use patterns within Europe. It is suspected that not only culture but also energy prices influenced behaviour; both effects will likely influence results if applied to other regions. Although the washing machine study was controlled for country, it was not for energy prices.

Increasing energy prices will increase the salience of the topic energy efficiency and may also create awareness in Eastern European countries that are, according to the result of the washing machine study, not so energy efficient in their behaviour. In general, the social norm will likely shift towards promoting more energy savings.

6.2.3 Avenues for further research

In general, there is too little focus on the sustainable behaviour of the mainstream consumer. If mainstream consumers chose to consume sustainable products, their impact on the environment would be of a great magnitude compared to growing the existing green consumer population. Focusing on green consumers and increasing their population has shown to be an ineffective route. To enthusiasm mainstream consumers to consume sustainable is best done indirectly. But how is likely different for different product categories. Some product categories (e.g. remanufactured and refurbished appliances or tyres) are more sustainable but often come with a perceived lower quality or additional risk. How to communicate and redesign these products to increase customer value for a mainstream public would be an additional challenge. Remanufacturing and refurbishing is a relatively young field of research (Mahmoodi & Heydari, 2021; Mugge et al., 2017; van Weelden et al., 2016).

In the shoe study we showed a direct effect of sustainable image on buying intention but were not able to define what created the sustainability image of the shoe. A specific mentioning of the environmental benefits would lead to a lower buying intention through fashion image and should therefore be avoided. These results are in line with research that showed more knowledge about the impact on the environment may not result in more sustainable consumption (Ellen, 1994; Heeren et al., 2016). Future research should investigate more effective ways to deliver knowledge to consumers about the impact of their sustainable consumption to

create awareness without causing a backlash. Is an ecolabel in the corner of product packaging sufficient, or is it more beneficial for companies to deliver more detailed declarations of their products and practices on their websites?

(e-)Word of mouth is seen as a powerful tool to increase green trust and change the social norm. However, the recommendations from buyers of energy-efficient models in the third study (Chapter 4) were not as positive as those who bought energy-inefficient models. The cause for this is still unclear, but it is assumed that the social norm of the buyers' social surrounding was not as sustainable as the buyers' personal norms. The data is collected around NPS-research and limited in details. Interviews and focus groups can give insight in why sustainable buyers are not as positive in their recommendations and why they bought lower specifications.

Not all the interventions in Table 1.1 were addressed in the four studies of this thesis. Especially interventions in the buying phase would make an interesting line of research. Breaking habits and making new habits in the purchasing phase of durables is difficult since durables are seldom bought or replaced. Maybe there are interventions that can be effective in breaking habitual buying behaviour over a group of durables like for household appliances or for apparel. Even though input power is not significantly correlated with cleaning performance, many vacuum cleaner buyers still seem to be convinced that vacuum cleaners with the highest input power perform best. Can the consumer's choice for a sustainable durable be made easier than making an unsustainable choice other than through choice editing by eliminating market access for unsustainable options? The EU performed choice editing to do so and closed the market for energy-inefficient appliances.

The sustainability of products is a temporal and spatial construct. How to reduce the discounting of sustainable consumption to increase sustainable consumption is not well researched yet. Zaval et al. (2015) found a focus on the future and considering one's legacy led to more sustainable consumer behaviour. How should this be used in combination with personal relevance in product communications?

The washing machine study (Chapter 5) showed the power of design to reduce energy consumption in the use phase. Every product type is specific in its use patterns and there is no universal solution how to steer consumers to more sustainable behaviour. With Bhamra et al. (2011), I would like to invite scholars to

do more case studies on the effectivity of design interventions for many different product categories and product service systems.

6.3 Implication for practice

6.3.1 Marketing and communicating sustainable products to the main market

The first two studies (Chapter 2 and 3) showed that most consumers of durables do not consider sustainability as a main buying criterion. Communication as well as design needs to be focused on the product's relevance for the buyer. This counts for both 'feel' and 'think' products alike. The distal qualities and spatial discounting of sustainability make sustainability a 'feel' attribute. Only after the main criteria are met, sustainability adds customer value. For some products, it is possible to link the sustainable benefits to personal relevance and thus increasing the personal benefits. This counts, for instance, for health benefits but also for energy savings or lower cost of ownership. In those cases, it is beneficial to combine the two benefits. In most 'think' products, environmental friendliness contributes not to the direct product performance for which the product is bought. In those cases, it is better to focus communication on technological advancements that makes performance possible while, at the same time also being environmentally friendly. Technological messages might also attract new customers who would likely otherwise repeat old behaviour of buying a version based on its highest input power or other misconceptions of the relationship between performances and energy consumption.

Recommendations may be a powerful tool to not only increase sustainable consumption but also change the social norm. At present, sustainable buyers are not as positive about their sustainable purchases likely because they might have bought a too low specification. To gain more sustainable product turnover and recommendations, it will be beneficial to keep specifications of sustainable models up to par with less sustainable alternatives, as there is no reason to suspect sustainable customers are satisfied with underperformance even if they trusted the communicated sustainable product claims beforehand.

6.3.2 Designing sustainable products

Sustainable consumption starts with designing attractive sustainable products fulfilling the needs of mainstream consumers. This means that sustainability must

never be perceived as a cost not only in a monetary sense but also in perceived product quality, performance, appeal and use. This may be especially true for durables with a longer product life, which many consumers consider to be an investment and buy risk avoidant. Energy-efficient engines are smaller, but, if an engine should be perceived as delivering power, performance or fun, the energy-efficient product must still look like it is powerful, high performing and fun to use. Behavioural interventions like feedback systems, scripting and coercion, and likely other interventions, demonstrate a significant reduction in energy consumption. Effects that are through design for sustainability are often much faster and cheaper to be realised then through technological innovations.

The focus on the consumer and sustainability can also be extended to the lengthening of the products' life. Many consumers have little repair skills. Product service offerings including repair even lowered these skills further. To increase product life the most common product breakdowns should be easy to repair and performable without expert knowledge or tools, preferably, with plug-and-play spare parts or software updates.

6.3.3 Legislation

Currently, the EU energy label is seen by both industry, retail and consumers as a quality label; over the last decennia, it became a major criterion when buying fridges, washing machines and dishwashers. Companies are seeking energy label A awards. However, the last study of this thesis (Chapter 5) showed only 5% of the potential 35% energy efficiency from eco-settings on energy label A washing machine was realised because users do not use the eco-settings. Using a 20-year-old washing machine on low temperatures might result in less energy consumption. This questions the credibility of awarded energy labels for appliances. In the development of eco-design legislation, more focus needs to go towards user behaviour and effectivity of energy efficiency.

For some products, the only way to make a fair platform for sustainable consumption is to implement a carbon tax or limit market entry of unsustainable options like the EU did with implementing eco-design legislation on household appliances and closing the market for energy-inefficient appliances. This led to increased innovations that deliver performance with high energy efficiency.

6.4 Final words

I started this research with the idea to find the reasons for the gap between sustainable intent and behaviour. Not until halfway through my research did I realised that sustainable intent, or willingness, is not important. It is the resulting sustainable consumption and behaviour that counts, and it does not matter whether consumers consume for the reason of sustainability or not, providing their consumption is sustainable. Sustainability is not a selling point. To realise sustainable consumption, the focus for marketers and product designers should be foremost on the relevance for the consumers and their main buying criteria. Only when sustainable benefits can be linked with the main buying criteria will it appeal to mainstream consumers. For instance, communicating the technological improvements that increase performance while consuming less energy. When it comes to communication and design for sustainable consumption, the old adage remains true; actions speak louder than words.

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7 Biography

Mirjam Visser is an industrial design engineer who graduated from the Delft University of Technology in 1990. Mirjam started her professional career at Fokker Aircraft N.V. as a project engineer developing a just-in-time factory for interior and composite aircraft parts. After implementation, she transferred to the manufacturing engineering department and oversaw the technology development and manufacturability of Fokker 70/100 interior parts. In 1995, she was granted a position in the Japan External Trade Organisation's (JETRO) Manufacturing Fellowship program to work and learn different manufacturing positions within IHI Corporation's large machine production facility. In 1997, she joined Coopers & Lybrand Management Consultants, which later merged into PricewaterhouseCoopers Management Consulting. As a principal consultant, she advised companies in automotive, high tech and manufacturing industries to optimise their supply chain, production and product development processes. She was also responsible for the product data management business in Northern Europe. Since 2003, she worked as a freelance consultant. From 2006 until 2011 in Shanghai, China where she started Design-4-Sustainability.com to inspire and share sustainability knowledge between designers. Since fashion is one of the most unsustainable industries worldwide, in addition to her PhD project, Mirjam also invests in sustainable fashion start-ups.

After the completion of this PhD project, there will be more sustainable problems to be solved and knowledge gaps to close; she is convinced that her doctorate will open even more doors to address them.

Appendix

A. Appendix to chapter 3

Table A.1: Reason to buy Definitions

What was your reason to buy this specific model vacuum cleaner? Choose one of the following reasons. I bought this while ……

Reason to buy	Definition
RS0 None of those	
RS1 Fit	The vacuum cleaner fits with the other products I own
RS2 Brand reputation	This brand has a good reputation in vacuum cleaners
RS3 Key feature	The vacuum cleaner's key features as dust chambers size, accessories, filter(s), performance, cord length etcetera
RS4 Service	Customer service helps me to solve my problems as soon as possible, user manual is clear and complete
RS5 Design/ Look	The vacuum cleaner's colours look nice, modern design, its shape is nice
RS6 Ease of Use	The vacuum cleaner is easy to store, good to manoeuvre, compact, easy to carry, easy to use on stairs It is easy to empty the dust chamber/ change the bag, clean the filter, to vacuum clean under furniture
RS7 environment	The vacuum cleaner has low power consumption It is made from environmentally friendly materials
RS8 Warranty	The warranty is good, its period is long
RS9 Value for Money	Price compared to what you get is good The vacuum cleaner, and its accessories and parts, feel durable

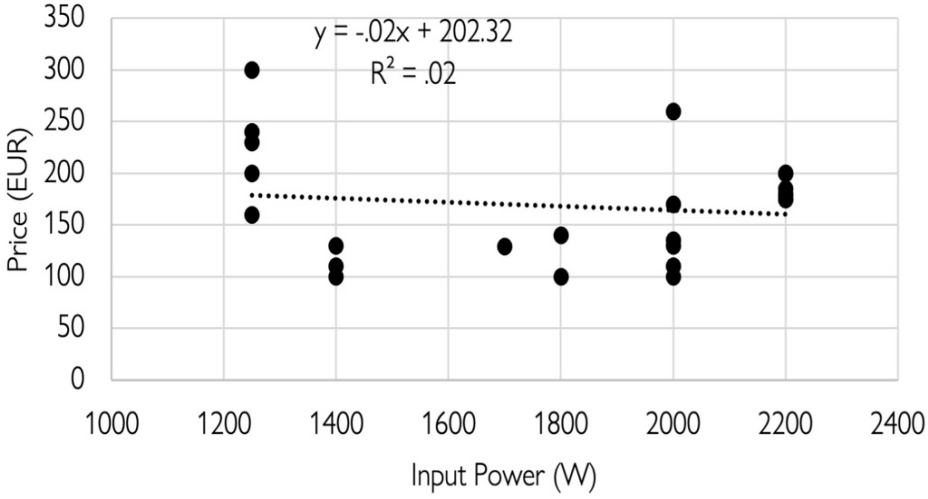


Figure A.1: Price (Euro) versus input power (W)

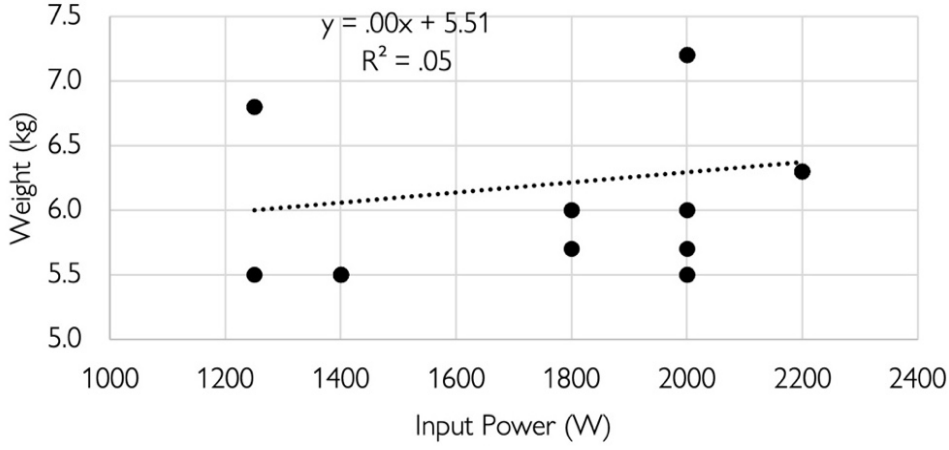


Figure A.2: Weight (kg) versus input power (W)

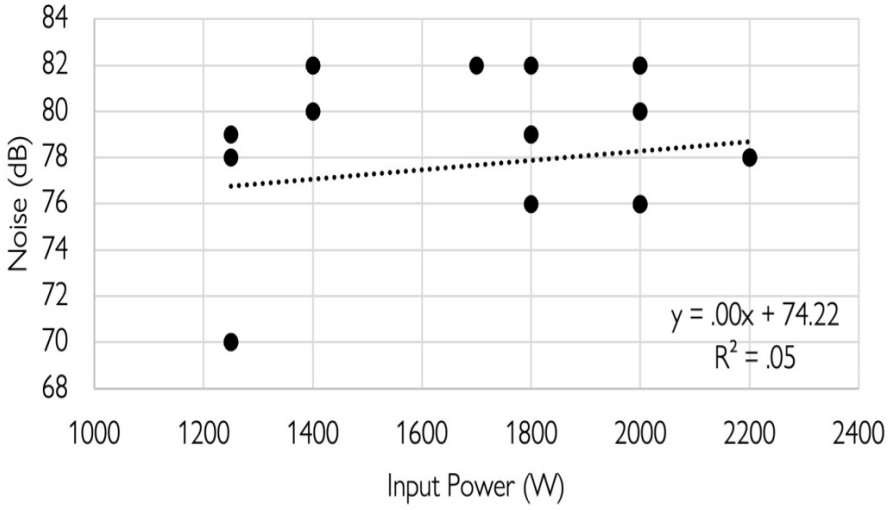


Figure A.3: Noise (dB) versus input power (W)

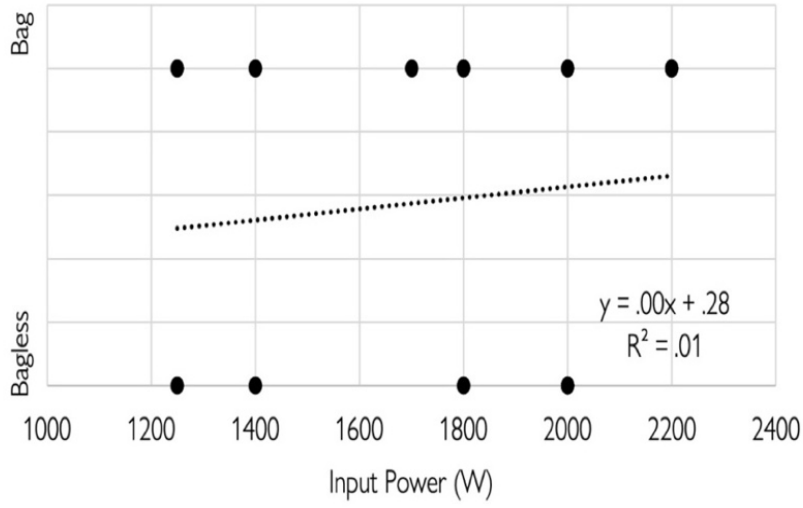


Figure A.4: Bag(less) versus input power (W)

Table A.2: Specification attributes versus input power correlations

		Input Power	Price	Weight	Noise	Suction	Bagless Bag
Pearson Corr.	Input power	1	-.136	.224	.213	.546	.121
	Price	-.136	1	.857	-.635	.192	-.168
	Weight	.224	.857	1	-.651	.054	-.365
	Noise	.213	-.635	-.651	1	-.251	-.025
	Suction	.546	.192	.054	-.251	1	.671
	Bagless Bag	.121	-.168	-.365	-.025	.671	1
Sig. (1-tailed)	Input power	.	.263	.126	.125	.001	.256
	Price	.263	.	.000	.000	.184	.216
	Weight	.126	.000	.	.000	.393	.028
	Noise	.125	.000	.000	.	.087	.447
	Suction	.001	.184	.393	.087	.	.000
	Bagless Bag	.256	.216	.028	.447	.000	.
N	Input power	32	24	28	31	31	32
	Price	24	24	21	24	24	24
	Weight	28	21	28	28	28	28
	Noise	31	24	28	31	31	31
	Suction	31	24	28	31	31	31
	Bagless Bag	32	24	28	31	31	32

Appendix

Table A.3: Pearson correlations between buying criteria and specification attributes (N=951)

	Power low/high	RS1 Fit	RS2 Brand reputation	RS3 Key feature	RS4 service	RS5 Design Look	RS6 Ease of use	RS7 Environment	RS8 Warranty	RS9 Value for money	RS10 reliability durability	Price RPP/NL EURO	Message Environment	Message Technology	Weight (kg)	Noise level (dB)	Suction (watt)	Bagless/ Bag
Power low/high	1																	
RS1	.02	1																
RS2	.06	-.06	1															
RS3	.02	-.06	-.21**	1														
RS4	.03	-.02	-.07*	-.08*	1													
RS5	.02	-.02	-.06	-.06	-.02	1												
RS6	.09**	-.04	-.13**	-.14**	-.05	-.04	1											
RS7	-.40**	-.03	-.11**	-.12**	-.04	-.00	-.07*	1										
RS8	.06	-.02	-.06	-.06	-.02	-.02	-.04	-.03	1									
RS9	-.02	-.06	-.20**	-.21**	-.07*	-.06	-.13**	-.11**	-.06	1								
RS10	.04	-.07*	-.24**	-.26**	-.09**	-.07*	-.16**	-.13**	-.07*	-.24**	1							
Price	-.00	.02	-.07*	.13**	.06	-.00	.01	-.02	-.02	-.11**	0	1						
M.Enviro	-1.0**	-.02	-.06	-.02	-.03	-.01	-.08*	.39**	-.05	.03	-.04	-.06	1					
M.Techn.	.36**	.06	-.06	.13**	.08*	.02	.04	-.16**	.03	-.10**	.02	.77**	-.36**	1				
Weight	.33**	.05	-.05	.14**	.07*	.01	.03	-.17**	.02	-.09**	.02	.84**	-.33**	.84**	1			
Noise	-.09**	-.04	.04	-.11**	-.06	.01	.05	.11**	-.01	.08*	-.06	-.71**	.09**	-.72**	-.80**	1		
Suction	.55**	.04	-.00	.05	.08*	.01	.06	-.25**	.04	-.04	.02	.48**	-.55**	.72**	.39**	-.39**	1	
Bag(less)	.42**	.05	.02	-.00	.08*	.04	.02	-.22**	.03	-.01	.04	.15**	-.40**	.51**	.19**	-.44**	.81**	1

* Correlation is significant at the .05 level (2-tailed).

** Correlation is significant at the .01 level (2-tailed).

Table A.4: Discriminant Function Analysis

Power low/high	Attributes	Mean	Std. Deviation	N
low <1600 Watt	Weight (kg)	5.83	.5679	243
	Message Technology	.27	.4457	243
	Bagless/Bag	.38	.4871	243
	RS7 Environment	.20	.4021	243
high >1600 Watt	Weight (kg)	6.20	.4215	666
	Message Technology	.70	.4574	666
	Bagless/Bag	.80	.4001	666
	RS7 Environment	.00	.0387	666
Total	Weight (kg)	6.10	.4921	909
	Message Technology	.59	.4926	909
	Bagless/Bag	.69	.4633	909
	RS7 Environment	.06	.2281	909

B. Appendix to Chapter 4

Table B.1: Descriptives

per consumer Number of respondents per prime cause of recommendation group (N=888)

Prime cause recommendation	Green and Low Energy	non-Green and Low Energy	High energy	Total
Ease of use	13	37	140	190
Cleaning performance	10	35	108	153
Price	4	28	92	124
Accessories etc.	6	20	83	109
Other	9	23	54	86
Brand & reputation	3	11	58	72
Product reliability/durability	0	10	34	44
Noise or emissions	2	7	25	34
Product features	1	8	18	27
Design & looks	2	2	21	25
Environmental friendliness	3	6	9	18
Customer support	0	4	2	6
Total	53	191	644	888

Table B.2: NPS Scores in spread per customer group

NPS	Green and Low Energy (N=53)	non-Green and Low Energy (N=191)	High energy (N=644)	Total (N=888)	Total %
0	2%	1%	1%	8	1%
1	2%	1%	0%	2	0%
2	0%	2%	0%	3	0%
3	0%	2%	0%	5	1%
4	6%	3%	0%	12	1%
5	2%	6%	2%	26	3%
6	13%	6%	3%	40	5%
7	21%	8%	14%	118	13%
8	26%	33%	29%	266	30%
9	9%	21%	28%	224	25%
10	19%	18%	22%	184	21%
total	100%	100%	100%	888	100%

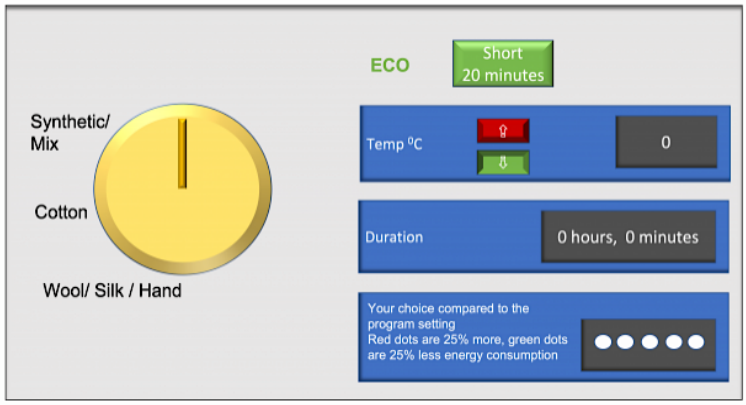
Table B.3: One-way between groups analysis of variance (N=888)

	Input power	Mean	SD	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Min	Max
NPS Score	<1600 W	7.71	2.03	0.13	7.45	7.97	0	10
	>1600 W	8.33	1.49	0.06	8.22	8.45	0	10
	Total	8.17	1.67	0.06	8.06	8.28	0	10
Satisfaction (0= NPS <=5, 1 = NPS>5)	<1600 W	0.87	0.34	0.02	0.82	0.91	0	1
	>1600 W	0.96	0.19	0.01	0.95	0.98	0	1
	Total	0.94	0.24	0.01	0.92	0.95	0	1
Accessoires	<1600 W	0.11	0.31	0.02	0.07	0.15	0	1
	>1600 W	0.13	0.33	0.01	0.1	0.15	0	1
	Total	0.12	0.33	0.01	0.1	0.14	0	1
Brand & Reputation	<1600 W	0.06	0.24	0.02	0.03	0.09	0	1
	>1600 W	0.09	0.29	0.01	0.07	0.11	0	1
	Total	0.08	0.27	0.01	0.06	0.1	0	1
Cleaning Performance	<1600 W	0.19	0.39	0.03	0.14	0.24	0	1
	>1600 W	0.17	0.37	0.02	0.14	0.2	0	1
	Total	0.17	0.38	0.01	0.15	0.2	0	1
Ease of Use	<1600 W	0.2	0.40	0.03	0.15	0.25	0	1
	>1600 W	0.22	0.41	0.02	0.19	0.25	0	1
	Total	0.21	0.41	0.01	0.19	0.24	0	1
Environmental friendliness	<1600 W	0.03	0.18	0.01	0.01	0.06	0	1
	>1600 W	0.02	0.12	0.01	0.01	0.02	0	1
	Total	0.02	0.14	0.01	0.01	0.03	0	1
Product Reliability /Durability	<1600 W	0.04	0.2	0.01	0.02	0.07	0	1
	>1600 W	0.05	0.22	0.01	0.04	0.07	0	1
	Total	0.05	0.22	0.01	0.04	0.06	0	1

C. Appendix to chapter 5

Table C.1: Washing machine data

Temperature(°C)				Duration (hours:min)			% Difference with machine			kWh		
	Cotton	Synthetic	Hand	Cotton	Synthetic	Hand	Cotton	Synthetic	Hand	Cotton	Synthetic	Hand
Short	30	30	30	00:20	00:20	00:20	-6%	-18%	83%	0.33	0.33	0.33
Coercion (M1 & M2) or M3 & M4 with e												
Start	20	20	20	03:45	02:05	00:49	0%	0%	0%	0.35	0.4	0.18
20	20	20	20	03:45	02:05	00:49	0%	0%	0%	0.35	0.4	0.18
30	30	30	30	03:41	02:02	00:45	14%	13%	11%	0.4	0.45	0.2
40	40	40		03:39	01:59		114%	45%		0.75	0.58	
50	50			03:24			137%			0.83		
60	60			03:09			186%			1		
No coercion (M3 & M4) and no eco												
Start	40	30	30	02:33	01:59	00:39	0%	0%	0%	0.83	0.5	0.23
20	20	20	20	02:39	02:02	00:45	-52%	-10%	-13%	0.4	0.45	0.2
30	30	30	30	02:36	01:59	00:39	-10%	0%	0%	0.75	0.5	0.23
40	40	40		02:33	01:56		0%	64%		0.83	0.82	
50	50			02:31			20%			1		
60	60			02:29			63%			1.35		
	according to Miele WEF 375 WPS Manual											
M =	Model#											



Please select a program for the underneath mentioned laundry

	Cotton	Synthetic/ mix	Handwash/ Wool/ Silk
Coloured cotton bedsheets, towels	○	○	○

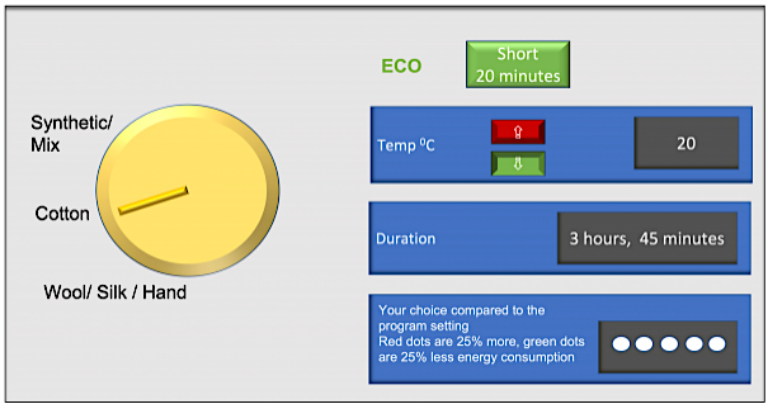
For this laundry basket do you select "Short 20 minutes at 30 degrees"?

○ Yes,

○ No, I set another temperature and/or longer duration,

→

Figure C.1: Script example Model 2 screen 1



This is the standard setting for a cotton fabrics program do you want to select another temperature and duration?

- ○ I leave it at 20 degrees and a duration of 3 hours and 45 minutes,
- ○ I select 30 degrees and a duration of 3 hours and 41 minutes,
- ○ I select 40 degrees and a duration of 3 hours and 39 minutes,
- ○ I select 50 degrees and a duration of 3 hours and 24 minutes,
- ○ I select 60 degrees and a duration of 3 hours and 9 minutes,

→

Figure C.2: Script example Model 2 (Coercion & Feedback) Screen 2

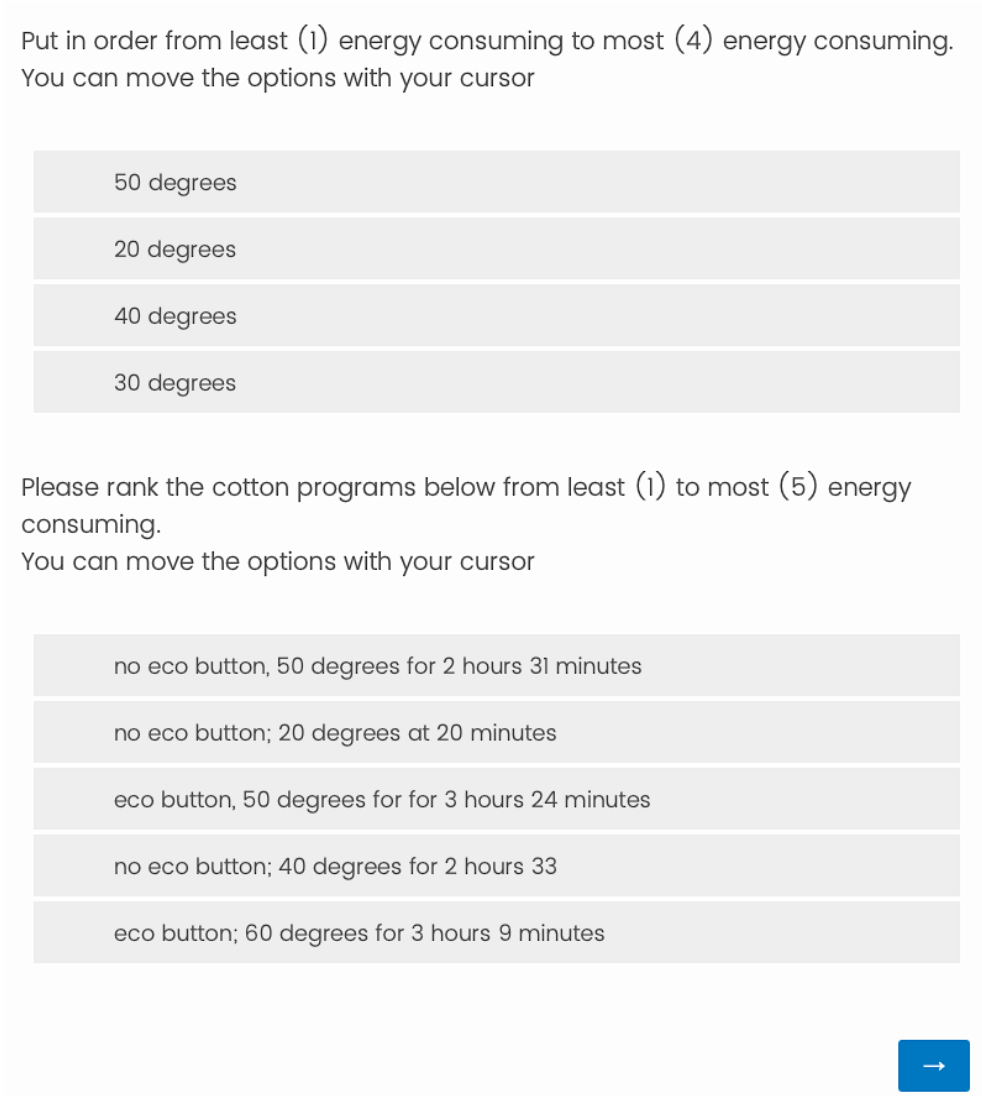


Figure C.3: Control questions screen