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The Complexity of Consumer Attitudes Towards Sustainable Alternatives

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CONTENT

CHAPTER 1

General Introduction

We need a systemic transformation of our way of life to limit climate change and stay within the planetary boundaries (Creutzig et al., 2022; Steffen et al., 2015). To achieve this, we need change across all levels of society from governmental policies to individual behaviour. In my PhD, I mainly addressed individual actions with a focus on consumer behaviour.

People engage in sustainable behaviour for all kinds of reasons: some conscious and intentional and others not. For example, one might act pro-environmentally because it is the norm in a given social context (e.g., everyone else choosing the meatless option might lead to social pressure to conform), or for financial reasons (e.g., repairing possessions and buying cheaper second-hand), or with sustainability as a side effect (e.g., choosing a Tesla over a petrol to get a sleek sports car, not because it is electric). That being said, there are more and more people who consciously decide to live in a way that is less harmful to the environment. That decision can lead to difficult choices in many aspects of life: what to eat, which products to buy, how to get to work, where to go on holiday, which phone to buy. Sometimes the benefits of behaving more sustainably are outweighed by other considerations. For example, for longer overland journeys, taking the train seems like the obvious sustainable choice, but compared to flying, the tickets are often more expensive, it can take much longer to reach one's destination, and it might even be necessary to book additional lodging because of the added travel time. Other times, it difficult to know whether the seemingly more sustainable choice *does* in fact reduce environmental harms. Let's say one did decide to fly and decided to pay to offset the carbon released doing that flight, how does one know that one is actually helping the environment? We see more and more seemingly sustainable products and materials appearing on supermarket shelves, with catchy sustainable buzzwords like 'green', 'bio-based', 'eco-friendly', 'made from recycled material', 'biodegradable', 'compostable', or 'all natural'. As a consumer, it can be difficult to judge whether these products are actually more sustainable and if so, to what extent. There may also be risks and uncertainties involved in deciding to give the novel and supposedly sustainable product a try, for example when it comes to the quality, use, or disposal. During my PhD, I investigated consumer attitudes and perceptions towards two of these new sustainable alternatives in particular: bio-based plastic and a modular smartphone.

Why Focus on Sustainable Alternatives?

My PhD was part of an interdisciplinary project between the Chemistry and Social Psychology departments of the University of Amsterdam, and with Avantium, a Dutch company that develops and commercialises next-generation bio-based plastic and chemicals. The aim of the larger project was to identify novel bio-based polymers (the building blocks of plastic) for potential large-scale applications, such as packaging materials, fibres, and injection-moulded parts. My role was to examine consumer perceptions of

these novel bio-based plastics (i.e., plastics made from renewable biomass, rather than fossil feedstock like oil), whether there is consumer demand for these materials, and to understand how to best translate this demand into action. Consequently, much of my thesis focuses on plastic and bio-based plastic products and how they are perceived.

Plastic has become an integral part of people's lives and an important material for our economy. Among other things, plastic helps to preserve food, insulate constructions, use electronics and make vehicles more fuel-efficient. Yet, the sheer magnitude of plastic consumption results in a high production-related carbon footprint, high volumes of waste, persistent pollution, and harm to wildlife and ecosystems. More than 98% of plastic today is produced from fossil feedstock (i.e., oil, coal, and natural gas). In 2019, plastic generated 1.8 billion tonnes of greenhouse gas (GHG) emissions—3.4% of global emissions—with 90% of these emissions coming from their production and conversion from fossil fuels (OECD, 2022). If current trends continue, by 2050 global plastic production could rise to 20% of oil consumption and 15% of annual carbon emissions (World Economic Forum, 2016). To align global CO_2 emissions with planetary boundaries (Creutzig et al., 2022; Steffen et al., 2015) and limit climate change to 1.5˚C (Paris Agreement), plastic production needs to be decoupled from fossil feedstock. Biomass is currently the only known alternative for carbon feedstock for making virgin, non-recycled plastic (Murcia Valderrama et al., 2019). So far, little is known about consumers' reactions, perceptions, and purchase intentions of plastic made from biomass, something that will need to be better understood before they enter the market on a large scale.

Mitigating Climate Change and Behavioural Change

There are many ways in which individuals can help mitigate climate change, both directly (e.g., through purchase decisions) and indirectly (e.g., through influencing products and services offered). Individual actions are at the core of governmental policies, they initiate and drive sustainable investments, and determine financial support and incentives for more environmentally friendly alternatives. Any individual who makes decisions that other people abide by (e.g., from food procurement, to company transport policies, and deciding on which kind of products and services to use and provide) has the potential to reduce our collective environmental footprint (Garnett & Balmford, 2022). Individuals can make their voices heard by those in power (e.g., by voting, joining initiatives, or demonstrating) and those around them (e.g., talking about climate change with friends, family or colleagues). Changing to a more plant-based and locally-sourced diet, using low-carbon transportation (e.g., cycling, public transport, car-sharing, flying less), and saving energy at home (e.g., good insulation, energy efficient appliances, solar panels) are also ways in which individuals can help climate change mitigation. Other consumption-related choices, like buying and consuming less, reusing and repairing the things already owned, and choosing more sustainable options when new purchases are unavoidable,

can also make an impact. There is power in numbers - without the support of the public, systemic change is unlikely to occur.

This thesis focuses on individual consumer actions, and choices for sustainable alternatives in particular. These, often novel, technologies need to be accepted and purchased by the consumer before they become widely available (Steenis et al., 2018). Through their consumption choices, consumers can therefore create crucial market pull, demanding more sustainable products and practices, thereby influencing what is offered (De Marchi et al., 2020; Gaffey et al., 2021). Research also suggests that demand-side solutions to climate change (i.e., changing how people use technologies and products) have positive impacts on human well-being (Creutzig et al., 2022). Although the majority of consumers indicate they at least sometimes consider the environment when shopping (Groening et al., 2018), this does not always translate into purchasing decisions, even when sustainable options are available (Gleim et al., 2013). It is therefore important to further our understanding of how consumers perceive sustainable alternatives and what influences them to choose them over their conventional counterparts.

Factors Affecting Pro-Environmental Behaviour

A myriad of factors influence people's behaviour. Joshi and Rahman (2015) provide an overview of some of the individual and situational factors that can affect green purchasing behaviour, defined as purchasing products that are environmentally friendly and evading those harmful to the environment (Soomro et al., 2020). These include individual factors, such as emotions, habits, perceived consumer effectiveness, perceived behavioural control, values, and personal norms, trust, and knowledge, to name just a few. Situational factors can also encourage or discourage consumers' purchase decisions. These situational factors include, but are not limited to, price, product availability, social norms, and reference groups, product attributes and quality, store related attributes, brand image, and eco-labelling and certification (for a review see Joshi & Rahman, 2015).

Many psychological theories have attempted to formalise the main psychological predictors of intentions and behaviour in a wide variety of contexts. One prominent example is the theory of planned behaviour (Ajzen, 1991) that has seen many derivatives but at its core suggests that attitudes, subjective norms, and perceived behavioural control relate to one another and together shape people's intentions, which in turn lead to behaviour. Other theories have focused on the pro-environmental context in particular. For example, the value-belief-norm theory (Stern, 2000) focuses on the importance of values, beliefs (e.g., of adverse consequences and outcome efficacy), and personal norms on influencing pro-environmental behaviours. The norm activation model (Onwezen et al., 2013), emphasises the role of perceived behavioural control, the feeling of responsibility, personal norms, and emotions (i.e., anticipated pride and guilt) in shaping intentions and pro-environmental behaviour. The value-identity-personal norm model (van

der Werff & Steg, 2016) states that biospheric values (i.e., concern for the environment) influence a person's environmental self-identity, which in turn influences personal norms, which then leads to pro-environmental behaviour. Other theories, such as the comprehensive action determination model (Klöckner & Blöbaum, 2010), incorporate situational factors. This model in particular suggests that normative processes influence habitual processes and intentional processes, and that these, together with situational influences, determine ecological behaviour.

All of these theories try to estimate pathways for how a small set of predictors leads to (pro-environmental) intentions and behaviour. Many of them assume casual relationships and that a very limited number of (mainly psychological) factors predict behaviour, often resulting in their ecological validity being relatively low. Research suggests that pro-environmental behaviours are very complex and context-dependent (Lange & Dewitte, 2019; Nielsen et al., 2021). This is unsurprising, given that pro-environmental behaviour describes any "behaviour that harms the environment as little as possible, or even benefits the environment" (Steg & Vlek, 2009), and can therefore be driven by a wide range of factors.

In this thesis, I took a descriptive and exploratory approach to do justice to the inherent complexity of what shapes people's attitudes and actions. I often used a descriptive, bottom-up approach that included a wide variety of factors related to pro-environmental intentions and behaviour, rather than using one particular theory, which would have limited me to a small selection of antecedents of behaviour. I used a network approach in two of the chapters to try to capture and understand the complexities of people's attitudes towards sustainable alternatives. Among other things, a network approach allows for the visual representation of psychological variables and the direct and indirect relationships between them. This can provide unique insights into which factors are important to the variable or behaviour of interest, and also gives information about how strongly different factors are related to one another. An approach like network modelling makes fewer assumptions about which variables are relevant and how they are related than the theories described above.

Different stages in the research process require different methods (Scheel et al., 2021). Given that we do not have much scientific knowledge about consumer attitudes and perceptions of novel sustainable alternatives (i.e., bio-based plastics and the modular Fairphone), a more descriptive approach is needed. When we have a better understanding of which factors are relevant and how they are related, we can test their predictive value in models like the ones described above. Next to network analyses, I also used a qualitative approach in several studies (e.g., asking participants to write down the associations that came into their mind). Other studies included confirmatory experimental manipulations, for example to determine whether factors identified as relevant by the qualitative and correlational methods also had predictive power.

This dissertation mainly focused on attitudes, perceptions, and intentions and only to a limited extent on actual behaviour. It is well-known that attitudes and intentions do not necessarily translate into behaviour (also referred to as attitude-behaviour gap or intention-behaviour gap). However, both attitudes and intentions are important pre-requisites of behaviour, so that if positive attitudes and intentions are not present, the action is not as likely to be performed (Kaiser et al., 2021; Onwezen et al., 2013; Sheeran & Webb, 2016). Relevant literature suggests that a positive attitude toward sustainable products is the starting point to stimulate sustainable consumption (Kaiser et al., 2020; Park & Lin, 2020), with attitudes towards a product impacting purchase intention of that product (Rausch & Kopplin, 2021). Purchase intentions, in turn, are frequently used to make strategic decisions concerning both new and existing products, forecast future demand, test which geographic market and consumer segment to target, pre-test advertising and promotions, and as a proxy for purchase behaviour (Morwitz et al., 2007). It is therefore important to first gain an understanding of people's attitudes towards the products of interest and measure their willingness to purchase and use them (intentions), before experiments and interventions that assess actual purchasing behaviour can be designed. Where possible, I included measures of actual behaviour such as donations or time investment.

Research Aims and Chapter Overview

This thesis aimed to shed some light on the factors that relate to and promote the uptake of sustainable alternatives. By using different types of methods and analytic approaches, I attempted to examine and illustrate the inherent complexity of people's attitudes, and determine the most relevant factors for the behaviour of interest (i.e., willingness to pay for or choose a sustainable product). *Chapters 2-4* focused on consumer perceptions of, attitudes about, and willingness to pay for conventional and bio-based plastic, and *Chapter 5* investigated attitudes towards a more sustainable smartphone across four European countries.

Chapter 2 investigated which associations people have towards conventional and bio-based plastic. As there was no pre-existing work on this topic, the aim was to conduct a descriptive study into what psychological factors play a role in this context. A first qualitative study ($N = 97$) helped distil 25 evaluative reactions (i.e., beliefs, emotions, and behaviours) describing people's attitudes towards using (bio-based) plastic. These were used to create a new scale, which was subsequently tested on 508 online participants (Study 2). Based on this data, we built a network displaying relationships between participants' evaluative reactions regarding plastic use. Analyses of this network indicated that guilt was most strongly connected to people's reported willingness to pay more for a bio-based plastic product. Based on this, another study ($N = 285$) was conducted, in which guilt was experimentally manipulated to determine its effects on

people's willingness to pay for a sustainable cause. Results showed that manipulating guilt can lead participants to donate more to a sustainable cause. This effect was fully mediated by self-reported guilt.

Chapter 3 served to gain further understanding into people's attitudes and perceptions about bio-based plastic and its attributes. In four studies, participants' attitudes towards fossil-based and bio-based plastic, their perceived importance of recycling both types of plastic, their willingness to pay, and their perceptions of bio-based plastic were examined (total $N = 961$). In addition, in the fourth study, the information about bio-based plastic was experimentally manipulated and willingness to pay for different types of plastic was measured. The results suggested participants held very favourable attitudes and reported being willing to pay more for bio-based products. However, they also harboured misconceptions, especially overestimating bio-based plastic's biodegradability, and found it less important to recycle bio-based than fossil-based plastic. Study 4 provided evidence that educating consumers about the properties of bio-based plastic can dispel misconceptions and retain a favourable attitude and a high willingness to pay. We found mixed evidence for the effect of attitudes on willingness to pay, suggesting other psychological factors may also play a role.

The previous empirical chapters compared a conventional plastic bottle to a visually identical bio-based one and found positive attitudes and a higher willingness to pay for the bio-based bottle. In **Chapter 4**, the aim was to replicate and extend these findings by including an additional, visually distinct, bio-based bottle. In an online study ($N = 529$), we therefore investigated psychological factors influencing preferences for three types of plastic bottles: a conventional fossil-based bottle, a visually identical bio-based bottle, and a visually distinct bio-based bottle with a paper outer layer. The key outcomes were attitudes and willingness to pay. We also tested whether consumers' choices being visible to (valued) others affected these judgments. Participants reported positive attitudes towards bio-based plastic and were willing to pay more for it. This was especially the case for the visually distinct bio-based bottle. Irrespective of being observed, participants overwhelmingly preferred the bio-based bottles (96.8%). This suggests both consumer demand, and that designs signalling pro-environmental behaviour (e.g., sustainable products looking different from conventional products), might be a promising way to promote sustainable purchasing choices.

To expand beyond the plastic context and test the applicability of the network approach to other environmental decisions, **Chapter 5** investigated consumer attitudes and purchase intentions towards a modular smartphone (Fairphone). A study (total $N = 2,202$) was conducted in four countries: the Netherlands, Germany, France, and the United Kingdom. Across countries, psychological factors were more important than product and brand characteristics when intending to buy a sustainable smartphone. Positive emotions, overall attitude, and green product interest in particular related

positively to purchase intentions, while the importance individuals placed on the status of a product and feelings of uncertainty about the product correlated negatively.

Together, these empirical chapters explored consumer attitudes and perceptions towards sustainable alternatives. In **Chapter 6,** the main findings of the studies described in the previous chapters are summarised and reflected on. I discuss the results in terms of consumer knowledge and demand for sustainable alternatives, factors that relate to sustainable consumption, and the implications for companies and future research. I also discuss the benefits of the complexity approach I used and go into the limitations of my research and how future research could improve on it.

The empirical chapters (*Chapters 2-5*) are based on stand-alone research articles that are either published or undergoing peer review. Consequently, they can be read independently, but also contain some overlap. These articles are the result of the collaboration with my supervisors and other collaborators. The empirical chapters are therefore written using plural personal pronouns. Because the Introduction and General Discussion also reflect my own thoughts, they are written using singular personal pronouns.

Finally, during my PhD I became more and more aware of the open science movement and the need for better research practices. I therefore took several steps to improve the transparency and replicability of my work. The majority of studies reported in this dissertation were preregistered. Whenever possible, I conducted a-priori power analyses or sensitivity analyses to ensure sufficient statistical power. For each chapter, all data, analysis scripts, pre-registration documents, and study materials are publicly available on OSF (https://osf.io/fth6n/), as are all papers (including an electronic version of this dissertation).

CHAPTER 2

Applying an Attitude Network Approach to Consumer Behaviour Towards Plastic

Abstract

In a time of rapid climate change, understanding what may encourage sustainable consumer behaviour is a vital but difficult challenge. Using an attitude network approach, we investigated which associations people have towards conventional and bio-based plastic in order to develop an empirically-based approach to initiate attitude and behaviour change. With a qualitative study (*N* = 97), we distilled 25 evaluative reactions (i.e., beliefs, emotions, and behaviours) that encompass people's attitudes towards using (bio-based) plastic. These reactions were used to create a new scale, which was subsequently tested among 508 online participants. The resulting data was then used to build a network displaying relationships between participants' evaluative reactions regarding plastic use. Analyses of this network indicated that guilt was most strongly connected to people's willingness to pay more for bio-based plastic products. Based on this, we conducted another study (*N* = 285) in which we experimentally manipulated guilt (general guilt, personal guilt, and control condition) to determine its effects on people's willingness to pay for a sustainable cause. Results indicate that manipulating guilt can lead participants to donate more to a sustainable cause. This effect was fully mediated by self-reported guilt. Determining which factors influence consumers to change their buying behaviour towards sustainability is the first step in creating a demand for more sustainable products amongst the public and investors.

This chapter is based on:

Zwicker, M. V., Nohlen, H. U., Dalege, J., Gruter, G.-J. M., & van Harreveld, F. (2020). Applying an attitude network approach to consumer behaviour towards plastic. *Journal of Environmental Psychology, 69,* 101433.

Supplementary material to this article can be found online at https:// doi.org/10.1016/j.jenvp.2020.101433. All data and analysis scripts are available on the Open Science Framework (https://osf.io/gw5cs/).

INTRODUCTION

Climate change is one of the most important societal challenges of the 21st century and while some fluctuation of the planet's temperature is natural, the rapid increase in average global temperature over the last 50 years can only be explained if we include the effects of greenhouse gases such as carbon dioxide (CO_2) emitted through human activity. One contributor to CO_2 emissions that is often overlooked is plastic. Plastic's carbon footprint can be traced to its production and the CO_2 that is released at the end of its life cycle. About half of plastic's CO_2 emission (1.43 Gt or 3% of total global annual CO_2 emissions; Hertwich, 2019) stems from the production process, the remaining carbon is captured in the plastic products themselves and is released as CO_2 later, for example when they are incinerated at the end of their life cycle (World Economic Forum, 2016). Annual global plastic production has increased to twenty times what it was 50 years ago (from 15 million tons in 1964 to 311 million tons in 2014), and is expected to almost quadruple by 2050 (Ellen McArthur Foundation, 2016; World Economic Forum, 2016). More than 90% of the over 1000 different types of plastic are currently manufactured from fossil feedstock (Bourguignon, 2017; Ellen McArthur Foundation, 2016; PlasticsEurope, 2018). Plastic production alone makes up about 6% of global oil consumption, about the same amount as used by the entire global aviation sector. The opposing trends of global CO_2 emission reduction targets (to below 10 Gt in 2050) (Paris Agreement) and the tripling of plastic volumes to more than a billion tons in 2050 are not widely recognised and require global action.

One of the options to reduce the large carbon footprint of plastic, while still retaining its versatility and properties, is bio-based plastic. Rather than being made from fossil feedstocks (such as oil, coal, or natural gas), bio-based materials are wholly or partially derived from renewable material of biological origin, or biomass (Bourguignon, 2017; European Commission, 2011; van den Oever et al., 2017). While often not biodegradable (van den Oever et al., 2017) bio-based plastic's main benefit is that no additional CO_2 is released at the end of their life cycle (i.e. during incineration or degradation).

Before new technologies such as bio-based plastics can be effective, they need to be adopted by the public (and investors), something that is notoriously difficult to achieve. Public reluctance can be observed towards many types of new technologies, for example nuclear energy in Germany (Wittneben, 2012), or underground carbon dioxide storage in the Netherlands (de Best-Waldhober et al., 2009). This reluctance can also manifest itself in conspiracy theories, for example towards vaccinations (Jolley & Douglas, 2014), or the low trust in the safety of genetically modified foods (GMOs) seen throughout Europe (Fresco, 2013).

The literature identifies several reasons for why people do not act against global issues such as climate change: for example, they do not have the right attitude (e.g., they

do not believe that climate change is happening, that it is man-made, or are unaware of the size of plastic's CO_2 footprint), the attitude is not strong enough to translate into behaviour (e.g., Armitage & Christian, 2003), or they are not able or do not *feel* able to effectively translate their attitudes into behaviour (e.g., they do not know what they can do to combat climate change). This relates to attitude behaviour models, such as the theory of planned behaviour (TPB; I Ajzen, 1991), which makes a similar distinction between people's attitude and their perceived behavioural control in driving behavioural intention and actual behaviour. The TPB for example argues that behaviour is predicted by attitudes (and social norms) and intentions, but it also stresses the importance of people's perceived behavioural control of being able (or knowing how) to enact a behaviour successfully. In this research we focus specifically on people's attitudes. In particular, we are interested in the structure of people's attitudes towards the use of plastic and how these attitudes drive behaviour. We do so by using attitude networks, a novel approach designed to provide insights into when and how attitudes might influence behaviours.

A Network Approach

A network is a system of variables (i.e., nodes) that share connections with each other (i.e., edges). In psychological networks these nodes represent observed variables (e.g., questionnaire items) and the edges represent the correlational or partial-correlational structure of the data (Dalege, Borsboom, van Harreveld, Waldorp, et al., 2017; Epskamp et al., 2012). For the network approach in the current chapter, we built on the Causal Attitude Network (CAN) model (Dalege et al., 2016), which was specifically developed to link research on attitudes to network theory by conceptualising attitudes as networks of causally interacting evaluative reactions (e.g., beliefs, emotions, and behaviours). The causal interactions between evaluative reactions lead to a coherent representation of the attitude object, in this case, people's attitudes towards conventional and bio-based plastics and their uses. This approach allows for the integration of the structural and dynamic properties of attitudes and how they relate to behaviours (Dalege et al., 2016; Dalege, Borsboom, van Harreveld, Waldorp, et al., 2017). Unlike previous network models, the CAN model incorporates the interrelatedness of the evaluative reactions. This is important because attitudes can be formed by and also in turn influence affect, behaviour, and cognition (Dalege et al., 2016).

Within the CAN model, the evaluative reactions are represented as 'nodes', and the causal influences between them as 'edges'. As an example of a simple attitude network, let's take Charlie's attitude towards eating meat. Say Charlie thinks that eating meat is bad for the environment and also thinks the current meat production is cruel. These two evaluative reactions lead Charlie to stop eating meat (behavioural node). These three nodes already represent a small network (Figure 1) in which the different nodes hold

each other in check, such that changing one of them without inflicting some change on the others is difficult. Within a given network, some nodes are more central than others (e.g., some nodes have more connections than other nodes). The centrality of a node provides information about its structural importance and can tell which evaluative reactions most likely influence decision-making and make the best targets for persuasion attempts (Dalege, Borsboom, van Harreveld, & van der Maas, 2017; Dalege, Borsboom, van Harreveld, Waldorp, et al., 2017).

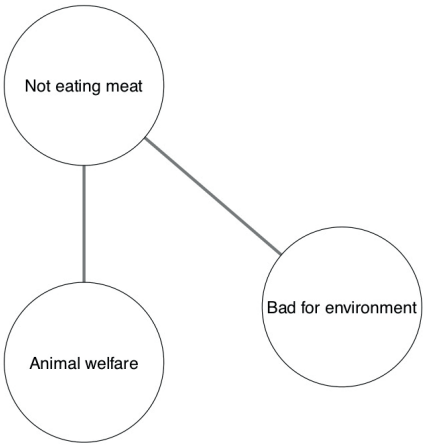


Figure 1. Hypothetical Attitude Network Towards Meat Consumption. The Different Circles (Nodes) Represent Evaluative Reactions and the Connecting Lines (Edges) Represent the Conditional Independence Between Them.

The attitude networks created with the CAN model conform to a small-world structure, which means that evaluative reactions that are similar to each other form tight clusters, are connected by "shortcuts", and influence each other more strongly than other nodes in the network (Dalege et al., 2016). Clusters are formed to balance the need for consistency and accuracy in people's attitudes, which clustering enables by allowing different sets of highly interconnected evaluative reactions while permitting inconsistency to allow for higher accuracy (Dalege et al., 2016; Dalege, Borsboom, van Harreveld, Waldorp, et al., 2017). With regards to an attitude network about plastic, clustering means that one can have positive evaluative reactions towards plastic (e.g., that it is convenient, lightweight, and good for packaging) while at the same time also harbouring negative evaluative reactions (e.g., that plastic is a source of waste and pollution, and the use of it invokes feelings of guilt).

Another structural feature of the network that provides insights into the effectiveness of persuasion attempts is node centrality. The most central evaluative reactions

of a network tend to have the strongest impact. For example, Dalege, Borsboom, van Harreveld and van der Maas (2017) analysed voting data and attitudes towards presidential candidates in past US elections and found that central nodes are the most predictive of voting decisions. Additionally, the higher the connectivity of the whole network, the more predictive the attitudes are of actual behaviour (Dalege et al., 2016; Dalege, Borsboom, van Harreveld, & van der Maas, 2017) and the more stable and resistant to change or persuasion (Dalege et al., 2016; Howe & Krosnick, 2017; van Borkulo et al., 2014).

The main reason why we are interested in studying attitudes and evaluative reactions is because they are important drivers of human behaviour. We therefore also add a behavioural node (willingness to pay) to the attitude network to investigate which of the evaluative reactions relate(s) most strongly to participants' behaviour. Because of this, we focus on the centrality of a node (rather than connectedness of the whole network) to inform us which persuasion attempts are more likely to successfully convince people to use and pay for more sustainable plastics, rather than being interested in changing the entire attitude towards (bio-based) plastic all together.

The Present Research

Psychological research on plastic-related behaviour is scarce (with the exception of recycling behaviour) and even more so with regard to new types of plastics, for example those that are bio-based. However, for products based on new technologies like bio-based plastic to be adopted and widely made available, people need to be willing to pay more for them, as the adaption of new technologies tends to be more expensive than continued use of current technologies. Only when consumers *want* products created by these new technologies, can they be produced on a large scale, at which point they will become cheaper. However, so far, we do not know whether people would be willing to pay more (and if so how much) for similar products made from biobased plastic. The fact that this is largely unknown may make large companies hesitant to switch to these new technologies in fear of suffering a financial deficit compared to their competitors. For example, as long as brand owners are able to say that 'the consumer is not willing to pay more for sustainable packaging', a switch to bio-based packaging is unlikely. Therefore, the specific behaviour we focus on in the present research is consumers' willingness to pay. More specifically, we are interested in how much people are willing to pay for a bio-based product compared to one made from conventional plastic, how this relates to the evaluative reactions people have about (bio-based) plastic and its use, and whether we can effectively target specific evaluative reactions to increase people's willingness to pay.

Moreover, we are trying to gain insight into what encourages people to behave more sustainably using a cutting-edge methodology, namely an attitude network approach (in addition to qualitative and experimental studies). Before the emergence

of the CAN model, network analysis has mostly been used in clinical and cognitive psychology (e.g., Cramer et al., 2010; Van der Maas et al., 2006). Recently, environmental psychologists have started to use graphical models to evaluate and understand the effects of intervention programmes on sustainable behaviour (e.g., using causal directed acyclic graphs; Bhushan et al., 2018) and to visualise and explain relationships between large sets of variables (e.g., using the Gaussian graphical model; Bhushan et al., 2019). However, the use of these types of models is still in its infancy. To our knowledge, the network approach has not yet been applied to attitudes about plastic or how they relate to people's willingness to pay, with previous research mainly focussing on sustainable energy behaviour (Bhushan et al., 2019; Bhushan et al., 2018).

The first study employed a qualitative approach, asking participants to list any thoughts, emotions, and associations they have regarding (bio-based) plastic. The results from Study 1 were then used to create a scale measuring evaluative reactions towards (bio-based) plastic, which was the basis for the network analysis in Study 2. The evaluative reactions indicated by the network analysis to have the highest connection with willingness to pay were then manipulated in the third study to determine whether the results of the network analysis can indeed be used to develop effective tools to influence people's actual behaviour. The experimental procedures of all studies were approved by the Ethics Review Board of the Faculty of Social and Behavioural Sciences, University of Amsterdam, The Netherlands.

STUDY 1

To our knowledge, no questionnaire exists that assesses people's attitudes specifically about plastic and its use, let alone one that assesses their attitudes about bio-based plastics. We therefore designed a new measure. We did so by asking participants directly (rather than assuming or guessing) which thoughts, emotions, and associations they have with (bio-based) plastic. We included questions about participants' feelings, rather than just asking about cognitions, because research suggests that affect, negative affect in particular, can be a strong predictor of different types of adaptive behaviour in response to climate change news (van Valkengoed & Steg, 2019).

Method

Participants

Using the online research platform Prolific Academic, 97 participants[1] were recruited to complete the online survey created using the survey software Qualtrics. Of these, 61 (62.9%) were female and 36 (37.1%) male with ages ranging from 18 to 64 years (M = 33.94, SD = 12.05). The majority of the participants either completed secondary education (30.9%) or an undergraduate degree (50.5%), while 9.3% finished trade/technical/vocational training, 8.4% completed graduate education, and one person (1.0%) did not complete secondary education. Most of the participants resided in or were nationals of the United Kingdom (58% and 52%, respectively), others lived in North America (14% and 13%), or the rest of Europe (30% and 32%). Participants received £1.50 for taking part in this approximately 18-minute survey.

Measures

Demographic Information. Participants indicated their age, gender, highest completed level of education, country of residence, and nationality.

Thoughts About Using Plastic. Items for this new scale were collected by way of a qualitative thought-listing survey (see also Cacioppo et al., 1997; Heimberg et al., 1987). This open-response method has previously been used as a basis for the development of self-report scales (e.g., Glass et al., 1982), and is particularly useful if one has few or no predetermined ideas about relevant cognitive dimensions (Cacioppo et al., 1997). During thought-listing, participants are instructed to write down any thoughts that come to mind in response to a question. We asked participants five questions: "What do you think are reasons for (against) using plastics?", "What feelings do you associate with plastic use?", "What do you think 'bio-based' plastic is?", and "Do you have any concerns that come to mind when you think about using bio-based plastics or buying products made from bio-based plastic?". Participants were given 3 minutes to write down a minimum of four thoughts per question into the 10 provided answer boxes. They were prevented from advancing in the survey for the first 60 seconds of each question (30 seconds in the case of the feelings and 'what is bio-based plastic' questions, because we did not want to have them try to come up with more feelings than they were experiencing and they were less likely to have knowledge and thoughts about bio-based plastic). There were no requirements for complete sentences, spelling, grammar, or punctuation.

1 As this is a qualitative study, no a priori power analysis was conducted to determine the sample size. The authors decided that recruiting 100 participants (after exclusions, N = 97) would be sufficient for this type of analysis.

Procedure

After reading information about the study and consenting to take part, participants filled out demographic information. The format of the thought-listing questions was then explained to them (including an example). In the first part of the study, participants answered the thought-listing questions concerning reasons for and against the use of plastic products, and the feelings they associate with plastic. The second part of the study included the two thought-listing questions about 'bio-based' plastic. Afterwards, the participants were debriefed and paid.

Results

Thoughts About Using Plastic

Responses were coded and combined to distil concrete evaluative reactions (see supplementary material). Items that would best give a meaningful indication of a person's attitude were favoured in the selection process to create 25 concrete evaluative reactions for and against plastic use that were mentioned with regard to both conventional and bio-based plastic: convenient, lightweight, cheap, available, useful, durable, hygienic, safe, good for storage/packaging, recyclable, takes a long time to decompose, pollutes bodies of water (e.g., oceans), causes waste, pollutes the air, harmful to people's health (e.g., by entering the food chain or drinking water), harmful to animals, depletes natural resources, and often being of poor quality (e.g., breaks easily), as well as feeling worried, joyful, guilty, sad, angry, uncertain, and excited. The frequent mention of feelings (negative ones in particular) illustrates that affect also plays a role in the formation of complex attitudes. The scale constructed using these 25 items can be seen in Appendix A.

Discussion

This qualitative thought-listing study helped to identify the evaluative reactions people most commonly have towards (bio-based) plastic products, and to create a 25-item scale with two parts (Appendix A). Part 1 consists of 18 cognitive evaluative reaction items, and Part 2 consists of 7 items inquiring about participants' emotions. The items of this scale will represent the nodes in the network analysis.

Next, we conducted a pilot study (N = 52) to test the reliability of the newly developed evaluative reactions scale, as well as the presentation order of the items (e.g., whether it made a difference whether participants saw the conventional or bio-based plastic items first). Details of the measures and results of this pilot study can be found in the supplementary materials.

STUDY 2

Study 1 provided 25 evaluative reactions that people most frequently have towards (bio-based) plastic. These, together with an added behavioural node (willingness to pay), built the foundation of the attitude network towards plastic. We added willingness to pay because we were particularly interested in how the components of people's attitudes towards (bio-based) plastic relate to behaviour. Ideally this would inform us which aspect(s) of people's attitude towards plastic should be targeted to effectively stimulate a change in buying behaviour. Understanding what encourages people to pay more for a bio-based product compared to one made from conventional plastic is an important step in enabling the adoption of a new and more sustainable type of plastic.

In addition to creating an attitude network, we also included a measure of participants' holistic attitude towards (bio-based) plastic. This was done to ensure that the set of evaluative reactions used in the network indeed accurately represents the attitudes people have towards (bio-based) plastic and its use.

Method

Participants

Epskamp (2016) suggests that for moderately sized networks (around 25 nodes) that are based on continuous data, a sample size of 250 is sufficient. We aimed to create two networks of 26 nodes (one for conventional and one for bio-based plastic), and thus recruited 508 participants via the online research platform Prolific to participate in our survey. Of these, 268 (52.8%) were female and 232 (45.7%) male (five participants indicated "other" and three preferred not to say). Their ages ranged from 18 to 72 years, with a mean age of 32.41 (SD = 10.83). The majority of the participants either completed secondary education (24.2%), an undergraduate degree (47.4%), or postgraduate education (17.9%), while 8.7% of the participants completed trade/technical/vocational training and 1.8% completed only primary education. Most participants resided in or were nationals of the United Kingdom (35.43% and 33.07% respectively), or the rest of Europe (43.50% and 46.06%), and some lived in North America (19.49% and 17.13%). The survey took approximately 15 minutes to complete, and participants received £1.25 as compensation.

Measures

Demographic Information. Participants indicated their age, gender, highest completed level of education, country of residence, and nationality.

Evaluative Reactions Towards (Bio-Based) Plastic. To assess participants' evaluative reactions towards both kinds of plastic, we used the scale we developed in Study 1 (Appendix A). The scale consists of 25 evaluative reaction statements to which partic-

ipants indicate their agreement using a 7-point Likert scale (1 = *strongly disagree* to *7* = *strongly agree*). The scale is divided into two parts: Part 1 consists of 18 items about evaluative reactions that are mostly cognitive in nature, while Part 2 includes the 7 remaining emotion items. The scale was divided so that the question statements for both parts could be phrased slightly differently in order to feel more natural. Part 1 of the scale includes very simple statements starting with "(Bio-based) Plastic..." followed by a random order of the 18 chosen evaluative reactions (excluding the 7 emotion items) from the qualitative study: ... is convenient, is lightweight, is cheap, is readily available, is useful, is durable, is hygienic, is safe, is good for storage and packaging, is recyclable, takes a long time to decompose, pollutes bodies of water (e.g., oceans), causes waste, pollutes the air, is harmful to people's health (e.g., by entering the food chain or drinking water), is harmful to animals, depletes natural resources, is often of poor quality (e.g., breaks easily). Part 1 showed a reliability of $\alpha = 0.70$ for the conventional plastic items and $\alpha = 0.81$ for the bio-based items. In the second part of the scale, participants saw statements starting with "When I think about (bio-based) plastic use, I feel..." and were then asked to indicate how much they felt worried, joy, guilty, sad, angry, uncertain, and excited (in a random order). This emotion measure (Part 2) had reliabilities of $\alpha = 0.82$ and $\alpha = 0.80$ for conventional and bio-based plastics, respectively[2].

Willingness to Pay. The behavioural measure and dependent variable of this study was participants' reported willingness to pay for bio-based compared to conventional plastic products. To ascertain this, participants were shown a picture of an unlabelled 1.5 L bottle of water, and were told that it was made from 'conventional'[3] plastic and costs 1€. They were then asked to indicate how much they would be willing to pay for the same bottle if it were made from bio-based plastic using a continuous slider from 0€ to 2€ (the starting position of the slider was at 1€).

Other Measures. In addition to the measures described above, we also assessed social norm factors, perceived behavioural control, and self-reported pro-environmental behaviour. As the main focus of this study was to determine the attitude network people have about (bio-based) plastic, these measures and their results will not be discussed here but are available in the supplementary material[4].

Attitudes. To test whether the network nodes we have chosen adequately reflect people's overall attitude, we also included a holistic attitude measure. Traditionally, when trying to assess an overall attitude (in this case the attitude towards plastics), a range of

2 One might judge the reliabilities of the scale as rather low. However, our aim for designing the scale was not to maximise reliability but to measure the evaluative reactions toward plastic in a comprehensive manner. This is likely to lead to a rather low reliability of the scale (Dalege et al., 2016).

3 In survey questions, we chose to use the terms 'normal' or 'regular' plastic, rather than 'conventional' plastic, because it is more in line with language used in everyday conversation.

4 For different research purposes, the study also measured misconceptions about bio-based plastic. The results are reported in *Chapter 3*.

more specific beliefs is assessed (here represented by the evaluative reaction nodes) that are predictive of the holistic attitude. We therefore expected the composite score of the evaluative reactions to correlate with the holistic attitude measure.

Attitudes are not always as dichotomous as seeing something as 'positive' or 'negative', or 'good' or 'evil' (Thompson et al., 1995). Many situations can lead one to have mixed feelings, be it about daily dietary temptations, large societal issues, or anything in between (van Harreveld et al., 2015). We therefore assessed both the positive and negative evaluations people hold towards plastic separately rather than in a single bipolar scale, to get a more accurate picture of people's attitudes towards plastics. This design mitigates one of the main limitations of traditional bipolar attitude scales, namely that it is impossible to determine whether participants are indifferent (*neither* positive nor negative) or ambivalent (*equally* positive and negative) when checking the midpoint of the scale (Thompson et al., 1995). Knowing this difference is important because ambivalence is known to have a wide range of consequences for affect, cognition, and behaviour (van Harreveld et al., 2015). We therefore asked participants to first consider only the positive aspects of (bio-based) plastic use and indicate on a 7-point scale (*1 = not favourable at all* to *7 = extremely favourable*) how favourably they evaluated conventional/bio-based plastic use. The same was then done for the negative aspects: "Considering only the negative aspects of using plastic products and ignoring the positive aspects, how unfavourable is your evaluation of (bio-based) plastic use?". Besides gaining a better understanding of how positively and negatively participants evaluate plastic, we were also interested in determining whether these evaluations differed with regards to conventional versus bio-based plastic.

Procedure

After reading the information letter about the study and giving consent, participants read some information about the difference between conventional and bio-based plastics. The first part of the survey concerned only conventional plastics. After responding to the newly developed evaluative reactions scale, participants were asked how positively and negatively they felt towards plastic use. The second part of the survey was identical to the first, but all the questions concerned bio-based plastic. This was followed by the willingness to pay item. After responding to demographic questions, participants were debriefed and paid.

Results

Network Analysis

Due to the fact that most participants did not have a correct perception of what bio-based plastic is (58% of the participants thought that bio-based plastic is biodegradable), we were not able to directly and meaningfully compare the attitude networks for conventional and bio-based plastic as we originally intended. We therefore only display

the results for the conventional plastic network (and provide the results for the bio-based plastic network analysis in the supplementary material). Our current goal is to pinpoint effective means to increase people's willingness to pay for bio-based plastics, but we do not want to achieve this goal by building on misconceptions people have towards bio-based plastics. As a result, we focus on how people's attitudes towards conventional plastic related to willingness to pay for bio-based plastics.

To estimate a weighted, undirected network, we followed the method described by Dalege, Borsboom, van Harreveld and van der Maas (2017), though we used continuous (rather than binary) data. Identical methods were used for both the conventional and bio-based plastic attitude networks. In particular, we used the *glasso* method implemented in the R package *qgraph*[5] (Epskamp et al., 2012) to create the partial correlation networks shown in Figure 2. The *glasso* method estimates partial correlations between each pair of variables conditioning on all other variables. It also decreases the number of spurious partial correlations by making use of the LASSO technique, and selects the best fitting regression function based on extended Bayesian information criteria (see Blanken et al., 2018). We also tested the stability of the estimated network using the R package *bootnet* (S. Epskamp et al., 2018), the results of which can be found in the supplementary material (Figure S4 and S5).

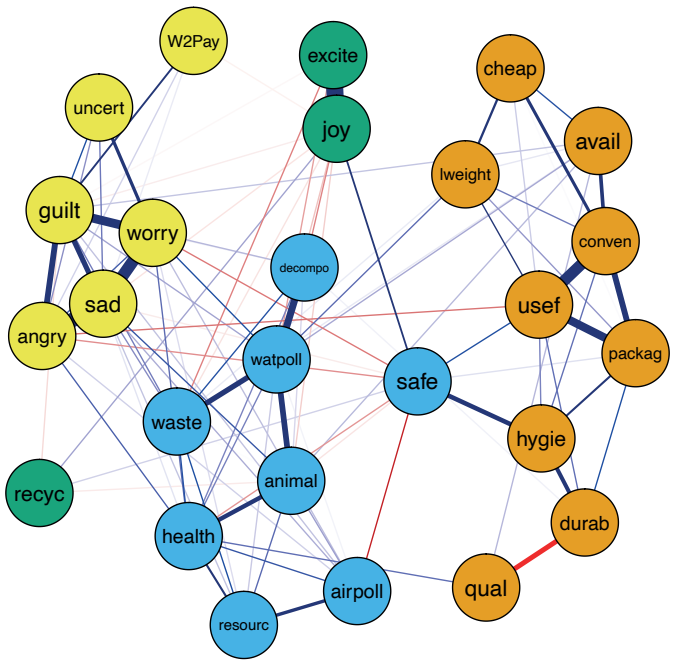
Community Detection. To be able to inspect the global structure of the network and the differing interconnectedness of the nodes, we used the walktrap algorithm (Pons & Latapy, 2005) to detect communities (clusters) within the network. To do this, we used the *igraph* package implemented in R (Amestoy et al., 2015). As illustrated by Figure 2, which shows the plastic network after community detection, all negative emotions form a community and cluster together with the behavioural node 'willingness to pay'. The positive emotions also form a cluster (together with the 'recycling' node), as do all the nodes describing the positive attributes of plastic. The evaluative reactions concerning mainly negative aspects of plastic use also form a community, together with how 'safe' participants thought plastic to be (which seems to act as a 'bridge' between multiple clusters). What is most relevant for this chapter is the finding that the behavioural node clusters together with the negative emotions, suggesting that targeting those emotions might have the largest influence on changing people's willingness to pay.

Node Centrality. A node's centrality is a reflection of its structural importance, and can help determine how changing it would affect the rest of the network (Dalege, Borsboom, van Harreveld, & van der Maas, 2017) and a specific node/ behaviour, as was the purpose of our study. Figure 3 displays the strength centrality measure for the plastic

5 If not stated otherwise, we used the default settings in the R-package *qgraph*. In the few cases that there was missing data (mainly concerning the bio-based network), those participants were excluded using the *na.omit* function in R. No outliers were omitted from the analysis.

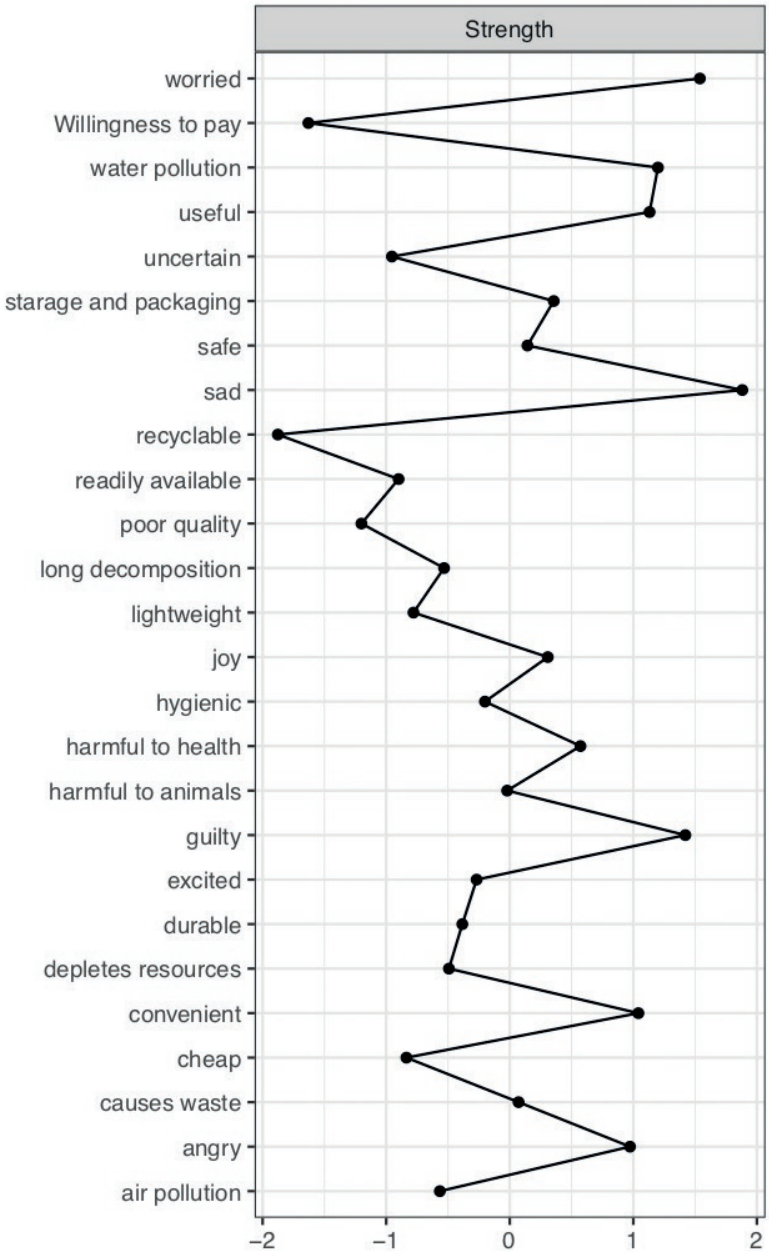
network. We focused on the strength measure of centrality, which represents the direct influence of a given node on the network and is calculated by summing the absolute values of all edge weights a given node has. For the plastic network, the nodes that are most central (have the highest strength) are the negative emotions 'sad', 'worried', and 'guilty'. This is because of their strong connections to each other and the other negative emotions (also see the partial correlation network, Figure 2). While all three of these negative emotions appear to be central to the network, only the extent to which participants experienced guilt was directly connected to people's willingness to pay, the behavioural node.

Guilt and Willingness to Pay



conven: convenient
lweight: lightweight
cheap: cheap
avail: readily available
usef: useful
durab: durable
hygie: hygienic
safe: safe
packag: starage and packaging
recyc: recyclable
decompo: long decomposition
watpoll: water pollution
waste: causes waste
airpoll: air pollution
health: harmful to health
animal: harmful to animals
resourc: depletes resources
qual: poor quality
worry: worried
joy: joy
guilt: guilty
sad: sad
angry: angry
uncert: uncertain
excite: excited
W2Pay: Willingness to pay

Figure 2. Partial Correlation Attitude Network of Evaluative Reactions Towards Plastic. No Partial Correlations Under 0.1 are Displayed, and Edges that Have Higher than a 0.3 Partial Correlation are Plotted with Thickness According to their Magnitude. Closely Connected Attitude Elements are Placed Near to Each Other. The Different Colours Represent Different Clusters (Communities) of Nodes that Consist of Closely Connected Evaluative Reactions. The Yellow Nodes Represent Negative Emotions (With the Addition of Willingness to Pay), the Orange Nodes Describe Positive Aspects of Plastic, the Blue Nodes Represent Mainly Negative Aspects of Plastic Use, and the Green Represent Positive Emotions (and Recycling).



Note. All relationships are statistically significant at p <.001

Figure 3. The Strength Scores Represent Standardised *Z*-Scores. A Score of 1, for Example, Means that this Node Has a Strength Score 1 *SD* Higher than the Mean Strength Score of the Network.

the negative emotions) and the analysis of node centrality suggest that some of the negative emotions might be good potential targets to influence people's behaviour. Looking more closely at the network displayed in Figure 2, the 'guilt' node has the strongest connection to willingness to pay, even though some other evaluative reactions also show edges to the behavioural node (i.e., anger, sadness, and joy). When examining the partial correlations with willingness to pay, only guilt's connection to the behavioural node stays significant ($r(482) = 0.156$, $p < .001$); none of the other negative emotions (anger: $r = 0.040$, $p = .383$, sadness: $r = 0.015$, $p = .737$, worry: $r = 0.030$, $p = .509$) or joy ($r = -0.076$, $p = .093$) remain significant. This was also corroborated by a regression analysis in which we regressed all the evaluative reactions onto willingness to pay. The results suggest that only guilt ($b = 0.243$, $t(482) = 3.566$, $p < .001$, 95% CIB [0.019, 0.064]) and, to a lesser extent, uncertainty ($b = -0.022$, $t(482) = -2.326$, $p = .020$, 95% CIB [-0.040, −0.003]) are significantly related to people's willingness to pay.

Other Analyses

Willingness to Pay. The majority of participants (72.83%) indicated that they would be willing to pay more for a water bottle made from bio-based plastic than for a bottle made from conventional plastic. On average, people were willing to pay 1.21€ ($SD = 0.28$) for a bio-based bottle, compared to the regular price of 1€.

Attitudes. We conducted a paired samples *t*-test to compare people's general attitudes towards conventional plastic with their attitudes towards bio-based plastics. There was a significant difference in generally positive evaluations towards conventional and bio-based plastic, with participants responding more positively towards bio-based plastic ($M = 5.94$, $SD = 1.28$) than conventional plastic ($M = 4.72$, $SD = 1.5$), $t(507) = -16.64$, $p < .001$, $d = -0.738$, 95% CI [-1.36, −1.07] (Figure 4). There was also a significant difference in negative evaluations, with participants being more unfavourable towards conventional plastic ($M = 5.10$, $SD = 1.80$) than towards bio-based plastic ($M = 3.33$, $SD = 1.52$), $t(507) = 17.80$, $p < .001$, $d = 0.790$, 95% CI [1.57, 1.96]. To calculate participants' ambivalence, we subtracted the absolute difference between the positive (P) and negative (N) attitude components from the average of the two components, $(P + N)/2 - |P - N|$ (Thompson et al., 1995). We found that participants were more ambivalent about conventional plastic ($M = 3.01$, $SD = 2.23$) than about bio-based plastic ($M = 1.77$, $SD = 2.24$), $t(507) = 9.39$, $p < .001$, $d = 0.417$, 95% CI [0.982, 1.50].

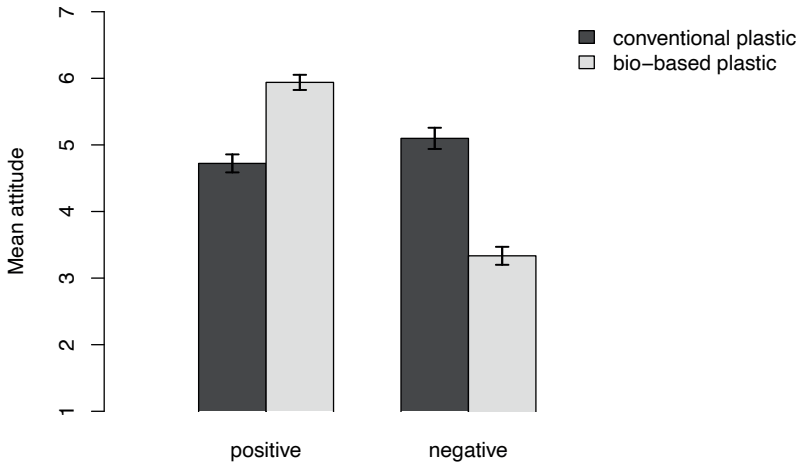


Figure 4. Mean Positive and Negative Evaluations (Holistic Attitude) Towards Conventional Plastic and Bio-Based Plastic With *1 = Not at all (Un)Favourable* and *7 = Extremely (Un)Favourable*. Error Bars Represent the Standard Error.

Correlational analysis revealed that holistic attitudes indeed significantly relate to the evaluative reactions used in the network (for the complete correlation matrix see Table 1). The aggregated evaluative reaction nodes of the network (excluding willingness to pay) correlated moderately with the holistic attitude measure $r(508) = 0.47$, $p < .001$. The cognitive nodes and the emotional nodes of the network individually also show significant positive correlations with the overall attitude with correlations of $r(508) = 0.41$, $p < .001$ and $r(508) = 0.37$, $p < .001$, respectively.

Discussion

Overall, the network approach provided a unique and informative insight into the structure and components of people's attitudes towards plastic. It demonstrated which evaluative reactions might be worth targeting with a persuasion attempt if we want to achieve a change in people's behaviour. In particular, the main finding of the network analysis was that guilt appears to be the best predictor of people's willingness to pay more for a water bottle made of bio-based plastic instead of conventional plastic. The examination of the holistic attitudes also confirmed our choice of network nodes, as well as illustrating people's ambivalence (and negativity) towards conventional plastics and favourable evaluations of bio-based plastics.

Table 1 Attitude Towards Plastic Correlation Matrix

		Holistic Attitude	Overall Evaluative Reaction	Cognitions	Emotions
Holistic Attitude	Pearson's r	—			
	p-value	—			
Overall Evaluative Reaction	Pearson's r	0.468 ***	—		
	p-value	< .001	—		
Cognitions	Pearson's r	0.411 ***	0.877 ***	—	
	p-value	< .001	< .001	—	
Emotions	Pearson's r	0.371 ***	0.793 ***	0.401 ***	—
	p-value	< .001	< .001	< .001	—

Note. * $p < .05$, ** $p < .01$, *** $p < .001$
The holistic attitude score was derived by subtracting the negative holistic evaluations from the positive. All other aggregate scores were computed by taking the summed mean scores of the (reverse coded) responses to (parts of) the Evaluative Reaction Scale.

While providing considerable insights into the cognitive structures underlying people's willingness to pay for bio-based plastic, the study did have its limitations. First of all, the insights were mostly limited to attitudes towards conventional plastic. As alluded to earlier, the misconceptions people hold about bio-based plastic might have distorted the bio-based attitude network. Another limitation is that the association between guilt and willingness to pay is correlational and that our measure of behaviour was hypothetical. Both of these limitations were addressed in the following study, where we manipulated participants' feelings of guilt and added a behavioural measure that asked participants to donate a portion of their earnings.

STUDY 3

While the previous study revealed a relation between guilt and willingness to pay, in this study we will shed light on the causality of this relation by experimentally manipulating guilt. To this end, we added a behavioural measure in which we asked participants to donate real money instead of indicating whether they would theoretically be willing to pay more. Studies on psychological distance suggest that the closer people are to a topic and the more personally responsible they feel, the more likely they are to act (e.g., Spence et al., 2012). In this study we aimed to reduce psychological distance by manipulating participants' feelings of guilt. This was done by emphasising participants'

individual contributions to plastic production related CO_2 emissions, and thereby to global warming. In particular, our design included three conditions (personal, general, and control) with differing levels of manipulated guilt (high, low, and none, respectively). As in the previous study, we used willingness to pay as the dependent variable. In addition to the bottle measure, in this study we also asked people whether they would be willing to donate (some of) their earnings for participating in the study to help plant a tree to reduce atmospheric CO_2. Because this measure concerns the donation of real money, it captures actual sustainable behaviour rather than relying on a self-report of intention.

We hypothesised that people in the personal guilt condition (i.e., the condition in which the participants' personal contributions to plastic-related CO_2 emissions were emphasised most) would report feeling more guilty than in the general guilt condition (where participants were simply informed about plastic-related CO_2 emissions), and that both these conditions would elicit more guilt than the control condition (where plastic-related CO_2 emissions were said to be very small). We also expected greater guilt to lead to a greater willingness to pay. We did not have any specific predictions about potential differences between the two willingness to pay measures, due to the first being more theoretical and the second being behavioural, as well as referring to a somewhat different topic (bio-based plastic bottle vs. planting a tree). However, seeing as it was more reflective of actual behaviour, we put greater importance on the donation measure.

Method

Participants and Design

In total, 307 participants[6] completed the online survey (created in Qualtrics and distributed using Prolific), 22 of which failed the reading comprehension check (i.e., we asked participants a multiple choice question the answer of which directly followed from the reading of an informative text about the benefits of bio-based plastic for the environment, which allowed us to check whether participants read and understood the text thoroughly). Of the remaining 285 valid participants, 155 (54.4%) were female and 128 (44.9%) male. Their age ranged from 18 to 70 years, with a mean age of 30.87 (SD = 10.83). The majority of the participants either completed secondary education (25.6%), an undergraduate degree (47.7%), or postgraduate education (15.8%), while 10.2% completed trade/technical/vocational training (less than 1% completed only primary education). The majority of participants lived in Europe (89.12%), and the majority of those live in the UK (28.74%), Portugal (25.59%), Italy (16.93%), or Spain (12.20%).

6 As we did not have a clear idea of what the effect size would be, we aimed for 100 participants per cell.

The study was made available to participants residing in Western countries (see Appendix B for a complete list). Participants were randomly assigned to one of the three conditions: personal guilt ($N = 96$), general guilt ($N = 89$), or control ($N = 100$). Participants were also asked to indicate the size/population of the town or city they live in; 9.1% lived in small towns (less than 2000 inhabitants), 40% in a town (2000 - 100,000), 31.2% in a city (100,000–1,000,000), and 19.6% live in a large city (more than 1 million inhabitants). Although provided by everybody, this information was only used for participants in the personal guilt condition, for whom the size/population of the town or city they lived in was inserted into the descriptive guilt manipulation text to increase the feeling of personal responsibility and guilt.

Measures[7]

Guilt Manipulation. Guilt was manipulated using descriptive texts about plastic production causing CO_2 emissions. There were two guilt conditions: general guilt and personal guilt. In the general guilt condition, participants were informed that plastic production is a large contributor to CO_2 emissions and thereby to global warming, without mention of participants' personal involvement in this process. Participants in the personal guilt condition received the same text but with one added sentence that highlighted personal contribution to global warming: "The average person living in a [city size indicated by participant] in your country consumes around 100 kg of plastic each year, which accounts for the release of 600 kg of CO_2 per person every year. If people like yourself continue buying and using this much plastic, plastic production will have a significant effect on global warming." Participants in the control condition read that, compared to other factors, "plastic's contribution to global warming is very small". See Appendix D for complete texts.

Emotion Measure. We measured the same seven emotions as in Study 2 (anger, excitement, guilt, joy, sadness, uncertainty, and worry, Cronbach's $\alpha = 0.78$), using Part 2 of the evaluative reaction scale. In addition to being our measure of self-reported guilt, this also served as a manipulation check to test whether we indeed manipulated guilt and not negative affect in a broader sense. Participants indicated on a 7- point Likert-scale (*1 = none at all* to *7 = a great deal*) to what extent they felt these emotions when thinking about their own contribution to plastic production by buying and using plastic products.

Willingness to Pay. As described earlier, there were two measures that assessed participants' willingness to pay. The first one was the bottle measure used in Study 2, where participants were shown a picture of an unlabelled 1.5 L plastic bottle of water

7 We also assessed participants' misconceptions about the recyclability and biodegradability of bio-based plastic at the beginning and the end of the survey. The results of which are the subject of *Chapter 3*.

and were told that it was made from 'regular' plastic and costs £1[8]. They were then asked to indicate how much they would be willing to pay for the same bottle if it had been made from bio-based plastic using a continuous slider from £0 to £2 (the starting position of the slider was at £1).

In the second willingness to pay measure, participants were informed about how trees can help combat global warming by absorbing CO_2. They were then told that for every £10 donated, a tree would be planted in real life. Participants were then asked whether they wanted to donate a portion of their earnings from taking part in this study to help plant trees to reduce CO_2, and if so, how much (on a slider from £0 to £0.85, with £0.85 being the maximum payout for this study). While this measure did not directly concern bio-based plastics, it did address the same issue: a pro-environmental behaviour aimed at reducing the CO_2 footprint. Regardless of how much they decided to donate, participants were paid in full.

Procedure

After reading the information letter and consenting to take part in the study, participants filled in demographic information (age, gender, education, country of residence, size of their town/city). Participants then read information about how the carbon cycle works and how CO_2 influences global warming (see Appendix C for complete texts). Depending on their condition, participants then received information about the contribution of plastic production to CO_2 emissions. After this, they filled in the emotion measure. Participants were then told that one way to reduce CO_2 is through the use of bio-based plastics, and received an informative text about the difference between conventional plastic and bio-based plastic (see Appendix C). This was followed by the two willingness to pay measures. Participants were debriefed and told that they could keep all their money regardless of how much they decided to donate, then they were thanked and paid.

Results

Willingness to Pay

Water Bottle. The majority of participants (74.04%) indicated that they would be willing to pay more for a water bottle made from bio-based plastic than for a bottle made from conventional plastic. On average, participants were willing to pay £1.18 (SD = 0.32) for a bio-based bottle, compared to the regular price of £1. These results are very similar to those obtained in Study 2 (M = 1.21, SD = 0.28).

8 Rather than using Euros, the currency of the bottle measure was switched to GBP for Study 3, in order to keep it consistent with the currency participants were paid in.

Donation of Earnings. Of the 285 participants who took part in this study, 141 (49.5%) decided to donate some of their earnings in order to help plant a tree and reduce atmospheric CO_2. The average amount offered for donation was £0.39 (*SD* = 0.28), which amounts to 45.27% of their earnings.

Main Analysis

Manipulation Check. An analysis of variance showed that the main effect of condition on experienced guilt was significant F (2,282) = 10.137, $p < .001$, ηp2 = 0.067. A Tukey post-hoc test revealed that there was no significant difference between the average guilt participants were experiencing in the general guilt condition (*M* = 4.89, *SD* = 1.50) compared to the personal guilt (*M* = 5.10, *SD* = 1.53) condition, $t(282) = -0.94$, $p = .62$, CI 95% [-0.76, 0.33]. Because of this, these two conditions were combined into one guilt condition in subsequent analyses. This combination was not unwarranted, as the main focus of this study was to determine whether guilt could encourage more sustainable behaviour, rather than investigating the effects of different levels of guilt). Participants in the guilt conditions reported significantly higher guilt than those in the control condition (*M* = 4.14, *SD* = 1.62) (the difference in experienced guilt between participants in the general guilt condition and the control group was $t(282) = 0.748$, $p = .004$, CI 95% [0.21, 1.29], and between participants in the personal guilt condition and control $t(282) = 0.94$, $p < .001$, CI 95% [0.43, 1.49]).

Effect of Guilt on Willingness to Pay/Donate. We recoded the willingness to donate into a continuous 'amount' variable, noting those who chose not to donate as £0 donations. We then ran independent samples t-tests to determine the effect of the condition participants were in (guilt or control) on their willingness to pay. There did not appear to be an effect of condition on participants' self-reported willingness to pay more for a bio-based bottle, $t(283) = -0.69$, $p = .49$, $d = 0.0865$; however, condition did appear to influence people's willingness to donate parts of their earnings towards donating money to plant a tree, $t(230.517) = -1.97$, $p = .05$[9][10], $d = 0.238$. To further investigate this relationship, a bootstrapping mediation analysis (5000 bootstrapped samples) was conducted using model 4 of Andrew Hayes' PROCESS v2 macro in SPSS (Hayes, 2012). While the total effect of condition on donation amount was only marginally signif-

9 This is the corrected *p*-value suggested by the statistically significant Levene's Test for Equality of Variances. The uncorrected *p*-value was only marginally significant $t(283) = -1.800$, $p = .061$.

10 Because the donation measure showed a significant skew (1.411 *SE* = 0.144) we also conducted a Mann-Whitney test, which revealed that donation amount was no longer significantly predicted by condition, $U = 10336$, $z = 1.754$, $p = .079$, $r = 0.104$. This is not surprising, as non-parametric tests have less statistical power than parametric tests. We decided to leave the complete mediation as the main analysis however, as we believe that the influence of condition on behaviour remains meaningful enough to further probe with the bootstrapping analysis, which provides the most comprehensive picture of how condition, guilt and donation relate. None of the other willingness to pay measures displayed as strong of a skew. Nevertheless, the parametric test results can be found in the supplementary material. None of the results are significantly different from what is reported in the main text.

icant, $B = 0.0642$, $p = .0612$ (the Levene's correction used in the *t*-test was not applied in the mediation analysis), the indirect effect was significant $B = 0.0241$, 95% CI [0.0077, 0.0493]. Because the direct effect of condition on donation amount was not significant ($B = 0.0401$, $p = .252$), guilt fully mediated the effect of condition on how much of their earnings people were willing to donate (Figure 5).

Effect of Emotions on Willingness to Donate. We ran a bootstrapped (5000 bootstrap samples) stepwise regression to determine whether any of the other emotions that we measured predict the amount donated. While this was not directly indicated by the network analysis in Study 2, the network did show the other emotions (especially the negative ones) as being quite central and closely connected to guilt. Despite this, we found2that only guilt emerged as a predictor for the donation amount, $R = 0.055$, $F(1, 277) = 2.293$, $p = .028$. While still only explaining 5.5% of the variance in donation amount, guilt was the only measured emotion that significantly predicted how much money people were willing to donate, $t = 2.424$, $p = .016$, $\beta = 0.213$, 99% CIB [0.005, 0.057]; all other emotions (anger, excitement, joy, sadness, uncertainty, worry) were excluded as predictors by the analysis.

Note: $N = 285$. *** p , .001, ** p , .01, * $p < .05$

Figure 5. Mediation Model: Unstandardised Regression Coefficients for the Relationship Between Experimental Condition and Donation Amount as Mediated by Self-Reported Guilt. Path in Parentheses is the Direct Effect of Condition on Donation Amount (i.e., Controlling for Perceived Reported Guilt).

Discussion

The aim of this study was to test whether actively manipulating guilt would lead people to behave more sustainably. We found that participants who experienced more guilt seemed to be willing to donate more than participants who experienced less guilt. The results also seem to suggest that guilt fully mediates the relationship between which condition participants were in and how much money they were willing to donate. This suggests that the effect that condition had on participants' willingness to donate seems to have been entirely caused by the reported levels of guilt. No other measured emotion influenced donation amount. Replicating the results of Study 2, we also found that people report they would be willing to pay more for bio-based products than products made from conventional plastic, though this did not appear to be due to the amount of guilt participants were experiencing. Not being able to successfully manipulate different intensities of guilt (high versus low) could be considered a limitation of this study, but the main focus of this research was whether any manipulation of guilt (rather than its intensity) could encourage more sustainable behaviour, so it is likely not a large hindrance to the findings.

Another limitation of Study 3 lies in the fact that the distribution of donations was skewed. When distributions are skewed, non-parametric tests are advised. Not surprisingly (as non-parametric tests have less statistical power) this led the effect of condition on donation amount to no longer reach a significance threshold ($p = .079$). We decided to leave the complete (bootstrapped) mediation as the main analysis however, as we believe that even when employing the non-parametric tests, the influence of condition on behaviour remains meaningful enough to further probe with the bootstrapping analysis, which provides the most comprehensive picture of how condition, guilt, and donation relate. However, because of this and the relatively small effect sizes that were achieved in this study, we urge for caution when interpreting the results.

GENERAL DISCUSSION

Climate change is one the largest problems facing the world today, and yet many people are not aware of the impact that plastic consumption has on warming our planet. With the media often focusing on the negative effects plastic has on marine life, the CO_2 emissions produced during the production and life cycle of plastic products has mainly escaped the public's notice. We hardly know anything about what people's attitudes towards plastic are, how they relate to behaviour, and how they can be influenced. The research presented in this chapter attempted to address this literature gap by using a multimethod and novel network approach.

The qualitative first study revealed which evaluative reactions are most commonly related to people's perceptions of (bio-based) plastics and Study 2 visualised how they relate to one another. The key takeaway message from this research is its demonstration of how useful attitude networks can be in designing persuasion attempts or behavioural interventions. In this case, we found that guilt was the evaluative reaction that was most strongly connected to participants' willingness to pay more for a water bottle made from bio-based plastic rather than conventional plastic, our behavioural measure. When we then actively manipulated participants' feelings of guilt, guilt appeared to fully mediate the relationship between the experimental condition participants were in and their willingness to donate to a sustainable cause. Upon further investigation, we found that no other emotion we measured was significantly related to behaviour. This confirms the results of the network analysis.

Examining holistic attitudes in Study 2 supported the selection of nodes derived from the qualitative first study, and indicated that people generally have more positive, less negative, and less ambivalent evaluations of bio-based plastic than conventional plastic. Although this research cannot make claims as to the reasons behind these differences in evaluations, these results are still encouraging. Positive evaluations of more sustainable products might indicate a certain willingness of the consumer to accept and even demand more sustainable choices. Also encouraging are our findings that people seem to be (at least theoretically) consistently willing to pay more for a bio-based product than for one made from conventional plastic (an average of 1.21€ in Study 2 and £1.18 in Study 3 compared to the 1 €/£ regular bottle) even without any active manipulation of guilt or other factors. A possible next step would be to further investigate which specific aspects of conventional and bio-based plastic people evaluate positively and negatively and how best to target these aspects to encourage more sustainable behaviour. This could be achieved by using a similar attitude network approach to the one that was used in this chapter. Understanding what drives people's behaviour, in this case their buying behaviour and willingness to pay, and being able to effectively change this behaviour (e.g., by targeting its antecedents), is an important first step in facilitating the adoption of new and more sustainable technologies such as bio-based plastics. This does not only have to relate to a financial willingness to pay, but to any kind of effort or discomfort related to choosing the more environmentally friendly option.

Our finding that guilt can encourage pro-environmental behaviour is not in itself a novel one. There is previous research that suggests that negative moral emotions may have the potential to motivate pro-environmental behaviour (e.g., Täuber et al., 2015). Guilt (whether group-based, individual, or simply anticipated) is the emotion that is most often studied when it comes to encouraging prosocial or pro-environmental behaviour (Elgaaied, 2012; Ferguson & Branscombe, 2010; Harth et al., 2013; Mallett et al., 2013; Onwezen et al., 2013; Rees et al., 2015; Schneider et al., 2017; Täuber et al., 2015). The

added value of this research lies in the fact that we reach the same conclusions as other research on this topic using a network approach that is agnostic about which factors relate to behaviour and which do not. Such an approach is novel to social and environmental psychology and applicable to many different behavioural domains.

At present, there is very little research in social or environmental psychology that uses network analysis to better understand attitudes, and none that looks into people's attitudes towards (bio-based) plastic. This is where the second valuable and more applied aspect of this research lies; it is the first systematic investigation into people's attitudes and behaviours regarding plastic. Moreover, we believe that it illustrates the value of using a network analysis, especially with regards to understanding the relationship between attitudes and behavioural decisions (Dalege, Borsboom, van Harreveld, Waldorp, et al., 2017). It provides a novel perspective and understanding of the structure of attitudes people have regarding plastic and its use, and it was successful in determining which evaluative reactions to target for persuasion attempts. In our research we focused mainly on the centrality of specific nodes, because more central nodes tend to have a stronger impact on other nodes (especially those in the same cluster), as well as on behavioural decisions (Dalege et al., 2016; Dalege, Borsboom, van Harreveld, Waldorp, et al., 2017). However, network analysis also provides other informative indices. The connectivity of a network, for example, illustrates the strength of a given attitude (stronger attitudes are represented by more strongly connected networks). Greater connectivity usually indicates a tendency of the attitude to be more resistant to change and persuasion (Dalege et al., 2016; Howe & Krosnick, 2017; van Borkulo et al., 2014). Network analysis also allows one to directly compare different attitude networks.

Our original plan for this research was to compare the conventional and bio-based plastic attitude networks to each other using the Network Comparison Test (NCT; van Borkulo et al., 2019). With the help of these types of network comparisons, it is possible to determine whether two networks significantly differ in structure, global strength, and the weight of specific edges. Edge weights can inform about the different roles the same node can play in the different networks (Dalege, Borsboom, van Harreveld, & van der Maas, 2017). For example, comparing the connectivity of the attitude networks of two different groups might reveal which group would more easily be persuaded to change its behaviour. Knowing one's audience is crucial when trying to communicate issues such as climate change and sustainability (Clayton & Manning, 2018), so being aware of which target audience will be most susceptible and likely adopt more sustainable behaviour can save a lot of resources and time.

The fact that we were not able to compare people's attitude networks regarding conventional and bio-based plastic due to the majority of participants believing bio-based plastic to be biodegradable might be considered a limitation (future research should make the properties and benefits of bio-based plastic very clear before

measuring participants' evaluative reactions towards it). However, it also raises an interesting question and opportunity. Attitude networks develop over time, with more nodes being added when new judgements, emotions, and beliefs about the attitude object emerge, for example through acquiring more information. With bio-based plastic being a relatively new and unknown technology, and with the public mostly unaware of its properties and benefits, most people do not yet have an attitude (and therefore also no attitude network) concerning bio-based plastic. It might therefore be an interesting case study to investigate the way in which attitude networks towards new technologies, such as bio-based plastic, emerge and develop. One could for example use network simulations to help make inferences on the dynamics of the newly forming network, to aid in the generation of hypotheses, and in devising behaviour predictions (Dalege, Borsboom, van Harreveld, & van der Maas, 2017).

Limitations

A possible limitation of the present research is the lack of a difference between the two guilt conditions in Study 3. Against our expectations, participants in the personal guilt condition (in which the participants' personal contributions to plastic-related CO_2 emissions were emphasised) did not report feeling more guilty than those in the general guilt condition (where participants were simply informed about plastic-related CO_2 emissions). It is possible that participants experienced more guilt than expected in the general guilt condition when hearing about the large amount of CO_2 that plastic production emits into the atmosphere, for example because it reminded them of their personal use, making this condition more similar to the personal condition than anticipated. Alternatively, mentioning the size of the town/ city the participants live in and including the phrase "If people like yourself" might not have had the desired effect of making participants feel more personally responsible. While combining both the guilt conditions was deemed acceptable for the present study, as the central question was whether guilt in general has an effect on willingness to pay, this limitation can be easily overcome in future studies through thorough pilot testing of the manipulations.

As already mentioned in the discussion of Study 3, the skew of the donation data and the small effect sizes achieved in that study urge for caution when interpreting the results of that final study. We do, however, still believe that these limitations do not lessen the potential value of network analyses to better understand and predict people's attitudes and encourage behavioural change.

Additionally, Study 3 only focused on guilt and not on any of the other evaluative reactions that the network analysis showed to be connected to willingness to pay (i.e. anger, sadness, and joy). We focused solely on guilt because it had the strongest connection with the behavioural node out of all the other evaluative reactions (see Figure 2). However, this also means that, while we know that network analysis is able to

identify relevant nodes connected to behaviour, we *do not know* whether these nodes are also more effective persuasion targets than the other nodes. Future research could investigate whether experimentally manipulating anger, sadness, or joy would also lead to higher willingness to pay, and if so, whether they are effective to the same or a lesser extent.

Implications

We hope that this research has implications for how social and environmental psychologists approach attitude and behaviour change studies, and encourages researchers to make more use of network approaches. It also supports previous research suggesting that guilt can encourage pro-environmental behaviour. Being the first research to specifically look at perceptions of plastic and bio-based plastic and create a scale designed to measure these, it might also prove useful in further reducing people's use of plastic, encouraging the switch to more sustainable plastic alternatives, and investigating people's relationship with plastics in greater detail. As previously mentioned, before new sustainable technologies can be adopted on a large scale, understanding how people can be encouraged to accept and be willing to pay more for it is an important step as new technologies are likely to be more expensive in the short term.

Future Directions

While frequently being used in climate change intervention campaigns and found to be effective in changing people's pro-environmental intention and behaviour, using guilt to encourage behaviour change also has its drawbacks. In short, people do not like feeling bad about themselves and may try to deny, deflect, or avoid anything that might make them feel this way, especially if they feel that they are being manipulated to feel guilty (Rees et al., 2015; Täuber et al., 2015). Additionally, with increased awareness of climate change and sustainability, many people have developed coping strategies to deal with guilt they might feel about the discrepancy between their actual behaviour and the more sustainable behaviour they could ideally adopt. It might therefore be interesting to investigate the effect of positive affect on pro-environmental behaviour. Positive emotions did not seem to play a large role in the attitude network we created; however, the type of questions the attitude network was based upon might not have been the most conducive to the expression of positive emotions. Positive emotions (e.g., pride or awe; Bissing-Olson et al., 2016; Harth et al., 2013; Onwezen et al., 2013; Piff et al., 2015) might be as effective, if not more so, than guilt in encouraging pro-environmental behaviour.

Conclusion

Trying to tackle one of the largest societal challenges of the century is not an easy task. Many researchers, politicians, and activists have tried many different approaches

to encourage people to behave more environmentally friendly, with varying levels of success. This chapter discussed a novel approach, namely using the Causal Attitude Network model to create an attitude network to better understand the structure and components of people's attitudes towards plastic and its use. We found that, in this case, people's willingness to pay for more environmentally friendly plastic was primarily determined by their feelings of guilt about their own plastic use. However, the main value of the present research transcends that result. We believe that this approach more broadly promises the ability to determine which evaluative reactions towards an attitude object are most likely to lead to behavioural change or the change of a person's attitude.

APPENDIX A

25-item evaluative reactions questionnaire constructed from the thought-listing study.

Part 1 (randomised items) You will now be presented with a number of statements. Please indicate to what extent you agree with each of the statements. (7-point Likert-scale from *1 = strongly disagree* to 7 = *strongly agree*)

Plastic/Bio-based plastic...
... is convenient.
... is lightweight.
... is cheap.
... is readily available.
... is useful.
... is durable.
... is hygienic.
... is safe.
... is good for storage and packaging.
... is recyclable.
... takes a long time to decompose.
... pollutes bodies of water (e.g., oceans).
... causes waste.
... pollutes the air.
... is harmful to people's health (e.g., by entering the food chain or drinking water).
... is harmful to animals.
... depletes natural resources.
... is often of poor quality (e.g., breaks easily).

Part 2: feelings (randomised items) We are now going to ask you about your feelings about (bio-plastic) plastic use. Please indicate how much you agree with the following statements. (7-point Likert-scale from *1 = strongly disagree* to *7 = strongly agree*)

When I think about plastic/bio-based plastic use, I feel....
... worried.
... joy.
... guilty.
... sad.
... angry.
... uncertain.
... excited.

APPENDIX B

Study 3 was made available to participants residing in the following Western countries: UK, USA, Ireland, Germany, France, Spain, Australia, Austria, Belgium, Canada, Denmark, Finland, Iceland, Italy, Lichtenstein, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland.

Within these countries, only people who had a Prolific Academic approval rate of > 99% were allowed to participate.

APPENDIX C

The information texts about the Carbon Cycle, the influence of CO_2 on global warming, and information about bio-based plastic.

Next, you will read some information about the carbon cycle and about how carbon dioxide (CO_2) influences global warming. Please read the information carefully. It is important that you understand these concepts to successfully complete the rest of the survey.

The Carbon Cycle

All living things are made of carbon. Carbon is also a part of the ocean, air, and even rocks. Because the Earth is a dynamic place, carbon does not stay still. In the atmosphere, carbon is attached to oxygen in a gas called carbon dioxide (CO_2). Plants use carbon dioxide and sunlight to make their own food and grow, and the carbon becomes part of the plant. Animals and humans consume these plants, and thus the carbon is transferred from the plants to animals and humans, who give it back to the atmosphere through the process of respiration (breathing). Also, when plants, animals, or humans die, their remains decay and their carbon is transferred to the Earth. Over millions of years, these remains form into fossil fuels (e.g., coal, oil, and natural gases). Burning of biomass (e.g., wood) and fossil fuels transfers carbon back into the atmosphere in the form of carbon dioxide (CO_2).

Information About the Influence of CO_2 on Global Warming

A fossil fuel is a material that is formed by nature and contains a high percentage of carbon (for example oil or coal). These fossil fuels produce large amounts of energy when they are burned. However, when they are burned, fossil fuels also release a lot of carbon dioxide (CO_2). CO_2 is in itself a harmless gas that can be found in our atmosphere. In the past, the amount of atmospheric CO_2 was more or less constant, but humans have burned so much fossil fuel that there is about 30% more carbon dioxide in the air today than there was about 150 years ago. In fact, ice cores show us that there is now more carbon dioxide in the atmosphere than there has ever been in the last 420,000 years.

CO_2 is called a greenhouse gas, because once emitted it helps the atmosphere to hold on to its heat. But because we emit too much CO_2, there are not enough plants to absorb the CO_2, the heat is trapped and can no longer pass through the atmosphere and the heat bounces back to the earth. That is why CO_2 leads to global warming.

Information about Bio-Based Plastic

One way of reducing CO_2 is through buying and using bio-based plastics.
The difference between 'regular' plastic and 'bio-based' plastic.

'Regular' plastic

The 'regular' plastic that you know from your everyday life is made from fossil fuels such as petroleum and natural gas. During the production of 'regular' plastic, oil and natural gas are heated to extremely high temperatures leading to the release of large amounts of CO_2.

Normally, fossil fuels are 'locked up' underground and do not really influence the carbon cycle. However, many of today's factories and vehicles use fossil fuels which leads to the emission of CO_2. The production of 'regular' plastic is an example of a CO_2-emitting process, and producing plastic thus contributes to global warming. The natural carbon cycle cannot handle the vast amounts of additional CO_2 that is created when burning such fuels, making CO_2 one of the main contributors to global warming.

'Bio-based' plastic

The defining feature of 'bio-based' plastic is that it is made (entirely or partially) from 'biomass'. Biomass is material usually made from plants, such as wood or crops and other plants that are not eligible for food or feed production. An example of a bio-based product is paper. Nowadays, plastic can also be made from biomass.

Products made from 'regular' and 'bio-based' plastic are virtually indistinguishable. They only differ in the materials they are made from. This also means that **'bio-based' is not the same as 'biodegradable'**. There are some regular and bio-based plastics that are biodegradable, but the majority are not.

What makes bio-based plastic better for the environment than the regular plastic, is that during its production there is no additional CO_2 added to the carbon cycle. The CO_2 contained in the biomass used for the production of bio-based plastic would have been released into the earth and the atmosphere naturally when the biomass decomposed. Thus, the production of bio-based plastic does not contribute to global warming because no additional CO_2 is released than what would occur naturally.

APPENDIX D

Guilt Manipulation Texts

General Condition (No Personal Involvement)

Plastic production is a large contributor to the amount of CO_2 in the atmosphere, and thus to global warming. That is because plastic is made from fossil fuels, such as oil and natural gas. During the production of plastic, oil and natural gas are heated to extremely high temperatures, which releases large amounts of CO_2. Specifically, to produce 1 kg of plastic (roughly 33 water bottles), 2 kg of oil are burned. Burning 1 kg of oil creates about 3 kg of CO_2. So, in order to produce 33 plastic water bottles around 6 kg of CO_2 are released into the atmosphere. In 2017, the global production of plastics reached 348 million metric tons, with 64 million metric tons produced in Europe alone. If these emissions continue like this, plastic production will have a significant effect on global warming. This is because it disrupts a delicate balance in our climate and will lead to severe floods, food shortages, animal extinction, ocean acidification, and extreme heat waves.

Personal Condition (Your Contribution to Global Warming)

Plastic production is a large contributor to the amount of CO_2 in the atmosphere, and thus to global warming. That is because plastic is made from fossil fuels, such as oil and natural gas. During the production of plastic, oil and natural gas are heated to extremely high temperatures, which releases large amounts of CO_2. Specifically, to produce 1kg of plastic (roughly 33 water bottles), 2 kg of oil are burned. Burning 1 kg of oil creates about 3 kg of CO_2. So, in order to produce 33 plastic water bottles, around 6 kg of CO_2 are released into the atmosphere. In 2017, the global production of plastics reached 348 million metric tons, with 64 million metric tons produced in Europe alone. The average person living in a [city size] in your country consumes around 100 kilograms of plastic each year, which accounts for the release of **600 kg of CO_2 per person every year.** If people like yourself continue buying and using this much plastic, plastic production will have a significant effect on global warming. This is because it disrupts a delicate balance in our climate and will lead to severe floods, food shortages, animal extinction, ocean acidification and extreme heat waves.

Control condition

There are many different factors that contribute to the production of CO_2, and thereby to global warming. Recently, more and more focus has been on the amount of CO_2 that is released during plastic production. That is because plastic is made from fossil fuels, such as oil and natural gas. During the production of plastic, oil and natural gas are heated to

extremely high temperatures, releasing CO_2. However, compared to other processes that use fossil fuels, **plastic's contribution to global warming is very small. Only 4% of global oil production is used for plastics**. 45% is used for transport, 42% energy and heating, 4% for chemicals, and the rest is simply burnt and lost. Thus, trying to reduce plastic use has a much smaller impact on reducing CO_2 than using public transport rather than a car, or turning off lights and appliances when leaving the room.

CHAPTER 3

(Not) Doing the Right Things for the Wrong Reasons: An Investigation of Consumer Attitudes, Perceptions, and Willingness to Pay for Bio-Based Plastics

Abstract

Fossil-based plastics are significant contributors to global warming through CO_2 emissions. For more sustainable alternatives to be successful, it is important to ensure that consumers become aware of the benefits of innovations such as bio-based plastics, in order to create demand and a willingness to initially pay more. Given that consumer attitudes and (inaccurate) beliefs can influence the uptake of such new technologies, we investigated participants' attitudes towards fossil-based and bio-based plastic, their perceived importance of recycling both types of plastic, their willingness to pay, and their perceptions of bio-based plastic in four studies (total N = 961). The pre-registered fourth study experimentally manipulated information about bio-based plastic and measured willingness to pay for different types of plastic. The results suggest participants hold very favourable attitudes and are willing to pay more for bio-based products. However, they also harbour misconceptions, especially overestimating bio-based plastic's biodegradability, and they find it less important to recycle bio-based than fossil-based plastic. Study 4 provided evidence that educating consumers about the properties of bio-based plastic can dispel misconceptions and retain a favourable attitude and a high willingness to pay. We found mixed evidence for the effect of attitudes on willingness to pay, suggesting other psychological factors may also play a role. We discuss how attitudes and misconceptions affect the uptake of new sustainable technologies such as bio-based plastics and consumers' willingness to purchase them.

This chapter is based on:

Zwicker, M. V., Brick, C., Gruter, G.-J. M., & van Harreveld, F. (2021). (Not) Doing the Right Things for the Wrong Reasons: An Investigation of Consumer Attitudes, Perceptions, and Willingness to Pay for Bio-Based Plastics. *Sustainability, 13*(12), 6819.

All supplementary materials, data, pre-registration documents, and analysis scripts are available on the Open Science Framework (https://osf.io/p3ftu/).

INTRODUCTION

Plastics are an extensive family of different materials designed for specific applications. In our daily lives, we are continuously surrounded by plastic in grocery packaging, clothes, other fabrics, transportation, medical devices, household objects, and tools, including electronics. In 2019, global plastics production reached 370 million tonnes, with 39.6% for packaging (PlasticsEurope, 2019). While plastics are a valuable resource that benefit society in numerous ways, they also contribute to marine litter and climate change (emitting almost 1 billion metric tons of CO_2 emissions in 2019).

Consumers are becoming increasingly aware that plastic can have harmful effects on the environment, which is at least partially due to the increased media coverage on the topic over the past few years (RESTCo, 2020). However, much of consumers' concern focuses on the post-consumption or end-of-life effects of plastic on the environment, such as recyclability, biodegradability, and reusability (Heidbreder et al., 2019; Herbes et al., 2018). The effect of plastic on the environment, however, starts well before it hits store shelves—it starts with the extraction of fossil fuels. Around 99% of virgin plastics are derived from fossil fuels (i.e., oil, coal, or natural gas) (European Bioplastics, 2021a). This currently makes up about 6% of global oil consumption and by 2050, it is expected that 20% of the current volume of global oil will be used for the production of plastic alone (Bourguignon, 2017). Consumers' focus on the end-of-life attributes of plastic makes sense as this stage in plastics' lifecycle is most visible to consumers and relevant to their own behaviour as they decide how to dispose of the product (Herbes et al., 2018).

In the next 30 years, plastic volumes are expected to triple (Ellen McArthur Foundation, 2016) or even quintuple to 1800 million tonnes per year (PAI Partners, 2019), and CO_2 emissions from plastic production will rise to 3–5 billion metric tonnes. In 2019, global anthropogenic CO_2 was 38 billion tonnes (Crippa et al., 2020) and the Paris agreement targets an 80–90% global reduction by 2050. For plastics to not overwhelm the total 2050 CO_2 emissions budget (4–8 billion tons), there are 30 years to reduce the carbon footprint of plastics. The only alternative carbon feedstock for making virgin (non-recycled) plastics is biomass (Murcia Valderrama et al., 2019).

Transitioning away from fossil-based plastics is difficult, especially because the continued increase in plastic production and use (PlasticsEurope, 2019; Ritchie, 2018) suggests that proximity to plastic waste in itself is not enough to persuade consumers to change their behaviour. Technological developments alone are also not sufficient to successfully make the transition; the adoption of new technologies by consumers, as well as a change in attitude and behaviour, is key. In order for new, more sustainable plastic alternatives to be adopted, a different type of awareness is needed—not just of the pollution of natural environments, but also of the production process, carbon footprint, and specific characteristics of plastic products.

The overall aim of the current research is to investigate consumers' willingness to adopt and pay for alternatives to fossil-based plastic. We focus on bio-based plastics, which are plastics derived from renewable materials, or 'biomass' (Klein et al., 2019; PlasticsEurope, 2019; van den Oever et al., 2017), because biomass is the only alternative material for making virgin (non-recycled) plastics (Murcia Valderrama et al., 2019). While product adoption and willingness to pay are important from an economic perspective, we also investigate the underlying psychological processes that make consumers more willing to pay. We therefore investigated several psychological factors that might influence consumers' willingness to pay, such as attitudes and bio-based plastic perceptions (e.g., its recyclability and biodegradability). We also experimentally manipulated the knowledge participants received about bio-based plastics to determine how that affects their attitudes, willingness to pay, and perceived importance to recycle.

Bio-Based Plastic

With new technological advances such as bio-based plastics, it is possible to retain the advantages and characteristics of conventional fossil-based plastics while reducing the impact plastic has on global warming. Bio-based plastics are derived from 'biomass', such as sugar cane, starch, vegetable oils, etc. (Klein et al., 2019; PlasticsEurope, 2019; van den Oever et al., 2017). Regardless of being fossil- or bio-based, certain plastics are biodegradable (i.e., under very specific conditions, they can biodegrade into mainly CO_2 and water, and compost), while others are not, depending on the application they were designed for (PlasticsEurope, 2019; van den Oever et al., 2017). Thus, many plastics made from biomass are not (readily) biodegradable (the bio-based plastics studied in this research are not) and therefore do not alleviate the pollution of natural environments. What makes bio-based plastics more sustainable than conventional fossil-based plastics is that they are produced from carbon that is already above the ground. Thus, even if bio-based plastics release the same amount of CO_2 upon incineration as waste at the end of life as fossil-based plastics, the CO_2 released was already above ground and no extra CO_2 is added when using this CO_2—biomass—bio-based plastic—CO_2 cycle. The largest benefit of bio-based plastic therefore lies in the material that it is made of (i.e., superterranean renewable material of biological origin). One example of a new type of bio-based plastic is Polyethylene Furanoate or PEF, which is expected to reach consumers in the next few years. PEF, for instance, has a carbon footprint that is less than half of that of conventional plastic (43–56% reduction in CO_2 emissions Eerhart et al., 2012; Orset et al., 2017).

Lack of Knowledge

For alternatives to conventional plastics to be successful, adoption by consumers is key to generate a market pull. Products made from bio-based plastic are initially more

expensive, while production is small and the processes are not optimised. It is therefore essential for companies and governments to stimulate consumer demand, for example through marketing. Without consumer demand, there is no incentive for companies to adopt bio-based plastics, as this can be financially costly. It is therefore important to ensure that consumers become aware of the benefits of innovations such as bio-based plastics in order to create a demand for them. The present research therefore aims to investigate consumers' attitudes and perceptions towards bio-based plastics, as well as their willingness to pay a price premium. We also aimed to determine the effects that different levels of information about bio-based plastic can have on the above-mentioned variables.

While more and more plastic alternatives such as bio-based plastics are entering the market, consumers lack the knowledge of what it means if a product is 'bio-based' or 'biodegradable' (Ulla Kainz et al., 2013). While consumers report preferring more sustainable plastics over conventional ones, there seems to be a general lack of knowledge about the characteristics of bio-based products (Dilkes-Hoffman et al., 2019; Herbes et al., 2018; Ulla Kainz et al., 2013; Koutsimanis et al., 2012; Lynch et al., 2017), giving rise to various misconceptions (InnProBio, 2017). This might partially be due to the aforementioned tendency to focus on the end-of-life attributes of plastics, which creates a disadvantage for bio-based products, whose pro-environmental effects are based on their origin from renewable resources (Herbes et al., 2018). Another reason for this lack of knowledge about bio-based plastics is their rarity and the confusion created through the term 'bioplastics' which can refer to either the bio-based origin or the biodegradable character of a plastic (van den Oever et al., 2017). Additionally, it can be difficult to differentiate between conventional and bio-based plastic products, since they are similar in appearance and attributes (Klein et al., 2019). Whatever the cause, many consumers appear to think that bio-based products are automatically biodegradable, which is not necessarily the case. The lack of knowledge can lead consumers to form their attitudes based on incorrect associations and expectations about bio-based plastics (Blesin et al., 2017). What kind of expectations and attitudes consumers have towards bio-based plastic can influence their behaviour.

Attitudes

Attitudes are a key predictor of behaviour (for an extensive overview, see Ajzen & Fishbein, 2005). In the present research, we therefore investigate people's attitudes towards plastic (both bio-based and conventional) as a first step in understanding how to best persuade people to adopt a more sustainable plastic-behaviour. Some research suggests that attitudes towards bio-based plastics are one of the strongest influencers of purchase intentions for bio-based plastic products (Klein et al., 2019); however, research on attitudes towards plastic, and especially bio-based plastic, is scarce. Some studies suggest

that, while people report having general reservations about fossil-based plastics, they indicate having a favourable view of products made from renewable resources (Herbes et al., 2018). Other studies indicate that most people seem to have positive associations with 'bioplastics' (whether or not biodegradable) and bio-based technologies (Blesin et al., 2017; Dilkes-Hoffman et al., 2019; Lynch et al., 2017). However, there are also studies that suggest that new environmental innovations, such as bio-based plastics, can evoke negative emotions, unfavourable attitudes, and lower purchase intentions (see Koenig-Lewis et al., 2014). Bio-based products can also produce simultaneously positive (related to environmental topics) and negative (related to technological topics) evaluations, generally causing uncertainty and mixed feelings (Sijtsema et al., 2016). We argue that consumers' positive and negative evaluations regarding plastic are likely to vary independently. The extent to which one thinks plastic is useful might very well be unrelated to how much one thinks plastic contributes to climate change (Sijtsema et al., 2016). In the present research, we therefore separately assess both the positive and negative evaluations people hold towards fossil-based and bio-based plastic, rather than in a single bipolar scale (for a similar approach, see *Chapter 2*).

In some cases, consumers might have positive associations with bio-based plastics for the wrong reasons, i.e., most consumers think that all bio-based plastics are biodegradable. People's perceptions of bio-based plastics may become less positive when they realise that bio-based and biodegradable are completely disconnected features. Conversely, few consumers realise that plastics and climate change are connected, as discussed above, and that bio-based alternatives can be a solution to this problem. In this work, we continue the investigation into attitudes towards bio-based plastics discussed in *Chapter 2*—we assess people's attitudes towards both conventional and bio-based plastic in a series of four studies, to obtain a better understanding of people's general evaluation of these different types of plastics. We also report on how consumers' attitudes change (in a negative or in a positive way) after communicating factual information about biodegradability and carbon footprint of bio-based plastics (Study 4). Having a favourable attitude and accurate knowledge of bio-based plastic is the foundation of consumer acceptance and willingness to pay (more) for bio-based plastic. This shift will support a durable transition towards a more sustainable plastic economy.

Overview of Studies

In four online studies, we examined consumers' attitudes and perceptions about conventional and bio-based plastics. In our first study (N = 97), we aimed to investigate whether participants' attitudes differed with regard to conventional and bio-based plastics. Study 2 (N = 52) replicated these results and examined behavioural factors such as willingness to pay and perceived importance to recycle, in order to test the attitude-behaviour relationship. The third study (N = 508) aimed to replicate the results

of the previous studies with a larger sample. It also assessed participants' most common misconceptions towards bio-based plastic, as they might influence both plastic-related attitudes and behaviour. To extend the correlational previous studies, Study 4 (N = 304) was a pre-registered experimental study that manipulated knowledge about bio-based plastic and measured the effect of this manipulation on attitudes, importance to recycle, willingness to pay, and objective pro-environmental behaviour. For an overview of the studies and measures, see Table 1. Additional analyses and more detailed information about the studies can be found in the Supplementary Materials (https://osf.io/p3ftu/).

Table 1. Overview of Studies 1 to 4 and the Concepts They Assessed.

Concepts Assessed	Study 1 (N = 97)	Study 2 (N = 52)	Study 3 (N = 508)	Study 4 (N = 304)
Attitudes	✓	✓	✓	✓
Perceived importance to recycle		✓	✓	✓
Willingness to pay		✓	✓	✓
Perceptions of bio-based plastic			✓	
Manipulation of level of knowledge				✓
Prior knowledge				✓

All studies were approved by the Ethics Review Board of the Faculty of Social and Behavioural Sciences, University of Amsterdam, the Netherlands, designed using Qualtrics and distributed to participants from Western countries via the online crowdsourcing platform Prolific (Palan & Schitter, 2018). All data, study items, analysis scripts, and additional information are available at the Open Science Framework (https://osf.io/p3ftu). All analyses were conducted using SPSS version 24 and all power analyses were conducted using the R 'pwr' package (Champely et al., 2020).

STUDY 1

This exploratory study aimed to establish whether participants had differing attitudes towards fossil-based and bio-based plastic, and if this was the case, how they differed. We had no directional hypotheses before conducting this study.

Materials and Method

Participants and Procedure

See Table 2 for sample details of the 97 participants. After consenting to take part, participants reported their demographic information and responded to a series of qualitative questions concerning conventional and bio-based plastic that are outside the

scope of this chapter. They then reported their attitudes towards both types of plastic before being debriefed and paid.

Table 2. Sample Details for Studies 1 to 4.

	Study 1	Study 2	Study 3	Study 4
Number of participants	97	52	508	304
Gender (%)				
Female	61 (62.9%)	29 (55.8%)	268 (52.8%)	164 (53.9%)
Male	36 (37.1%)	23 (44.2%)	232 (45.7%)	137 (45.1%)
Preferred not to say/other	0 (0%)	0 (0%)	8 (1.6%)	3 (1.0%)
Mean age (SD)	33.9 (12.1)	28.5 (9.7)	32.4 (10.8)	34.7 (12.1)
Age range	18 - 64 years	18 - 68 years	18 - 72 years	18 - 74 years
Education completed (%)	30.9%	26.9%		
secondary education	50.5%	42.3%	24.2%	26.9%
undergraduate degree	8.4%	21.2%	47.4%	42.3%
postgraduate education			17.9%	21.2%
trade/technical/or vocational training	9.3%	9.6%		
primary school	1.0%	0.0%	8.7%	9.6%
			1.8%	0.0%
Country of residence				
United Kingdom	58%	46%	33.1%	61.5%
Europe	28%	44%	46.1%	29.6%
North America	14%	8%	17.1%	4.3%
Other	0%	2%	3.7%	4.6%

Attitudes

In all four studies, we assessed participants' attitude towards both conventional and bio-based plastic. Individuals can hold both positive and negative attitudes about a target (Thompson et al., 1995), leading to ambivalence and mixed feelings (van Harreveld et al., 2015). We therefore adapted the split semantic differential scale proposed by Kaplan (1972) and later used by Itzchakov and Van Harreveld (2018). *Chapter 2* adapted the scale for the use on conventional and bio-based plastic, the same version of the scale used in the present research. We measured participants' attitudes towards (bio-based) plastic by asking them to consider only the positive/negative aspects of using (bio-based) plastic products and enquiring how (un)favourable their evaluation of (bio-based) plastic use is on a seven-point Likert scale ranging from 1 = *Not at all (un)favourable* to 7 = *Extremely (un)favourable* (in Study 1, a five-point version of the same scale was used).

Results

We conducted a series of paired samples t-tests to compare people's attitudes towards conventional plastic with their attitudes towards bio-based plastics. A sensitivity analysis revealed 80% power to detect a medium effect size (d = 0.41) at α = 0.05. As illustrated in Figure 1 (Study 1), evaluations of conventional plastic were less positive

than those of bio-based plastic, t (96) = −5.76, p < 0.001, d = −0.59. Participants were also more unfavourable towards conventional than towards bio-based plastic, t (96) = 7.17, p < 0.001, d = 0.73. This indicates that participants had both more positive and less negative attitudes towards bio-based plastics than towards conventional plastics. While there was no difference between positive and negative attitudes towards conventional plastic t (96) = −1.43, p = 0.16, d = −0.15, participants reported being more positive than negative towards bio-based plastic, t (96) = −10.71, p < 0.001, d = 1.09.

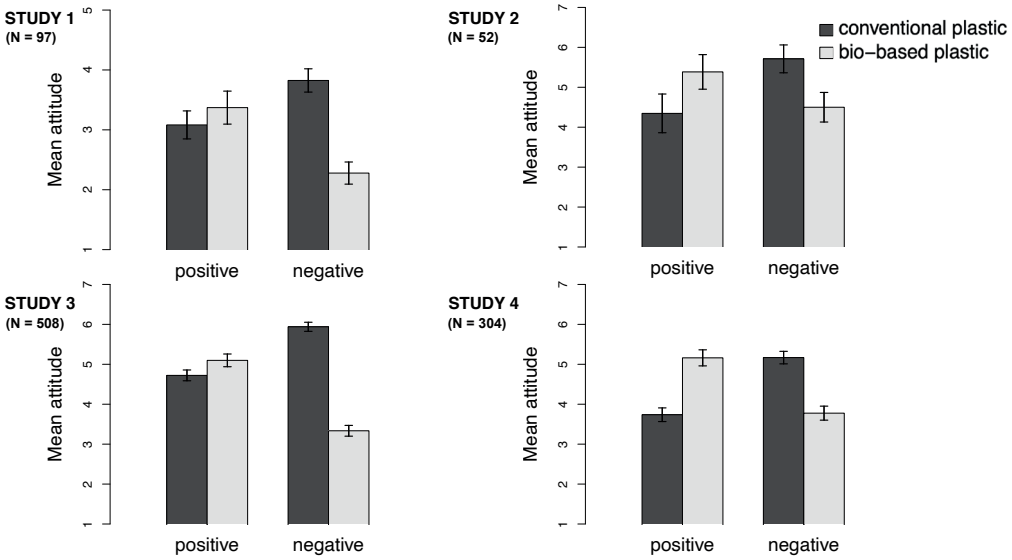


Figure 1. Mean Attitudes Towards Regular and Bio-Based Plastic for Studies 1 to 4. Error Bars Represent the Standard Error.

Discussion

Study 1 provided a first indication that participants' attitudes differ from one type of plastic to another. The results show that bio-based plastic was evaluated more positively (and less negatively) than conventional plastic. We next aimed to replicate this finding and assess behavioural factors related to bio-based plastic, namely the perceived importance to recycle the different types of plastic and people's willingness to pay.

STUDY 2

The first study indicated positive attitudes towards bio-based products. As attitudes are presumed to influence behaviour, we wanted to investigate whether attitudes would relate to participants' willingness to pay more for bio-based products. Due to small production scales and an early stage of technology development, these new materials are likely to be initially more expensive. For new and more sustainable technologies to be made widely available, companies need to know that consumers are willing to pay more to make the financial investment worth it. There are studies that suggest consumers would indeed be willing to pay 'a little' more for bio-based products (Lynch et al., 2017), but the literature is sparse on the willingness to pay for bio-based products. We hypothesised that consumers would have a more positive (and less negative) attitude towards bio-based plastic than towards fossil-based plastic (i.e., replicating the results found in Study 1). Whether participants would be willing to pay more for a bio-based product than for an item made from conventional plastic was purely exploratory. We did expect that attitudes would influence participants' willingness to pay, although we had no clear predictions about whether it would be positive attitudes towards bio-based or negative ones about fossil-based plastic (or both) that would drive willingness to pay.

Furthermore, despite the generally positive attitudes towards bio-based plastic, uncertainty remains about how to correctly dispose of bio-based products (Lynch et al., 2017; Taufik et al., 2020). People may know how to correctly dispose of non-biodegradable recyclable plastic but not how to deal with (biodegradable) bio-based plastic (Taufik et al., 2020). This is problematic because the common misconception that all bio-based plastics are biodegradable could lead to a continuation (or even increase) of littering, with consumers assuming that this type of plastic waste will degrade in nature. Additionally, bio-based plastic might be perceived as a technical solution to the plastic problem that does not require specific actions or a change in behaviour from the individual, effectively removing any responsibility from the consumer to dispose of plastic products properly (Haider et al., 2019). We therefore also assessed how important participants considered recycling of both conventional and bio-based plastics. This was purely exploratory and we did not have a pre-formulated hypothesis about whether there would be a difference in perceived importance to recycle.

Materials and Method

Participants and Procedure

See Table 2 for sample details of the 52 participants. After consenting to take part, participants received information about conventional and bio-based plastics. They then reported their willingness to pay, their perceived importance to recycle, and their attitudes about both types of plastic. Before being debriefed and paid, they also filled in their demographic information.

Willingness to Pay

Studies 2, 3, and 4 included a measure of participants' willingness to pay. This measure was created for *Chapter 2* and was chosen for its simplicity and face validity. Participants were shown an image of a 1.5 L water bottle made from conventional plastic and told that it costs 1€. They were then asked how much they would be willing to pay for the same bottle if it were made from bio-based plastic instead. Participants responded on a continuous slider measure reaching from 0–2€, with the slider's starting position being 1€.

Importance to Recycle

Importance to recycle was assessed by two items (one for each type of plastic) asking participants how important they thought it was to recycle items made from conventional and bio-based plastic on a seven-point Likert scale ranging from 1 = *not at all important* to 7 = *extremely important*. The items did not significantly correlate, r (50) = 0.26, p = 0.063, and were treated separately in the analysis. This measure was again chosen for its face validity and to get a first indication of possible differences in recycling perception between the different plastic types.

Results

Attitudes

Paired samples *t*-tests compared participants' attitudes towards conventional and bio-based plastic. The means and standard errors are displayed in Figure 1 (Study 2). As hypothesised, participants felt more positive towards bio-based than towards conventional plastic t (51) = −5.70, $p < 0.001$, d = −0.79. Conversely, participants reported being more negative towards regular plastic than towards bio-based plastic, t (51) = 2.76, p = 0.008, d = 0.38. This replicates the findings from Study 1 and indicates that participants again had both more positive and less negative attitudes towards bio-based plastics than towards regular plastics. Unlike in Study 1, participants felt significantly more negative than positive towards conventional plastic, t (51) = −3.04, p = 0.004, d = −0.42. As in the first study, their general attitudes were more positive than negative concerning bio-based plastics, t (51) = 5.68, $p < 0.001$, d = 0.79.

Importance to Recycle

Participants found it important to recycle in general. The distributions for participants' perceived importance to recycle were significantly skewed (−3.45 and −2.18 for conventional and bio-based plastic, respectively, SE = 0.33). We therefore conducted a Wilcoxon signed-rank test, which suggested that participants found it more important to recycle items made from conventional plastic (M = 6.8, SD = 0.7) than bio-based plastic (M = 6.4, SD = 1.1), T = 20, p = 0.021, r = −0.33; see Figure 2 (Study 2).

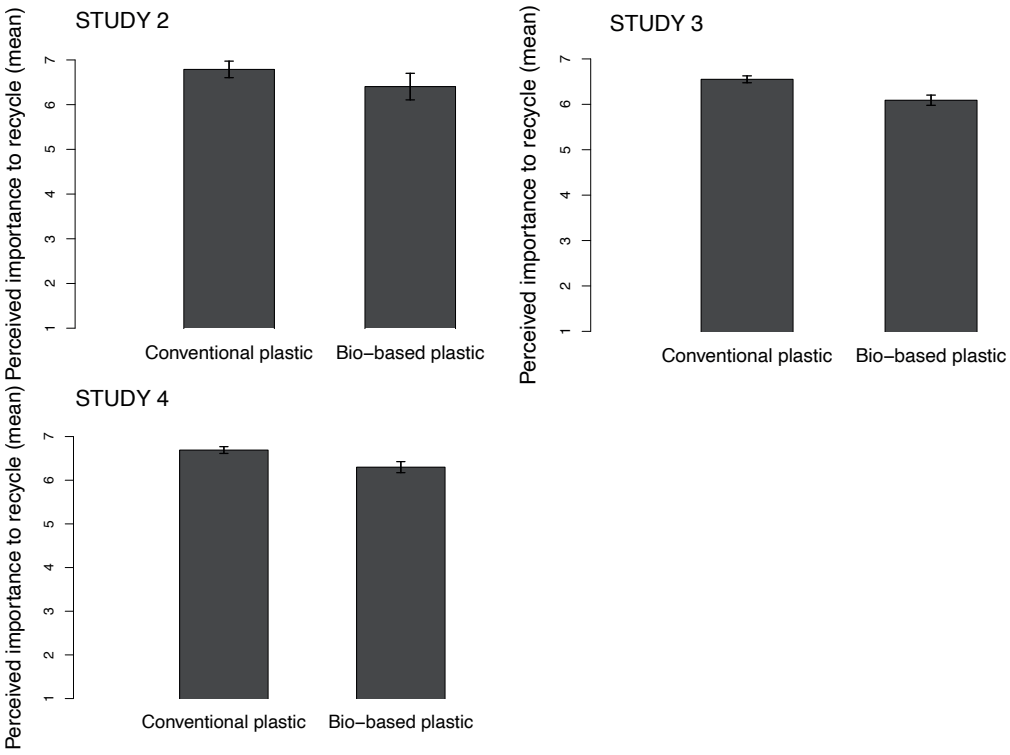


Figure 2. Mean Perceived Importance to Recycle for Regular and Bio-Based Plastic for Studies 2, 3 and 4. Error Bars Represent the Standard Error.

Willingness to Pay

A paired samples *t*-test showed that participants were willing to pay more for a bio-based than a conventional plastic bottle, t (51) = −6.18, $p < 0.001$, $d = 0.86$, with the majority of participants having this preference (70.6%). On average, participants reported that they would be willing to pay 1.30€ (median = 1.20, $SD = 0.36$) for a bio-based bottle, 30% more than for a water bottle made from conventional plastic that costs 1€.

We also ran a bootstrapped regression (5000 bootstraps) to determine the relationship between people's attitudes and willingness to pay. The results suggest that, while attitude towards conventional plastic predicted willingness to pay for a bio-based plastic product, $B = -0.041$, t (49) = −2.04, $p = 0.047$, $95\%CI_{Bootstrap}$ [−0.081, −0.001], attitude towards bio-based plastic did not, $B = 0.031$, t (49) = 0.96, $p = 0.34$, $95\%CI_{Bootstrap}$ [−0.043, 0.095]. Together, the attitudes towards both types of plastic did not significantly explain the variance of people's reported willingness to pay for the bio-based product ($R^2 = 0.088$, F (2, 49) = 2.37, $p = 0.104$).

Discussion

Study 2 replicated that participants have more positive attitudes toward bio-based than conventional plastic and that this was driven by being more positive and less negative about the more sustainable plastic. Study 2 also demonstrated that people report being willing to pay more for a bio-based plastic water bottle. The results suggest that participants' attitudes towards conventional but not bio-based plastic might have influenced their willingness to pay more for a bio-based product. This contradicts findings by Klein et al. (2019) and might relate to the fact that consumers are willing to pay more when feeling guilty about their use of conventional plastic (*Chapter 2*). This would suggest willingness to pay to be mainly driven by an aversion to conventional plastic, rather than liking of bio-based plastic. Participants also reported finding it less important to recycle bio-based plastic. This indicates that, while participants have positive attitudes towards bio-based plastic, they may also have misconceptions which may drive their apparent willingness to pay, as well as their perception that it is less important to recycle bio-based plastic. In practice, it is just as important to recycle bio-based plastic as regular plastic, as both are harmful to the environment as they degrade slowly. One limitation of this study was its low statistical power due to the small sample size. A sensitivity power analysis revealed 80% power to detect a medium effect of $d = 0.57$ at $\alpha = 0.05$ (paired samples *t*-test). We therefore aimed to replicate and extend the findings with a larger sample size.

STUDY 3

Previous research suggests that consumers lack knowledge about bio-based plastics and thus fill this knowledge gap with assumptions. That all bio-based plastics are biodegradable seems to be the most common misconception (Herbes et al., 2018; Ulla Kainz et al., 2013; Koutsimanis et al., 2012; Lynch et al., 2017); however, there is also uncertainty about the disposal (Lynch et al., 2017; Taufik et al., 2020) and recyclability (Study 2) of bio-based products. Other perceptions pertaining to bio-based plastic are concerns about the production of biomass (required to make bio-based plastic) leading to deforestation and competition with land for food production (Blesin et al., 2017; Lynch et al., 2017; *Chapter 2*; Supplementary Materials, Study 1). This is not true. Today, bio-based plastics are mostly made from carbohydrate-rich food crops, such as corn, sugar cane, and plant oil (i.e., first generation feedstock). However, land use for the production of bio-based plastic only accounts for 0.01% of agricultural land use, is predicted to stay this low, and is not in competition with land use for food or animal feed growth (European Bioplastics, 2016; Lovett & de Bie, 2016). Research is also being carried out on large-scale use of second-generation feedstock (crops and plants not suitable for human

or animal consumption, such as straw, forestry residues, corn stover, or bagasse, which are usually left on the field) and third generation feedstock (i.e., biomass derived from algae) (Barrett, 2018; European Bioplastics, 2016).

As these kinds of perceptions might influence consumers' (bio-based) plastic-related attitudes, behaviour, and willingness to pay, we investigated next whether participants shared these perceptions. As in the previous study, we also assessed participants' general attitudes about both conventional and bio-based plastic, their perceived importance to recycle, and willingness to pay.

While we expected that our participants would share (at least some of) the perceptions of bio-based plastic found in previous research, we did not have any specific hypotheses as to the frequency of these perceptions. As in Study 2, we hypothesised that consumers would have a more positive (and less negative) attitude towards bio-based plastic than towards fossil-based plastic, and that attitudes would be related to willingness to pay. Again, we did not make any predictions about whether it would be attitudes towards bio-based or fossil-based plastic or both that would relate most strongly to willingness to pay (we found the sample size in Study 2 too small to add a specific direction towards our expectation based on its findings). We also hypothesised that participants would be willing to pay more for a bio-based than for a fossil-based plastic bottle and that they would find it more important to recycle products made from conventional plastic than those made from bio-based plastic (i.e., direct replication of Study 2's results).

Materials and Method

Participants and Procedure

See Table 2 for sample details. A sensitivity power analysis (paired samples *t*-test) revealed that with a sample of 508 participants we had 80% to detect a small effect ($d = 0.18$) at $\alpha = 0.05$.

After reading the information letter and consenting to take part, participants read information about the difference between conventional and bio-based plastics (Supplementary Materials). First, participants reported their perceived importance to recycle and their attitudes about conventional, then about bio-based plastic. Next, they responded to the perception/misconception items. Finally, their demographic information was noted, and the participants were debriefed and paid.

Perceptions of Bio-Based Plastic

We assessed four common perceptions concerning plastic made from biomass pertaining to its recyclability, biodegradability, deforestation, and competition for land used for food production. Participants indicated how much they agreed with these four items on a seven-point Likert scale ranging from *1 = strongly disagree* to *7 = strongly agree*. These

items were based on the results of mainly qualitative research (e.g., Blesin et al., 2017; *Chapter 2;* Lynch et al., 2017), formulated as one-item measures, as there is very little quantitative research on the topic of bio-based plastic perceptions so far.

Results

Attitudes

A paired-sampled *t*-test comparing participants' attitudes towards conventional and bio-based plastic suggested that participants felt more favourable towards bio-based plastic than towards conventional plastic, t (507) = –16.64, $p < 0.001$, $d = -0.74$ (means and *SE*s displayed in Figure 1, Study 3). Participants also felt more unfavourable towards regular plastic than towards bio-based plastic, t (507) = 17.80, $p < 0.001$, $d = 0.79$. This replicates the findings from the previous two studies. As in Study 2, participants were more negative than positive towards regular plastic (t (507) = –3.43, $p < 0.001$, $d = -0.15$) and more positive than negative towards bio-based plastic (t (507) = 26.61, $p < 0.001$, d = 1.18). Our hypotheses concerning attitudes were therefore confirmed.

Importance to Recycle

Again, the general perceived importance to recycle was very high. Due to the skewed nature of the data (–2.40 and –1.52 for regular and bio-based plastic, respectively, *SE* = 0.11), we conducted a Wilcoxon signed-rank test to determine whether there was a difference in how important participants found it to recycle the two different types of plastic. As in the previous study, participants found it more important to recycle items made from conventional plastic (M = 6.55, SD = 0.86) than from bio-based plastic (M = 6.1, SD = 1.3), T = 4120, $p < 0.001$, $r = -0.35$ (Figure 2, Study 3), supporting our hypothesis.

Perceptions of Bio-Based Plastic

As illustrated in Figure 3, most participants thought that bio-based plastic could be recycled (as is the case for the bio-based plastic studied here). However, participants also thought that bio-based plastic was biodegradable, which is not necessarily the case. Participants were not as concerned about the production of bio-based plastic resulting in deforestation, or competing with land otherwise used for food production. See Table 3 for response frequencies.

Willingness to Pay

A large majority of participants (78.6%) indicated that they would be willing to pay a price premium for a bio-based water bottle. On average, participants reported being willing to pay 1.20€ for the bio-based plastic bottle (median = 1.15, SD = 0.3). This suggests that they were willing to pay 20% more for a water bottle made from bio-based plastic than for one made from conventional plastic (which costs 1€), thereby supporting our hypothesis.

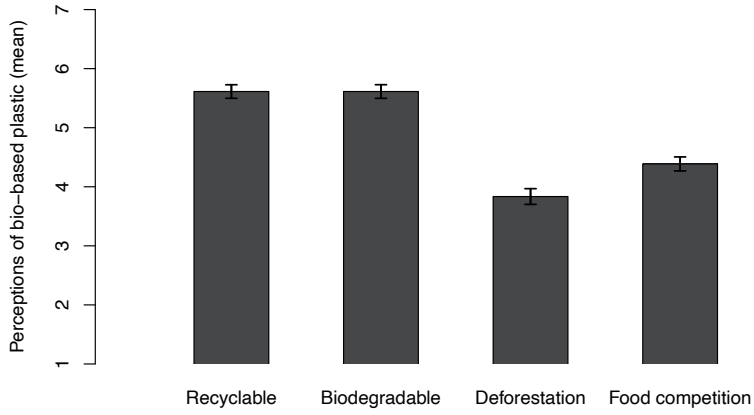


Figure 3. Common Perceptions of Bio-Based Plastic. Error Bars Represent the Standard Error (Study 3, *N* = 508).

We also ran a bootstrapped regression (5000 bootstraps) to determine the relationship between participants' attitudes towards conventional and bio-based plastic and their self-reported willingness to pay. The results suggest that both attitude towards conventional plastic ($B = -0.012$, t (505) = −2.49, $p = 0.013$, 95%$CI_{Bootstrap}$ [−0.022, −0.003]) and towards bio-based plastic ($B = 0.018$, t (505) = 3.22, $p = 0.001$, 95%$CI_{Bootstrap}$ [0.007, 0.029]) predict willingness to pay for a bio-based plastic product. Together, the attitudes towards both types of plastic explained 3% of variance of people's reported willingness to pay, $R^2 = 0.029$, F (1, 505) = 7.58, $p < 0.001$.

Table 3. Response Frequencies to the Perceptions of Bio-Based Plastic (Study 3, *N = 508*).

	Response frequency (%)			
	Recyclability	**Biodegradability**	**Deforestation**	**Food competition**
1 Strongly disagree	3 (0.6 %)	4 (0.8%)	39 (7.7%)	19 (3.7%)
2	6 (1.2%)	8 (1.6%)	58 (11.4%)	23 (4.5%)
3	10 (2%)	7 (1.4%)	86 (16.9%)	40 (7.9%)
4 Neither agree nor disagree	96 (18.9%)	87 (17.1%)	172 (33.9%)	207 (40.7%)
5	92 (18.1%)	100 (19.7%)	81 (15.9%)	121 (23.8%)
6	144 (28.3%)	143 (28.1%)	50 (9.8%)	69 (13.6%)
7 Strongly agree	155 (30.5%)	154 (30.3%)	19 (3.7%)	27 (5.3%)
Total *N*	506 (99.6%)	503 (99%)	505 (99.4%)	506 (99.6%)

Discussion

In Study 3 we directly replicated that participants were both more positive and less negative towards bio-based compared to conventional plastic. We also found that the assumptions or misconceptions about bio-based plastic found in previous literature (i.e., concerning recyclability, biodegradability, deforestation, and competition with food production) were also present in the current sample, with the incorrect assumption that bio-based products are biodegradable being most prevalent. We also found a strong belief in the recyclability of bio-based plastic, but also replicated that participants found it less important to recycle bio-based compared to conventional plastic products. We again found that participants were willing to pay more for bio-based than fossil-based plastic products. While in Study 2 we only found attitudes towards conventional plastic to be predictive of willingness to pay, in Study 3 we found that attitudes towards both plastic types influenced willingness to pay for a bio-based bottle.

Studies 1–3 were exploratory and correlational, and assessed self-reported willingness to pay rather than objective behaviour. These limitations were addressed in the final study, which was experimental and pre-registered (https://aspredicted.org/blind.php?x=5bw9yz).

STUDY 4

Above, participants evaluated bio-based plastic more favourably and reported being willing to pay more for it than for conventional plastic, with some indication of attitudes being related to willingness to pay. Having only assessed self-reported willingness to pay in our previous studies, we also assessed objective behaviour in the form of a donation. We added a measure of objective behaviour because of the well-known inconsistency or 'gap' between what consumers say they are going or willing to do and what they actually do. Research suggests that models that predict behaviour solely based on intentions, are wrong up to 90% of the time (see Carrington et al., 2010).

Study 3 suggested that many participants had misconceptions, especially about the biodegradability of bio-based plastic. It is therefore unclear whether the positive attitudes and willingness to pay are (at least partially) due to their misconception of biodegradability and its consequences (e.g., less marine pollution). Such attitudes that are positive for the wrong reasons may lead to disillusionment among consumers who learn more about the nature of bio-based plastics. Indeed, some research suggests that when confronted with information that bio-based plastic either is not biodegradable, or only under very specific composting conditions (as is the case for biodegradable plastic), consumers can react 'shocked and disappointed' (Blesin et al., 2017).

In the present study, we investigated ways through which such disillusionment may

be avoided. We manipulated the amount of information about bio-based plastics participants received in order to vary misconceptions. The main question was whether people still feel positive towards and are willing to pay more for bio-based plastic after learning that not all bio-based plastic is biodegradable and that its true advantage is lowering CO_2 emissions. We again focus on bio-based plastic that is not biodegradable. This allows us to distinguish between participants' attitudes towards bio-based plastic from their attitudes towards biodegradability (Herbes et al., 2018).

Conditions and Hypotheses

We used three conditions (control, negative, balanced) in which we varied the amount of information about bio-based plastic participants received, with the aim to reduce misconceptions about biodegradability. In particular, we wanted to be able to distinguish between a partial (negative condition) and complete resolution (balanced condition) of misconceptions. While positive attitudes are better than negative ones for the adaptation of more sustainable plastics, positive attitudes based on misconceptions can prove fragile when people learn more about the actual properties of bio-based plastic. In addition, there are good reasons for consumers to be positive about bio-based plastics that are based on renewable resources and reduce CO_2 emissions. While reducing the misconceptions might not lead to as positive of an attitude than the one many people hold before learning more about bio-based plastic, it may lead to more stable attitudes.

Control Condition

The control condition was the baseline in which participants received the same information about bio-based plastic as in Studies 2 and 3—they read that bio-based plastic is entirely or partially made from biomass and is similar in appearance and function to conventional plastic. Here, we expected the same results as in the previous studies, namely that people feel positive about bio-based plastic. We also expected the majority of participants to believe that bio-based plastic is always biodegradable and we did not expect them to know much about the CO_2footprint of bio-based plastic (or regular plastic for that matter).

Negative Condition

In the negative condition, participants received the same information about bio-based plastic as in the control condition *plus* information that bio-based plastic is not necessarily biodegradable. This condition aimed to remove any misconceptions about the biodegradability of plastic and the linked perceived advantage to marine pollution and wildlife participants might hold. We therefore expected people's attitude about bio-based plastic to become less positive relative to the control condition, but expected their knowledge about biodegradability to increase.

Balanced Condition

The balanced condition provided the same information as the negative condition with an *added* description of what makes bio-based plastic more sustainable (i.e., a smaller CO_2 footprint). In this condition, we hypothesised the attitude towards bio-based plastic to be less positive than in the control condition, but more positive than in the negative condition. Because participants in this condition have more knowledge about both the lack of biodegradability and the CO_2 benefits of bio-based plastic, we expected their attitudes about bio-based plastic to be more balanced and stable. A summary of the conditions and the corresponding hypotheses can be found in Table 4. We did not expect the manipulations to affect attitudes towards conventional plastic.

Table 4. Hypotheses on Product Knowledge (i.e., Biodegradability and CO_2 Footprint) and Attitudes About Bio-Based Plastic per Condition (Study 4, *N* = 304).

Control		**Message Condition**		
		Negative	**Balanced**	
Knowledge	Biodegradability	low	correct	correct
	CO_2 footprint	none	none	correct
Attitude		+	–	+/– (stable)

Willingness to Pay and Attitudes

We expected that the manipulation of knowledge would have an effect on people's willingness to pay (both self-reported and objective behaviour). In particular, we expected that compared to the control condition, participants would be willing to pay the lowest amount in the negative condition, in which participants are told that not all bio-based plastics are biodegradable. We hypothesised that adding a description of the benefits of bio-based plastic in the balanced condition would lead people to be willing to pay more in this condition than in the negative condition, but less than in the control condition.

Importance to Recycle

We expected misconceptions about the biodegradability of bio-based plastic to lead people to believe that it is less important to recycle bio-based plastic compared to conventional plastic. We therefore hypothesised that participants in the control condition would find it less important to recycle bio-based products than in the other two conditions. We did not expect knowledge about conventional plastic's or bio-based plastic's CO_2 footprint to affect perceived importance to recycle.

Other Hypotheses

We also expected to replicate the results of the previous studies. We therefore hypothesised that participants would have a more positive (and less negative) attitude towards bio-based plastic than towards fossil-based plastic, that they would be willing to pay more for bio-based products than conventional plastic products, and that they would find it more important to recycle conventional plastic items compared to bio-based ones.

Materials and Methods

Procedure

After consenting to take part, participants were randomly assigned to one of three conditions: control, negative, and balanced. They were then asked how much knowledge they had about bio-based plastic and read an informational text about bio-based plastic (content depended on condition). This was followed by the manipulation check and the same questions about their attitude as in the previous studies. Participants were also asked how important they thought it was to recycle regular and bio-based plastic, before they indicated their willingness to pay (bottle and donation). Participants then filled out demographic information and were debriefed and paid.

Participants

See Table 2 for sample details. A sensitivity power analysis suggested that the sample size of 304 provided 80% power to detect relatively small effects of $f = 0.18$ ($d = 0.23$) at $\alpha = 0.05$. The participants received GBP 0.85 as compensation for this approximately ten-minute study. We also asked participants about their prior knowledge of bio-based plastic, to test whether the general lack of knowledge about bio-based plastics reported in previous research (Dilkes-Hoffman et al., 2019; Herbes et al., 2018; Ulla Kainz et al., 2013; Koutsimanis et al., 2012; Lynch et al., 2017) is reflected in participants' self-reported knowledge level. The majority of participants reported having little prior knowledge of bio-based plastic (see Figure 4).

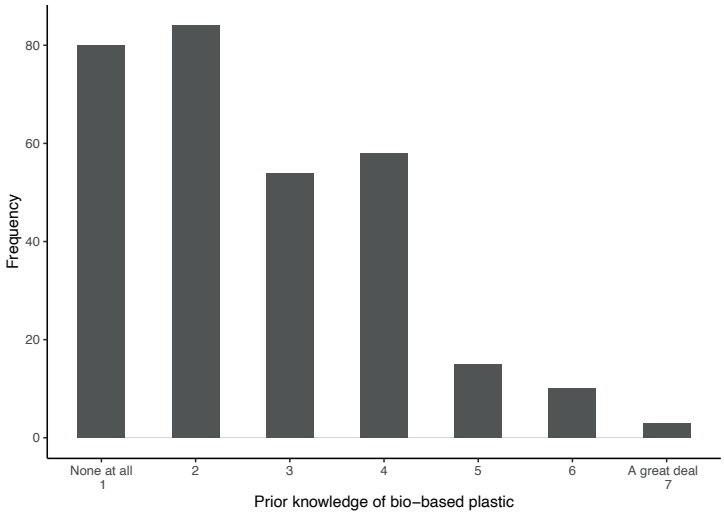


Figure 4. Frequencies of Prior Knowledge About Bio-Based Plastic (Study 4, *N* = 304).

Manipulation

In the different conditions (control, negative, balanced), participants read informational texts with varying amounts of information about bio-based plastic. They also completed a manipulation check that tested the knowledge about bio-based plastic they gained from reading the different manipulation texts. On a seven-point Likert scale (*1 = completely untrue* to *7 = completely true*) they responded to two items each about the biodegradability of bio-based plastic (biodegradability score) and about the CO_2 footprint of bio-based plastic (CO_2 score). Depending on condition, participants were expected to have different amounts of knowledge about bio-based plastic (see Table 4). The full text for each condition, as well as more information about the manipulation check, can be found in the Supplementary Materials.

Willingness to Pay

In addition to completing the self-reported bottle measure, participants were asked whether they would like to donate some (or all) of the earnings they receive for participating in this research to help plant real-life trees to reduce CO_2, and if so, how much. Again, this was performed using a slider measure, this time reaching from 0 GBP *('I don't want to donate')* to 0.85 GBP (the amount they received for participating in the study).

Results

All analyses were pre-registered unless explicitly declared otherwise.

Attitudes

As in the previous studies, we ran a paired-sampled *t*-tests comparing participants' general attitudes (collapsed across all conditions) towards conventional and bio-based plastic (this analysis was not pre-registered). Participants felt much more favourable towards bio-based plastic than towards conventional plastic, t (303) = –15, $p < 0.001$, d = –0.86 (for means and standard errors, see Figure 1, Study 4). Participants also felt more unfavourable towards conventional plastic than towards bio-based plastic, t (303) = 11.46, $p < 0.001$, $d = 0.65$. This replicates Studies 1–3 and suggests that participants had both more positive and less negative attitudes towards bio-based plastics than towards conventional plastics. As in Studies 2 and 3, we found that participants were more negative than positive towards conventional plastic, t (303) = –9.79, $p < 0.001$, d = –0.56, while having more positive than negative evaluations of bio-based plastic, t (303) = 10.05, $p < 0.001$, $d = 0.58$.

Manipulation Check

We conducted two one-way ANOVAs to determine whether there was a main effect of condition on people's misconceptions (Figure 5a). As expected, there were differences between the conditions in misconceptions about bio-based plastics' biodegradability, F (2, 301) = 124.56, $p < 0.001$. A Tukey post-hoc test further revealed that misconceptions were higher in the control condition than in the negative condition, $p < 0.001$, 95%CI [2.57, 3.59], and the balanced condition, $p < 0.001$, 95%CI [2.23, 3.21]. There was no difference between the negative and balanced condition ($p = 0.19$, 95%CI [–0.84, 0.13]). There was also a difference between conditions with regard to people's perceptions of bio-based plastic's CO_2 impact, F (2, 301) = 124.38, $p < 0.001$. A Tukey post-hoc test showed that this was driven by participants in the balanced condition having a much better understanding of bio-based plastic's CO_2 advantage than participants in the control, $p <$ 0.001, 95%CI [–2.61, –1.76], or negative conditions, $p < 0.001$, 95%CI [–3.08, –2.22]. The difference between the control and negative condition was close to the alpha threshold ($p = 0.043$, 95%CI [0.018, 0.913]).

Willingness to Pay and Attitudes

Effect of Manipulation on Attitudes. To assess whether the (level of knowledge) manipulation affected people's attitudes towards bio-based (and conventional) plastic, two one-way ANOVAs were conducted with condition as the independent and product attitudes as the dependent variables. As expected, the manipulation had no effect on people's attitudes towards conventional plastic (F (2, 301) = 1.44, $p = 0.238$), but did significantly affect the attitudes people held towards bio-based plastic, F (2, 301) = 32.59, $p < 0.001$.

A Tukey post-hoc test revealed that all conditions differed in attitudes towards bio-based plastic (all *p*-values < 0.001). As illustrated in Figure 5b, and as hypothesised, attitudes were most positive in the control condition and least positive in the negative condition, with the balanced condition in the middle.

Overall Willingness to Pay. The majority of participants (64.5%) indicated that they were willing to pay more for a bio-based than a conventional plastic bottle. On average, participants reported that they were willing to pay 1.08 GBP (median = 1.05, *SD* = 0.28) for the bio-based plastic bottle (less than in the previous studies). This suggests that they were willing to pay 8% more for a product made from bio-based plastic than for a bottle made from conventional plastic (which costs 1 GBP). With regard to objective behaviour, participants donated on average 0.20 GBP (median = 0.05, *SD* = 0.29), which is 23.8% of the 0.85 GBP they received. The majority of participants (57.6%) were willing to act pro-environmentally by donating some amount of money. An exploratory bootstrapped (5000 bootstraps) two-tailed Pearson correlation between self-reported willingness to pay and objective donation behaviour revealed a small positive correlation, r (302) = 0.14, 95% BCa CI [0.009, 0.27], p = 0.01.

The Effect of Condition on Willingness to Pay. Table 5 shows the descriptions of participants' willingness to pay for both measures. We pre-registered several one-way ANOVAs to determine the effects of condition on the willingness to pay. However, because the data for both the bottle and donation measure were skewed, we conducted non-parametric tests instead.

With regard to the bottle measure, an independent samples Kruskal–Wallis test conducted due to the moderate skew (–0.83) of the self-reported willingness to pay data (Bulmer, 1979). The results showed that willingness to pay for the bio-based plastic bottle was significantly affected by condition H (2) = 11.06, p = 0.004. Pairwise comparisons with adjusted *p*-values showed that participants in the negative condition were willing to pay 0.05 GBP less than in the control condition (p = 0.029, r = 0.19), and in the balanced condition (p = 0.005, r = –0.22). A one-sample Wilcoxon signed-rank test revealed that being willing to pay 1.05 GBP for a bio-based plastic bottle constitutes a significant increase compared to the 1 GBP cost of a conventional plastic bottle, T = 20913, p < 0.001, r = 0.45. There was no difference in willingness to pay between the control and the balanced condition (p = 1, r = –0.03). This suggests that when participants only received the additional information that bio-based plastic was not necessarily biodegradable, participants were less willing to pay. However, when they also read information about bio-based plastic's small CO_2 footprint, participants were willing to pay as much as in the control condition.

The donation data were highly skewed (1.36) and thus an independent samples Kruskal–Wallis test was performed to determine the effects of condition on willingness to donate. The results suggest that condition did not affect donation behaviour, H (2) = 0.64, p = 0.73.

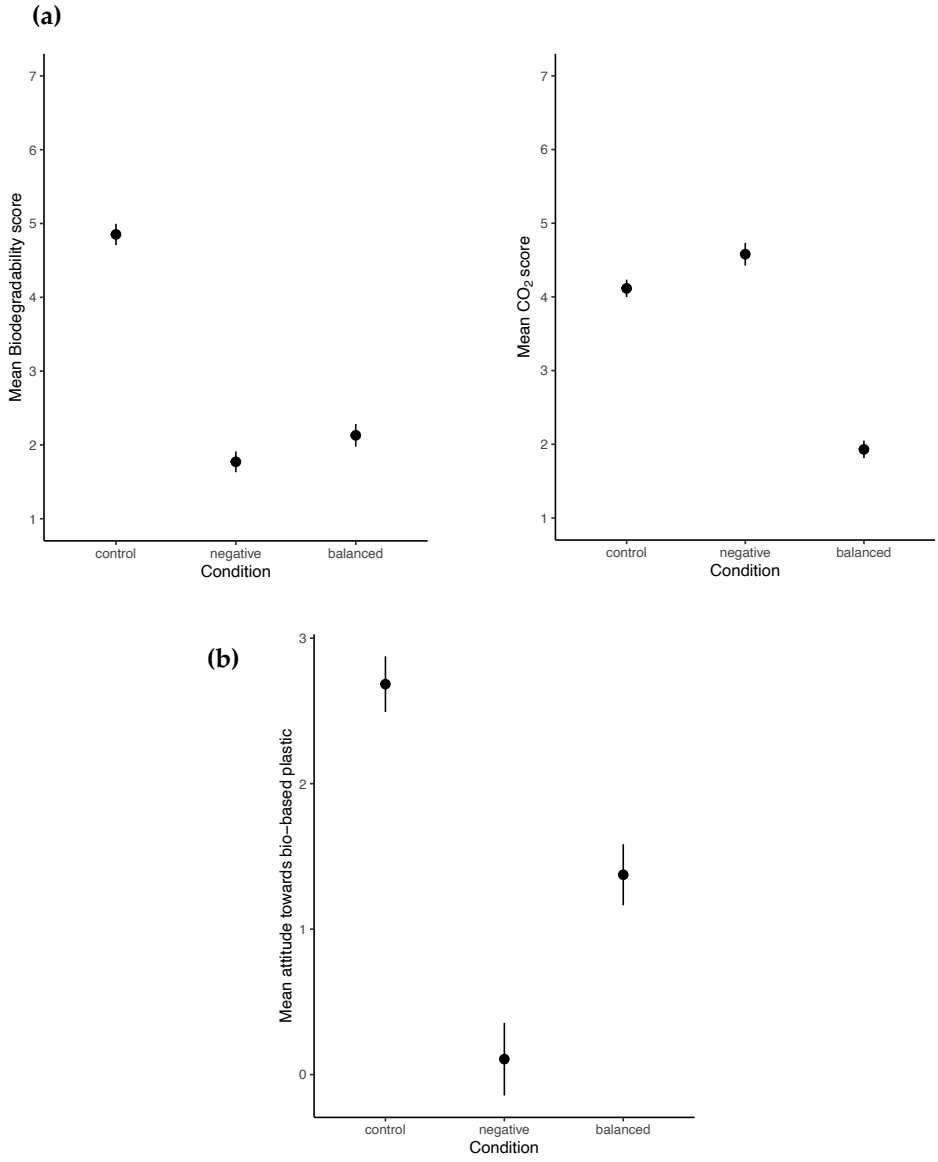


Figure 5. (**a**) Mean Biodegradability and CO_2 Perception Scores per Condition (Manipulation Check; Study 4, *N* = 304). Higher Numbers Indicate Factual Incorrectness or Misconceptions. (**b**) Mean Attitudes Towards Bio-Based Plastic per Condition. The Error Bars Represent the Standard Error.

The Effect of Overall Attitude on Willingness to Pay. We ran a bootstrapped regression (5000 bootstraps) to determine the relationship between participant's attitudes towards conventional and bio-based plastic and their self-reported willingness to pay for the bio-based plastic bottle. Contrary to expectations and to the results of the previous study, neither attitudes towards conventional plastic (B = −0.001, t (301) = −0.13, p = 0.900, 95%$CI_{Bootstrap}$ [−0.015, 0.014]) nor attitudes towards bio-based plastic (B = 0.009, t (301) = 1.35, p = 0.178, 95%$CI_{Bootstrap}$ [−0.006, 0.024]) predicted willingness to pay for a bio-based plastic product. The combined attitudes towards both types of plastic did not explain variance in reported willingness to pay, R^2 = 0.01, F (2, 301) = 0.93, p = 0.40.

The same analysis was run for the donation measure with the same pattern of results. Neither attitude towards conventional plastic (B = −0.009, t (301) = −1.36, p = 0.174, 95%$CI_{Bootstrap}$ [−0.021, 0.003]) nor towards bio-based plastic (B = −0.004, t (301) = −0.58, p = 0.560, 95%$CI_{Bootstrap}$ [−0.019, 0.010]) predicted willingness to donate to a sustainable cause. Together, the attitudes towards both types of plastic did not explain variance in donation, R^2 = 0.01, F (2, 301) = 1.36, p = 0.26.

Table 5. Willingness to Pay Descriptives Per Condition (Study 4, N = 304).

	Condition	**N**	***M*** (in GBP)	**SD**
Bottle	Control	95	1.10	0.3
	Negative	94	1.05	0.3
	Balanced	115	1.10	0.3
Donation	Control	95	0.20	0.3
	Negative	94	0.18	0.3
	Balanced	115	0.22	0.3

Importance to Recycle

To test whether participants' misconceptions influence perceived importance to recycle, we performed several bootstrapped (5000 bootstraps) regressions. As predicted, knowledge of bio-based plastic's CO_2 emissions did not influence participants' perceived importance of recycling bio-based plastic, F (1, 302) = 0.38, p = 0.54, B = −0.022, 95%CI [−0.09, 0.048]. However, the stronger participants' misconceptions about bio-based plastic's biodegradability, the less they thought recycling it was important, F (1, 302) = 12.1, p < 0.001, B = −0.108, 95%CI [−0.17, −0.041]. When it comes to regular plastic, neither participants' knowledge about bio-based plastic's CO_2 advantage, F (1, 302) = 2.82, p = 0.094, B = −0.037, 95%CI [−0.08, 0.004] nor misconceptions about its biodegradability F (1, 302) = 0.032, p = 0.86, B = −0.003, 95%CI [−0.04, 0.03] affected how important participants felt it was to recycle conventional plastic.

As in Studies 2 and 3, we also tested in an exploratory analysis whether there was a difference in how important participants found it to recycle both types of plastic (see Figure 2). Reported importance of recycling was overall very high. Because both the distributions were skewed (bio-based plastic: −1.78, regular plastic: −2.68, $SE = 0.14$), we performed a Wilcoxon rank-sum test. The results suggest that participants found it more important to recycle items made from conventional rather than bio-based plastic, $T = 135$, $p < 0.001$, $r = -0.43$. Given the results described above, this may be driven by those participants who harboured misconceptions about bio-based plastic's biodegradability.

Discussion

In this pre-registered experimental study, we replicated the findings from the previous three studies concerning participants' attitudes towards both conventional and bio-based plastic. We also successfully manipulated participants' level of knowledge about bio-based plastic and found that this influenced the attitudes they had towards bio-based plastic. In particular, participants' evaluations of bio-based plastics were most positive in the control condition (with misconceptions), least positive in the negative condition in which they were informed that not all bio-based plastics are biodegradable, and somewhere in between in the balanced condition in which participants received additional information about the small CO_2 footprint of bio-based plastics.

As in Studies 2 and 3, participants reported being willing to pay more for a bio-based product, compared to one made from conventional plastic. However, the willingness to pay was lower than in the previous study, with participants indicating that they would be willing to pay on average 0.05 GBP more for a bio-based bottle. 0.05 GBP might not seem like much, but the production cost for a fossil-based plastic water bottle is between 0.0175 USD and 0.0375 USD (IEA, 2014). Willingness to pay (only the bottle measure) was affected by condition, with participants in the negative condition being willing to pay less than in the other two conditions. Contrary to hypotheses, there was no effect of attitude on willingness to pay, nor did attitude influence the relationship between condition and willingness to pay. However, misconceptions about bio-based plastic's biodegradability led participants to think it less important to recycle products made from bio-based compared to those made from conventional plastic.

GENERAL DISCUSSION

In combatting climate change, the development of more sustainable technologies has to go hand in hand with enhancing consumers' willingness to adopt these technologies. For example, consumer attitudes and perceptions are important when introducing a new technology such as bio-based plastic to the market, because cognitions can influence how

much people are willing to pay for sustainable alternatives. There are many cases where more sustainable products or new technologies were not readily accepted by consumers, e.g., Nike's line of environmental 'Considered' shoes, car manufacturers switching their wiring from conventional to soy-based plastic, or attitudes towards genetic modification (Confente et al., 2020; Sijtsema et al., 2016). With the present research, we tested how this might be avoided for bio-based plastics.

The current results provide insight into consumers' attitudes towards conventional and bio-based plastics. Throughout all four studies, we found that participants had more positive and less negative evaluations of bio-based compared to conventional plastic products. Even when participants gained more knowledge about bio-based plastic and its characteristics, their attitudes remained positive (Study 4). However, attitudes alone do not paint the whole picture. We found some indication that attitudes about the different types of plastic directly affect people's willingness to pay (Studies 2 and 3). However, those results did not replicate in Study 4.

Misconceptions

That people have positive attitudes towards bio-based plastics is encouraging. However, throughout our studies, we also found that participants had very little prior knowledge about bio-based plastic and harboured several misconceptions, including that bio-based plastic is by default biodegradable. This potentially makes these positive attitudes unstable, as they are likely based on these misconceptions. Positive attitudes that are based on misconceptions pose a risk for two reasons.

Firstly, learning that they have been positive for the wrong reasons may lead people to become more negative or even feel cheated because they had the wrong assumptions. Previous literature shows that consumers can react shocked and disappointed when told that bio-based plastic does not have all the properties they believed it to possess (Blesin et al., 2017). This was also demonstrated in the negative condition of Study 4—when participants were told that bio-based plastics are not by default biodegradable and thus do not alleviate problems such as marine pollution, their attitudes became more negative (see Figure 5b).

Secondly, people might attribute positive characteristics to bio-based plastic that are in fact untrue (that bio-based plastic is always biodegradable) and that can have unwanted behavioural consequences, such as littering. Throughout our research, we consistently found that participants perceived it less important to recycle products made from bio-based plastic, compared to those made from conventional plastic. The results of our final study suggest that this is driven by those participants who believe that bio-based plastic is biodegradable.

As a result, we argue that it is important to educate people about the properties of different types of plastic and their uses, and render them as positive about bio-based

plastics as they were before, but now in a more stable fashion, i.e., for the right reasons. Bio-based plastic can have many advantages such as being made from renewable biomass and having a smaller CO_2 footprint. Some bio-based plastics, such as PEF, also possess similar or better chemical barrier qualities than conventional PET plastics. In our final study we also demonstrated that the information about bio-based plastic does not need to be extensive to successfully dispel misconceptions. In short, we believe that educating consumers about the properties of different types of plastic can lead to a more durable transition to sustainability than ignoring misconceptions about bio-based plastics. Our research indicates that consumers remain willing to pay a price premium and favourably evaluate this new, more sustainable technology.

From a psychological perceptive, it is valuable to investigate attitudes and perceptions of novel products, as they can determine whether or not the product will be adopted by consumers. Beliefs, both accurate and inaccurate, can drive consumers' willingness to pay and aid in predicting consumer behaviour. The present research thereby contributes to the existing literature by investigating both the applied and economic perspective of the novel bio-based plastics, while also studying the psychological factors (e.g., attitudes and perceptions) that influence consumers' willingness to pay. These results could therefore be useful not only for companies and their marketing campaigns, but also for policymakers trying to create a demand for more sustainable products. These insights also make it easier to study consumer perception and gauge willingness to pay for novel products.

Willingness to Pay

Previous research suggests that many consumers are willing to pay a premium for environmentally friendly products (see Orset et al., 2017). We found the same results with regard to bio-based products. Participants consistently reported being willing to pay 8–30% more for a bio-based compared to conventional water bottle. Whether this willingness translates into objective behaviour is unknown; we only found a small correlation between participants' self-reported willingness to pay and their objective donation behaviour in Study 4. This might be due to the differing nature of those two pro-environmental tasks (one assessing willingness to pay for a more sustainable plastic bottle and the other asking to donate actual money to help plant real-world trees), or due to a social desirability bias. However, it might also be due to the well-known intention behaviour gap (Sheeran, 2002), which describes the failure to translate intentions into action.

Limitations and Future Directions

While attitudes are essential for the acceptance of new technologies such as bio-based plastics, we found inconsistent evidence that attitudes influenced participants

willingness to pay and no evidence that attitudes influenced objective behaviour. This suggests that non-attitude factors should also be investigated. For example, emotions might be a useful tool in encouraging pro-environmental behaviour (*Chapter 2*; Bissing-Olson et al., 2016). Other lines of research also show positive effects of using social norms (Poškus, 2016) and commitments (Jaeger & Schultz, 2017) to encourage consumers to behave more sustainably. Future research directly comparing the effectiveness of these other factors in addition to attitudes might provide more information about how to encourage consumers to purchase bio-based and other more sustainable products.

Another limitation was the potential disconnect between willingness to pay for a plastic bottle compared to the objective behaviour measure of donation. Participants might not have seen a direct connection between paying more for a water bottle and donating to plant trees, as reflected in the small correlation between them. Future research should investigate actual consumer behaviour and test whether participants would actually pay as much for a bio-based product as they indicated. The remote nature of the objective behaviour measure might also be the reason why we did not find an effect of attitude on donation behaviour, as the attitude questions were specifically about the different types of plastic.

Another potential limitation of this research is the use of single or two-item measures to assess most of the factors investigated in this research. Given the pioneering nature of this research, we chose many measures based on their simplicity and face value, aiming to get a first indication of participants' perceptions of (bio-based) plastics. While we replicated many of the measures in multiple studies (i.e., attitudes, willingness to pay, perceived importance to recycle), we are aware that the use of single and two-item measures makes it impossible to gauge the statistical validity and reliability of these measures. We therefore urge caution when interpreting the results and emphasise the need to independently replicate the findings using validated multi-item scales.

The data for the current research were collected from Western participants residing in multiple countries. This sample was chosen to get a first and general insight into consumer (bio-based) plastic perceptions. However, the wide spread of the sample also means that the results might not generalise to consumer perceptions in specific countries.

GENERAL CONCLUSIONS

Plastic production and disposal are an often-overlooked contributor to climate change. While consumers are increasingly becoming aware of plastic's negative effects on marine life, many remain unaware of the large amounts of CO_2 that are released during the production and lifecycle of plastic products. One possible solution to this plastic problem

is the market introduction of more sustainable products (e.g., bio-based plastics). This transition requires that (1) companies provide these environmentally friendly products and that (2) consumers accept and are willing to purchase them. Across four studies, we showed that consumers are very positive towards bio-based plastics and are willing to pay a price premium for them. However, we also demonstrated that many consumers lack knowledge about the properties of these new plastics and harbour misconceptions, particularly by overestimating biodegradability. We also showed that these misconceptions can be resolved through brief written messages. After being informed about bio-based plastics' properties and benefits, consumers attitudes towards products made of bio-based plastic remain positive and they are still willing to pay a price premium. These are encouraging results with regard to a transition towards sustainability, and the results contribute to the broader literature identifying psychological predictors of pro-environmental behaviour, including emotions, values, norms, and beliefs (Bissing-Olson et al., 2016; *Chapter 2;* Jaeger & Schultz, 2017; Poškus, 2016).

CHAPTER 4

Consumer Attitudes and Willingness to Pay for Novel Bio-Based Products Using Hypothetical Bottle Choice

Abstract

Fossil-based plastic contributes to environmental pollution through carbon dioxide emissions during production and lifecycle. Bio-based plastic from renewable biomass retains functionality and can have a lower carbon footprint. Any large-scale investment in bio-based plastic by the industry requires knowing that consumers are willing to purchase these products and learning how best to market them. This online study (N = 529) investigated psychological factors influencing preferences for three types of plastic bottles: a conventional fossil-based bottle (PET plastic), a visually identical bio-based bottle (PEF plastic), and a visually distinct bio-based bottle with a paper outer layer (paper PEF). The key outcomes were attitudes and willingness to pay. We also tested whether consumers' choices being visible to valued others affected these judgments. Participants reported positive attitudes towards bio-based plastic, were willing to pay more for it, and, irrespective of being observed, overwhelmingly preferred the bio-based bottles (96.8 %). We discuss how these findings may be applied by the industry to increase the uptake of bio-based plastic and other sustainable consumer alternatives.

This chapter is based on:

Zwicker, M. V., Brick, C., Gruter, G.-J. M., & van Harreveld, F. (2023). Consumer attitudes and willingness to pay for novel bio-based products using hypothetical bottle choice. *Sustainable Production and Consumption*, *35*, 173-183.

All supplementary materials, data, pre-registration documents, and analysis scripts are available on the Open Science Framework (https://osf.io/62xvj/).

INTRODUCTION

Fossil fuels (i.e., oil, coal, and natural gas) have been powering economies for over 150 years. Burning fossil fuels accounts for around three-quarters of global greenhouse gas emissions (Ritchie et al., 2020). While there is increasing pressure to move away from fossil fuels, they still accounted for 84 % of the world's primary energy consumption in 2019 (Rapier, 2020). The plastic industry is mainly based on fossil feedstocks and has an increasingly large contribution to CO_2 emissions. Plastic emits greenhouse gases both during its production (1.4 Gt or 3 % of total global annual CO_2 emissions; Hertwich, 2019) and at the end of its lifecycle (e.g., during incineration; World Economic Forum, 2016). By 2050, plastic production alone is expected to use 15 % of the carbon budget (Paris Agreement) required to keep global warming under 2 °C (World Economic Forum, 2016). We have fewer than 30 years to reduce the carbon footprint of plastic before overwhelming the 2050 CO_2 emissions budget, but it seems unrealistic to stop using plastic. Currently, biomass is the only known alternative carbon feedstock for making virgin, non-recycled plastic (Murcia Valderrama et al., 2019).

Bio-Based Plastic

Bio-based plastic may help reduce the carbon footprint of the plastic industry and mitigate climate change (Ruf et al., 2022; Scherer et al., 2018). Bio-based plastic is made from biomass such as starch, vegetable oils, wood, animal waste, or crops and their by-products (Mehta et al., 2021; Mohanty et al., 2002; Scherer et al., 2018; van den Oever et al., 2017), which can be cultivated in many parts of the world (Scherer et al., 2018). Like the fossil-based material, bio-based plastic has a great variety of properties and applications. Some types of bio-based plastic are biodegradable (i.e., under specific conditions they biodegrade into mainly CO_2, water, and compost), while others biodegrade slowly like traditional plastic (Mohanty et al., 2002; Orset et al., 2017; van den Oever et al., 2017). Bio-based plastic does not add any additional CO_2 to the atmosphere, even if not recycled, because it is produced from carbon (biomass) that was already above the ground. Therefore, the natural carbon cycle already includes most of the CO_2 released during the lifecycle of bio-based products.

Bio-based plastic currently makes up <1 % of the plastic market share (European Bioplastics, 2021a). However, the share of bio-based and biodegradable plastic production is expected to more than triple within the next five years (European Bioplastics, 2021b). The current paper focusses on Polyethylene Furanoate (PEF) (Avantium, 2022b), which is made from renewable resources, 100 % recyclable, but poorly biodegradable (Orset et al., 2017). PEF will reach consumers in 2024 (Avantium, 2022a) and has half the carbon footprint of fossil-based plastic (Eerhart et al., 2012).

The Importance of Consumer Attitudes

The successful transition away from fossil-based plastic will require a profound transformation of production and consumption patterns and involve actors across different sectors (Gaffey et al., 2021). The development of sustainable alternatives is only part of the solution. For bio-based plastic products to become widely adopted, they need to be accepted and purchased by the consumer (Steenis et al., 2018). Through their consumption choices, consumers can create crucial market pull, demanding more sustainable products and practices (De Marchi et al., 2020; Gaffey et al., 2021). The environmental benefit of sustainable alternatives is not only dependent on the physical characteristics of the products but also on consumer willingness to purchase these alternatives (Steenis et al., 2018). A positive attitude towards sustainable products is the starting point to stimulate sustainable consumption (Park & Lin, 2020), with attitudes towards a product having the highest impact on the purchase intention of that product (Rausch & Kopplin, 2021). The limited literature on attitudes towards bio-based products suggests that while many consumers feel positively towards bio-based plastic products and are willing to pay more for them, people also report mixed or negative feelings towards bio-based products in part due to a lack of knowledge (e.g., see Gaffey et al., 2021).

The Present Research

This research aimed to determine how interested people are in bio-based bottles. We also compared bio-based options to the fossil-based industry standard and determined consumer reactions to both. We measured consumer demand for bio-based plastic bottles as an alternative to a conventional (fossil-based) plastic bottle and investigated what conditions underlie this preference (e.g., bottle appearance). Previous research compared visually identical products to determine whether consumers preferred the more sustainable option and would be willing to pay more for it (*Chapter 2; Chapter 3*). Here, we extended this work by investigating when participants are willing to pay more for a real product that is more sustainable and visually different from the conventional alternative. Moreover, we investigated whether the social context of a choice (e.g., being observed by members of an important social group) influenced the more sustainable choice. This research aimed to provide insights into some of the psychological factors related to the choice of a sustainable alternative (i.e., a bio-based plastic bottle).

LITERATURE REVIEW

Consumer Demand: Attitudes and Willingness to Pay

One drawback of more sustainable or "green" products such as bio-based plastic is their initially higher price caused by small production volume that results in production costs that are 2–3 times higher (Filho et al., 2022). Consumer demand can facilitate more efficient large-scale production systems that in turn lower prices (European Bioplastics, 2020; Wensing et al., 2020) Therefore, consumer attitudes and willingness to pay constitute a first step of whether consumers would purchase different bio-based products.

A growing body of literature suggests that consumers prefer, think positively about, and are willing to pay more for bio-based products (*Chapter 2; Chapter 3;* De Marchi et al., 2020; Gaffey et al., 2021; Ruf et al., 2022; Scherer et al., 2018). Consumers report being willing to pay a price premium for sustainable plastic alternatives including recycled or bio-based plastic bottles (*Chapter 3*; Orset et al., 2017), plant-based takeout food containers (Barnes et al., 2011), products made of recycled ocean plastic (Magnier et al., 2019), wood-polymer packaging (Friedrich, 2020), and bowls made of wheat straw fibre (Gill et al., 2020). However, consumers can also have mixed or negative feelings towards bio-based products for example due to a lack of knowledge (e.g., see Gaffey et al., 2021). Mehta et al. (2021) found that while most environmental professionals and plastic processors found it acceptable to pay higher prices for bio-based plastic, cynicism towards the industry resulted in lower willingness to pay among most consumers. So, while there is some evidence pointing towards consumers holding mixed or negative attitudes towards bio-based products, most studies suggested that consumers hold positive attitudes and are willing to pay a price premium.

We expected to replicate the findings of general positivity towards bio-based plastic and therefore hypothesised that participants would have more positive attitudes towards products made from bio-based, compared to those made from fossil-based plastic (H1a[11]). We also expected that participants would indicate that they would be willing to pay more for bio-based products, compared to fossil-based products (H2a). Given that attitudes tend to be one of the main predictors of behaviour, we also expected that participants' attitudes towards the different types of materials would relate to their choice of bottle. In particular, we hypothesised that attitudes will relate to bottle choice, i.e., positive attitudes towards bio-based plastic, and/or negative attitudes about fossil-based plastic will relate to choosing a bio-based bottle (H3). We did not have specific predictions of whether positive or negative attitudes about a certain material would relate most to bottle choice.

11 The hypothesis numbering does not correspond with the pre-registration numbering, but the content is consistent.

The findings about consumers' apparent demand for sustainable alternatives parallel increases in the availability of more sustainable products. In November 2021, the Coca-Cola Company announced its first-ever beverage bottle made from 100 % plant-based plastic, following the launch of their PlantBottle™ in 2009 (The Coca-Cola Company, 2021). The Kraft Heinz Company is shifting to reduce their packaging and to use more sustainable materials, including plant-based materials (The Kraft Heinz Company, 2022). Additionally, a long list of other big brands announced that they are working towards using 100 % reusable, recyclable, or compostable packaging by 2025 (Tuckerman, 2018).

In this research, we focused on beverage bottles. Globally, more than 76 billion cases of bottled water and 36 billion cases of carbonated soft drinks are sold per year (Ridder, 2022), the majority of which bottled in plastic. A large and increasing amount of fossil fuel consumption and CO_2 emissions occur at various stages of the supply chain from the manufacturing of the plastic bottles to their transportation, and the pollution caused by (improper) disposal (Etale et al., 2018). It is therefore important to determine what factors might influence consumers to switch to more sustainable materials, especially given that most consumers will come across bottled beverages and have the means to purchase them. Given their importance in creating consumer demand, we assessed the attitudes and willingness to pay towards the different materials (one fossil-based and two bio-based plastic bottles), and under which conditions (i.e., observability of behaviour and social context) consumers might make different product choices.

Signalling Benefit

The studies above provide initial evidence for positive attitudes and willingness to pay but not about what factors influence them. Such positive attitudes towards sustainable alternatives are often not translated into behaviour. This intention-behaviour gap has been observed in many sustainability-related domains (Fielding et al., 2008; Ketelsen et al., 2020). One reason is that the environmental rewards of the sustainable consumer decision are psychologically distant (e.g., longer term), whereas the costs such as price or inconvenience are psychologically proximate (e.g., immediate). In this research, we tested whether we could change that temporal imbalance by generating more immediate benefits for the sustainable decision. One way of boosting benefits is to make the sustainable choice a signal for something socially desirable. This is based on the notion of "going green to be seen" (Brick et al., 2017), in which reputation concerns and social signalling help explain the purchase, possession, or consumption of sustainable products. To create a visual signal, we manipulated the appearance of one of the bio-based bottles to make the sustainable behaviour more visible to others.

Following signalling theory, green products can serve as a signal of social status by signalling wealth and prosocial traits, both of which can increase people's attractiveness

as allies and exchange partners (Berger, 2017). More expensive sustainable products can signal a person's ability to spend and are thus perceived as higher in status and wealthier (Berger, 2017). Additionally, pro-environmental behaviour can signal prosocial traits (Berger, 2019; Braun Kohlová & Urban, 2020). Consumers of sustainable goods are perceived as more cooperative and trustworthy because they buy products benefiting the environment (and thus, the public; Vesely et al., 2022). Green consumption has also been linked to valued personality traits such as morality and competence (see Braun Kohlová & Urban, 2020), innovativeness, knowledge, and intelligence (Noppers et al., 2014). Thus, consumers might be willing to pay more for sustainable products because of the positive attributes they signal (Berger, 2017; Berger, 2019).

For this signalling to pay off, the pro-environmental behaviour needs to be observable by others, for example during purchase or consumption. Accordingly, consumers are willing to pay more for sustainable products when their choice is made in public rather than in private (Berger, 2019). Also, participants whose decisions were observable to others donated 23 % more towards a renewable energy development than those in a control condition (Vesely et al., 2022). Relatedly, consumers paid more for clearly identifiable hybrid cars (e.g., the Toyota Prius™) compared to hybrid models that looked similar to conventional cars (Sexton & Sexton, 2012).

We therefore hypothesised that, not only will participants have more favourable attitudes towards bio-based plastic compared to fossil-based plastic (H1a), but that their attitude will be most favourable towards the bio-based option that is visually recognisable as being the sustainable choice (H1b). We expected the signalling benefit of the visually distinct bio-based bottle to also relate to how much participants indicate being willing to pay for it. We therefore hypothesised that participants will report higher willingness to pay for bio-based than conventional plastic bottles (H2a) and that they will be willing to pay the most for the visually distinct bio-based bottle (H2b).

Social Influence

Above we argued that social factors can play an important role in the present context, and one such factor is identifying as a member of a group. The social identity approach (Reicher et al., 2010) suggests that social identities reflect where people feel they belong, who they are, and shape their behaviour (Fritsche et al., 2018). Social identities are "an individual's self-concept, which derives from his [or her] knowledge of his [or her] membership of a social group (or groups) together with the value and emotional significance attached to that membership" (Tajfel, 1978, p. 63).

Individuals often act in accordance with the groups they belong to, especially groups they strongly identify with and that are relevant and salient in a given situation (Bouman et al., 2020). That is, individuals are more likely to engage in behaviours they believe are common or accepted within a valued group (see Bouman et al., 2020). Individuals

may therefore increase or reduce their pro-environmental behaviour to either bolster a valued identity or to avoid signalling unwanted associations, depending on the context and company (Berger & Heath, 2007; Brick & Sherman, 2021). As group norms and identification are focal predictors of environmentally friendly behaviour, the pro-environmental social identities of an individual's valued social group are crucial when trying to understand pro-environmental behaviour (Fritsche et al., 2018; Jans, 2021). We therefore hypothesised that being observed will affect bottle choice. In particular, when observed by others important to them, participants will choose the visibly distinct bio-based bottle more (H4). This main effect is likely also qualified by whether the observers think positively about the sustainable choice, but the current design did not allow for testing this interaction.

Similar to H4 we thought that social identity will affect collective self-esteem: an individual's level of social identity based on their social group membership (Luhtanen & Crocker, 1992). Therefore, we hypothesised that participants' collective self-esteem will be higher when participants imagine being with members of a social group that is important to them, compared to when they are with members of a social group that is not very important to them (H5). This served as a manipulation check for group importance.

There are inconsistencies in the literature about whether being watched affects pro-environmental behaviour which might be explained by who is doing the watching. People may not care about being observed by strangers in one-shot social interactions (Brick & Sherman, 2021; Lange et al., 2020). Brick and Sherman (2021) therefore suggested measuring and manipulating which audience is observing the behaviours, as well as varying the visibility of the behaviour. The present research addresses both these points. By manipulating the presence and importance of the audience observing the behavioural choice, we investigated two potential moderators: one, does being observed influence the bottle choice? And second, does the importance of observers to one's social identity influence the choice of bottle? Both factors were investigated using random assignment to experimental conditions. How much individuals see themselves as (or want to be seen as) environmentalists has been shown to be a strong predictor of self-reported pro-environmental behaviour (Brick & Lai, 2018; Brick et al., 2017). Environmentalist identity might therefore also affect bottle choice and how much participants indicate they would be willing to pay for the bio-based bottles.

While self-reported willingness to pay can give a good first indication of consumer acceptance and signal a demand for sustainable alternatives, it does not reflect actual purchasing behaviour. We therefore also included the WEPT (Work for Environmental Protection Task; Lange & Dewitte, 2021) as a measure of actual behaviour. We hypothesised that higher environmentalist identity will positively relate to a) choosing a bio-based bottle, b) being more willing to pay for bio-based bottles, and c) showing

more pro-environmental behaviour in the WEPT (H6).

We also tested how attitudes relate to willingness to pay (WTP). We wanted to determine whether more negative attitudes towards a material type led to lower WTP for that type of plastic and whether more negative attitudes towards fossil-based plastic could lead to a higher WTP for bio-based bottles. We also assessed political orientation, because it might relate to belief in climate change as a whole (McCright et al., 2016) and visible pro-environmental behaviour in particular (Brick et al., 2017). For additional secondary hypotheses and their results, refer to the Supplement. All hypotheses and analyses were pre-registered unless stated otherwise.

METHODS

General Overview

In this research, participants chose between beverages in three different kinds of bottles in a scenario situation: a see-through plastic bottle made from fossil-based plastic (PET, or polyethylene terephthalate), a visually identical bio-based bottle, and another bio-based bottle with a thin bio-based plastic inner lining and a paper exterior (see Table 1). Depending on condition, participants imagined being in the company of members from a social group that was very important to them (most valued condition), or not very important to them (least valued condition), or the control condition where no social group was mentioned.

Participants for both the pilot and the main study were recruited via the crowd-sourcing platform Prolific, an online subject recruitment platform that caters to researchers (Palan & Schitter, 2018). Prolific is widely used in psychological research because the quality of its samples compares positively to similar alternatives (Peer et al., 2017). Samples were chosen based on nationality, language fluency, and approval rate.

All measures, data, and analysis code are available at the Open Science Framework https://osf.io/62xvj/. The full questionnaire is in the Supplement.

Table 1. Participants Read These Bottle Type Descriptions.

Bottle Type	Description
PET plastic 	You know the plastic that water bottles are made of? That is **PET**. **PET**'s uses range from packaging, polyester clothing, fabrics, films, car parts, electronics, to many other products. **PET** can be recycled; however, a lot of single-use plastic still finds its way into the environment and only a small percentage of the recycled plastic can be made into the same product again. *Downsides:* **PET** is made from fossil feedstock such as oil and natural gas. Plastic production alone makes up 6% of global oil consumption, about the same as the entire global aviation sector. During its life cycle, **PET** releases large amounts of CO_2 into the atmosphere and thereby substantially contributes to global warming. **PET** bottles are not biodegradable and take about 450 years to decompose. Other products made from **PET** can take up to 1000 years to decompose.
PEF plastic 	**PEF** is very similar to **PET** both chemically and visually, but is derived from 100% renewable raw materials such as wood, straw, sugar, maize, algae, or bio-waste. **PEF** bottles require less material and can be lighter than **PET** as they are stronger. **PEF** can also easily hold carbonated drinks like soda or beer for long periods of time because of better barrier properties than other plastics. The carbon footprint of **PEF** is also 50-70% smaller than that of **PET**. **PEF** typically biodegrades within 5 years (**PET**: 450 years), so **PEF** will not endlessly accumulate in nature. It can also be recycled just like the current **PET** plastic bottles. Additionally, **PEF** can be incinerated in an environmentally friendly manner (generating electricity), as no additional fossil-based CO_2 emissions are produced. *Downsides*: **PEF** cannot be produced on an industrial scale yet. While there are pilot production plants, the quantities are currently too small to replace **PET**.
Paper PEF 	Because traditional **PET** does not hold liquids as well as the newer materials, bottles made from **PEF** could use less plastic and still hold carbonated drinks like soda and beer. However, bottles that are too thin become floppy. One solution is to provide structure and stability by adding an outer paper/cardboard structure (see image). This way, the bottle is stable and even less **PEF** is needed, making **paper PEF** bottles even more sustainable than bottles made just of **PEF** plastic. Because the paper and plastic layer are separable, **paper PEF** bottles can also be recycled. Using only a very thin layer of **PEF** also allows for even faster biodegration. *Downsides*: **Paper PEF** bottles have the same downsides as bottles made from only **PEF**. However, because much less **PEF** is used in the **paper PEF** bottle, more bottles can be produced at less cost.

Pilot Study

A qualitative pilot study determined common social groups people are typically part of (Table 2). Fifty-two Dutch participants took part in the pilot study, 28 males and 24 females, age *M* (*SD*) = 28.6 (10.8). Participants came from varied educational backgrounds with 52 % having a university degree as their highest education.

Table 2. Social Groups Reported in the Pilot Study (*N* = 29).

(Former) colleagues, close friends, (old) school friends, sports group, sports team, gaming group, neighbours, roommates, study group, student association, classmates, pop culture fan group, going out group, online community members, book club, fellow movie lovers, fellow animal lovers, fellow nature lovers, music group, arts group, religious community members, cooking club, fellow British people, expat community members, LGBT community members, fellow house owners, fellow people living in your town/city, fellow people from your country.

After consenting, participants received information about what makes up a social group. They then listed five social groups they were a member of (forced response). Participants were prompted to list additional social groups they might be part of, while being reminded of the ones they previously mentioned (no forced response). They were then asked whether there were any other social groups they would like to mention. For all these social groups they indicated how much they valued the groups with two 7-point Likert questions, e.g., "How important is it to you that the members of this group think positively about you?" (*1 = not important at all* to *7 = extremely important*). To inquire about the influence of the social groups on participants' behaviour we asked: "How often do you adapt or change your usual behaviour to make a positive impression on the members of this social group?" (*1 = never* to *7 = most of the time*). Finally, they provided demographics and were debriefed and paid.

The qualitative social group responses were distilled into 29 social groups (Table 2) (see Supplement for coding process). They included both groups frequently mentioned as being important and several higher-level groups that several participants mentioned being part of but rarely made it into the first five groups they mentioned (e.g., people from your country, fellow house owners). The group 'family' was excluded because people's complex relationships with their families might influence the effectiveness of our manipulation. These pilot-tested groups were used in the main study below to increase psychological realism of the vignette situation.

Main Study

Participants and Design

The online survey was distributed by panel provider Prolific to 529 individuals with British nationality, English fluency, and a study approval rate at or above 99 % (Table 3). We aimed to recruit 525 participants (175 per condition) based on an a priori power analysis conducted using the 'pwr' package in R (Champely et al., 2020) showing 80 % power at $\alpha = .05$ to detect chi-square: $\omega = 0.15$ (H4); paired samples *t*-test: $d = 0.2$ (H1 and H2); independent samples *t*-test: $d = 0.3$ (H5), a small-to-moderate effect size in psychology.

Table 3. Demographic Information (*N* = 529).

	M	SD	%	Value
Gender			70.5	Female
			28.7	Male
			0.6	Other
			0.2	Prefer not to say
Age	36.4	13.4		Years
Education			0.4	Primary
			25.3	Secondary
			9.5	Trade, technical, or vocational
			47.3	Undergraduate
			17.6	Postgraduate

Note: There were no significant differences between the conditions in demographics, prior knowledge, environmentalist identity, or political orientation, all *ps* > 0.73 (Table S1).

Participants were randomly assigned to one of three conditions with varying social contexts: most valued (*N* = 177), least valued (*N* = 173), and control (*N* = 179). In the most valued condition, participants imagined being in the company of members from a social group that was very important to them; in the least valued condition they imagined the presence of members of a social group not very important to them; and in the control condition no social group was mentioned. They were paid £1.30 for the 15-minute study.

Bottle choice was the main dependent variable and participants chose one of three bottles (see Table 1). We expected choice to be predicted by condition (H4) and attitudes (H3). Consumer demand was assessed with attitudes and reported willingness to pay. These measures were compared between different bottle types (H1 and H2). We also tested the relationships between bottle choice, environmentalist identity, willingness to pay, and pro-environmental behaviour (H6).

Materials

Plastic Information. Participants read three informational texts each describing the characteristics and downsides of the three different types of materials: PET plastic, PEF plastic, and paper PEF in that order (see Table 1 for the complete text). Throughout the study, the names of the different materials were printed in three different colours (PET plastic: blue, PEF plastic: purple, paper PEF: orange) to help distinguish the options. The labels and bottle caps also had these colours. To ensure that participants read the text thoroughly, they could only proceed to the next question after 10 seconds. The texts were each about 150 words and were displayed next to a picture of the corresponding bottle.

Each text was followed by a 1-item multiple-choice comprehension check with three response options to ensure that participants understood the differences between bottle types. Participants could try again until they selected the correct answer. A summary of the information provided in Table 1 was displayed after participants read all the information and successfully completed the comprehension checks and remained visible during the assessment of attitudes.

Attitudes. Because consumers' positive and negative evaluations regarding the different types of materials are likely to vary independently (e.g., van Harreveld et al., 2015) we separately assessed both the positive and negative evaluations of the three different materials (i.e., PET plastic, PEF plastic, and paper PEF) (for a similar approach see *Chapter 3*). For example, how much one thinks plastic is useful is not the same as how much one thinks plastic contributes to climate change (also see Sijtsema et al., 2016).

Participants saw one positive and one negative attitude item about each material. The PET plastic items read: "Think about your attitude towards PET plastic products. Considering only the *positive/negative* aspects of PET plastic products, how (un)favourable is your evaluation of PET plastic product use?". Participants responded on a 7-point Likert scale ranging from *1 = Not at all (un)favourable* to *7 = Extremely (un)favourable*.

Group Manipulation and Choice Scenario. The most valued and least valued condition manipulated the social context in which participants made a behavioural choice. Participants responded to an adapted version of the self-affirmation procedure used by Voisin et al. (2018), which presented them with the 28 different social groups identified in the pilot (Table 2). In the most valued condition, participants indicated the one social group that was most important to them other than their family. In the least valued condition, participants selected one social group that they belong to but that was of little importance to them. If the specific group they were thinking of was not on the list, they picked the one that best described that specific group.

Participants then wrote down 2–3 sentences (minimum of 100 characters) describing why they made that choice. For example, in the least valued condition participants were asked to "Explain why this group is of less importance to you than other groups you belong to. Give an example of why it does not influence your everyday as much as other groups you belong to." Control condition participants were asked to write 2–3 sentences describing what they ate for breakfast the day before, whether that was their usual breakfast, and whether they enjoyed it or not.

Scenario and Bottle Choice. This research was conducted during the COVID-19 pandemic. It was not feasible to conduct a field or laboratory study to let participants handle the actual bottles. We therefore aimed to create a realistic and immersive purchase choice situation online, as is common in psychological research on decision-making (Connolly & Zeelenberg, 2002; Inman & Zeelenberg, 2002).

Participants read a scenario describing the atmosphere at a festival. A sketch of an

outdoor festival was also displayed to help participants visualise being at the festival. Depending on condition, the participant was either alone (control), with members of a group that (s)he valued highly (most valued condition), or that were not very important to him/her (least valued condition). The participants were told they wanted something to drink, and that they and their group (if applicable) were headed to a refreshment stall with beverages offered in three types of bottles (PET plastic, PEF plastic, and paper PEF). Participants were shown pictures of the three different bottle types and asked to choose a type of bottle, while being told that all group members present were expectantly awaiting the participant's choice (in all but the control condition). The complete scenarios including the visuals are in the Supplement. At the end of this section participants were asked how clearly they imagined the situation as a manipulation check.

Willingness to Pay. Participants reported their willingness to pay for each of the three bottle types: PET plastic, PEF plastic, and Paper PEF. Using a similar approach as in *Chapters 2* and *3*, participants indicated their willingness to pay on a slider from £0 - £2. The slider started at £0 and increased in increments of £0.20.

Environmentalist Identity. Participants indicated how much they identified as an environmentalist in four items (e.g., "I see myself as an environmentalist"; *1 = disagree strongly* to *7 = agree strongly*) based on Brick et al. (2017) . The scale showed excellent reliability with a Cronbach's alpha = .94.

Collective Self-Esteem. Participants in the most valued and least valued condition completed the 16-item Collective Self-Esteem Scale (Luhtanen & Crocker, 1992). This scale assessed participants' level of social identity based on their social group membership. Participants were asked to think of their most/least important group (piped text) when responding to the four subscales (membership, private, public, and identity), *1 = strongly disagree* to *7 = strongly agree*. This scale had a very good reliability for both conditions with a Cronbach's alpha = .88.

Pro-Environmental Behaviour. To objectively measure pro-environmental behaviour, we used the Work for Environmental Protection Task (WEPT; Lange & Dewitte, 2021). The WEPT is highly reliable and correlates with self-reports and objective observations of other pro-environmental behaviours and conceptually related measures (Lange & Dewitte, 2021). The repeated trade-offs between behavioural costs and environmental benefits mean this represents an objectively observed pro-environmental behaviour. In this web-based, multi-trial task, participants could choose to exert extra effort in completing trivial operations with numbers in exchange for genuine donations to an environmental organisation. Participants were shown a series of two-digit numbers and asked to select all numbers that consisted of an even first digit and an odd second digit. After a familiarisation period, participants could decide how much time and effort to invest into the task. Completion of this task was voluntary and they could stop at any time. There were 15 pages of 50 numbers each that could be completed and partici-

pants were told that 90 % accuracy was required for completion (not enforced). For each completed page, £0.10 was donated by the researchers to the Woodland Trust, a UK based pro-environmental charity (total = £147.10). Split-half reliability sampling using 1000 iterations revealed an excellent median reliability, $\rho_{SP} = 0.96$. Of the sampled reliability coefficients, 95 % were between $\rho_{SP} = 0.90$ and $\rho_{SP} = 0.98$ (Steinke & Kopp, 2020).

Perceived Environmental Norms of the Group. Participants in the most valued and least valued condition were asked how important the environment was to their mentioned social group. Participants responded to a 3-item pro-environmental descriptive norm measure used by Bissing-Olson et al. (2016) (1 = *disagree strongly* to 7 = *agree strongly)*. For both conditions, this scale showed an excellent reliability of α = .96. This measure was exploratory and was not included in the main analysis.

Motivation. We also assessed intrinsic and extrinsic motivation for pro-environmental behaviour. Participants indicated on a 7-point Likert scale how much they agreed with five statements assessing their explicit and five items assessing their implicit motivation (Brick & Lai, 2018). Both subscales showed very good reliability with respective Cronbach's alphas = .79, .87. This measure was exploratory and was not included in the main analysis.

Demographics. We also assessed participants' age, gender, education, political orientation, and inquired how much they knew about the different types of plastic before this study. To measure political orientation, participants indicated on a 11-point Likert scale where they placed themselves on a political left-right and progressive-conservative continuum, as well as two more left-right continua for economic and then social issues (measure adapted from Zwicker et al., 2020). The four combined items had an excellent reliability of α = .92.

Procedure

After consenting to take part, participants read informational texts about the three different types of materials, followed by the corresponding comprehension checks. We then assessed participants attitudes towards the three materials. According to their condition, participants then indicated which social group was of most or least importance to them. Then followed the scenario and the subsequent bottle choice task. Participants then indicated their willingness to pay for each of the three bottles and how much they identified as an environmentalist. Participants in the most valued and least valued condition also responded to the collective self-esteem scale. All participants completed demographic questions before getting the option to complete the WEPT, which was followed by the debriefing and payment.

RESULTS

Manipulation Checks

Collective self-esteem was higher in the valued condition (M = 5.48, SD = 0.75) than in the least valued condition in an independent samples t-test (M = 3.95, SD = 0.88), $t(348)$ = 17.60, $p < .001$, which is supportive evidence of the intent for the social group manipulation and H5.

Generally, participants imagined the festival scenario clearly (M = 6.2 out of 7) and there were no differences between conditions in a one-way ANOVA, $F(2, 526) = 0.98$, p = .38. Imagination did relate to bottle choice, $F(1, 527) = 6.30$, $p = .012$, $R^2 = 0.11$, with less immersion leading to a less sustainable bottle choice.

Condition on Bottle Choice

Participants strongly preferred the paper PEF bottle over the other two bottle types (Table 4). Contrary to H4, there was no association between imagined group type and bottle choice in a chi-square test, $\chi2(4) = 0.884$, $p = .927$, Cramer's $V = 0.029$. Bonferroni-corrected post-hoc analysis with adjusted residuals did not reveal any significant differences between the conditions.

Table 4. Bottle Choice by Condition.

	Bottle Choice		
Condition	PET plastic	PEF plastic	PEF paper
Control	2.8%	29.1%	68.2%
Most valued	3.4%	25.4%	71.2%
Least valued	3.5%	25.4%	71.1%

Attitudes and Willingness to Pay by Bottle

We deviated from the pre-registration to test the additional contrasts of H1a and H1b, and H2a and H2b as suggested by an anonymous reviewer. Paired-samples t-tests revealed that participants were more positive towards bio-based bottles (M = 2.89, SD = 1.67) than towards the fossil-based bottle (M = –1.86, SD = 2.90), $t(528)$ = –29.50, $p < .001$, d = 3.70, 95 % CI [–5.06, –4.43]. As predicted, attitudes were most positive towards paper PEF and most negative towards PET plastic, with attitudes towards PEF plastic in between (Table 5).

Table 5. Means (SD) for Attitude and WTP by Bottle Type.

	Bottle Type		
Mean (*SD*)	**PET plastic**	**PEF plastic**	**Paper PEF**
Attitude*	-1.86 (2.90)	2.34 (1.87)	3.44 (2.29)
Willingness to pay	£0.80 (0.36)	£1.03 (0.38)	£1.12 (0.42)

*Mean composite of favourable and unfavourable attitudes (range – 6 to 6).

The same pattern was found for willingness to pay (WTP). Participants indicated that they would be willing to pay more for a bio-based bottle (M = £1.08, SD = 0.37) than for a fossil-based bottle (M = £0.80, SD = 0.36), $t(528) = -21.78$, $p < .001$, $d = 0.29$, 95 % CI [−0.30, −0.25]. Participants were willing to pay the least for PET plastic, followed by PEF plastic, and the most for paper PEF (Table 5). Paired sampled *t*-tests examined whether the attitudes and WTP were lowest for the PET plastic bottle, and whether there was a difference between the PEF plastic and paper PEF[12]. Attitudes and WTP differed for all bottle types (all *p*s < .001; Table 6). This supports both H1 and H2.

Attitude on Bottle Choice

We hypothesised that attitudes would relate to bottle choice (H3). We pre-registered a correlational analysis, but realised that would not be sufficient to test the full hypothesis. Correlations would only inform us whether bottle choice in general related to different attitudes. To determine which attitude aspects (e.g., unfavourable attitude towards PET plastic, favourable attitude towards paper PEF) drove the choice for a specific bottle, we instead conducted a logistic regression. In all cases, PET plastic was used as the reference category.

Table 6. Paired-Sample Tests: Attitudes and WTP by Bottle Comparisons.

		t	*d*	*p*	95% CI of the Difference	
					Lower	**Upper**
Attitude Pair	PET – PEF	-27.7	3.5	< .001	-4.50	-3.90
	PET – Paper PEF	-28.4	4.3	< .001	-5.66	-4.93
	PEF – Paper PEF	-10.1	2.5	< .001	-1.31	-0.89
WTP Pair	PET – PEF	-20.8	.26	< .001	-0.26	-0.21
	PET – Paper PEF	-19.5	.38	< .001	-0.35	-0.29
	PEF – Paper PEF	-7.13	.28	< .001	-0.11	-0.06

12 Even when using the Bonferroni method to correct for multiple testing (0.05 / 3 for both attitudes and WTP), the *p*-values were still statistically significant (all *p*s < 0.001).

Participants were more likely to choose the PEF plastic over the PET bottle when their positive attitude towards PET was low ($b = -0.59$, Wald $\chi^2 = 9.64$, $p = .020$) and their positive attitude towards PEF plastic was high ($b = 0.55$, Wald $\chi^2 = 4.80$, $p = .029$). None of the other factors were significant (Table S2).

Participants were more likely to choose the paper PEF bottle over the PET plastic bottle when their positive attitude towards PET was low ($b = -0.78$, Wald $\chi^2 = 16.55$, $p < .001$) and their positive attitude towards paper PEF was high ($b = 1.12$, Wald $\chi^2 = 22.89$, $p < .001$). The positive attitude towards paper PEF appeared to be the largest driver of the effect. None of the other factors were significant.

In sum, less positive attitudes towards PET, and positive attitudes towards the bio-based choice, both related to choosing PEF plastic and paper PEF bottles.

Environmentalist Identity

We hypothesised that identifying as an environmentalist would be positively correlated with choosing a sustainable bottle (i.e., PEF plastic or paper PEF), the willingness to pay more for the bio-based bottles (compared to low-identifiers), and with completed WEPT rounds (H6). As with the effect of attitude on bottle choice, we pre-registered a correlational analysis, but realised that a multinomial logistic regression would better determine whether environmentalist identity relates to the choice of the different bottle types. PET plastic was used as the reference category.

Bottle Choice

People identifying more vs. less as environmentalists did not differ in choosing the PEF plastic bottle, $b = 0.20$, Wald $\chi^2 = 1.16$, $p = .281$. Environmentalist identification did relate to the choice of the paper PEF bottle, $b = 0.57$, Wald $\chi^2 = 10.15$, $p < .001$. This hypothesis was partially supported: participants who identified more as environmentalists more often chose the paper PEF bottle, but not the plastic PEF bottle that was visually identical to the conventional fossil-based option.

Willingness to Pay

Participants who identified more as environmentalists were willing to pay more for bottles made from PEF plastic, $r(527) = 0.092$, $p = .034$, 95 % CI [0.01, 0.18], and especially paper PEF bottles, $r(527) = 0.23$, $p < .001$, 95 % CI [0.15, 0.31] in a bootstrapped Pearson correlation (5000). Willingness to pay for the conventional PET plastic bottle did not correlate with environmentalist identity, $r(527) = -0.056$, $p = .199$, 95 % CI [−0.14, 0.03].

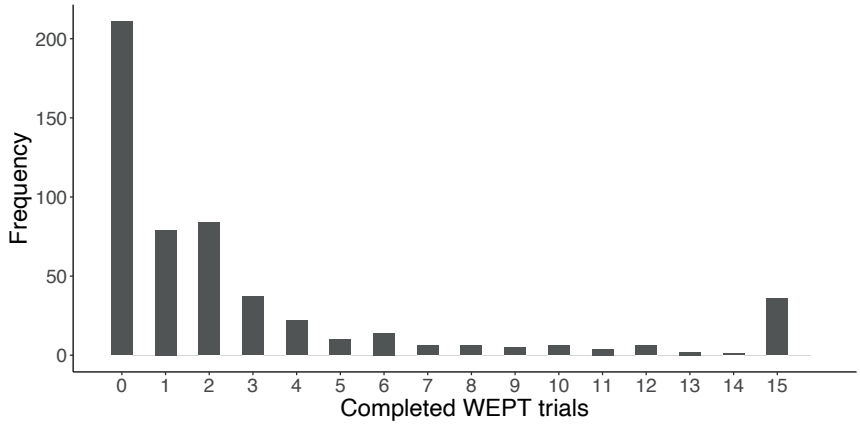


Figure 1. Histogram of the WEPT (Pro-Environmental Behaviour).

WEPT

Most participants (60.1 %) completed at least one WEPT trial ($M = 2.78$, $SD = 4.23$) (Figure 1). 36 participants (6.8 %) completed all the trials. The more participants identified with being an environmentalist, the more time they invested in the WEPT task, $r(527) = 0.183$, $p < .001$, 95 % CI [0.10, 0.26] (Table 7). The WEPT also positively correlated with choice of the bio-based bottles, $r(527) = 0.11$, $p = .012$, BCa 95 % CI [0.21, 0.20].

Pre-Registered Exploratory Analyses

Attitude on Willingness to Pay

A multiple regression (rather than the pre-registered ANOVA, because of the ordinal nature of the attitude variables) assessed the effect of overall attitude towards the different kind of materials on the WTP for the different bottle types, while controlling for environmentalist identity.

The more negative participants' attitude towards paper PEF ($\beta = -0.16$, $p < .001$, 95 % CI_B [−0.04, −0.01]), and the more positive their attitude towards PEF plastic ($\beta = 0.10$, $p = .028$, 95 % CI_B [0.002, 0.04]), the more they were willing to pay for the PET plastic bottle. Attitude towards the PET plastic bottle did not relate to WTP, ($\beta = -0.02$, $p = .74$, 95 % CI_B [−0.01, 0.01]).

Table 7. Correlations (5000 Bootstraps).

	1	2	3	4*	5	6*	7	8	9
1. PET WTP									
2. PEF plastic WTP	.76^{z}								
3. Paper PEF WTP	.54^{z}	.76^{z}							
4. Bio-based bottle choice*	-.10^{x}	.03	.06						
5. Political orientation (conservatism)	-.03	-.15^{z}	-.20^{z}	-.05					
6. WEPT trials*	-.05	.02	.04	.11^{x}	-.16^{z}				
7. Environmentalist ID	-.06	.09^{x}	.23^{z}	.11^{x}	-.35^{z}	.18^{z}			
8. PET attitude	.04	-.02	-.11^{x}	-.19^{z}	.12^{y}	-.04	-.11^{x}		
9. PEF plastic attitude	.05	.13^{y}	.01	-.09	-.08	.09	.06	-.03	
10. Paper PEF attitude	-.13^{y}	-.03	.09^{x}	.14^{y}	-.11^{y}	.14^{y}	.15^{z}	-.36^{z}	.29^{z}

Note. ^{x} $p < .05$; ^{y} $p < .01$; ^{z} $p < .001$; * Spearman correlation instead of Pearson correlation. 'Bio-based bottle choice' combines the choices of the PEF plastic and the paper PEF bottle because their carbon footprint is similar compared to PET plastic, and because it simplifies the analyses and communicating the results.

Both a more positive attitude towards PEF plastic, ($\beta = 0.15$, $p < .001$, 95 % CI_B [0.013, 0.049]) and a more negative attitude towards paper PEF ($\beta = -0.16$, $p < .001$, 95 % CI_B[−0.041, −0.010]) related to WTP for the PEF plastic bottle. Attitude towards the PET plastic bottle had no effect, $\beta = -0.041$, $p = .38$, 95 % CI_B [−0.02, 0.007]. Higher identification as an environmentalist also lead to higher WTP for the PEF plastic bottle, $\beta = 0.032$, $p = .032$, 95 % CI_B [0.002, 0.049].

Only environmentalist identity ($\beta = 0.22$, $p < .001$, 95 % CI_B [0.04, 0.09]) related to WTP for the paper PEF bottle. In summary, attitudes towards the bio-based bottles had the strongest relation to WTP for the PET and PEF plastic bottles. WTP for the paper PEF bottle was related to other factors, including participants' identification as an environmentalist.

DISCUSSION

Plastic is an increasingly large contributor to climate change and novel alternatives to fossil-based plastic such as PEF are under development. However, just creating sustainable technologies will not slow climate change by itself, because consumers have to adopt these novel technologies (Filho et al., 2022; Ketelsen et al., 2020). We examined the psychological factors that determine consumers' attitudes and willingness to pay for different types of plastic bottles.

Participants clearly preferred and indicated being willing to pay more for the visually distinct paper PEF over PEF plastic, and for PEF plastic over PET plastic; indeed, 70 % chose the paper PEF bottle. Psychological variables such as attitudes and environmentalist identity helped explain preferences for the different bottles. For example, less positive attitudes towards PET and more positive attitudes towards the bio-based options were associated with choosing PEF plastic and paper PEF bottles. The more participants identified as an environmentalist, the more likely they were to choose the paper PEF bottle, pay more for bio-based bottles, and spend more time on a pro-environmental behaviour task. There was no difference in bottle choice between the experimental conditions that manipulated social context.

Positive Attitudes Towards Bio-Based Plastic

Participants held positive attitudes towards bio-based plastic, indicated being willing to pay more for it, and, irrespective of social context, chose a bio-based bottle (96.8 %) over a fossil-based one. This replicates previous research finding more positive attitudes and higher willingness to pay (WTP) for bio-based plastic (Chapter 2; Chapter 3; De Marchi et al., 2020; Gaffey et al., 2021).

Not only were consumers positive about bio-based plastic, but they were willing to pay up to 40 % more for bio-based compared to fossil-based products. This is encouraging, given that early small production volumes are partially responsible for initially making new products and materials more expensive. These findings signal to companies that consumers are demanding more sustainable products and that there might be a commercial upside to providing more sustainable bio-based plastic products.

These results extend previous work on observability by showing that both positive attitudes and WTP were highest for the visually distinct paper PEF bottle, followed by the PEF plastic bottle, followed by the PET plastic bottle. That the visually distinct sustainable option was overwhelmingly rated more favourably and as more valuable aligns with signalling theory, which suggests that sustainable products can serve as a signal of social status by signalling wealth and prosocial traits (Berger, 2017; Berger, 2019; Braun Kohlová & Urban, 2020). For this beneficial signalling to work, the pro-environmental behaviour needs to be observable by others, for example by being visually recognisable as a sustainable choice. Participants choosing the paper PEF over the PEF plastic bottle therefore correspond with previous research findings on consumers paying more for clearly identifiable sustainable choices (e.g., Sexton & Sexton, 2012). These results suggest that using visually distinct packaging or appearances for sustainable alternatives could increase sales of sustainable products. This corresponds with the findings by De Marchi et al. (2020), who found a higher WTP for materials with easily recognisable sustainable characteristics. Given the distinct differences in attitudes and WTP towards the three bottles, communicating the differences in attributes between

different products is not trivial. Previous research found a lack of knowledge and misconceptions about bio-based plastic (Chapter 2; Chapter 3; U. Kainz et al., 2013; Ruf et al., 2022). Therefore, communicating the benefits and harms of different materials remains critical (Ketelsen et al., 2020).

This research focused on beverage bottles. While the findings about attitudes and willingness to pay were aligned with studies of other bio-based products, e.g., sand toys for children (Scherer et al., 2017) and sports equipment (Scherer et al., 2018), they might not generalise to all bio-based products (Ruf et al., 2022). Similarly, these null results for social context may be specific to these products and this study context.

Factors Influencing WTP and Product Uptake

There is increasing attention to attitudes about bioplastic in general (e.g., Filho et al., 2022). In this study, we provided evidence for a specific product in a more psychologically realistic scenario, moving this research along the continuum from attitudes towards intention and behaviours. We found that attitudes towards the bio-based bottles related to WTP for the PET and PEF plastic bottles. This suggests that a marketing focus on the positive characteristics of bio-based products may be more effective than emphasising the negative impact of fossil-based products. In addition to attitudes, many other factors might influence individuals to behave more sustainably. Environmentalist identity and political orientation were both linked to WTP for bio-based bottles in the present research and associated with other pro-environmental behaviours in the literature (Brick & Lai, 2018; Brick et al., 2017). This would suggest that targeting environmentally concerned and politically left-wing consumers might be most effective when first introducing sustainable technologies such as bio-based plastic.

No Effects on Bottle Choice of Being Observed nor Social Group

The type of social group people had in mind when making the decision did not appear to affect bottle choice. This may be due to the use of scenario vignettes. Participants who imagined the scenario less clearly made less sustainable choices, but there were no differences in scenario immersion between conditions. The social group manipulation might also have been ineffective or too subtle. However, participants indicated that they felt higher collective self-esteem in the most valued condition than in the least valued condition.

The effect of observability on sustainable behaviours might also be smaller or less general than previous literature would suggest. A recent Registered Report did not find any evidence that being observed changed pro-environmental behaviour (Lange et al., 2020). Brick and Sherman (2021) conducted three experiments in which they tested for and did not find visibility effects, even though they employed a different manipulation of visibility in each study, and investigated a range of pro-environmental preferences and

behaviours. Given the large body of previous literature, we suspect there are genuine effects of reputation management, demand, and signalling with pro-environmental behaviours, although they appear to be more elusive than originally thought.

Other Limitations and Future Directions

Participants might have preferred the paper PEF bottle not solely because of its appearance and signalling properties, but because it seemed more sustainable than the plastic PEF. An alternative way of testing might be to keep the properties of the PEF and the paper PEF bottle constant and just vary the appearance. Both bottles exist and are expected to reach the market in 2024 (Avantium, 2022a, 2022b).

We cannot rule out an order effect in this design. All participants saw information about the PET plastic bottle first, followed by PEF plastic, followed by paper PEF. We consistently kept this order throughout to avoid confusion (as the names are very similar) and because knowledge of conventional PET plastic and its characteristics is crucial in understanding PEF plastic and its properties. As the paper PEF bottle is made from PEF, an understanding of PEF is required before seeing the paper PEF. Seeing the paper PEF last might have given of the impression that it was the most sustainable choice.

We investigated self-reported willingness to pay (WTP), not actual purchasing. WTP was related to actual behaviour in earlier work on plastic-related attitudes and behaviour (data Study 3, *Chapter 2*). In this study, we did not find a relationship between WPT and the objective WEPT task of donating time for environmental causes. However, the WEPT did relate to bottle choice. Given the well-known intention-behaviour gap (Sheeran, 2002), we encourage future studies to assess actual WTP.

The participants were highly educated and disproportionately female, which was not representative of the sample population. Some research suggests that education (e.g., Meyer, 2015) and gender (e.g., Vicente-Molina et al., 2018) can increase the likelihood of acting pro-environmentally. Future research with more representative samples is needed to test whether these results generalise to other populations including in the Global South (Ruf et al., 2022).

Future research could also investigate recycling behaviour with the paper PEF bottle. Consumers often harbour misconceptions about recycling bio-based plastic (*Chapter 3*) and the paper layer might lead to more confusion. Communicators will need to be careful about explaining that the two layers of the paper PEF bottle are separable and give disposal instructions, or these bottles will end up in the refuse stream.

CONCLUSION

The present study provides encouraging results about consumer attitudes and willingness to pay for bio-based plastic. The results suggest that there is consumer demand for these materials, as attitudes were positive and hypothetical willingness to pay higher for bio-based than for conventional fossil-based bottles. These outcomes related to other beliefs and factors such as environmentalist identity and suggest that more sustainable alternatives are not only in demand but that consumers might be willing to initially pay more for them. Future research could investigate actual purchasing behaviour, test the generalisability of these results to other bio-based products and different populations, and identify other individual difference and contextual factors influencing sustainable choices. Our findings also inform the potential marketing of bio-based products. We recommend that the sustainable nature of the product be made visible, and marketing focus on the positive aspects of the sustainable product, as well as clear communication about the key characteristics of the materials (e.g., biodegradability). Ultimately, such materials could help solve the problems of the current linear, extractive plastic industry based on fossil fuels.

CHAPTER 5

Intentions to Purchase a Sustainable Mobile Phone by Network Analysis in Four European Countries

Abstract

Most consumers say they are willing to consume more sustainably, but this does not often translate into commensurate behaviour. To investigate this discrepancy in the context of smartphone purchase, a pre-registered online study (total *N* = 2,202) was conducted in four countries: the Netherlands, Germany, France, and the United Kingdom. We used an attitude network approach to explore factors related to the intention to purchase a sustainable smartphone (the Fairphone 4). Across countries, psychological factors were more important than product and brand characteristics for intentions to buy a sustainable smartphone. In particular, joy and excitement, overall attitude, and green product interest related positively to purchase intentions, while the status of a product and feelings of uncertainty about the product correlated negatively with intentions. We discuss network analysis as a tool for information gathering and hypothesis generation, and give suggestions for how the results could inform marketing and communication strategies.

This chapter is based on:

Zwicker, M. V., van Harreveld, F., Zickfeld, J., & Brick, C. (2023, February 3). Intentions to Purchase a Sustainable Mobile Phone by Network Analysis in Four European Countries. Manuscript submitted for publication.

All supplementary materials, data, pre-registration documents, and analysis scripts are available on the Open Science Framework (https://osf.io/tjrg3/).

INTRODUCTION

In the last 50 years, the global consumption of electronic devices has increased sixfold (Belkhir & Elmeligi, 2018). Information and communication technologies will grow from 1% in 2007 to a projected 14% of global greenhouse gasses by 2040 (Cordella et al., 2021). Between 2010 and 2020, the greenhouse gas emissions associated with smartphones increased by 730% from 17 to 125 Mt-CO_2-e (Belkhir & Elmeligi, 2018), which is around the same as the CO_2 emissions of the whole country of Nigeria in 2020 (World Pupulation Review, 2022). The number of smartphones is rising particularly rapidly, caused both by increased market proliferation and short replacement cycles (under two years), subsidized by the two-year contracts of many telecoms (Belkhir & Elmeligi, 2018; Cordella et al., 2021). The environmental impact of smartphones varies during their lifecycle, from mining materials including precious metals, to manufacturing, energy consumption during use, and waste disposal. Less than 16% of discarded smartphones are recycled each year, creating e-waste, which can emit dangerous contaminants potentially damaging to both the environment and human health (Envirotech, 2019). The electronics industry also has issues with inadequate working conditions, compensation, insufficient health and safety routines, and labor law violations (TCO certified, 2014).

Buying a new smartphone is infrequent and has high environmental impact, especially compared to everyday pro-environmental behaviours (PEB) such as recycling or reusing shopping bags. 'Pro-environmental behaviour' describes a heterogeneous group of behaviours, including bringing a shopping bag, not eating meat, and installing solar panels. Psychological research often assumes that these behaviours are linked by a unitary psychological construct (Lange & Dewitte, 2019; Nielsen et al., 2021), which may be an overgeneralization (Brick et al., 2022). Different types of behaviour are influenced by different psychological and contextual factors (Ertz et al., 2016) and antecedents of everyday behaviours do not necessarily generalize to costlier and less frequent behaviours (Nielsen et al., 2021). We therefore included a variety of psychological variables related to everyday PEB to investigate their relationship to the intentions to purchase a smartphone (the Fairphone 4), an impactful real-world behaviour. We do so using an attitude network approach to visualise the relationships between psychological factors and purchase intentions across four different countries: The Netherlands, Germany, France, and the United Kingdom.

LITERATURE REVIEW

Move Towards Sustainability

Consumers play a key role in the mitigation of global warming. On one hand, the cumulative effect of individual consumption and disposal is devastating (Trudel, 2018). On the other hand, consumers can influence the market and aid the sustainable transition through their preferences and consumption patterns (De Marchi et al., 2020). Demand influences the types of products that are produced (Gaffey et al., 2021). Many consumers appear willing to contribute to a more sustainable society, as the majority sometimes considers the environment when shopping (Groening et al., 2018; Testa et al., 2021). Some companies are responding to this demand by marketing new products and services as environmentally friendly. However, despite endorsing environmental values and the increasing amount of green products on retail shelves, consumers are not buying green products and services as much as expected (Gleim et al., 2013; Park & Lin, 2020; Young et al., 2010). Despite the importance of determining whether consumers will choose a green product, the decision process is not well understood (ElHaffar et al., 2020; Park & Lin, 2020; Trudel, 2018). While purchase behaviour is often influenced by a great variety of factors, previous research often focused on a single or a few groups of factors, rather than providing a comprehensive picture (Testa et al., 2021).

Using Attitudes to Understand Consumer Behaviour

Companies often focus on consumers' preferences when designing marketing strategies. Specifically, companies use consumer profiles to categorize and target specific consumer groups and increase sales. This segmentation divides the market into types of customers that behave in a similar way or have similar needs (e.g., based on purchase behaviour, usage, demographics, or geography), and who might respond similarly to marketing (Amine & Smith, 2009; Jadczaková, 2013). For example, companies might categorize certain consumers into 'light green' (early adopters of sustainable products) or 'dark green' (pioneers of sustainability). Such segmentation can also be useful beyond marketing, for example by facilitating effective messaging, or for characterizing distinct audiences based on climate change beliefs (Kácha et al., 2022). To investigate consumer segments, we separately analysed four countries in this research. However, consumer profiles are also a simplification that aggregates how consumers differ between and within segments. Segmentation has therefore also been criticized for stigmatizing the relevant groups and uncertainty about whether the groups are socially constructed rather than discovered (Brick et al., 2022; Kácha et al., 2022).

Attitudes might provide a more nuanced view for trying to understand and change the consumer behaviour of smartphone purchase. An attitude is an enduring evaluation of an object, person, or event. This evaluation can include beliefs (cognition), feelings

(affect), as well as intentions and behaviours (Bhattacherjee & Sanford, 2009). Attitudes and perceived difficulty are the main predictors of behaviour (Kaiser et al., 2021; Taube et al., 2018). Positive attitude toward sustainable products is the starting point to stimulate sustainable consumption (Kaiser et al., 2020; Park & Lin, 2020; Chapter 4), with attitudes towards a product having the highest impact on purchase intentions of that product (Rausch & Kopplin, 2021; Zhuang et al., 2021).

A New Kind of Smartphone

As a reaction to the severe issues in the smartphone lifecycle, several companies produce more sustainable smartphones, including Fairphone (Fairphone, 2022), SHIFT (Shift, 2022), and Teracube (Teracube, 2022). These companies aim to lower the environmental and social impact of the electronics industry by creating products with a longer lifespan, reduced e-waste, fairer materials, and improved working conditions. Modular and/or easy-to-repair smartphones with long warranties ensure longevity. The market share of these more sustainable phones is still very small and mostly limited to Europe. As of February, Fairphone has sold about 400,000 and SHIFT around 70,000 devices, but their sales are expected to increase (Schweiger, 2022). More established companies are also pledging to become more sustainable. For example, Apple committed to be 100% carbon neutral for its supply chain and products by 2030 (Apple, 2020).

In this research, we focused on the electronics manufacturer Fairphone. In particular, we examined which psychological factors were related to the purchase intentions of their newest product, the Fairphone 4. The present research was conducted in the four countries with Fairphone's largest market share: Germany, France, The Netherlands, and The United Kingdom.

Factors Affecting Purchase Intention

Purchase intentions are frequently used to make strategic decisions concerning both new and existing products, forecast future demand, test which geographic market and consumer segment to target, pre-test advertising and promotions, and to proxy purchase behaviour (Morwitz et al., 2007). Since actual behaviour is difficult to measure in part because it is relatively infrequent, we chose to focus on purchase intentions as a proxy. However, there can be a substantial gap between intentions and behaviours (Sheeran & Webb, 2016).

Numerous theories detail the psychological factors that relate to pro-environmental intentions and behaviours (Table 1). The most frequent psychological factors include: attitudes, norms, motivations, values, perceived behavioural control/efficacy, affect/emotions, perceived responsibility, pro-environmental identities, habits, and situational factors (also see Gifford et al., 2011). Other factors such as status (Berger, 2017; Vesely et al., 2020), trust (Bray et al., 2010; Gleim et al., 2013; Joshi & Rahman, 2015), and product

characteristics (e.g., price, features) also appear important (Joshi & Rahman, 2015; Testa et al., 2021).

In the present research, we included emotions, attitude, trust, status, pro-environmental identity, social norms, previous consumer behaviour, (egoistic) values, prior knowledge, and some factors related to the product and producer such as technical features of the phone. This broad range of variables provides good coverage for the key factors expected to be related to the purchase intentions of a more sustainable smartphone.

Table 1. Selection of Psychological Theories Predicting Intentions and Behaviour

Theory	Psychological factors related to intentions or behaviour	Reference
Theory of Planned Behaviour	Attitudes, subjective norms, perceived behavioural control	(Icek Ajzen, 1991)
Value Belief Norm Theory	Values, problem awareness, outcome efficacy, personal norms	(Stern, 2000)
Norm Activation Model	Perceived behavioural control, responsibility, norms, attitude, emotions (pride and guilt)	(Onwezen et al., 2013)
Value Identity Personal Norm Model	Values, environmental self-identity, personal norm	(van der Werff & Steg, 2016)
Comprehensive Action Determination Model	Normative processes, habitual processes, situational influences	(Klöckner & Blöbaum, 2010)
Social Identity Model of Collective Action	Injustice, identity, efficacy	(van Zomeren et al., 2008)
Social Identity Model of Pro-Environmental Action	Ingroup identification, collective efficacy beliefs, ingroup norms and goals, social identity, emotions and motivations, appraisal	(Fritsche et al., 2018)

Attitude Network Approach

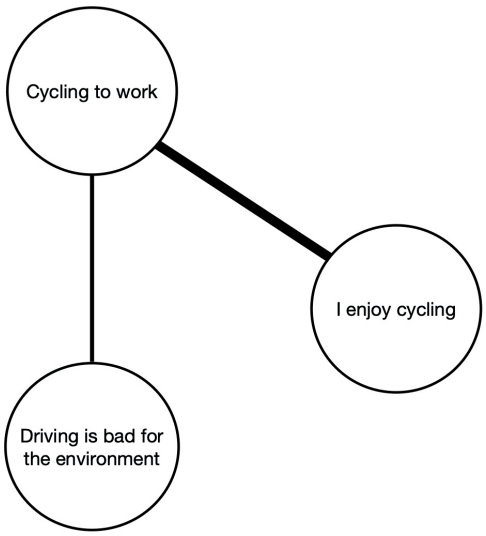
In this study, we used an attitude network approach (Dalege et al., 2016) to visualise consumer attitudes and investigate factors that might relate to purchase intention. Attitude networks represent psychometric networks in which different variables, or evaluative reactions (called *nodes*) are conditionally related to each other (via so-called *edges*; Borsboom et al., 2021). Each object in an attitude network could represent beliefs, feelings, or behaviours towards the attitude object.

Consider a person's attitude towards cycling and imagine that a person thinks cars are bad for the environment and really enjoys cycling. These two evaluative reactions (an attitude and an emotion respectively) relate strongly to that person deciding to cycle to work (a behaviour). These three nodes constitute a simple network (Figure 1).

The individual nodes differ in how strongly they are connected. A connecting edge means that two nodes are conditionally dependent taking into account all other nodes in the network. Edge strength can be estimated with partial correlations. Evaluative reactions that are similar to one another tend to cluster together (Dalege et al., 2016). Similar evaluative reactions are more strongly related to each other than dissimilar ones (Dalege, Borsboom, van Harreveld, & van der Maas, 2017). For example, enjoying cycling may be more strongly connected to cycling to work than to knowing that driving is bad for the environment (Figure 1). Attitude networks are a useful descriptive starting point for characterising context and populations and establishing relationships between concepts (see Scheel et al., 2021 on the importance of descriptive research). Importantly, cross-sectional attitude networks do not provide strong evidence about causation.

The added value of a network analysis over other approaches, e.g., over a correlation matrix, is that networks provide better visualisations, and are easier to interpret (cf. Jones et al., 2018) and build theories from. Attitude networks also visualise the indirect relationships between variables and provide information on the structural importance of the different nodes (centrality), which may help infer which evaluative reactions are most likely to influence decision making (Dalege, Borsboom, van Harreveld, Waldorp, et al., 2017). Mathematical proofs show that network models are equivalent to latent variable modes or factor analysis (Sacha Epskamp et al., 2018). While factor analysis reduces a large number of variables into fewer numbers of factors by extracting maximum common variables from all items, network models visualise the pattern of interconnectedness. It is also possible to compare different networks across countries or demographics.

Figure 1. Hypothetical Attitude Network Towards Cycling to Work



Note. Each node represents evaluative reactions and the width of the connecting lines (edges) represent their conditional independence (e.g., the strength of the partial correlation).

Network models have been applied to other sustainability attitudes. For example, in *Chapter 3* we visualised perceptions towards plastics to determine which evaluative reactions related most strongly to people's willingness to pay for a hypothetical bio-based plastic bottle. We determined which nodes to include with a qualitative method: asking participants to note down thoughts that came to mind about different plastic types. This type of introspective research has merits but it only examines factors that participants are aware of and consider important. The current research took a more theoretical approach to selecting nodes based on factors previously linked to pro-environmental behaviour. We further extend the previous research by focusing on an existing consumer product (a Fairphone smartphone) using existing marketing material. When participants in an online study see the same marketing materials used by the company itself, the responses are more likely to correspond to consumers' purchasing outside of the study (i.e., greater ecological validity).

As this study was exploratory and descriptive, there were no directional hypotheses. The pre-registration, data, and materials are available on the Open Science Framework (https://osf.io/tjrg3/?view_only=28e84172b08f4e55b68eeb613bfa3e39).

METHOD

The survey was conducted online through Prolific.co in the United Kingdom, Germany, France, and the Netherlands in their respective languages. The items were developed in English and then translations were done by native speakers with academic backgrounds and edited by a second native speaker. The English version of the questionnaire can be found in the Supplements.

Participants

Epskamp (2016) suggested that a sample size of 250 is sufficient for moderately sized networks (around 25 nodes) based on continuous data. We expected to create networks around that size but decided to recruit double the participants because the size of the network could vary depending on how many nodes were included (see the pre-registration). We pre-registered recruiting 550 per country to allow for possible exclusions. In total, we recruited 2,223 participants. We excluded participants who reported a substantially high annual net income (> €1m, n = 4) and participants who finished less than 70% of the questionnaire (n = 17) (these exclusions were not pre-registered). The final sample contained 2,202 participants with about 550 each from the United Kingdom, Germany, France, and the Netherlands (Table 2).

Table 2. Demographics.

	Netherlands *n* **= 547**	**Germany** *n* **= 543**	**France** *n* **= 563**	**United Kingdom** *n* **= 549**
Gender	49.8% male 47.6% female 2.6% other	49.0% male 49.9% female 1.1% other	49.8% male 47.5% female 2.7% other	49.9% male 49.4% female 0.7% other
		Mean (*SD*)		
Age	28.0 (9.1)	29.7 (9.8)	29.0 (9.69)	42.4 (14.3)
Education in years	15.6 (4.3)	14.1 (3.3)	15.2 (3.7)	16.0 (3.4)
Rurality*	2.20 (1.0)	2.13 (1.2)	1.98 (1.1)	2.64 (1.0)
Political orientation**	4.17 (2.0)	4.14 (1.9)	4.37 (2.1)	4.87 (2.1)
Net income/year k€	38.4 (69.6)	30.0 (34.0)	27.8 (27.5)	38.9 (39.0)

* 1 = A big city, 2 = The suburbs or outskirts of a big city, 3 = A town or a small city, 4 = A country village, 5 = A farm or home in the countryside
** 1 = very left-wing/progressive, 11 = very right-wing/conservative

Procedure

Participants who tried to complete the survey on a mobile phone were automatically screened out. This was done to ensure that everyone was able to view the Fairphone marketing materials and image (which contained small text and numbers) with the same ease, and to reduce the likelihood of participants completing the survey in potentially distracting surroundings. The remaining participants received information about the study and agreed to the consent form. They then indicated their prior knowledge about Fairphone before reading an informational text about Fairphone that was accompanied by a graphic. Participants then responded to questions assessing their emotions and overall attitude about the Fairphone 4, and indicated how much trust they had in the Fairphone organisation and the phone. Afterwards, participants indicated their intentions to buy a Fairphone. This was followed by questions about the importance of 11 product and brand characteristics and status when purchasing a new phone. Participants then reported their interest in green products, indicated how much they identified as an environmentalist, their values, and responded to questions about social norms. After filling in the demographic questions and receiving the option to learn more about Fairphone, they were debriefed and paid.

Measures

Unless otherwise indicated, all items were measured on 7-point Likert scales. The Cronbach alphas for all scales are in Table 3.

Prior Knowledge About Fairphone

As Fairphone is a relatively young and unknown company, we gauged how much knowledge participants had about Fairphone and their objectives. We asked participants: "Which of these companies strive(s) to use fair, recycled, and responsibly mined materials in their phones?" and "Which of these companies has modular, easy-to-repair phones?" In both cases we provided them with five response options: *Apple*, *Fairphone*, *Nokia*, *OnePlus*, and *Samsung* and told the participants to "Select all that apply". We also inquired how familiar participants were with the Fairphone brand from 1 (*very unfamiliar*) to 7 (*very familiar*).

Information About Fairphone

In order to make sure that all participants were relatively familiar with Fairphone and the Fairphone 4, participants read about 100 words about the Fairphone company, their mission, and the Fairphone 4. The text was accompanied by a screenshot taken from the Fairphone website, displaying the Fairphone 4, its price (adjusted per country), and the colour and memory options.

Purchase Intention

The main outcome variable was purchase intentions measured by agreement from 1 (*completely disagree*) to *7* (*completely agree*) with three statements: "I am considering buying a Fairphone", "I am willing to switch to Fairphone", and "The next time I am buying a new phone, I will buy a Fairphone". The responses to these three statements were combined into a 'purchase intention' mean composite score.

As a measure of actual behaviour, we also included a link at the end of the survey that participants could voluntarily follow to learn more about the Fairphone 4 and the brand and its aims. However, due to a technical error, the number of participants who clicked the link was not recorded.

Table 3. Cronbach Alphas and Composite Scale Means by Country.

Variable	Netherlands		Germany		France		United Kingdom	
	α	*M (SD)*	*α*	*M (SD)*	*α*	*M (SD)*	*α*	*M (SD)*
Overall attitude	.82	5.2 (0.8)	.87	5.6 (0.8)	.82	5.5 (0.8)	.89	5.5 (0.8)
Trust	.81	5.7 (0.8)	.86	5.7 (0.9)	.81	5.6 (0.9)	.87	5.8 (0.9)
Purchase intention	.92	3.6 (1.6)	.92	3.9 (1.5)	.88	3.6 (1.5)	.92	4.0 (1.5)
Status	.88	2.8 (1.4)	.93	2.4 (1.4)	.89	2.7 (1.4)	.91	2.5 (1.4)
Green product interest	.92	4.1 (1.1)	.90	4.5 (1.1)	.91	4.6 (1.1)	.93	4.4 (1.2)
Environmental identity	.92	3.0 (1.4)	.91	4.1 (1.4)	.90	4.0 (1.4)	.95	3.9 (1.5)
Egoistic values	.77	4.0 (1.1)	.78	4.0 (1.2)	.80	3.9 (1.2)	.79	3.6 (1.2)
Norms	.94	3.8 (1.3)	.94	4.2 (1.3)	.93	4.4 (1.3)	.82	4.8 (1.2)
Political orientation	.91	4.2 (2.0)	.92	4.1 (1.9)	.92	4.4 (2.1)	.94	4.9 (2.1)

Emotions About the Fairphone

Participants indicated how much of the following emotions they felt when thinking about buying or using a Fairphone from 1 (*completely disagree*) to 7 (*completely agree*): worry, joy, guilt, sadness, anger, uncertainty, excitement, pride, awe, hope, and annoyance. This measure was adapted from *Chapter 3*, which assessed the first seven emotions. We added three positive emotions that have been linked to pro-environmental intentions and behaviour, pride (Bissing-Olson et al., 2016; Onwezen et al., 2013; Schneider et al., 2017; Shipley & van Riper, 2022), awe (Skurka et al., 2022; Zelenski & Desrochers, 2021; Zhao et al., 2018), and hope (Ojala, 2012; van Zomeren et al., 2019). We also added annoyance, as people might feel annoyed or frustrated by the current increased focus on sustainability of products and policies.

Overall Attitude

As Fairphone is relatively new and this research was mainly exploratory, we assessed participants' general attitude towards the Fairphone 4. This was done using semantic differentials. We showed participants seven pairs of polar adjectives (e.g., bad-good, unreliable-reliable) (see Figure 3). Participants rated the Fairphone on each of the 7-point differentials.

Trust

Participants reported their trust in Fairphone with four items ranging from 1 (*completely disagree*) to 7 (*completely agree*). The first three were adapted from van Prooijen (2019) but we made adjustments to simplify the wording and relate the items to the Fairphone organisation. Each item measures one of the factors known to influence perceived trustworthiness: ability, integrity, and benevolence (Mayer et al., 1995). For example, this item assessed integrity: "I think the Fairphone organisation is guided by sound morals." We also included one item that assessed trust in the mobile phone (rather than the Fairphone organisation): "I consider the Fairphone smartphone to be a reliable product."

Product and Brand Characteristics

We assessed the importance of 11 characteristics when purchasing a new phone: price; appearance; technical specifications; quality of the phone; size; camera; sustainability of the phone; treatment of the workforce; the brand's reputation; customer service; and sustainability of the company. These were based on previous literature and Fairphone's market research (see van den Heuvel, 2020). Participants responded to the following question for each of the characteristics on a scale from 1 (*not very important*) to 7 (*very important*): "How important is …. to you when you purchase a new phone?" These items were analysed separately.

Status

We used the Status Consumption Scale (Eastman et al., 1999; used in Goldsmith & Clark, 2012) to assess how much the status of a product mattered to the participants. Participants indicated how much they agreed from 1 (*completely disagree*) to 7 (*completely agree*) with the scale's five items (e.g., "I would pay more for a product if it had status.").

Green Product Interest

The ethically minded consumer behaviour scale (Sudbury-Riley & Kohlbacher, 2016) was used to measure green product interest. This 10-item scale assessed how important it was to participants that products they buy are sustainable and ethical. Participants indicated how true statements were such as "I will not buy a product if I know that the company that sells it is socially irresponsible" from 1 (*never true*) to 7 (*always true*).

Environmentalist Identity

We assessed how much participants identified with being an environmentalist (Brick & Lai, 2018; Brick et al., 2017). This 4-item Likert-type measure included items such as "I see myself as an environmentalist" rated from 1 (*completely disagree*) to 7 (*completely agree*).

Egoistic Values

We used the egoistic value orientation subscale (De Groot & Steg, 2007) to determine how important from 1 (*not very important*) to *7* (*very important*) participants valued these principles: social power, wealth, authority, being influential, and being ambitious. Only this subscale was chosen, as the other values (altruistic and biospheric) overlap with other measures in this study and were omitted for time constraints.

Pro-Environmental Norms

Norms were assessed with two sets of three items adapted from Bissing-Olson et al. (2016). Participants indicated (dis)agreement with three statements about the environmental actions of people close to them (e.g., "Most people who are important to me act in environmentally-friendly ways.") on a scale from 1 (*completely disagree*) to 7 (*completely agree*). Participants then responded to the same items about the expectations of close others about the participant's behaviour (e.g., "Most people who are important to me expect me to act in environmentally-friendly ways.").

Demographics

Participants reported their age, gender, education (completed years of education), and household income. We also asked participants to indicate whether they lived in a city or the countryside (rurality). Political orientation was assessed with four items on a 11-point Likert scale. Participants placed themselves on a political left-right and progressive-

conservative continuum, as well as two more left-right continua for economic and then social issues (measure adapted from Zwicker et al., 2020).

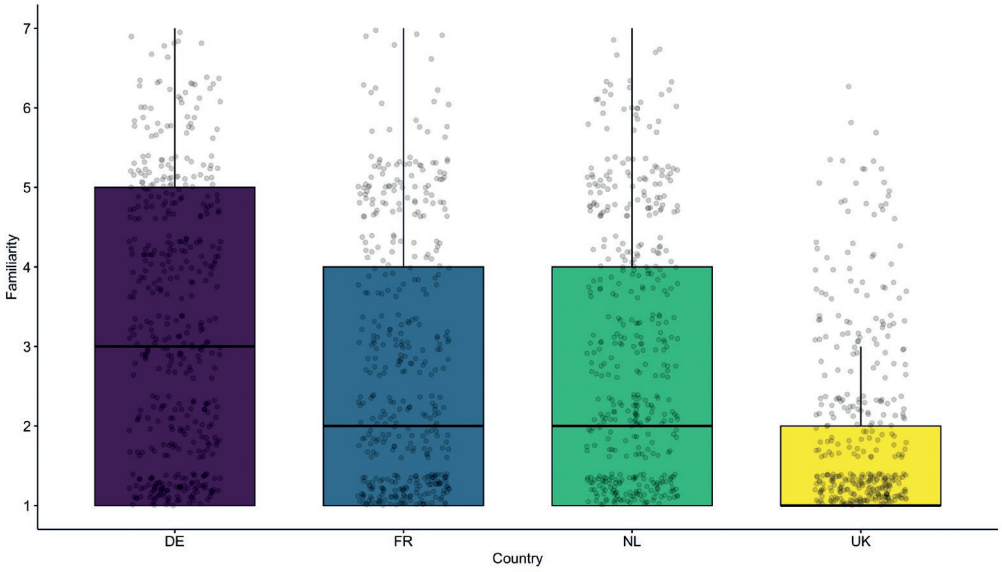
RESULTS

All analyses were pre-registered and identical across countries except where explicitly noted. The data, scripts, and additional information are on the Open Science Framework (link in section 2.6). Alpha was set at .05 and all analyses were conducted in R 4.2.2 (R Core Team, 2022).

Prior Knowledge

As expected, participants were unfamiliar with the Fairphone brand, $M_{overall} = 2.44$ (Figure 2 for country medians and *SD*s). A Kruskal-Wallis test (not pre-registered but used because of the skewed nature of the outcome variable) revealed significant differences in familiarity with the Fairphone across countries, $H(3) = 205$, $p < .001$, $\eta 2 = .09$, 95% CI [.07, .12]. A post-hoc pairwise comparison using Wilcoxon rank sum test with corrections for multiple testing showed significant differences between all countries (*p*s < .036). Of the four countries, Germans were most familiar with Fairphone followed by the Dutch and the French, and the British least familiar (Figure 2).

Figure 2. Boxplots of Familiarity with Fairphone by Country.

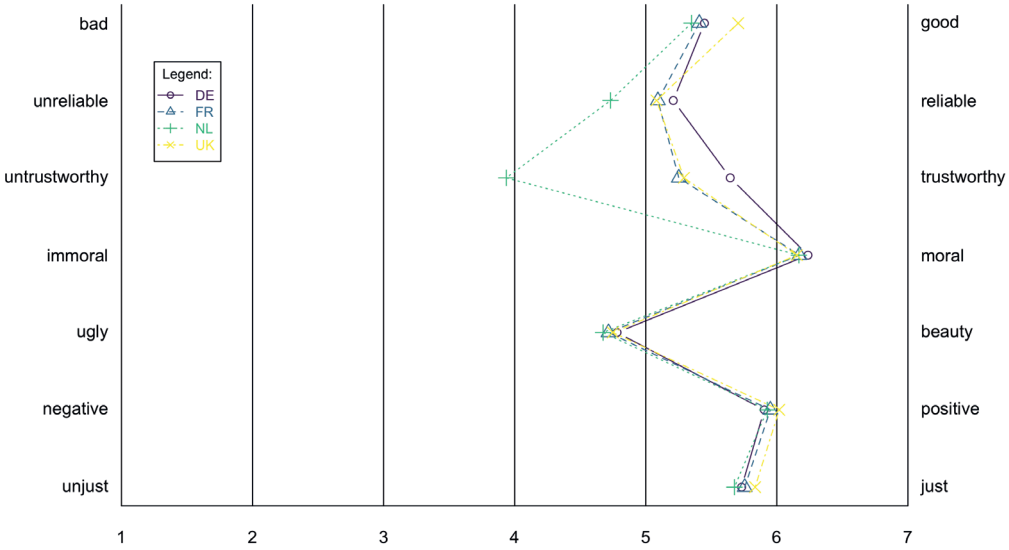


Note. The horizontal line represents the median and the coloured boxes the interquartile range.

Attitude Towards Fairphone

Overall, participants were positive about the Fairphone (M = 5.45, SD = .81). Figure 3 visualises participants' mean attitudes across countries and shows that most responses are on the positive side of the semantic adjective pairings. The overall pattern was similar across countries, but one-way ANOVA results (not pre-registered) found a significant main effect by country, $F(3, 2209) = 23.76$, $p = <.001$, $\eta 2 = .03$. Post-hoc comparisons revealed that the Dutch were less positive about Fairphone (M = 5.21, SD = .75) than the French (M = 5.48, SD = .75, d = -.36 [-.47, -.24]), British (M = 5.55, SD = .83, d = -.43 [-.54, -.30]), and Germans (M = 5.56, SD = .83, d = -.45 [-.57, -.33]). These differences were mainly driven by the Dutch perceiving the Fairphone as less trustworthy and less reliable than the other countries.

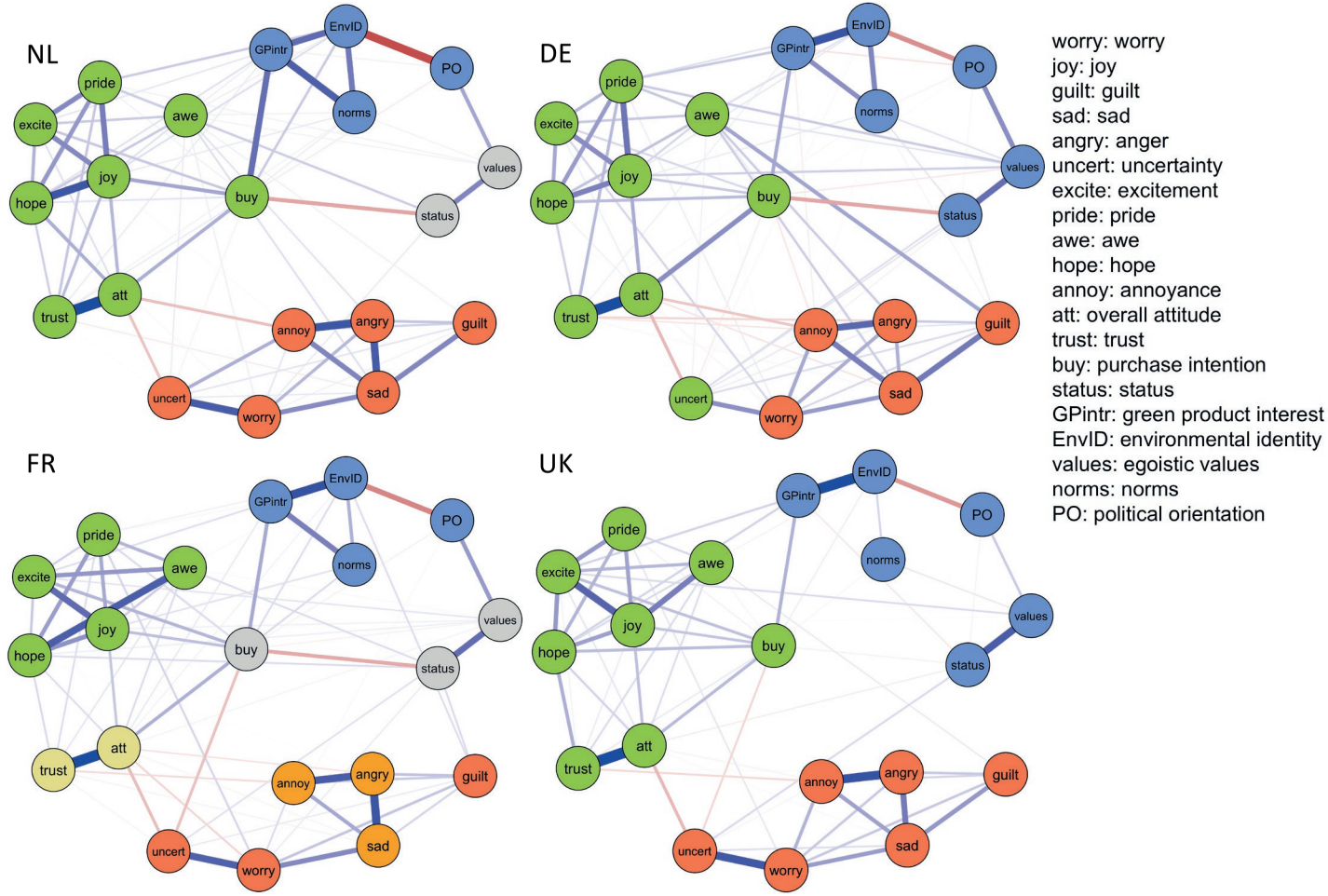
Figure 3. Attitude Pairs and Their Results Per Country



Network Analysis

The main network analysis was based on the Causal Attitude Network model (Dalege et al., 2016; Dalege, Borsboom, van Harreveld, & van der Maas, 2017). To estimate the network for continuous variables, the Gaussian Graphical Model was applied (Sacha Epskamp et al., 2018). In this model, two variables or nodes are connected via an edge if they are conditionally dependent given all other variables in the network. We estimated such dependencies via partial correlation coefficients between the variables. We constructed a weighted, undirected network for each country, estimating a Gaussian Graphical Model based on the partial correlation matrix using regularization (EBICglasso) as the model selection procedure in *bootnet* (Sacha Epskamp et al., 2018).

Figure 4. Networks of Attitudes and Purchase Intentions Across Four Countries



Note. Node placement is based on average placement across all networks. Blue edges are positive and red edges are negative partial correlations.

Interpretation

In order to find densely connected subgraphs in each network, we employed the Walktrap algorithm (Pons & Latapy, 2005). Nodes that are similar and more strongly connected to one another are coloured the same and form a cluster. Positive relationships are represented by blue edges and negative relationships by red edges. The thicker the line, the stronger the relationship. Importantly, these are partial correlations and do not provide strong causal evidence, as we focused on an undirected network and cross-sectional data. Below, we focused on variables relating to purchase intention. An overview of all four networks is provided in Figure 4. Node placement is based on the average node placement of all four networks. In general, the clusters were similar across countries but the grouping and number varied slightly. One of the limitations of cluster detection algorithms is that they allocate each node to only one cluster, precluding nodes from being shared between multiple clusters (Lange & Zickfeld, 2021). We believe purchase intentions to be one such shared node. Testing whether purchase intentions is part of more than one community is very complex and falls outside the scope of this chapter, we therefore do not place a lot of importance on which cluster it belongs to in our interpretation.

The Dutch Attitude Network

Figure 4 visualises the Dutch attitude network. There were four distinct clusters: positive emotions and overall attitude (green), negative emotions (red), personal identity (blue), and egoistic values and status (gray). Green product interest looked particularly important for purchase intentions ($r_{partial}$ = .25): the more interested a person was in 'green' products, the more they intended to buy a Fairphone. The more a person cared about status, the less likely they wanted to buy a Fairphone ($r_{partial}$ = -.14).

Positive edges connected intentions with the positive emotions joy (r = .13) and excitement ($r_{partial}$ = .08), and positive overall attitude ($r_{partial}$ = .12). Negative emotions were mostly unrelated to purchase intention. The more participants identified with being an environmentalist, the more they intended to buy a Fairphone ($r_{partial}$ = .07).

The German Attitude Network

The German network (Figure 4) had a similar structure but only three clusters: positive emotions (green; this time including uncertainty), negative emotions (red), and identity (blue). Purchase intentions were part of the positive emotion cluster (green), indicating that intentions were more closely related to positive emotions than to the other psychological factors. Again, people with higher purchase intentions reported more positive emotions of joy ($r_{partial}$ = .09), excitement ($r_{partial}$ = .06), and hope (r_{partia} = .12) and positive attitudes towards Fairphone (overall attitude, $r_{partial}$ = .22). Negative emotions seemed less relevant to purchase intentions. Only two negative emotions (uncertainty, $r_{partial}$ = -.03, and annoyance, $r_{partial}$ = -.04) were weakly and negatively linked to purchase

intention. Like the Dutch network, people for whom status was more important reported lower purchase intentions ($r_{partial}$ = -.17) and individuals with more green product interest indicated more purchase intentions ($r_{partial}$ = .15).

The United Kingdom Attitude Network

The United Kingdom network (Figure 4) had three clusters: positive emotions and overall attitude (green), negative emotions (red), and identity (blue). Purchase intentions were again part of the positive emotion and overall attitude cluster. There were positive relationships between purchase intentions and joy ($r_{partial}$ = .10), excitement ($r_{partial}$ = .11), hope ($r_{partial}$ = .11). Purchase intentions correlated positively to overall attitudes ($r_{partial}$ = .12), green product interest ($r_{partial}$ = .14), and negatively to uncertainty ($r_{partial}$ = -.07).

Network Analyses Including Product and Brand Characteristics

We also ran a network analysis including all the product and brand characteristics (Figure 5). The four countries appeared very similar and showed four clusters: positive emotions and overall attitude (green), negative emotions (red), identity (blue), and device characteristics, (status, and values; gray). The inclusion of the product and brand characteristics variables did not change the inferences we drew from the original networks discussed above. Purchase intentions related mostly to the psychological factors. In particular, intentions correlated positively to overall attitude, positive emotions, and green product interest, and negatively to status and in some cases uncertainty. The sustainability of the phone was positively related to purchase intentions in Germany and the Netherlands (DE: $r_{partial}$ = .16; NL: $r_{partial}$ = .11), and and so was the sustainability of the company in the Netherlands and the UK (NL: $r_{partial}$ = .12; UK: $r_{partial}$ = .06). Apart from these brand characteristics, none of the product or brand characteristics related to purchase intentions. This lack of relationships suggests that psychological factors are relatively more important for intentions to purchase a Fairphone.

Network Summary

The four countries were broadly similar in network structure and purchase intentions correlated with similar factors across countries. Purchase intentions were most closely linked to positive emotions (specifically joy and excitement), overall attitudes, and green product interest. Purchase intentions were also negatively related to the importance of product status. Unrelated to purchase intentions, we also found trust to be positively and strongly related to the overall attitudes across all countries. The countries also differed in the strength of relationships between nodes.

Network Comparison

We compared the networks in Figure 4 in an exploratory analysis to outline overarching similarities and differences using the Network Comparison Test (van Borkulo et al., 2022). See

the Supplement for more information (Table S3). All four networks had similar connectivity, meaning that they did not significantly differ in how well various parts of a network connected to one another. Most networks showed some edge variation, suggesting at least one of the edges was different between most networks. This overall similarity in structure with some edge variation corresponds with the visual inspection of the networks.

We also tested for network centrality of all four networks (Figure S1) to determine the structural importance of the individual nodes. We focused on the strength measure of centrality, which represents the direct influence of a given node on the network and is calculated by summing the absolute values of all edge weights a given node has. Across all four countries, overall attitude was one of the nodes with the greatest strength, as was joy, which corresponds with the visual representation discussed above. Depending on the country, other positive emotions, such as pride, excitement, and hope also had comparatively high strength, as did environmental identity.

While we compared data from four different countries, we cannot assume that participants from all countries interpreted the measures in a conceptually similar manner. The results of a measurement invariance analysis (see Supplement) suggested that the countries are not directly comparable, which was expected because these tests are very stringent. In particular, the factor loadings of the three items making up the purchase intentions variable differed across countries, especially for the French sample. We tested other scales most commonly related to purchase intentions (status, overall attitude, green product interest), and none reached strict measurement invariance (see OSF link in section 2.6 for procedure and code). As measurement invariance is almost never met in practice and many researchers argue for more relaxed criteria (e.g., Van De Schoot et al., 2015), we argue that comparing the four countries in this chapter is viable.

Regression

We also conducted a regression analysis to investigate the unique variance explained by psychological factors, product and brand characteristics, and demographic variables (Table 4). The pre-registration did not include the product and brand characteristics, but we included them to extend the network analyses and also investigate the unique variance explained by non-psychological factors. The regression removes shared variance between predictors and reveals the unique contribution of each predictor.

The regression (Table 4) indicated that two positive emotions (joy and excitement) and overall attitudes were positively related to purchase intentions in most countries and overall. Uncertainty was negatively related to purchasing intentions across most countries. No other factors consistently explained unique variance. Most overall variance was explained by overall attitude ($\beta = 0.15$), followed by excitement ($\beta = 0.14$), joy ($\beta = 0.13$), and uncertainty ($\beta = -0.10$). Green product interest appeared to be of importance in the Netherlands ($\beta = 0.18$) and the UK ($\beta = 0.16$), but did not reach statistical significance in Germany and France.

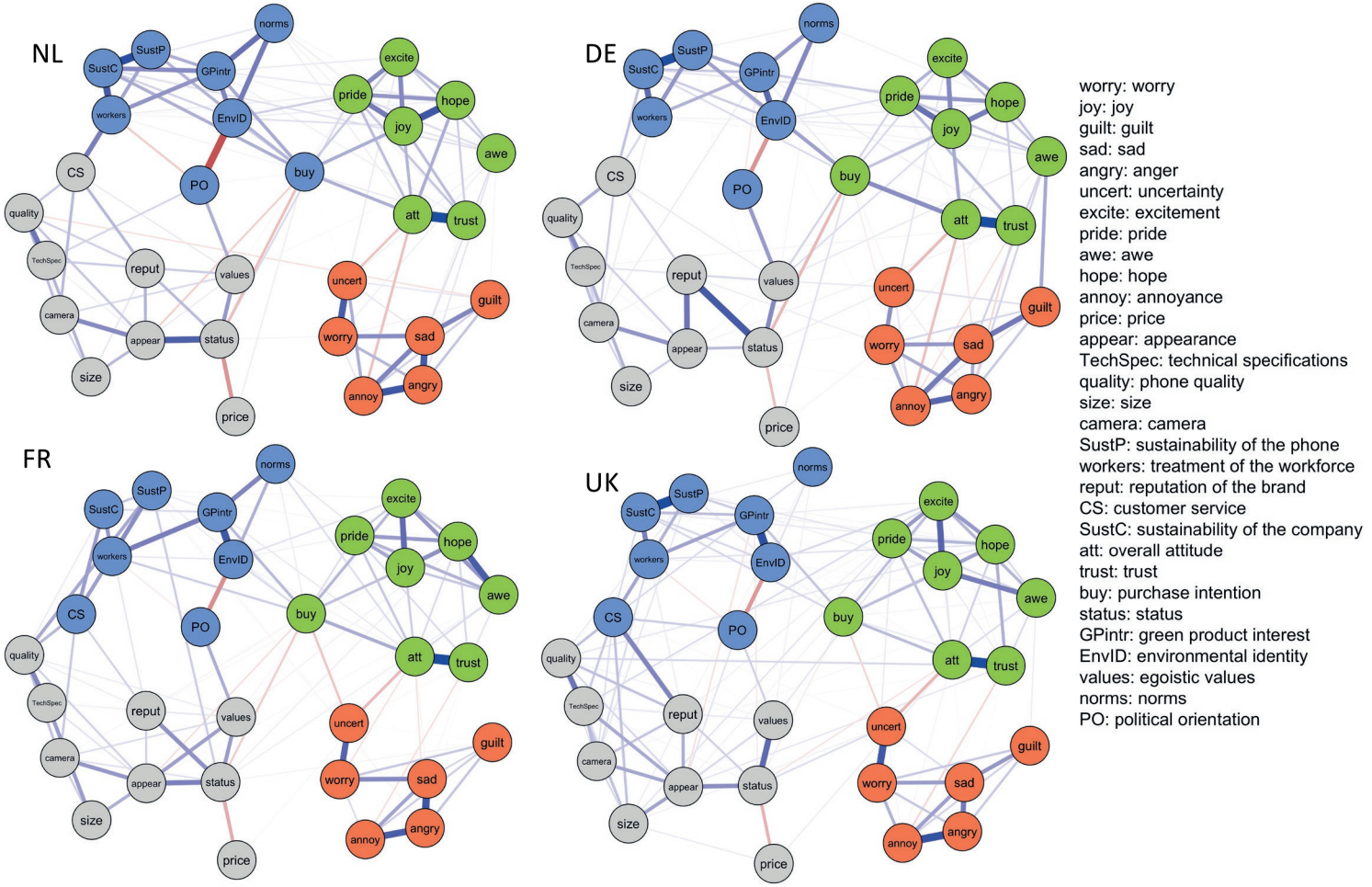
Table 4. Regression Betas on Purchase Intentions (95% CIs)

	Overall	DE	FR	NL	UK
Predictors			*beta* **(95% CI)**		
Worried	0.01 (-0.03 – 0.05)	0.07 (-0.01 – 0.15)	0.01 (-0.07 – 0.09)	0.02 (-0.05 – 0.10)	-0.07 (-0.16 – 0.02)
Joy	0.13 (0.09 – 0.18)	0.13 (0.04 – 0.23)	0.14 (0.05 – 0.23)	0.11 (0.01 – 0.21)	0.14 (0.03 – 0.25)
Guilty	**0.05 (0.01 – 0.08)**	0.04 (-0.03 – 0.12)	0.07 (-0.00 – 0.14)	0.06 (-0.01 – 0.13)	0.01 (-0.07 – 0.08)
Sad	-0.01 (-0.05 – 0.04)	-0.02 (-0.11 – 0.06)	-0.08 (-0.17 – 0.01)	-0.02 (-0.10 – 0.07)	0.07 (-0.02 – 0.16)
Angry	0.03 (-0.01 – 0.08)	0.02 (-0.06 – 0.11)	0.05 (-0.04 – 0.14)	0.03 (-0.05 – 0.12)	-0.03 (-0.12 – 0.07)
Uncertain	**-0.10 (-0.14 – -0.06)**	-0.03 (-0.10 – 0.05)	**-0.11 (-0.18 – -0.03)**	**-0.10 (-0.17 – -0.03)**	**-0.09 (-0.17 – -0.00)**
Excited	**0.14 (0.09 – 0.18)**	0.07 (-0.01 – 0.15)	**0.14** (0.05 – 0.23)	0.14 (0.06 – 0.22)	0.14 (0.03 – 0.25)
Proud	0.04 (-0.01 – 0.08)	-0.01 (-0.10 – 0.08)	0.08 (-0.01 – 0.17)	0.06 (-0.02 – 0.15)	0.06 (-0.04 – 0.15)
In awe	-0.02 (-0.06 – 0.01)	0.00 (-0.07 – 0.08)	-0.01 (-0.11 – 0.08)	0.01 (-0.06 – 0.08)	0.00 (-0.09 – 0.09)
Hopeful	**0.08 (0.04 – 0.13)**	**0.10 (0.01 – 0.19)**	0.05 (-0.05 – 0.14)	0.01 (-0.08 – 0.10)	**0.14 (0.04 – 0.24)**
Annoyed	-0.04 (-0.08 – 0.00)	**-0.12 (-0.21 – -0.03)**	-0.00 (-0.08 – 0.08)	-0.02 (-0.10 – 0.07)	-0.02 (-0.11 – 0.08)
Price	**0.07 (0.04 – 0.11)**	**0.10 (0.04 – 0.17)**	0.01 (-0.06 – 0.08)	**0.07 (0.00 – 0.13)**	0.04 (-0.03 – 0.11)
Appearance	**-0.05 (-0.09 – -0.01)**	-0.06 (-0.13 – 0.02)	**-0.11 (-0.19 – -0.03)**	**-0.08 (-0.15 – -0.00)**	0.02 (-0.07 – 0.10)
Technical specifications	-0.03 (-0.06 – 0.01)	-0.06 (-0.13 – 0.01)	0.01 (-0.07 – 0.08)	-0.05 (-0.12 – 0.02)	-0.02 (-0.10 – 0.06)
Quality of the phone	**-0.04 (-0.08 – -0.00)**	-0.03 (-0.10 – 0.04)	**-0.11 (-0.19 – -0.04)**	-0.03 (-0.09 – 0.04)	0.00 (-0.08 – 0.08)
Size	-0.02 (-0.06 – 0.01)	**-0.07 (-0.13 – -0.00)**	0.03 (-0.04 – 0.10)	0.03 (-0.03 – 0.10)	-0.06 (-0.14 – 0.01)
Camera	-0.01 (-0.05 – 0.02)	0.02 (-0.05 – 0.09)	-0.05 (-0.12 – 0.03)	-0.02 (-0.09 – 0.05)	0.07 (-0.00 – 0.14)
Sustainability of the phone	0.04 (-0.00 – 0.09)	**0.20 (0.08 – 0.32)**	0.06 (-0.02 – 0.13)	**0.11 (0.02 – 0.20)**	0.00 (-0.12 – 0.12)
Treatment of the workforce	**0.07 (0.03 – 0.12)**	0.04 (-0.05 – 0.14)	**0.14 (0.05 – 0.22)**	0.01 (-0.09 – 0.10)	-0.07 (-0.17 – 0.03)
The brand's reputation	-0.08 (-0.12 – -0.05)	-0.04 (-0.12 – 0.04)	-0.07 (-0.14 – 0.00)	**-0.08 (-0.15 – -0.01)**	**-0.08 (-0.16 – -0.01)**

Customer service	0.02 (-0.02 – 0.06)	0.03 (-0.04 – 0.10)	0.06 (-0.02 – 0.13)	-0.03 (-0.10 – 0.04)	-0.02 (-0.10 – 0.07)
Sustainability of the company	**0.07 (0.03 – 0.12)**	0.07 (-0.05 – 0.20)	-0.02 (-0.10 – 0.05)	**0.16 (0.06 – 0.26)**	**0.14 (0.01 – 0.26)**
Trust	**0.05 (0.01 – 0.10)**	0.05 (-0.05 – 0.15)	0.04 (-0.06 – 0.14)	0.03 (-0.06 – 0.12)	0.05 (-0.06 – 0.17)
Status	**-0.07 (-0.11 – -0.03)**	-0.04 (-0.12 – 0.04)	**-0.12 (-0.20 – -0.03)**	**-0.10 (-0.17 – -0.02)**	-0.06 (-0.15 – 0.02)
Values	**-0.04 (-0.08 – -0.00)**	**-0.08 (-0.16 – -0.00)**	-0.03 (-0.10 – 0.05)	-0.01 (-0.08 – 0.06)	-0.02 (-0.10 – 0.06)
Attitude	**0.15 (0.10 – 0.20)**	**0.24 (0.13 – 0.35)**	**0.16 (0.05 – 0.27)**	**0.12 (0.02 – 0.22)**	0.09 (-0.02 – 0.21)
Green product interest	**0.11 (0.07 – 0.16)**	0.05 (-0.05 – 0.14)	0.09 (-0.01 – 0.19)	**0.18 (0.09 – 0.28)**	**0.16 (0.06 – 0.26)**
Environmental ID	0.01 (-0.03 – 0.05)	-0.06 (-0.15 – 0.03)	-0.00 (-0.09 – 0.09)	0.09 (0.00 – 0.18)	-0.01 (-0.10 – 0.09)
Norms	0.02 (-0.02 – 0.05)	0.00 (-0.07 – 0.08)	0.05 (-0.02 – 0.12)	**-0.12 (-0.20 – -0.04)**	0.07 (0.00 – 0.13)
Political orientation	-0.01 (-0.04 – 0.03)	0.03 (-0.04 – 0.11)	-0.06 (-0.13 – 0.02)	-0.00 (-0.08 – 0.08)	-0.00 (-0.08 – 0.07)
Age	0.05 **(0.02 – 0.09)**	**0.09 (0.02 – 0.16)**	0.05 (-0.03 – 0.12)	0.03 (-0.04 – 0.10)	-0.05 (-0.13 – 0.03)
Education	0.03 (-0.00 – 0.06)	0.02 (-0.05 – 0.08)	0.02 (-0.04 – 0.09)	0.05 (-0.01 – 0.11)	0.01 (-0.06 – 0.08)
Income	-0.00 (-0.03 – 0.03)	-0.03 (-0.09 – 0.03)	0.03 (-0.04 – 0.10)	0.01 (-0.06 – 0.07)	-0.07 (-0.14 – 0.00)
Rurality	0.02 (-0.01 – 0.05)	-0.02 (-0.08 – 0.05)	0.03 (-0.04 – 0.09)	0.02 (-0.04 – 0.08)	0.02 (-0.05 – 0.09)
Familiar	0.03 (-0.01 – 0.06)	0.04 (-0.03 – 0.10)	0.00 (-0.06 – 0.07)	0.06 (-0.00 – 0.13)	0.01 (-0.06 – 0.08)
Observations	2175	534	559	535	547
R^2	.47	.54	.49	.54	.47
R^2 adjusted	.46	.51	.46	.51	.44

Note. **Bold** estimates are $p < .05$. Predictors are shown in bold if significant in at least three countries. Colours are added to improve readability and reflect effect sizes.

Figure 5. Overview of Networks for the German (DE), French (FR), Dutch (NL) and UK Data Including the Phone and Brand Characteristics



There were differences across countries concerning the importance of different product and brand characteristics, but no product and brand characteristic was significant across more than two countries. Nevertheless, the sustainability of the phone showed comparatively large ($\beta > 0.10$) effect sizes in Germany ($\beta = 0.20$) and the Netherlands ($\beta = 0.11$), as did the sustainability of the company in the Netherlands ($\beta = 0.16$) and the UK ($\beta = 0.14$).

Overall, this pattern of results is consistent with the network analysis in demonstrating the importance of psychological factors and particularly emotions for purchase intention. The examined variables explained about half of the variance in purchase intentions. That is typical for the field (Ballard, 2019; Frost, 2018), and suggests that we included most of the important psychological and demographic variables in this study.

DISCUSSION

Understanding the psychology behind sustainable behaviours is critical in determining whether consumers will choose a green product. Despite the importance of consumer decisions, intentions to buy environmentally friendly products are not well understood (Park & Lin, 2020; Trudel, 2018) and are often influenced by many factors. In this research, we employed the attitude network approach to determine which psychological factors were related to the purchase of a commercially available smartphone (Fairphone 4), a proxy of a meaningful and high-impact real-world behaviour. We used this descriptive approach because the antecedents of low-impact behaviours do not necessarily generalize to costlier and less frequent high-impact behaviours (Nielsen et al., 2021).

Interpretation

On the whole, the results underline that consumer's willingness to purchase a product is driven not primarily by the characteristics of the product but by the way in which the product is perceived. The network structure and connectivity across the four countries was similar, mainly including three clusters: positive emotions and overall attitudes, negative emotions, identity, and a cluster of product characteristics when included. Purchase intentions were most closely linked to positive emotions (excitement and joy), overall attitudes, and green product interest. Purchase intentions were also negatively related to the importance individuals placed on the status of a product when buying a new phone and feelings of uncertainty about the product. Including product and brand characteristics in the network (Figure 5) and regression analyses illustrated the importance of psychological factors (especially emotions) for purchase intentions compared to product and brand characteristics and demographics. This is encouraging because psychological factors might be more malleable, for example through marketing.

In our results, price appeared as less of a barrier for this sustainable alternative than previously assumed (Sheoran & Kumar, 2020). Across these samples, price was only very weakly related to purchase intentions in Germany and the Netherlands (see Figure 5 and Table 4), with psychological factors being comparatively more important.

Attitude

Purchase intentions were consistently and strongly linked to overall attitudes ($rs_{partial}$ = .12 -.22). Participants who were more positive towards the Fairphone also reported greater intentions to purchase one. This is in accordance with a large literature suggesting that attitude is one of the main drivers of behaviour (Kaiser et al., 2021; Taube et al., 2018), and sustainable consumption in particular (Park & Lin, 2020; Zhuang et al., 2021; *Chapter 4*). This is also consistent with consumer demand being important for a sustainable transition; when consumers do not feel positively towards a sustainable alternative, they are likely less willing to adopt it.

We also found a strong relationship between trust and overall attitude: participants who reported higher trust in the Fairphone smartphone and the brand were more positive towards the phone ($r_{partial}$ = .46 - $r_{partial}$ = .57). This might partially be caused by one of the seven items specifically mentioning trustworthiness. However, customer trust appeared tightly connected to people's attitudes, which were in turn related to intentions to purchase. The Dutch sample found the Fairphone much less trustworthy than participants from other countries. We are unsure why this is the case. Fairphone is a Dutch company and we were not able to find any obvious controversy surrounding it.

Emotions

Across all countries, joy and excitement positively related to purchase intention. There were less consistent positive relationships with pride and hope. There were consistent negative relationships between how uncertain participants felt about the product and their intentions to buy a Fairphone. No other negative emotion showed a consistent relationship with purchase intention. This suggests that evoking positive emotions and reducing uncertainty about the product might be ways to effectively market sustainable smartphones.

Much of the psychological literature suggests that negative emotions (especially guilt) more consistently relate to pro-environmental behaviour than positive emotions (of which pride has received particular attention) (Adams et al., 2020; Hurst & Sintov, 2022; *Chapter 2*). However, there is precedent for positive emotions having an important role. Recent reviews illustrate that both (anticipated) negative and positive emotions relate to and predict a wide range of climate change related judgements and behaviours (Brosch, 2021; Shipley & van Riper, 2022). Other research showed that anticipated positive emotions are more effective than negative emotions in predicting pro-environmental behaviour (Bissing-Olson et al., 2016; Schneider et al., 2017).

However, caution needs to be taken not to overgeneralize the relationship between purchase intentions and positive emotions. Positive emotions do not universally increase prosocial behaviour, but rather encourage different types of prosocial behaviour through different mechanisms (Brosch, 2021; Zelenski & Desrochers, 2021), depending on the type of person or cause benefited (Brick et al., 2021; Cavanaugh et al., 2015). It is therefore important for marketers and policymakers to be aware of the type of emotion used in their appeals to consumers and in which context they occur (Cavanaugh et al., 2015). Even though negative emotions other than uncertainty were mostly unrelated to purchase intention, negative emotions might still drive other relevant behaviours. For example, negative emotions towards an unsustainable brand could translate into actions against it by propagating negative word of mouth, avoidance, or vengeance (Khatoon & Rehman, 2021).

Green Product Interest and Status

Both green product interest and status were related to purchase intentions in the network analyses across all four countries. Consumers who care about the environment, social justice and human rights, animal welfare and local community, and who consciously reduce purchasing certain products (i.e., who are high in green product interest; Sudbury-Riley & Kohlbacher, 2016) also indicated a greater willingness to purchase a Fairphone. This makes sense, as Fairphone's stated values closely align with the values of ethical consumption. Predictably, green product interest was closely and strongly related to environmental identity across countries (Figures 4 and 5).

Sustainable products can act as status symbols by indicating wealth or prosocial traits (Berger, 2017; Sheoran & Kumar, 2020). Our results indicate that this is not currently working for the Fairphone, as customers more concerned with social status were less likely to intend to purchase a Fairphone. This might be related to people's unfamiliarity with Fairphone, as buying a product from a relatively unknown brand might make it less likely to increase status. The Fairphone's appearance might also not be noticeably different enough from similar, non-sustainable products. Recent research suggests that consumers prefer sustainable products that look visually distinct from their conventional counterparts (*Chapter 4*). Products that are visually recognizable as the sustainable choice might serve stronger signaling function, for example indicating prosocial traits (Berger, 2019; Braun Kohlová & Urban, 2020).

Network Approach

We chose a network approach over other analytic approaches (e.g., correlation matrices) because it provides a visualisation of how different types of evaluative reactions relate to the attitude object or behaviour of interest. Specifically, it shows both the indirect and direct relationships between the examined variables in an easily interpretable way, as well as providing information about the structural importance of different nodes (van

Borkulo et al., 2022). We argue that attitude networks are a useful descriptive starting point and recommend other researchers to use this and other descriptive tools, especially when examining (consumer) attitudes towards novel products, services or interventions.

Networks can help predict the extent to which individuals base their decision on their attitude and the extent to which an attitude element influences a behaviour (e.g., purchase decision, willingness to pay etc.) (Dalege, Borsboom, van Harreveld, Waldorp, et al., 2017). The network approach can also be used to run (causal) simulations, making it possible to derive concrete hypotheses. In this way, network theory provides a framework for both testing and developing formalized hypotheses on attitudes and related core social psychological constructs (Dalege, Borsboom, van Harreveld, & van der Maas, 2017).

Lack of Knowledge

Participants were not very familiar with Fairphone but were overall positive towards its smartphone. This aligns with research on other sustainable technologies such as bio-based plastic products, which consistently finds positive attitudes despite a lack of knowledge about the material and its properties (*Chapters 2-4*). Lack of awareness about ethical or sustainable alternatives is one of the main barriers to sustainable consumption (Sheoran & Kumar, 2020). Adding green products to the shelves is not enough (Gleim et al., 2013). Lacking relevant information can prevent consumers from selecting products that follow their ethical or environmental principles (Bray et al., 2010).

Future research could examine how much the provision of information contributes to purchase intentions and behaviour and how that compares to the role of psychological factors such as attitudes and emotions. This was not possible in the current study, as participants received information about the Fairphone brand and smartphone before indicating their purchase intention. Information-based strategies are available to all sizes of retailers and can create awareness of green products as well as creating consumer expertise. Information-based promotion also builds trust, which in turn can generate greater interest in green products (Gleim et al., 2013).

Limitations

This study used purchase intentions as a proxy for a high-impact environmental behaviour. We did measure whether participants followed a link to the official Fairphone site to learn more about the new smartphone and the brand itself. This could have provided a more accurate measure of interest and possibly a better indication of purchase intention. However, due to a technical error, how many participants clicked the link was not recorded. Because intentions do not necessarily translate into actual purchasing behaviour even when consumers hold positive attitudes towards sustainable products (Bray et al., 2010; Groening et al., 2018; Morwitz et al., 2007), the predictors of actual purchase behaviour

might differ (Nielsen et al., 2022; Nielsen et al., 2021). Only measuring intentions can therefore lead to biased conclusions, potentially exaggerated by participants wanting to appear socially desirable. The strength of the relationship between purchase intentions and actual behaviour varies with product type and measurement design. For example, the predictive accuracy of purchase intentions is lower for new products, for non-durable goods, and for more temporally distant purchase occasions (Morwitz et al., 2007).

It is difficult to measure actual purchasing behaviour for relatively infrequent and expensive purchases like buying a smartphone. Intentions can therefore provide a first idea and be a useful proxy. Including a broader range of measures that tap into different kinds of behaviour, and including online measures of actual behaviour (e.g., a donation or the Work for Environmental Protection Task; Lange & Dewitte, 2021) might give a better indication of whether participants' intentions are likely to translate into behaviour. A future retrospective study asking people that bought a Fairphone about their reasons and attitudes might also shed more light into successful attitude-behaviour translation.

We compared four different countries (The Netherlands, Germany, France, and the United Kingdom). However, we cannot assume that participants from all countries interpreted the measures in a conceptually similar manner. Nevertheless, we still feel that comparing the four countries in this chapter is viable, as measurement invariance is almost never met in practice (Van De Schoot et al., 2015).

Another limitation of this research is its correlational nature and therefore the lack of causal conclusions. We deliberately chose an exploratory design (Scheel et al., 2021). Our aim was to determine which (psychological) factors relate to the intentions to purchase a Fairphone and to see whether these differed between the four countries. To test the predictive power of the different psychological factors, one could conduct an experimental study or use a temporal network approach like Chambon et al. (2022). This kind of temporal network approach can determine whether one node predicts other nodes in the next measurement, while controlling for all other nodes. Another approach to establishing causality was taken in *Chapter 2*, where we first conducted a survey to establish the empirical network and in a subsequent study experimentally manipulated the evaluative reaction most strongly related to the node of interest, in order to test whether the manipulation would lead to an increase in behaviour. For example, one could manipulate positive emotions (joy and excitement in particular) to test whether that leads to greater purchase intentions or actual purchase of a Fairphone.

We did not ask participants whether they already own a Fairphone or did in the past. However, due to Fairphone's very small market share - as of February 2022, Fairphone had sold around 400,000 devices (Schweiger, 2022) - the likelihood of this affecting our results is very low. Future research could get insights into whether people who already own a Fairphone still have strong intentions to buy one in the future and how their attitudes compare to potential customers and those who have low purchase intentions.

Finally, the present study focused on the countries most relevant to Fairphone's market share. However, all of them are Western countries with relatively similar economies, societal structures, and culture. The findings might therefore not generalize to non-European and/or non-Western countries.

CONCLUSION

We used an attitude network approach across four countries to determine which factors relate to the intention to purchase a sustainable smartphone. Understanding which factors play a role in consumer decision-making to switch to more sustainable products is vital in the fight against climate change. Psychological factors appeared to be more important for purchase intentions than product and brand characteristics. Future research could employ similar descriptive approaches to examine whether these results generalize to other (novel) sustainable products and technologies, and non-European and non-Western populations. Subsequent research can also investigate whether marketing and communication strategies aimed at the psychological variables identified here, such as positive emotions, are effective in changing purchase behaviours.

CHAPTER 6

General Discussion

SUMMARY OF RESULTS

Overarching Findings

Across the thesis, people held positive attitudes towards sustainable alternatives, from bio-based plastic (*Chapters 2-4*) to a modular smartphone (Fairphone) (*Chapter 5*). Similarly, participants indicated that they would be willing to pay (WTP) more for bio-based plastic compared to conventional plastic (*Chapters 2-4*). Aside from this apparent consumer demand, participants generally lacked knowledge of and held misconceptions towards the sustainable alternatives (*Chapters 2, 3,* and *5*). Participants' experience of emotions was also related to the adoption of novel sustainable alternatives (*Chapters 2* and *5*), although the specific emotions varied across studies. Both *Chapters 2* and *5* demonstrated the usefulness of a visually exploratory network approach for the initial stages of investigating consumer attitudes towards sustainable alternatives.

Chapter-Specific Findings

In *Chapter 2*, we found that feelings of guilt about one's plastic use was most strongly related to the reported willingness to pay for a bio-based alternative (Study 2) and that guilt predicted the amount participants donated to a tree-planting initiative (Study 3). *Chapter 3* revealed that the majority of participants had misconceptions about bio-based plastic, many assuming it to be biodegradable. The experimental fourth study in *Chapter 3* demonstrated that providing information about the actual properties and benefits of the material could retain participants' positive attitudes towards bio-based plastic and their willingness to pay a price premium while removing misconceptions. *Chapter 4* investigated different factors affecting product choice. It demonstrated that the appearance of green alternatives is important, as participants consistently chose the visually distinct sustainable option independent of the social context. Other psychological factors, such as attitude and environmental identity were also related to bottle choice. *Chapter 5* found similar attitude networks towards a more sustainable smartphone across four European countries and highlighted the importance of psychological factors over product and brand characteristics for purchase intentions. Positive emotions, overall attitude, and green product interest related positively to purchase intentions of a Fairphone, while the importance individuals placed on the status of a product and feelings of uncertainty about the product related negatively.

IMPLICATIONS

Consumer Demand

It is encouraging that we consistently found positive attitudes towards sustainable alternatives and a reported willingness to pay a price premium for them. This demonstrates a consumer demand despite potential higher prices and potential perceived risks that may be associated with novel technologies. For companies, switching to producing or using bio-based plastic and deciding to focus on designing, producing, and selling a sustainable alternative is costly: it requires substantial financial investment. For example, it might be necessary to invest in new equipment and new marketing strategies, as well as training and hiring new personnel. In the absence of governmental regulations demanding the switch to sustainable alternatives, companies need to know that the risk of investing in product development is mitigated by consumer demand for these alternatives.

That being said, the actual willingness to pay might be smaller than what was found in this thesis, which was 5 - 40% more for bio-based than conventional plastic (*Chapter 3* Study 4 negative condition and *Chapter 4* WTP for paper PEF respectively). Intentions and attitudes do not necessarily translate into behaviour (Sheeran & Webb, 2016). This might be especially the case if taken beyond the purchase of one bottle, but in light of all plastic consumers buy: paying up to 40% more for each item would add up. Similarly, consumer attitudes towards bio-based products might not be as positive as found in my research. As with self-reported willingness to pay, participants might have reported more positive attitudes towards these sustainable alternatives in order to appear more socially desirable (Koller et al., 2023).

Despite these considerations, the apparent demand for sustainable alternatives is encouraging. Both attitudes and intentions are important predictors of behaviour, with greater intentions and stronger attitudes leading to a greater likelihood of corresponding behaviour (e.g., Kaiser et al., 2021; Onwezen et al., 2013). Participants indicated being willing to pay an average of 23% more for bio-based compared to fossil-based plastic. Even if the actual percentage people end up being willing to pay in real life is lower, that is still substantial and encouraging for companies, given that the average cost of making one plastic bottle ranges from 0.02-0.04 cents (Martin's Plastics, 2020). The research in this thesis suggests that consumers already have positive attitudes towards these sustainable alternatives. According to the Campbell Paradigm (Kaiser et al., 2010), the more pronounced these attitudes are, the more cost (financial, effort etc.) people are willing to bear to engage in the attitude-related behaviour (Henn et al., 2020; Kaiser et al., 2021). This would suggest that increasing people's positive attitudes towards these alternatives and making them less costly to purchase (e.g., by making them more easily available, decreasing the price, increasing people's knowledge about them etc.) could

increase consumption of these products. A positive side effect of increasing people's pro-environmental attitudes, besides encouraging more sustainable consumption, might be that people's likelihood to engage in other pro-environmental behaviours also increases (e.g., public transport or eating less meat), which is an effect called 'positive spillover' (Henn et al., 2020) (however, see also Geiger et al., 2021).

Lack of Knowledge

Across the studies, participants consistently lacked knowledge about the properties of bio-based plastic and about Fairphone and its products. This is consistent with other research finding lack of knowledge and misperceptions concerning sustainable alternatives, from bio-based plastic (Blesin et al., 2017; Gaffey et al., 2021; Mehta et al., 2021) to the more general acceptance and development of green energy technologies (Biresselioglu et al., 2018; Zeng et al., 2022).

Knowledge is a pre-requisite for people to make an informed decision. Simply knowing that there is a sustainable alternative (e.g., that there are more sustainable smartphones) itself might encourage people to research and buy these alternatives. Moreover, accurate perceptions about the properties and mitigation potential of different products and behaviours can help consumers to make informed choices and reduce their emissions (Cologna et al., 2022). For example, knowing the properties of bio-based materials allows for proper use (e.g., knowing whether it is reusable, dishwashable, or microwaveable) and disposal (e.g., knowing whether it is recyclable or compostable). Similarly, knowing about the processes and materials involved in the production and life-cycle of smartphones and the associated environmental footprint, might encourage people to keep their devices for longer and search for more sustainable alternatives. That being said, knowledge alone is often not enough to get people to act (see critique of knowledge deficit model; e.g., Cook & Overpeck, 2019).

People may be inaccurate about their own knowledge. For example, research suggests that people underestimate the environmental impact of some behaviours (e.g., switching to a sustainable diet), while overestimating the impact of others (e.g., installing more efficient light bulbs) (Cologna et al., 2022). Similarly, consumer perceptions about the sustainability of different packaging materials does not correspond with (in some cases being opposite to) their actual life cycle assessments (Steenis et al., 2017). Misconceptions can lead to positive attitudes towards green alternatives but also cause negative consequences. With regard to bio-based plastic, assuming all bio-based plastic to be biodegradable (as suggested in *Chapter 3*), could lead to incorrect disposal and increased littering (e.g., people found it less likely to recycle bio-based plastic, *Chapter 3*) (UNEP, 2015). Alternatively, learning that their positive assumptions were wrong might lead to negative reactions (see negative condition Study 4 in *Chapter 3* and Blesin et al., 2017), stopping people from trying to engage in pro-environmental behaviour

altogether, or to mistrust in companies providing green products (Yang et al., 2020). Overestimating energy efficiency improvements (such as installing energy efficient light-bulbs) can lead to rebound effects through the reduction of perceived consequences, moral licensing (i.e., when a person uses their prior 'good' behaviour to justify later 'bad' behaviour), or an increased diffusion of responsibility (i.e., feeling less responsible for taking action in a given situation, because there are other people who could also be responsible for taking action) (Santarius & Soland, 2018).

In light of the presence of misconceptions, any (new) sustainable product should be accompanied with information regarding its properties, environmental impact, and use and disposal instructions, even if information alone often has only a small effect on behaviour (Nisa et al., 2019). Information can be conveyed in the form of labelling, informational campaigns, or product design. Information-based strategies can be used in combination with governmental regulations, financial incentives, or behavioural interventions (e.g., nudges), in order to increase their impact and effectiveness. *Chapter 4* suggests that product design can influence consumer choice. In this case, participants preferred the visually distinct sustainable product over the sustainable product of the same appearance as the conventional version. While we only tested this online and in regard to a specific product (beverage bottles), companies could test different product designs, especially those that set sustainable products apart, when bringing new products onto the market. The material choice for the packaging can also have an effect on the perceived sustainability of the product, as can graphics and colouring (e.g., green colour is implicitly associated with sustainability) (Steenis et al., 2017) and certifications (Morone et al., 2021). Of course, all these features (labels, design, information) can also be exploited by companies and organisations that want to appear more sustainable to the public than they actually are. This kind of greenwashing can mislead consumers into buying products they think are sustainable when this is in fact not the case. Ideally, labels and provided information should therefore be standardised and vetted, for example in a similar way to the EU energy labels for electric appliances (European Commission, 2021).

Complexity Approach

People are complex and multifaceted and so is their behaviour. No single method or approach can fully capture an attitude or behaviour. Throughout my thesis, I aimed to study and understand the complexity of perceptions and attitudes using different approaches: from non-confirmatory qualitative, correlational, and network studies, to immersive scenarios and confirmatory experiments. Different approaches produce different insights, which does not mean that one approach is superior; rather, it points to the danger of overreliance on a few preferred methods or strategies (Davis et al., 2011). Social psychology mainly relies on single-method quantitative designs intended to test specific hypotheses. I argue that more descriptive research plays an important role in

understanding attitudes and determinants of behaviour. Especially in the context of novel or sustainable technologies, getting a multidimensional view of consumer attitudes and perceptions can be useful to understand what might encourage the acceptance, uptake, and use of these products. More descriptive research can also create a better understanding on the antecedents of behaviours with a high environmental impact (e.g., the installation of solar panels, or the purchase of an electric vehicle) and how they might differ from the drivers of frequently studied low-impact behaviours such as recycling or turning off the lights (Nielsen et al., 2021).

Network Approach

I repeatedly used a network approach in an attempt to do justice to the inherently complex phenomenon that is human attitudes, without confining myself to a limited number of factors. I hope that my dissertation shows how useful networks can be, because they allow the investigation of association patterns (both direct and indirect) between different factors related to products or behaviour. I think that the added value of a network analysis over other approaches, e.g., over a correlation matrix, lies in the visual nature of the results that make networks easier to interpret and build theories from. Networks can provide insight into clustering, i.e., which factors are most closely related to one another, give information on the structural importance of the different elements, and can be used to compare different populations (e.g., see *Chapter 5*) or attitudes about different products (see *Chapter 2*). In that way, networks can inform hypotheses, intervention design, as well as marketing campaigns. They also allow a detailed examination of consumer perceptions of novel products (as was done in this thesis) and an examination of whether antecedents of self-reported low-impact pro-environmental behaviours generalise to less frequent higher-impact behaviour.

Expanding on what has been done in this thesis, the network approach can also be used to run simulations, making it possible to derive concrete hypotheses that often cannot be discovered through descriptives alone, thereby providing a framework for both the testing and development of formalised hypotheses (Dalege et al., 2017). Applying a network approach in longitudinal research can test the temporal stability of psychological constructs, as well as allowing for more elaborate testing of the impact of interventions over time (e.g., Chambon et al., 2022). Another advantage of this longitudinal approach is the ability to test for causality.

Non-Psychological Predictors of Behaviour

This dissertation aimed to extend beyond the traditional models of intentions and behaviour by including more psychological variables. However, contextual and product related factors can also influence consumer behaviour (Testa et al., 2021). One way forward in trying to do justice to the complexity of sustainable consumer behaviour is to include

non-psychological factors. Higher prices, concerns about the quality of the product, and unavailability of green products in mainstream markets are some of the barriers that hinder the purchase of sustainable products (Bray et al., 2010; Gleim et al., 2013; Young et al., 2010), but it is unclear how important these are compared to psychological variables like motivation. Product and producer-related factors, such as product features, expected economic benefit (e.g., sales, subsidies, or other incentives), the presence of a label and knowledge, as well as the image of the brand can also play a role (see Testa et al., 2021 for a review). While we examined some of these factors, especially in the network analyses (*Chapters 2* and *5*), more research into non-psychological factors is needed to get a more comprehensive understanding of sustainable consumer behaviour. This is especially the case for higher impact behaviours, like installing solar panels or buying an electric vehicle, as context is especially important for these behaviours (Nielsen et al., 2021).

The Role of Emotions

Emotions were consistently related to the sustainable behaviour of interest. However, which emotions were most relevant differed across studies. While guilt was most strongly (negatively) related to pro-environmental intentions and behaviour in *Chapter 2,* joy and excitement were most strongly (positively) related to the intention to purchase a sustainable smartphone, as was uncertainty (negatively)(*Chapter 5*).

What causes the variety of emotions relevant for sustainable consumption will need to be explored in future research. Both the network analyses in *Chapter 2* (i.e., Study 2) and in *Chapter 5* included these most relevant emotions (guilt, uncertainty, joy, and excitement). However, only the feeling of guilt about fossil-based plastic use was related to the willingness to pay more for a bio-based plastic bottle in *Chapter 2*. When guilt was experimentally manipulated in Study 3, it led to higher donations to a sustainable cause. The effectiveness of guilt might have been due to the fact that these studies were problem-focussed, emphasising the negative effects of fossil-based plastics and the damages associated with past, present, and future plastic use. Additionally, plastic and its harm to the environment has received a lot of media attention, leaving little room for uncertainty about plastic's potential harm. Participants might therefore already have negative connotations about (fossil-based) plastics, and have existing or easily evoked feelings of guilt about their contribution to plastic-caused harm. The studies in *Chapter 2* provided a comparatively easy way to alleviate the guilty feeling, i.e., paying more for a bio-based bottle or donating to plant trees.

Chapter 5 on the other hand, presented a solution (i.e., a more sustainable smartphone) without diving into the problems of the current market alternatives. It painted an avenue towards a more sustainable future without emphasising the damages of the past or present. The general tone was more one of hope than one of doom and gloom, which might explain why joy and excitement where consistently related to the intention

to purchase a Fairphone. Fairphone is not well known (as demonstrated by participants' lack of familiarity), potentially explaining the prevalence of uncertainty. Contrary to plastic, smartphones have not been at the centre of negative media attention, possibly preventing the build-up of existing connotations with the Fairphone. Learning about the positive product details and brand aims might therefore more easily lead to positive emotions and increased purchase intention. We could not test for causality in the cross-sectional data, so this interpretation is speculative.

I believe that the variability of the emotions related to sustainable consumption demonstrates the value of the network approach for determining consumer perceptions and sustainable intentions. Networks visualise which factors might be of greatest relevance to the product or behaviour of interest, as well as illustrate how these factors are directly and indirectly related. In my thesis, networks demonstrated that emotions might be a valuable tool in bringing sustainable alternatives to the market, but also that there are still many unknowns. Building interventions on specific emotions will not always successfully influence pro-environmental behaviour. The success of such interventions depends on many moderating factors (both internal and external to the individual), the circumstances, variables, and research question or behaviour of interest (Schneider et al., 2021). Even within this dissertation, which did not specifically focus on emotions, factors such as framing, product/behaviour of interest, and population influenced the relevance and effectiveness of positive emotions.

Future research into the effectiveness of emotions for different types of pro-environmental behaviours might investigate the underlying mechanisms. For example, recent research suggests that it might not be a specific emotion that consistently encourages behaviour, but the mechanism (e.g., the feeling of connectedness to other people or nature) through which it functions (Manokara, Zwicker et al., in preparation). Other research could focus on which types of emotional appeals work best for which kinds of pro-environmental behaviour and whether there are differences in the longevity of emotional approaches. For example, guilt might be effective in prompting short-term behaviour change but might be less effective at leading to long-term pro-environmental behaviour, as people dislike feeling guilty and will find strategies to avoid it (e.g., see McGrath, 2017). Positive emotions might be more suitable for encouraging more long-term behaviour change. There is a growing body of work that suggests that positive emotions are positively linked to and can promote engagement in pro-environmental behaviour (Schneider et al., 2021).

The use of emotional appeals thus seems a promising tactic to encourage pro-environmental behaviour and the switch to sustainable alternatives. Positive emotions in particular might be advantageous for brands to use, as associating themselves with negative emotions might lead to unwanted side effects (e.g., consumers associating the brand itself with negativity). However, the effectiveness of emotional appeals

might depend on the emotion in question, the context to which it is applied, as well as a myriad of other factors. While it is well known that emotions play a central role in advertising, research into the use of deliberately induced discrete emotions (e.g., fear, anger, awe, hope, relief, shame, guilt) on advertising-related behaviour is scarce (Poels & Dewitte, 2019). Currently, the advertising industry mainly uses A/B testing of advertising messages, which is to a large extent data-driven and theory-blind: keep what works and remove what does not result in predetermined key performance metrics, without a priori theoretical predictions (Poels & Dewitte, 2019). Using exploratory research (*Chapters 2* and *5*) could be a first step in determining which emotions are relevant for the product or behaviour of interest. The next step would be to determine and test which mechanisms these emotions might work through (e.g., connectedness, smallness of self) and what the corresponding action tendencies are for the behaviour of interest.

LIMITATIONS AND FUTURE RESEARCH

Self-Reported Intentions

While some studies discussed in this dissertation measured actual behaviour (i.e., donations in *Chapter 2* Study 3 and time commitment on the WEPT in *Chapter 4*), most studies focused on self-reported willingness to pay or purchase intentions. There is extensive literature suggesting that intentions do not necessarily translate into behaviour, even when consumers hold positive attitudes towards sustainable products (ElHaffar et al., 2020; Groening et al., 2018; Hassan et al., 2016; Koller et al., 2023; Rausch & Kopplin, 2021; Sheeran & Webb, 2016). At the same time, Kaiser et al. (2021) argue that we need to stop confusing weak attitude-behaviour correlations with the behavioural irrelevance of attitudes and that a person's attitude must be strong enough to offset the costs of an attitude-implied behaviour before such behaviour is likely to be performed. Moreover, relying on self-reported measures also has limitations. For example, people often lack the introspective abilities to assess why they do what they do, they may have different interpretations of concepts like "often" or "recycling", may forget instances or be overly optimistic about future behaviour, or respond in ways that make them look moral and competent (Koller et al., 2023; Lange & Dewitte, 2019; Nisbett & Wilson, 1977).

That being said, studying consumer intentions allows for early and broad insights into perceptions of novel technologies, such as bio-based plastics, or when investigating infrequent behaviour, such as the purchase of a smartphone. Self-reported positive attitudes, willingness to pay, and purchase intentions can provide a first indication of consumer demand, and are often a pre-requisite for actual purchase behaviour. Relatedly, in industry, purchase intention is frequently used to test which geographic market and consumer segment to target, and to pre-test advertising and promotions

(Morwitz et al., 2007). Self-reported consumer demand is an encouraging and maybe necessary sign for companies that investing in sustainable products and technologies is worth the costly investment. Exploratory research into consumer perceptions can also be useful in shaping product design (see *Chapter 4*) and in designing marketing campaigns (e.g., which psychological factors might be most effective, *Chapter 5*). In summary: intentions do not necessarily translate into behaviour but they provide valuable insights into relevant factors and can shed light on consumer perceptions.

Beyond Self-Reports

There are relatively simple ways to go beyond self-reports and approach the measurement of actual behaviour. These include giving participants the opportunity to make actual donations (*Chapter 2*), to sign petitions, or to choose to invest time and effort into reading additional information (*Chapter 5*). Other ways in which behaviour can be measured is by assessing actual energy or water usage. Life cycle assessment and other measures capturing greenhouse gas emissions can be used to measure the environmental impact of specific behaviours, products, or services (Ivanova et al., 2016; Ivanova & Wood, 2020).

Recently, more and more behavioural paradigms have been developed to assess consequential pro-environmental behaviour in the lab or online. In the Work for Environmental Protection Task (WEPT; Lange & Dewitte, 2021), participants can voluntarily exert effort in a time-consuming numerical task to donate money to a pro-environmental charity (*Chapter 4*). In the Carbon Emission Task (CET; Berger & Wyss, 2021), participants face repeated trade-offs between financial bonus opportunities paired with real carbon emissions and foregoing such opportunities while staying carbon neutral. On each trial of the Pro-Environmental Behaviour Task (PEBT; Lange et al., 2018), participants in the laboratory can either choose the faster car option, which causes a series of lights to be illuminated, or they can save the associated energy by choosing the bicycle option at the expense of spending more time in the laboratory. While there is some discussion about whether these measures tap into impactful behaviour, or rather the propensity to act more pro-environmentally, these consequential measures are less biased and have lower measurement error than self-reports (Bosshard et al., under review). Additionally, they are relatively easy and cheap to implement. The use of these consequential behaviour measures provides more validity and a test of when and how much the antecedents of pro-environmental behavioural intentions and self-reported behaviour are applicable to actual behaviour.

CONCLUSION

This dissertation aimed to shed light on the complexity of consumer attitudes towards sustainable alternatives. I took a broad, multi-method, and generally descriptive approach to go beyond traditional models and increase the understanding of perceptions and demand for sustainable alternatives. My research findings showed an apparent consumer demand for bio-based bottles and sustainable smartphones. Participants consistently had positive attitudes towards these products, and indicated purchase intentions and a willingness to pay a price premium. However, they also displayed a general lack of knowledge about these sustainable alternatives, in some cases resulting in influential misconceptions. A variety of factors related to the willingness to pay for or purchase sustainable alternatives. For example, greater feelings of guilt about fossil-based plastic use related to higher WTP for a bio-based alternative and encouraged participants to donate more to an environmental cause. Providing information about the actual properties of the product dispelled misconceptions, while keeping attitudes positive and willingness to pay high. This research also showed that sustainable products that were visually distinct from their fossil-based counterpart, were overwhelmingly preferred to conventional-looking bio-based products. For the intention to purchase a sustainable smartphone, psychological factors (emotions, overall attitude, status, and green product interest) were more relevant than product and brand characteristics.

This research demonstrates the complexity of attitudes and perceptions towards sustainable alternatives. A great variety of factors are related to purchase intentions, a small fraction of which were examined in this thesis. While this complexity is daunting, the fact that so many factors are relevant illustrates that there are many ways to reach the goal of more sustainable consumption. More descriptive research like this can illuminate which 'tools' we can add to our existing toolbox as we strive towards greater sustainability. I hope that this thesis can be a stepping stone for future research to expand on the psychological and contextual factors investigated here and test their effectiveness on actual purchasing behaviour. I also hope that it sparks more exploratory research into consumer perceptions of novel technologies and emboldens companies to invest in sustainable alternatives.

References

Adams, I., Hurst, K., & Sintov, N. D. (2020). Experienced guilt, but not pride, mediates the effect of feedback on pro-environmental behavior. *Journal of Environmental Psychology*, *71*. https://doi.org/10.1016/j.jenvp.2020.101476

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, *50*, 179-211.

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and the Human Decision Process*, *50*, 179-211.

Ajzen, I., & Fishbein, M. (2005). The Influence of Attitudes on Behavior. In D. Albarracín, B. T. Johnson, & M. P. Zanna (Eds.), *The handbook of attitudes* (pp. 173-221). Lawrence Erlbaum Associates.

Amestoy, P. R., Azzalini, A., Badics, T., Benison, G., Böhm, W., Briggs, K., ., & Yang, C. (2015). *igraph: Network analysis and visualization (R package Version 1.0.1)*. In https://cran.r-project.org/web/packages/igraph/

Amine, L. S., & Smith, A. J. (2009). Challenges to Modern Consumer Segmentation in a Changing World: The Need for a Second Step. *Multinational business review*, *17*(3), 71-100. https://doi.org/10.1108/1525383X200900018

Apple. (2020). *Apple commits to be 100 percent carbon neutral for its supply chain and products by 2030*. Apple Newsroom. Retrieved November 17, 2022 from https://www.apple.com/newsroom/2020/07/apple-commits-to-be-100-percent-carbon-neutral-for-its-supply-chain-and-products-by-2030/

Armitage, C. J., & Christian, J. (2003). From Attitudes to Behaviour: Basic and Applied Researchon the Theory of Planned Behaviour. *Current Psychology: Developmental, Learning, Personality, Social*, *22*(3), 187-195.

Avantium. (2022a, 31 March 2022). *Avantium reaches Financial Close for its FDCA Flagship Plant* https://www.avantium.com/press-releases/avantium-reaches-financial-close-for-its-fdca-flagship-plant/

Avantium. (2022b). *FDCA and plantMEG™ together make a 100% plant-based plastic PEF*. Avantium. Retrieved 10 February 2022 from https://www.avantium.com/lead-products/

Ballard, C. (2019). *An Ode To R-Squared or, The Statistician's Crusade: A Duty-Dance with Determination*. towards data science. Retrieved Jan 25 from https://towardsdatascience.com/an-ode-to-r-squared-804d8d0ed22c#:~:text=Generally%2C%20an%20R%2DSquared%20above,squared%20values%20lower%20than%200.5.

Barnes, M., Chan-Halbrendt, C., Zhang, Q., & Abejon, N. (2011). Consumer Preference and Willingness to Pay for Non-Plastic Food Containers in Honolulu, USA. *Journal of Environmental Protection*, *02*(09), 1264-1273. https://doi.org/10.4236/jep.2011.29146

Barrett, A. (2018). Bioplastic Feedstock 1st, 2nd and 3rd Generations. *Bioplastic News*. https://bioplasticsnews.com/2018/09/12/bioplastic-feedstock-1st-2nd-and-3rd-generations/

Belkhir, L., & Elmeligi, A. (2018). Assessing ICT global emissions footprint: Trends to 2040 & recommendations. *Journal of Cleaner Production*, *177*, 448-463. https://doi.org/10.1016/j.jclepro.2017.12.239

Berger, J. (2017). Are Luxury Brand Labels and "Green" Labels Costly Signals of Social Status? An Extended Replication. *PLoS One*, *12*(2). https://doi.org/10.1371/journal.pone.0170216

Berger, J. (2019). Signaling can increase consumers' willingness to pay for green products. Theoretical model and experimental evidence. *Journal of Consumer Behaviour*, *18*(3), 233-246. https://doi.org/10.1002/cb.1760

Berger, J., & Heath, C. (2007). Where Consumers Diverge from Others: Identity Signaling and Product Domains. *Journal of Consumer Research*, *34*(2), 121-134. https://doi.org/10.1086/519142

Bhattacherjee, A., & Sanford, C. (2009). The intention–behaviour gap in technology usage: the moderating role of attitude strength. *Behaviour & Information Technology*, *28*(4), 389-401. https://doi.org/10.1080/01449290802121230

Bhushan, N., Mohnert, F., Sloot, D., Jans, L., Albers, C., & Steg, L. (2019). Using a Gaussian Graphical Model to Explore Relationships Between Items and Variables in Environmental Psychology Research. *Front Psychol*, *10*, 1050. https://doi.org/10.3389/fpsyg.2019.01050

Bhushan, N., Steg, L., & Albers, C. (2018). Studying the effects of intervention programmes on household energy saving behaviours using graphical causal models. *Energy Research & Social Science*, *45*, 75-80. https://doi.org/10.1016/j.erss.2018.07.027

Bissing-Olson, M. J., Fielding, K. S., & Iyer, A. (2016). Experiences of pride, not guilt, predict pro-environmental behavior when pro-environmental descriptive norms are more positive. *Journal of Environmental Psychology*, *45*, 145-153. https://doi.org/10.1016/j.jenvp.2016.01.001

Blanken, T. F., Deserno, M. K., Dalege, J., Borsboom, D., Blanken, P., Kerkhof, G. A., & Cramer, A. O. J. (2018). The role of stabilizing and communicating symptoms given overlapping communities in psychopathology networks. *Sci Rep*, *8*(1), 5854. https://doi.org/10.1038/s41598-018-24224-2

Blesin, J.-M., Jaspersen, M., & Möhring, W. (2017). Boosting plastics' image? Communicative challenges of innovative bioplastics. *Journal of Historic Polymeric Materials, Plastics Heritage and History*, *3*, 1-5.

Borsboom, D., Deserno, M. K., Rhemtulla, M., Epskamp, S., Fried, E. I., McNally, R. J., Robinaugh, D. J., Perugini, M., Dalege, J., Costantini, G., Isvoranu, A.-M., Wysocki, A. C., van Borkulo, C. D., van Bork, R., & Waldorp, L. J. (2021). Network analysis of multivariate data in psychological science. *Nature Reviews Methods Primers*, *1*(1), 58. https://doi.org/10.1038/s43586-021-00055-w

Bouman, T., Steg, L., & Zawadzki, S. J. (2020). The value of what others value: When perceived biospheric group values influence individuals' pro-environmental engagement. *Journal of Environmental Psychology*, *71*. https://doi.org/10.1016/j.jenvp.2020.101470

Bourguignon, D. (2017). *Plastics in a circular economy: Opportunities and challenges*. E. Parliament. http://www.europarl.europa.eu/RegData/etudes/BRIE/2017/603940/EPRS_BRI(2017)603940_EN.pdf

Braun Kohlová, M., & Urban, J. (2020). Buy green, gain prestige and social status. *Journal of Environmental Psychology*, *69*, 101416. https://doi.org/10.1016/j.jenvp.2020.101416

Bray, J., Johns, N., & Kilburn, D. (2010). An Exploratory Study into the Factors Impeding Ethical Consumption. *Journal of Business Ethics*, *98*(4), 597-608. https://doi.org/10.1007/s10551-010-0640-9

Brick, C., Bosshard, A., & Whitmarsh, L. (2021). Motivation and climate change: A review. *Current Opinion in Psychology*, *42*, 82-88. https://doi.org/https://doi.org/10.1016/j.copsyc.2021.04.001

Brick, C., Hood, B., Ekroll, V., & de-Wit, L. (2022). Illusory Essences: A Bias Holding Back Theorizing in Psychological Science. *Perspectives on Psychological Science*, *17*(2), 491-506. https://doi.org/10.1177/1745691621991838

Brick, C., & Lai, C. K. (2018). Explicit (but not implicit) environmentalist identity predicts pro-environmental behavior and policy preferences. *Journal of Environmental Psychology*, *58*, 8-17. https://doi.org/10.1016/j.jenvp.2018.07.003

Brick, C., & Sherman, D. K. (2021). When Does Being Watched Change Pro-Environmental Behaviors in the Laboratory? *Sustainability*, *13*(5). https://doi.org/10.3390/su13052766

Brick, C., Sherman, D. K., & Kim, H. S. (2017). "Green to be seen" and "brown to keep down": Visibility moderates the effect of identity on pro-environmental behavior. *Journal of Environmental Psychology*, *51*, 226-238. https://doi.org/10.1016/j.jenvp.2017.04.004

Brosch, T. (2021). Affect and emotions as drivers of climate change perception and action: a review. *Current Opinion in Behavioral Sciences*, *42*, 15-21. https://doi.org/10.1016/j.cobeha.2021.02.001

Bulmer, S. (1979). *Principles of Statistics*. Dover Publications.

Cacioppo, J. T., von Hippel, W., & Ernst, J. M. (1997). Mapping Cognitive Structures and Processes Through Verbal Content: The Thought-Listing Technique. *Journal of Consulting and Clinical Psychology*, *65*(6), 928-940.

Carrington, M. J., Neville, B. A., & Whitwell, G. J. (2010). Why Ethical Consumers Don't Walk Their Talk: Towards a Framework for Understanding the Gap Between the Ethical Purchase Intentions and Actual Buying Behaviour of Ethically Minded Consumers. *Journal of Business Ethics*, *97*(1), 139-158. https://doi.org/10.1007/s10551-010-0501-6

Cavanaugh, L. A., Bettman, J. R., & Luce, M. F. (2015). Feeling Love and Doing More for Distant Others: Specific Positive Emotions Differentially Affect Prosocial Consumption. *Journal of Marketing Research*, *52*(5), 657-673. https://doi.org/10.1509/jmr.10.0219

Chambon, M., Dalege, J., Borsboom, D., Waldorp, L. J., van der Maas, H. L. J., & van Harreveld, F. (2022). How compliance with behavioural measures during the initial phase of a pandemic develops over time: A longitudinal COVID-19 study. *Br J Soc Psychol*. https://doi.org/10.1111/bjso.12572

Champely, S., Ekstrom, C., Dalgaard, P., Gill, J., Weibelzahl, S., Anandkumar, A., Ford, C., Volcic, R., & De Rosario, H. (2020). *Basic Functions for Power Analysis*. In (Version 1.3-0)

Clayton, S., & Manning, C. (2018). *Psychology and climate change: Human perceptions, impacts, and responses*. Academic Press.

Confente, I., Scarpi, D., & Russo, I. (2020). Marketing a new generation of bio-plastics products for a circular economy: The role of green self-identity, self-congruity, and perceived value. *Journal of Business Research*, *112*, 431-439. https://doi.org/https://doi.org/10.1016/j.jbusres.2019.10.030

Connolly, T., & Zeelenberg, M. (2002). Regret in Decision Making. *Current Directions in Psychological Science*, *11*(6), 212-216. https://doi.org/10.1111/1467-8721.00203

Cordella, M., Alfieri, F., & Sanfelix, J. (2021). Reducing the carbon footprint of ICT products through material efficiency strategies: A life cycle analysis of smartphones. *Journal of Industrial Ecology*, *25*(2), 448-464. https://doi.org/10.1111/jiec.13119

Cramer, A. O., Waldorp, L. J., van der Maas, H. L., & Borsboom, D. (2010). Comorbidity: a network perspective. *Behavioral and Brain Sciences*, *33*(2-3), 137-150. https://doi.org/10.1017/S0140525X09991567

Crippa, M., Guizzardi, D., Muntean, M., Schaaf, E., Solazzo, E., Monforti-Ferrario, F., Olivier, J. G. J., V, & ignati, E. (2020). *Fossil CO2 emissions of all world countries - 2020 Report*. P. O. o. t. E. Union. https://edgar.jrc.ec.europa.eu/overview.php?v=booklet2020

Dalege, J., Borsboom, D., van Harreveld, F., van den Berg, H., Conner, M., & van der Maas, H. L. (2016). Toward a formalized account of attitudes: The Causal Attitude Network (CAN) model. *Psychol Rev*, *123*(1), 2-22. https://doi.org/10.1037/a0039802

Dalege, J., Borsboom, D., van Harreveld, F., & van der Maas, H. L. (2017). Network Analysis on Attitudes: A Brief Tutorial. *Social Psychological and Personality Science*, *8*(5), 528-537. https://doi.org/10.1177/1948550617709827

Dalege, J., Borsboom, D., van Harreveld, F., Waldorp, L. J., & van der Maas, H. L. J. (2017). Network Structure Explains the Impact of Attitudes on Voting Decisions. *Scientific Reports*, *7*(1). https://doi.org/10.1038/s41598-017-05048-y

de Best-Waldhober, M., Daamen, D., & Faaij, A. (2009). Informed and uninformed public opinions on CO2 capture and storage technologies in the Netherlands. *International Journal of Greenhouse Gas Control*, *3*(3), 322-332. https://doi.org/10.1016/j.ijggc.2008.09.001

De Groot, J. I. M., & Steg, L. (2007). Value Orientations and Environmental Beliefs in Five Countries:Validity of an Instrument to Measure Egoistic, Altruistic and Biospheric Value Orientations. *Journal of Cross-Cultural Psychology*, *38*(3), 318-332. https://doi.org/10.1177/0022022107300278

De Marchi, E., Pigliafreddo, S., Banterle, A., Parolini, M., & Cavaliere, A. (2020). Plastic packaging goes sustainable: An analysis of consumer preferences for plastic water bottles. *Environmental Science & Policy*, *114*, 305-311. https://doi.org/10.1016/j.envsci.2020.08.014

Dilkes-Hoffman, L., Ashworth, P., Laycock, B., Pratt, S., & Lant, P. (2019). Public attitudes towards bioplastics – knowledge, perception and end-of-life management. *Resources, Conservation and Recycling*, *151*. https://doi.org/10.1016/j.resconrec.2019.104479

Eastman, J. K., Goldsmith, R. E., & Flynn, L. R. (1999). Status Consumption in Consumer Behavior: Scale Development and Validation. *Journal of Marketing Theory and Practice*, *7*(3), 41-52. http://www.jstor.org/stable/40469967

Eerhart, A. J. J. E., Faaij, A. P. C., & Patel, M. K. (2012). Replacing fossil based PET with biobased PEF; process analysis, energy and GHG balance. *Energy & Environmental Science*, *5*(4). https://doi.org/10.1039/c2ee02480b

Elgaaied, L. (2012). Exploring the role of anticipated guilt on pro-environmental behavior – a suggested typology of residents in France based on their recycling patterns. *Journal of Consumer Marketing*, *29*(5), 369-377. https://doi.org/10.1108/07363761211247488

ElHaffar, G., Durif, F., & Dubé, L. (2020). Towards closing the attitude-intention-behavior gap in green consumption: A narrative review of the literature and an overview of future research directions. *Journal of Cleaner Production*, *275*. https://doi.org/10.1016/j.jclepro.2020.122556

Ellen McArthur Foundation. (2016). *The new plastic economy: rethinking the future of plastics & catalysing action* (The New Plastics Economy, Issue. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/NPEC-Hybrid_English_22-11-17_Digital.pdf

Envirotech. (2019). How Do Smartphones Affect the Environment? Retrieved 19 July 2022, from https://www.envirotech-online.com/news/environmental-laboratory/7/breaking-news/how-do-smartphones-affect-the-environment/48339

Epskamp, S. (2016). *Regularized Gaussian psychological networks: Brief Report on Estimating Regularized Gaussian Networks from Continuous and Ordinal Data*.

Epskamp, S., Borsboom, D., & Fried, E. I. (2018). Estimating psychological networks and their accuracy: A tutorial paper. *Behav Res Methods*, *50*(1), 195-212. https://doi.org/10.3758/s13428-017-0862-1

Epskamp, S., Cramer, A. e. O. J., Waldorp, L. J., Schmittmann, V. D., & Borsboom, D. (2012). qgraph: Network Visualizations of Relationships in Psychometric Data. *Journal of Statistical Software*, *48*(4).

Epskamp, S., Waldorp, L. J., Mõttus, R., & Borsboom, D. (2018). The Gaussian Graphical Model in Cross-Sectional and Time-Series Data. *Multivariate Behavioral Research*, *53*(4), 453-480. https://doi.org/10.1080/00273171.2018.1454823

Ertz, M., Karakas, F., & Sarigöllü, E. (2016). Exploring pro-environmental behaviors of consumers: An analysis of contextual factors, attitude, and behaviors. *Journal of Business Research*, *69*(10), 3971-3980. https://doi.org/10.1016/j.jbusres.2016.06.010

Etale, A., Jobin, M., & Siegrist, M. (2018). Tap versus bottled water consumption: The influence of social norms, affect and image on consumer choice. *Appetite*, *121*, 138-146. https://doi.org/10.1016/j.appet.2017.11.090

European Bioplastics. (2016). *Biobased plastics – fostering a resource efficient circular economy: Benefits, feedstock types, sustainable sourcing, land use*. E. Bioplastics. https://docs.european-bioplastics.org/2016/publications/fs/EUBP_fs_renewable_resources.pdf

European Bioplastics. (2020). Frequently Asked Questions on Bioplastics. In *https://docs.european-bioplastics.org/publications/EUBP_FAQ_on_bioplastics.pdf*.

European Bioplastics. (2021a). *Bioplastics market data*. Retrieved 20 January 2022 from https://www.european-bioplastics.org/market/

European Bioplastics. (2021b, 13 December 2021). *United Nations recommends bioplastics as a sustainable alternative to conventional plastics* https://www.european-bioplastics.org/united-nations-recommends-bioplastics-as-a-sustainable-alternative-to-conventional-plastics/

European Commission, D. E. (2011). *Plastic Waste in the Environment*. https://ec.europa.eu/environment/waste/studies/pdf/plastics.pdf

Fairphone. (2022). *The phone that cares for people and planet*. Fairphone. Retrieved November 17, 2022 from https://www.fairphone.com

Ferguson, M. A., & Branscombe, N. R. (2010). Collective guilt mediates the effect of beliefs about global warming on willingness to engage in mitigation behavior. *Journal of Environmental Psychology*, *30*(2), 135-142. https://doi.org/10.1016/j.jenvp.2009.11.010

Fielding, K. S., McDonald, R., & Louis, W. R. (2008). Theory of planned behaviour, identity and intentions to engage in environmental activism. *Journal of Environmental Psychology*, *28*(4), 318-326. https://doi.org/10.1016/j.jenvp.2008.03.003

Filho, W. L., Barbir, J., Abubakar, I. R., Paco, A., Stasiskiene, Z., Hornbogen, M., Christin Fendt, M. T., Voronova, V., & Kloga, M. (2022). Consumer attitudes and concerns with bioplastics use: An international study. *Plos One*, *17*(4), e0266918. https://doi.org/10.1371/journal.pone.0266918

Fresco, L. O. (2013). The GMO stalemate in Europe. *Science*, *339*(6122), 883. https://doi.org/10.1126/science.1236010

Friedrich, D. (2020). Consumer behaviour towards Wood-Polymer packaging in convenience and shopping goods: A comparative analysis to conventional materials. *Resources, Conservation and Recycling*, *163*. https://doi.org/10.1016/j.resconrec.2020.105097

Fritsche, I., Barth, M., Jugert, P., Masson, T., & Reese, G. (2018). A social identity model of pro-environmental action (SIMPEA). *Psychol Rev*, *125*(2), 245-269. https://doi.org/10.1037/rev0000090

Frost, J. (2018). *How High Does R-squared Need to Be?* Statistics By Jim Retrieved Jan 25 from https://statisticsbyjim.com/regression/how-high-r-squared/

Gaffey, J., McMahon, H., Marsh, E., Vehmas, K., Kymäläinen, T., & Vos, J. (2021). Understanding Consumer Perspectives of Bio-Based Products—A Comparative Case Study from Ireland and The Netherlands. *Sustainability*, *13*(11). https://doi.org/10.3390/su13116062

Gifford, R., Kormos, C., & McIntyre, A. (2011). Behavioral dimensions of climate change: drivers, responses, barriers, and interventions. *WIREs Climate Change*, *2*(6), 801-827. https://doi.org/10.1002/wcc.143

Gill, M., Jensen, K. L., Upendram, S., Labbé, N., English, B. C., Lambert, D. M., Jackson, S. W., & Menardh, R. J. (2020). Tennessee Consumer Willingness to Pay for Disposable Dinnerware Molded from Wheat Straw. *Journal of Food Distribution Research*, *51*(2), 19-39.

Glass, C. R., Merluzzi, T. V., Biever, J. L., & Larsen, K. H. (1982). Cognitive Assessment of Social Anxiety: Development and Validation of a Self-Statement Questionnaire. *Cognitive Therapy and REsearch*, *6*(1), 37-55.

Gleim, M. R., Smith, J. S., Andrews, D., & Cronin, J. J. (2013). Against the Green: A Multi-method Examination of the Barriers to Green Consumption. *Journal of Retailing*, *89*(1), 44-61. https://doi.org/10.1016/j.jretai.2012.10.001

Goldsmith, R. E., & Clark, R. A. (2012). Materialism, status consumption, and consumer independence. *J Soc Psychol*, *152*(1), 43-60. https://doi.org/10.1080/00224545.2011.555434

Groening, C., Sarkis, J., & Zhu, Q. (2018). Green marketing consumer-level theory review: A compendium of applied theories and further research directions. *Journal of Cleaner Production*, *172*, 1848-1866. https://doi.org/10.1016/j.jclepro.2017.12.002

Haider, T. P., Volker, C., Kramm, J., Landfester, K., & Wurm, F. R. (2019). Plastics of the Future? The Impact of Biodegradable Polymers on the Environment and on Society. *Angew Chem Int Ed Engl*, *58*(1), 50-62. https://doi.org/10.1002/anie.201805766

Harth, N. S., Leach, C. W., & Kessler, T. (2013). Guilt, anger, and pride about in-group environmental behaviour: Different emotions predict distinct intentions. *Journal of Environmental Psychology*, *34*, 18-26. https://doi.org/10.1016/j.jenvp.2012.12.005

Hayes, A. F. (2012). *PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling*. In http://www.afhayes.com/ public/process2012.pdf

Heidbreder, L. M., Bablok, I., Drews, S., & Menzel, C. (2019). Tackling the plastic problem: A review on perceptions, behaviors, and interventions. *Science of The Total Environment*, *668*, 1077-1093. https://doi.org/https://doi.org/10.1016/j.scitotenv.2019.02.437

Heimberg, R. G., Nyman, D., & O'Brien, G. T. (1987). Assessing Variations of the Thought-Listing Technique: Effects of Instructions, Stimulus Intensity, Stimulus Modality, and Scoring Procedures. *Cognitive Therapy and REsearch*, *11*(1), 13-24. https://link.springer.com/content/pdf/10.1007%2FBF01183129.pdf

Herbes, C., Beuthner, C., & Ramme, I. (2018). Consumer attitudes towards biobased packaging – A cross-cultural comparative study. *Journal of Cleaner Production*, *194*, 203-218. https://doi.org/10.1016/j.jclepro.2018.05.106

Hertwich, E. G. (2019). The Carbon Footprint of Material Production Rises to 23% of Global Greenhouse Gas Emissions. *https://doi.org/10.31235/osf.io/n9ecw*.

Howe, L. C., & Krosnick, J. A. (2017). Attitude Strength. *Annual Review Psychology*, *68*, 327-351. https://doi.org/10.1146/annurev-psych-122414-033600

Hurst, K. F., & Sintov, N. D. (2022). Guilt consistently motivates pro-environmental outcomes while pride depends on context. *Journal of Environmental Psychology*, *80*. https://doi.org/10.1016/j.jenvp.2022.101776

IEA. (2014). *World Energy Outlook 2014*. IEA. https://www.iea.org/reports/world-energy-outlook-2014

Inman, J. J., & Zeelenberg, M. (2002). Regret in Repeat Purchase versus Switching Decisions: The Attenuating Role of Decision Justifiability. *Journal of Consumer Research*, *29*(1), 116-128. https://doi.org/10.1086/339925

InnProBio. (2017). Biodegradability: Exposing some of the myths and facts. In *https://www.biobasedconsultancy.com/uploads/files/InnProBio_Factsheet_n3.pdf*.

Itzchakov, G., & Van Harreveld, F. (2018). Feeling torn and fearing rue: Attitude ambivalence and anticipated regret as antecedents of biased information seeking. *Journal of Experimental Social Psychology*, *75*, 19-26. https://doi.org/10.1016/j.jesp.2017.11.003

Jadczaková, V. (2013). Review of segmentation process in consumer markets. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, *61*(4), 1215-1224. https://doi.org/10.11118/actaun201361041215

Jaeger, C. M., & Schultz, P. W. (2017). Coupling social norms and commitments: Testing the underdetected nature of social influence. *Journal of Environmental Psychology*, *51*, 199-208. https://doi.org/10.1016/j.jenvp.2017.03.015

Jans, L. (2021). Changing environmental behaviour from the bottom up: The formation of pro-environmental social identities. *Journal of Environmental Psychology*, *73*. https://doi.org/10.1016/j.jenvp.2020.101531

Jolley, D., & Douglas, K. M. (2014). The effects of anti-vaccine conspiracy theories on vaccination intentions. *Plos One*, *9*(2), e89177. https://doi.org/10.1371/journal.pone.0089177

Jones, P. J., Mair, P., & McNally, R. J. (2018). Visualizing Psychological Networks: A Tutorial in R [Review]. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.01742

Joshi, Y., & Rahman, Z. (2015). Factors Affecting Green Purchase Behaviour and Future Research Directions. *International Strategic Management Review*, *3*(1-2), 128-143. https://doi.org/10.1016/j.ism.2015.04.001

Kácha, O., Vintr, J., & Brick, C. (2022). Four Europes: Climate change beliefs and attitudes predict behavior and policy preferences using a latent class analysis on 23 countries. *Journal of Environmental Psychology*, *81*. https://doi.org/10.1016/j.jenvp.2022.101815

Kainz, U., Zapilko, M., Decker, T., & Menrad, K. (2013). Consumer-relevant information about bioplastics. first international conference on resource efficiency in interorganizational networks,

Kainz, U., Zapilko, M., Decker, T., & Menrad, K. (2013). Consumer-relevant information about bioplastics. In J. Geldermann & M. Schumann (Eds.), *First International Conference on Resource Efficiency in Interorganizational Networks* (pp. 391-402). Universitätsverlag.

Kaiser, F. G., Henn, L., & Marschke, B. (2020). Financial rewards for long-term environmental protection. *Journal of Environmental Psychology*. https://doi.org/10.1016/j.jenvp.2020.101411

Kaiser, F. G., Kibbe, A., & Hentschke, L. (2021). Offsetting behavioral costs with personal attitudes: A slightly more complex view of the attitude-behavior relation. *Personality and Individual Differences*, *183*, 111158. https://doi.org/https://doi.org/10.1016/j.paid.2021.111158

Kaplan, K. J. (1972). On the ambivalence-indifference problem in attitude theory and measurement: A suggested modification of the semantic differential technique. *Psychological Bulletin*, *77*(5), 361-372. https://doi.org/10.1037/h0032590

Ketelsen, M., Janssen, M., & Hamm, U. (2020). Consumers' response to environmentally-friendly food packaging - A systematic review. *Journal of Cleaner Production*, *254*, 120123. https://doi.org/10.1016/j.jclepro.2020.120123

Khatoon, S., & Rehman, V. (2021). Negative emotions in consumer brand relationship: A review and future research agenda. *International Journal of Consumer Studies*, *45*(4), 719-749. https://doi.org/10.1111/ijcs.12665

Klein, F., Emberger-Klein, A., Menrad, K., Möhring, W., & Blesin, J.-M. (2019). Influencing factors for the purchase intention of consumers choosing bioplastic products in Germany. *Sustainable Production and Consumption*, *19*, 33-43. https://doi.org/https://doi.org/10.1016/j.spc.2019.01.004

Klöckner, C. A., & Blöbaum, A. (2010). A comprehensive action determination model: Toward a broader understanding of ecological behaviour using the example of travel mode choice. *Journal of Environmental Psychology*, *30*(4), 574-586. https://doi.org/10.1016/j.jenvp.2010.03.001

Koenig-Lewis, N., Palmer, A., Dermody, J., & Urbye, A. (2014). Consumers' evaluations of ecological packaging – Rational and emotional approaches. *Journal of Environmental Psychology*, *37*, 94-105. https://doi.org/10.1016/j.jenvp.2013.11.009

Koutsimanis, G., Getter, K., Behe, B., Harte, J., & Almenar, E. (2012). Influences of packaging attributes on consumer purchase decisions for fresh produce. *Appetite*, *59*(2), 270-280. https://doi.org/https://doi.org/10.1016/j.appet.2012.05.012

Lange, F., Brick, C., & Dewitte, S. (2020). Green when seen? No support for an effect of observability on environmental conservation in the laboratory: a registered report. *Royal Society Open Science*, *7*(4). https://doi.org/10.1098/rsos.190189

Lange, F., & Dewitte, S. (2019). Measuring pro-environmental behavior: Review and recommendations. *Journal of Environmental Psychology*. https://doi.org/10.1016/j.jenvp.2019.04.009

Lange, F., & Dewitte, S. (2021). The Work for Environmental Protection Task: A consequential web-based procedure for studying pro-environmental behavior. *Behavior Research Methods*. https://doi.org/10.3758/s13428-021-01617-2

Lange, J., & Zickfeld, J. H. (2021). Emotions as overlapping causal networks of emotion components: Implications and methodological approaches. *Emotion Review*, *13*, 157-167. https://doi.org/10.1177/1754073920988787

Lovett, J., & de Bie, F. (2016). *Sustainable Sourcing of Feedstocks for Bioplastics: Clarifying sustainability aspects around feedstock use for the production of bioplastics*. C. G. N. B.V. https://www.corbion.com/media/550170/corbion_whitepaper_feedstock_sourcing_11.pdf

Luhtanen, R., & Crocker, J. (1992). A Collective Self-Esteem Scale: Self-Evaluation of One's Social Identity. *Personality and Social Psychology Bulletin*, *18*(3), 302-318. https://doi.org/10.1177/0146167292183006

Lynch, D. H. J., Klaassen, P., & Broerse, J. E. W. (2017). Unraveling Dutch citizens' perceptions on the bio-based economy: The case of bioplastics, bio-jetfuels and small-scale bio-refineries. *Industrial Crops and Products*, *106*, 130-137. https://doi.org/10.1016/j.indcrop.2016.10.035

Magnier, L., Mugge, R., & Schoormans, J. (2019). Turning ocean garbage into products – Consumers' evaluations of products made of recycled ocean plastic. *Journal of Cleaner Production*, *215*, 84-98. https://doi.org/10.1016/j.jclepro.2018.12.246

Mallett, R. K., Melchiori, K. J., & Strickroth, T. (2013). Self-Confrontation via a Carbon Footprint Calculator Increases Guilt and Support for a Proenvironmental Group. *Ecopsychology*, *5*(1), 9-16. https://doi.org/10.1089/eco.2012.0067

Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An Integrative Model of Organizational Trust. *The Academy of Management Review*, *20*(3), 709-734. https://doi.org/10.2307/258792

McCright, A. M., Dunlap, R. E., & Marquart-Pyatt, S. T. (2016). Political ideology and views about climate change in the European Union. *Environmental Politics*, *25*(2), 338-358. https://doi.org/10.1080/09644016.2015.1090371

Mehta, N., Cunningham, E., Roy, D., Cathcart, A., Dempster, M., Berry, E., & Smyth, B. M. (2021). Exploring perceptions of environmental professionals, plastic processors, students and consumers of bio-based plastics: Informing the development of the sector. *Sustainable Production and Consumption*, *26*, 574-587. https://doi.org/10.1016/j.spc.2020.12.015

Meyer, A. (2015). Does education increase pro-environmental behavior? Evidence from Europe. *Ecological Economics*, *116*, 108-121. https://doi.org/https://doi.org/10.1016/j.ecolecon.2015.04.018

Mohanty, A. K., Misra, M., & Drzal, L. T. (2002). Sustainable Bio-Composites from renewable resources: Opportunities and challenges in the green materials world [Article]. *Journal of Polymers and the Environment*, *10*(1-2), 19-26. https://doi.org/10.1023/A:1021013921916

Morwitz, V. G., Steckel, J. H., & Gupta, A. (2007). When do purchase intentions predict sales? *International Journal of Forecasting*, *23*(3), 347-364. https://doi.org/https://doi.org/10.1016/j.ijforecast.2007.05.015

Murcia Valderrama, M. A., van Putten, R.-J., & Gruter, G.-J. M. (2019). The potential of oxalic – and glycolic acid based polyesters (review). Towards CO2 as a feedstock (Carbon Capture and Utilization – CCU). *European Polymer Journal*, *119*, 445-468. https://doi.org/10.1016/j.eurpolymj.2019.07.036

Nielsen, K. S., Brick, C., Hofmann, W., Joanes, T., Lange, F., & Gwozdz, W. (2022). The motivation–impact gap in pro-environmental clothing consumption. *Nature Sustainability*, *5*(8), 665-668. https://doi.org/10.1038/s41893-022-00888-7

Nielsen, K. S., Cologna, V., Lange, F., Brick, C., & Stern, P. C. (2021). The case for impact-focused environmental psychology. *Journal of Environmental Psychology*, *74*, 101559. https://doi.org/https://doi.org/10.1016/j.jenvp.2021.101559

Noppers, E. H., Keizer, K., Bolderdijk, J. W., & Steg, L. (2014). The adoption of sustainable innovations: Driven by symbolic and environmental motives. *Global Environmental Change*, *25*, 52-62. https://doi.org/10.1016/j.gloenvcha.2014.01.012

Ojala, M. (2012). Hope and climate change: the importance of hope for environmental engagement among young people. *Environmental Education Research*, *18*(5), 625-642. https://doi.org/10.1080/13504622.2011.637157

Onwezen, M. C., Antonides, G., & Bartels, J. (2013). The Norm Activation Model: An exploration of the functions of anticipated pride and guilt in pro-environmental behaviour. *Journal of Economic Psychology*, *39*, 141-153. https://doi.org/10.1016/j.joep.2013.07.005

Orset, C., Barret, N., & Lemaire, A. (2017). How consumers of plastic water bottles are responding to environmental policies? *Waste Management*, *61*, 13-27. https://doi.org/https://doi.org/10.1016/j.wasman.2016.12.034

PAI Partners. (2019). ESG Lab | The plastics issue. https://www.paipartners.com/mediaitem/the-plastics-issue/

Palan, S., & Schitter, C. (2018). Prolific.ac—A subject pool for online experiments. *Journal of Behavioral and Experimental Finance*, *17*, 22-27. https://doi.org/10.1016/j.jbef.2017.12.004

Park, H. J., & Lin, L. M. (2020). Exploring attitude–behavior gap in sustainable consumption: comparison of recycled and upcycled fashion products. *Journal of Business Research*, *117*, 623-628. https://doi.org/10.1016/j.jbusres.2018.08.025

Peer, E., Brandimarte, L., Samat, S., & Acquisti, A. (2017). Beyond the Turk: Alternative platforms for crowdsourcing behavioral research. *Journal of Experimental Social Psychology*, *70*, 153-163. https://doi.org/10.1016/j.jesp.2017.01.006

Piff, P. K., Dietze, P., Feinberg, M., Stancato, D. M., & Keltner, D. (2015). Awe, the small self, and prosocial behavior. *J Pers Soc Psychol*, *108*(6), 883-899. https://doi.org/10.1037/pspi0000018

PlasticsEurope. (2018). *Plastics – the Facts 2017: An analysis of European plastics production, demand and waste data*. https://www.plasticseurope.org/application/files/5715/1717/4180/Plastics_the_facts_2017_FINAL_for_website_one_page.pdf

PlasticsEurope. (2019). *Plastic - the Facts 2019: An analysis of European plastics production, demand and waste data*. https://www.plasticseurope.org/application/files/9715/7129/9584/FINAL_web_version_Plastics_the_facts2019_14102019.pdf

Pons, P., & Latapy, M. (2005, 2005//). Computing Communities in Large Networks Using Random Walks. Computer and Information Sciences - ISCIS 2005, Berlin, Heidelberg.

Poškus, M. S. (2016). Using Social Norms to Encourage Sustainable Behaviour: A Meta-Analysis. *Psichologija*, *53*(0). https://doi.org/10.15388/Psichol.2016.53.10031

R Core Team. (2022). *R: A language and environment for statistical computing*. In (Version 4.2.2) R Foundation for Statistical Computing. https://www.R-project.org/

Rapier, R. (2020). Fossil fuels still supply 84 percent of world energy - and other eye openers from BP's Annual Review. *Forbes*. https://www.forbes.com/sites/rrapier/2020/06/20/bp-review-new-highs-in-global-energy-consumption-and-carbon-emissions-in-2019/

Rausch, T. M., & Kopplin, C. S. (2021). Bridge the gap: Consumers' purchase intention and behavior regarding sustainable clothing. *Journal of Cleaner Production*, *278*. https://doi.org/10.1016/j.jclepro.2020.123882

Rees, J. H., Klug, S., & Bamberg, S. (2015). Guilty conscience: motivating pro-environmental behavior by inducing negative moral emotions. *Climatic Change*, *130*(3), 439-452. https://doi.org/10.1007/s10584-014-1278-x

Reicher, S., Spears, R., & Haslam, S. A. (2010). The Social Identity Approach in Social Psychology. In M. Wetherell & C. Talpade Mohanty (Eds.), *The SAGE Handbook of Identities* (pp. 45-62). SAGE Publications Ltd. https://doi.org/10.4135/9781446200889

RESTCo. (2020, July 2020). *Media Coverage of Plastic Pollution*. Resco.ca. Retrieved 20 July from https://www.restco.ca/Plastic_Pollution_Media_Coverage.shtml

Ridder, M. (2022). *Non-alcoholic beverages and soft drinks in the U.S. - statistics & facts*. Statistica. Retrieved 14 July 2022 from https://www.statista.com/topics/1662/non-alcoholic-beverages-and-soft-drinks-in-the-us/#dossierContents__outerWrapper

Ritchie, H. (2018). *Plastic Pollution*. https://ourworldindata.org/plastic-pollution

Ritchie, H., Roser, M., & Rosado, P. (2020). Energy Mix. *Our World in Data*. https://ourworldindata.org/energy-mix

Ruf, J., Emberger-Klein, A., & Menrad, K. (2022). Consumer response to bio-based products – A systematic review. *Sustainable Production and Consumption*, *34*, 353-370. https://doi.org/https://doi.org/10.1016/j.spc.2022.09.022

Scheel, A. M., Tiokhin, L., Isager, P. M., & Lakens, D. (2021). Why Hypothesis Testers Should Spend Less Time Testing Hypotheses. *Perspectives on Psychological Science*, *16*(4), 744-755. https://doi.org/10.1177/1745691620966795

Scherer, C., Emberger-Klein, A., & Menrad, K. (2017). Biogenic product alternatives for children: Consumer preferences for a set of sand toys made of bio-based plastic. *Sustainable Production and Consumption*, *10*, 1-14. https://doi.org/10.1016/j.spc.2016.11.001

Scherer, C., Emberger-Klein, A., & Menrad, K. (2018). Segmentation of interested and less interested consumers in sports equipment made of bio-based plastic. *Sustainable Production and Consumption*, *14*, 53-65. https://doi.org/10.1016/j.spc.2018.01.003

Schneider, C. R., Zaval, L., Weber, E. U., & Markowitz, E. M. (2017). The influence of anticipated pride and guilt on pro-environmental decision making. *Plos One*, *12*(11), e0188781. https://doi.org/10.1371/journal.pone.0188781

Schweiger, F. (2022, 22 February). The mobile phones you can take apart and repair yourself. *BBC News*. https://www.bbc.com/news/business-60374806

Sexton, S. E., & Sexton, A. L. (2012). Conspicuous Conservation: The Prius Halo and Willingness to Pay for Environmental Bona Fides. https://doi.org/10.1016/j.jeem.2013.11.004

Sheeran, P. (2002). Intention—Behavior Relations: A Conceptual and Empirical Review. *European Review of Social Psychology*, *12*(1), 1-36. https://doi.org/10.1080/14792772143000003

Sheeran, P., & Webb, T. L. (2016). The Intention–Behavior Gap. *Social and Personality Psychology Compass*, *10*(9), 503-518. https://doi.org/https://doi.org/10.1111/spc3.12265

Sheoran, M., & Kumar, D. (2020). Benchmarking the barriers of sustainable consumer behaviour. *Social Responsibility Journal*, *18*(1), 19-42. https://doi.org/10.1108/srj-05-2020-0203

Shift. (2022). *SHIFT6mq - shiftphones* -. Shift. Retrieved November 17, 2022 from https://www.shiftphones.com/shift6mq/

Shipley, N. J., & van Riper, C. J. (2022). Pride and guilt predict pro-environmental behavior: A meta-analysis of correlational and experimental evidence. *Journal of Environmental Psychology*, *79*. https://doi.org/10.1016/j.jenvp.2021.101753

Sijtsema, S. J., Onwezen, M. C., Reinders, M. J., Dagevos, H., Partanenc, A., & Meeusen, M. (2016). Consumer perception of bio-based products—An exploratory study in 5 European countries. *NJAS - Wageningen Journal of Life Sciences*, *77*, 61-69. https://doi.org/10.1016/j.njas.2016.03.007

Skurka, C., Eng, N., & Oliver, M. B. (2022). *On the Effects and Boundaries of Awe and Humor Appeals for Pro-Environmental Engagement* (Vol. 16) [awe, humor, emotional appeals, climate change, air pollution]. https://ijoc.org/index.php/ijoc/article/view/19513/3786

Spence, A., Poortinga, W., & Pidgeon, N. (2012). The Psychological Distance of Climate Change. *Risk Analysis*, *32*(6), 957-972. https://doi.org/10.1111/j.1539-6924.2011.01695.x

Steenis, N. D., van der Lans, I. A., van Herpen, E., & van Trijp, H. C. M. (2018). Effects of sustainable design strategies on consumer preferences for redesigned packaging. *Journal of Cleaner Production*, *205*, 854-865. https://doi.org/10.1016/j.jclepro.2018.09.137

Steinke, A., & Kopp, B. (2020). RELEX: An Excel-based software tool for sampling split-half reliability coefficients. *Methods in Psychology*, *2*. https://doi.org/10.1016/j.metip.2020.100023

Stern, P. C. (2000). New Environmental Theories: Toward a Coherent Theory of Environmentally Significant Behavior. *Journal of Social Issues*, *56*(3), 407-424. https://doi.org/10.1111/0022-4537.00175

Sudbury-Riley, L., & Kohlbacher, F. (2016). Ethically minded consumer behavior: Scale review, development, and validation. *Journal of Business Research*, *69*(8), 2697-2710. https://doi.org/10.1016/j.jbusres.2015.11.005

Tajfel, H. (1978). *Differentiation between social groups : studies in the social psychology of intergroup relations*. Academic Press [for] European Association of Experimental Social Psychology.

Taube, O., Kibbe, A., Vetter, M., Adler, M., & Kaiser, F. G. (2018). Applying the Campbell Paradigm to sustainable travel behavior: Compensatory effects of environmental attitude and the transportation environment. *Transportation Research Part F: Traffic Psychology and Behaviour*, *56*, 392-407. https://doi.org/https://doi.org/10.1016/j.trf.2018.05.006

Täuber, S., van Zomeren, M., & Kutlaca, M. (2015). Should the moral core of climate issues be emphasized or downplayed in public discourse? Three ways to successfully manage the double-edged sword of moral communication. *Climatic Change*, *130*(3), 453-464. https://doi.org/10.1007/s10584-014-1200-6

Taufik, D., Reinders, M. J., Molenveld, K., & Onwezen, M. C. (2020). The paradox between the environmental appeal of bio-based plastic packaging for consumers and their disposal behaviour. *Sci Total Environ*, *705*, 135820. https://doi.org/10.1016/j.scitotenv.2019.135820

TCO certified. (2014). *The State of Socially Responsible Manufacturing in the IT Industry*. TCO certified. Retrieved 19 July 2022 from https://tcocertified.com/news/the-state-of-socially-responsible-manufacturing-in-the-it-industry/

Teracube. (2022). *The sustainable smartphone with a 4 year warranty*. Teracube. Retrieved November 17, 2022 from https://myteracube.com

Testa, F., Pretner, G., Iovino, R., Bianchi, G., Tessitore, S., & Iraldo, F. (2021). Drivers to green consumption: a systematic review. *Environment, Development and Sustainability*, *23*(4), 4826-4880. https://doi.org/10.1007/s10668-020-00844-5

The Coca-Cola Company. (2021, 21 Octover 2021). *Coca-Cola Unveils New Prototype Bottle Made From 100% Plant-Based Sources* https://www.coca-colacompany.com/press-releases/coca-cola-unveils-new-prototype-bottle-made-from-100-percent-plant-based-sources

The Kraft Heinz Company. (2022). Sustainable Packaging. Retrieved 13 July 2022, from https://www.kraftheinzcompany.com/esg/sustainable-packaging.html

Thompson, M. M., Zanna, M. P., & Griffin, D. W. (1995). Let's not be indifferent about (attitudinal) ambivalence. In *Attitude strength: Antecedents and consequences*. (pp. 361-386). Lawrence Erlbaum Associates, Inc.

Trudel, R. (2018). Sustainable consumer behavior. *Consumer Psychology Review*. https://doi.org/10.1002/arcp.1045

Tuckerman, R. (2018, 4 July 2018). Big Brands Embracing Bioplastics. *Australasian Bioplastics Association*. https://bioplastics.org.au/big-brands-embracing-bioplastics/

van Borkulo, C. D., Borsboom, D., Epskamp, S., Blanken, T. F., Boschloo, L., Schoevers, R. A., & Waldorp, L. J. (2014). A new method for constructing networks from binary data. *Scientific Reports*, *4*, 5918. https://doi.org/10.1038/srep05918

van Borkulo, C. D., Epskamp, S., Jones, P., Halsbeck, J., & Millner, A. (2019). *Network Comparison Test: Statistical Comparison of Two Networks Based on Three Invariance Measures*. https://cran.r-project.org/web/packages/NetworkComparisonTest/NetworkComparisonTest.pdf

van Borkulo, C. D., van Bork, R., Boschloo, L., Kossakowski, J. J., Tio, P., Schoevers, R. A., Borsboom, D., & Waldorp, L. J. (2022). Comparing network structures on three aspects: A permutation test. *Psychol Methods*. https://doi.org/10.1037/met0000476

Van De Schoot, R., Schmidt, P., De Beuckelaer, A., Lek, K., & Zondervan-Zwijnenburg, M. (2015). Editorial: Measurement Invariance [Editorial]. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.01064

van den Heuvel, J. (2020). *Barriers and triggers in the process of purchasing a Fairphone*. Delft University of Technology]. https://repository.tudelft.nl/islandora/object/uuid%3Ad2fd0260-75a5-4d1a-a922-dd49ec827204

van den Oever, M., Molenveld, K., van der Zee, M., & Bos, H. t. (2017). *Bio-based and biodegradable plastics – Facts and Figures: Focus on food packaging in the Netherlands* (Wageningen Food & Biobased Research number 1722). http://edepot.wur.nl/408350

Van der Maas, H. L. J., Dolan, C. V., Grasman, R. P. P. P., Wicherts, J. M., Huizenga, H. M., & Raijmakers, M. E. J. (2006). A dynamical model of general intelligence: The positive manifold of intelligence by mutualism. *Psychological Review*, *113*(4), 842-861. https://doi.org/10.1037/0033-295X.113.4.842

van der Werff, E., & Steg, L. (2016). The psychology of participation and interest in smart energy systems: Comparing the value-belief-norm theory and the value-identity-personal norm model. *Energy Research & Social Science*, *22*, 107-114. https://doi.org/https://doi.org/10.1016/j.erss.2016.08.022

van Harreveld, F., Nohlen, H. U., & Schneider, I. K. (2015). The ABC of Ambivalence: Affective, Behavioral, and Cognitive Consequences of Attitudinal Conflict. In *Advances in Experimental Social Psychology* (Vol. 52, pp. 285-324). https://doi.org/10.1016/bs.aesp.2015.01.002

van Prooijen, A.-M. (2019). Public trust in energy suppliers' communicated motives for investing in wind power. *Journal of Environmental Psychology*, *61*, 115-124. https://doi.org/10.1016/j.jenvp.2019.01.004

van Valkengoed, A. M., & Steg, L. (2019). Meta-analyses of factors motivating climate change adaptation behaviour. *Nature Climate Change*, *9*(2), 158-163. https://doi.org/10.1038/s41558-018-0371-y

van Zomeren, M., Pauls, I. L., & Cohen-Chen, S. (2019). Is hope good for motivating collective action in the context of climate change? Differentiating hope's emotion- and problem-focused coping functions. *Global Environmental Change*, *58*. https://doi.org/10.1016/j.gloenvcha.2019.04.003

van Zomeren, M., Postmes, T., & Spears, R. (2008). Toward an integrative social identity model of collective action: a quantitative research synthesis of three socio-psychological perspectives. *Psychol Bull*, *134*(4), 504-535. https://doi.org/10.1037/0033-2909.134.4.504

Vesely, S., Klöckner, C. A., & Brick, C. (2020). Pro-environmental behavior as a signal of cooperativeness: Evidence from a social dilemma experiment. *Journal of Environmental Psychology*, *67*, 101362. https://doi.org/https://doi.org/10.1016/j.jenvp.2019.101362

Vesely, S., Klöckner, C. A., Carrus, G., Chokrai, P., Fritsche, I., Masson, T., Panno, A., Tiberio, L., & Udall, A. M. (2022). Donations to renewable energy projects: The role of social norms and donor anonymity. *Ecological Economics*, *193*, 107277. https://doi.org/10.1016/j.ecolecon.2021.107277

Vicente-Molina, M. A., Fernández-Sainz, A., & Izagirre-Olaizola, J. (2018). Does gender make a difference in pro-environmental behavior? The case of the Basque Country University students. *Journal of Cleaner Production*, *176*, 89-98. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.12.079

Voisin, D., Brick, C., Vallée, B., & Pascual, A. (2018). When stereotype threat does not impair performance, self-affirmation can be harmful. *Self and Identity*, *18*(3), 331-348. https://doi.org/10.1080/15298868.2018.1454339

Wensing, J., Caputo, V., Carraresi, L., & Bröring, S. (2020). The effects of green nudges on consumer valuation of bio-based plastic packaging. *Ecological Economics*, *178*. https://doi.org/10.1016/j.ecolecon.2020.106783

Wittneben, B. B. F. (2012). The impact of the Fukushima nuclear accident on European energy policy. *Environmental Science & Policy*, *15*(1), 1-3. https://doi.org/10.1016/j.envsci.2011.09.002

World Economic Forum. (2016). *The New Plastics Economy: Rethinking the future of plastics* [report]. W. E. Forum. https://www.weforum.org/reports/the-new-plastics-economy-rethinking-the-future-of-plastics/

World Pupulation Review. (2022). *CO_2 Emissions by Country 2022*. Retrieved October 4 2022 from https://worldpopulationreview.com/country-rankings/co2-emissions-by-country

Young, W., Hwang, K., McDonald, S., & Oates, C. J. (2010). Sustainable consumption: green consumer behaviour when purchasing products. *Sustainable Development*, n/a-n/a. https://doi.org/10.1002/sd.394

Zelenski, J. M., & Desrochers, J. E. (2021). Can positive and self-transcendent emotions promote pro-environmental behavior? *Current Opinion in Psychology*, *42*, 31-35. https://doi.org/https://doi.org/10.1016/j.copsyc.2021.02.009

Zhao, H., Zhang, H., Xu, Y., Lu, J., & He, W. (2018). Relation Between Awe and Environmentalism: The Role of Social Dominance Orientation [Original Research]. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.02367

Zhuang, W., Luo, X., & Riaz, M. U. (2021). On the Factors Influencing Green Purchase Intention: A Meta-Analysis Approach [Original Research]. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.644020

Zwicker, M. V., van Prooijen, J. W., & Krouwel, A. P. (2020). Persistent Beliefs: Political Extremism Predicts Ideological Stability over Time. *Group Processes & Intergroup Relations*, *23*(8), 1137-1149. https://doi.org/10.1177/1368430220917753

Supplementary Materials

Supplementary Material Chapter 2

STUDY 1

See Excel spreadsheet titled 'Study 1 qualitative response coding' for the coding for the thought-listing responses. As becomes apparent from the Excel spreadsheet, there were more evaluative reactions mentioned than the 25 we ended up choosing for the scale. We tried to combine similar reactions into broader categories, while very general responses such as 'harmful to the environment', were removed in favour of more specific categories.

As the thought-listing was fully exploratory, we did not have a hypothesised set of possible responses, and therefore did not have a predetermined coding scheme. The primary coding was done by the first author of the manuscript. The coding went through multiple stages of combining similar responses into categories. After every of the three 'combining stages', the coding was thoroughly discussed with the second and last author. As they did not code the responses independently, there is no official inter-rater reliability score. We also added this explanation to the supplementary qualitative response coding.

PILOT STUDY

The aim of this pilot study was to test the reliability of the newly developed evaluative reactions scale and the other items we were planning on using and whether the order of items and blocks of items mattered. This pilot study was created using Qualtrics and conducted online using the research platform 'Prolific Academic'.

Methods

Participants

Fifty-two participants took part in the pilot study, 29 (55.8%) of which were female and 23 (44.2%) male. Their ages ranged from 18 to 68 years, with a mean age of 22.5 (SD = 9.69). The majority of the participants either completed secondary education (26.9%), an undergraduate degree (42.3%), or postgraduate education (21.2%), and 9.6% of the participants completed trade/technical/or vocational training. Most of the participants resided or came from (nationality) the United Kingdom (46% and 40%, respectively) and North America (8% and 12%), or the rest of Europe (44% and 46%).

Participants were randomly assigned to one of two conditions, in one of which half the participants (N = 25) saw the regular plastic items first and the other half (N = 27) began with questions concerning bio-based plastic.

Measures

Demographic Information. Participants indicated their age, gender, highest completed level of education, country of residence, and nationality.

Evaluative Reactions Towards (Bio-Based) Plastic. To assess participants' evaluative reactions towards (bio-based) plastic, we used the evaluative reaction scale developed in study 1. See Appendix A and Study 2 for details about the scale and its application. The reliability for Part 1 of the scale (i.e., the 18 cognitive items) was α = .69 for the plastic items and α = .81 for the bio-based items. The reliabilities for the second part of the scale (i.e., the 7 emotion items) were α = .84 and α = .90 for plastic and bio-based plastic respectively.

Behaviour and Intention. Various items assessed participants' behaviours and intentions with regards to (bio-based) plastic use. Our main behavioural measure was willingness to pay. To assess this, participants were shown a picture of an unlabelled 1.5 litre bottle of water. They were told that this bottle is made from 'normal' plastic and that it costs 1€. They were then asked to indicate how much they would be willing to pay for the same bottle made from bio-based plastic using a continuous slider from 0€ to 2€ (the starting position of the slider was at 1€). This question was asked twice (at different time points), once showing a 'normal' plastic bottle and asking for the 'bio-based' price and once starting with a bottle made from 'bio-based' plastic and asking for the amount people would pay for the same bottle made from 'normal' plastic. The order depended on the condition participants were in. Participants who saw items about normal plastic first, were first shown an image of the normal plastic bottle and asked how much they would be willing to pay for a bio-based bottle. Those who saw bio-based items first saw an image of the bio-based plastic bottle first and were asked how much they would be willing to pay for the same bottle if made from normal plastic.

Pro-Environmental Behaviour. In order to assess participants' general pro-environmental behaviour, we adapted the Pro-Environmental Behaviour Questionnaire from Félonneau and Becker (2008). We used 12 of the original 19 items of the scale (1-6, 8, 9, 11, 12, 15, 16), rephrased two (item 18 into "I try to reduce my shower time to conserve water." and 19 into "If I were to buy a new car, I would prefer it to be a low emission vehicle."), and added an item of our own ("I try to make environmentally friendly food choices."). Our 15-item version of the scale had a reliability of α = .81.

Feedback. As this was a 'test run' for Study 2 and still rather exploratory, we also asked participants to give feedback and to let us know whether anything was unclear or could be improved upon.

Procedure. Participants were randomly assigned to one of two counterbalancing conditions which determined the order in which participants completed the items. After reading the information letter about the study and consenting to take part, participants either saw all the items about conventional plastic first, followed by the bio-based

plastic items (plastic first condition), or they say the bio-based items first and then items concerning conventional plastic. Within the blocks of (bio-based) plastic items, participants saw part 1 and then part 2 of the evaluative reaction scale. This was followed by the items assessing behaviour and intention (i.e., willingness to pay, social norm, and perceived control). The positive and negative general evaluations people have towards (bio-based) plastic was the last measure participants saw before moving to the other type of plastic or to the pro-environmental behaviour questions. After giving their demographical information and feedback (optional), participants were debriefed.

Results

Possible Order Effects

Evaluative Reactions Towards (Bio-Based) Plastic. We ran a repeated measures General Linear Model (GLM) with the cognitive evaluations of the type of plastic (conventional and bio-based) as the within-subject factor and condition (i.e., whether participants saw the conventional or bio-based plastic items first) as the between-subjects factor. The results showed a significant difference in people's cognitive evaluative reactions (i.e. part 1 of the evaluative reactions scale) towards the different types of plastic, $F(1, 50) = 39.35$, $p < .001$, $\eta^2_{p=.}44$, but no significant interaction between type of plastic and the order of items ($F(1, 50) = .731$, $p = .397$, $\eta^2_{p=.}014$). The same was found for the feelings (part 2 of the scale): participants felt significantly different towards conventional and bio-based plastic ($F(1, 50) = 63.66$, $p < .001$, $\eta^2_{p=.}56$), but there was no significant interaction between type of plastic and whether participants saw the conventional or bio-based plastic items first ($F(1, 50) = 3.60$, $p = .064$, $\eta^2_{p=.}067$). The lack of an interaction indicates that there was no significant effect of order, suggesting that it did not matter whether participants saw plastic or bio-based plastic items first.

Willingness to Pay. A repeated measures GLM was conducted to determine people's willingness to pay for bio-based compared to conventional plastic, and to test whether it mattered if participants saw the conventional or bio-based bottle as a reference group first. Willingness to pay (for conventional vs. bio-based plastic) was the within-subject factor of the analysis, and condition (conventional or bio-based items first) the between-subjects factor. Looking at the between subject effects, there was no significant effect of counterbalancing, $F(1, 50) = 3.14$, $p = .083$, $\eta^2_{p=.}059$. However, when looking at the within subject effects, there is a main effect of willingness to pay ($F(1, 50) = 42.95$, $p < .001$, $\eta^2_{p=.}46$), as well as a significant interaction between willingness to pay and whether participants saw the conventional or bio-based plastic items first ($F(1, 50) = 5.89$, $p = .019$, $\eta^2_{p=.}11$). As illustrated in Figure S1 and Table S1, participants were always willing to pay more for a bio-based plastic bottle, compared to a bottle made from conventional plastic, $t(50) = 6.55$, $p < .001$ (with a mean difference of €0.48). However, when

participants saw the bio-based bottle first, they were willing to pay significantly less for the bio-based bottle later on ($t(90.2) = 3.004$, $p = .019$), compared to those who saw the conventional plastic bottle first. This effect could be due to an anchoring effect. Participants who first saw that a bio-based plastic bottle costs €1.00, might be less inclined to pay more for it later. Overall, the results are encouraging, because they indicate that people are willing to pay more for a bottle made of bio-based plastic ($M = 1.30$, $SD = 0.36$) compared to one made of conventional plastic ($M = 0.84$, $SD = 0.31$).

Table S1. Willingness to Pay Means (In €), SE, And CI According to Counterbalancing Condition.

				95% CI	
Willingness to Pay	**Condition**	**Mean**	**SE**	**Lower**	**Upper**
Bio-Based Plastic	(1) conventional plastic first	1.44	0.064	1.32	1.57
	(2) bio-based plastic first	1.18	0.062	1.05	1.30
Conventional Plastic	(1) conventional plastic first	0.79	0.064	0.66	0.92
	(2) bio-based plastic first	0.88	0.062	0.75	1.00

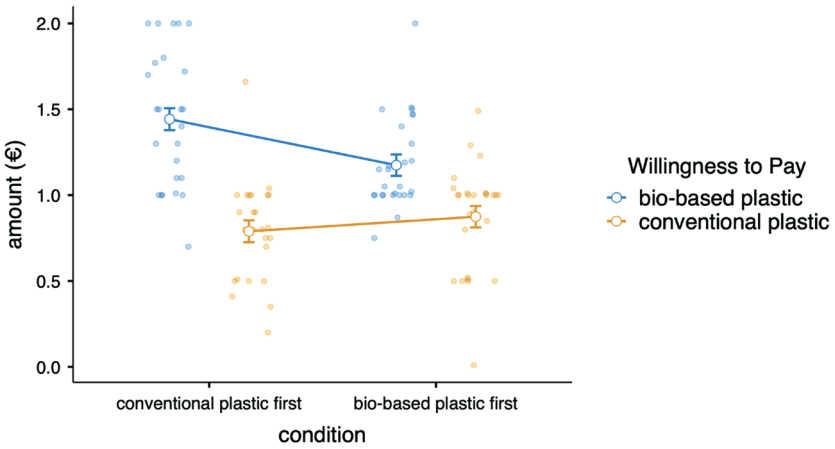


Figure S1. The Amount Participants Were Willing to Pay for a Bottle Made of Conventional and Bio-Based Plastic Depending on Condition. Error Bars Represent the Standard Error.

Other Analyses

Pro-Environmental Behaviour. Participants' self-reported pro-environmental behaviour was not significantly correlated with willingness to pay (for bio-based Plastic: $R(51) = 0.079$, $P = .58$ Or For Conventional Plastic: $R(51) = 0.16$, $P = .26$).

Pilot Study Short Discussion

Based on the results of the pilot study, we decided to show both conventional plastic and then bio-based plastic items to all participants in the primary study, rather than having two conditions. According to our reasoning, this is similar to how it happens in 'real life,' where familiarity with conventional plastic is used as a reference point when learning about bio-based plastic. However, we did decide to add a description page to the beginning of the survey to let participants know that they will be answering questions about both 'normal' plastic and 'bio-based' plastic and avoid comparison coming as a surprise.

STUDY 2

This section includes all measures and results that are not included in the main manuscript (or are part of a different paper).

Measures and Results

Social Norms and Perceived Control

Next to attitudes, social norms and perceived behavioural control are well-established predictors of behaviour (e.g., see the theory of planned behaviour; Ajzen 1991). We therefore also included self-report measures of both social norms and perceived control.

Two items assessed social norm factors, namely to what extent participants think that people in their social network think it is important to recycle items made from bio-based and conventional plastic, and how important the opinion of people in their social network is to them regarding this.

Three items measured participants' perceived control. Participants were asked how much control they think they have about how much (bio-based) plastic they use, recycling their (bio-based) plastic, and buying (bio-based) plastic products. The reliability for these three items was $\alpha = 0.63$ for normal plastic and $\alpha = 0.79$ for bio-based plastic.

Results. Paired samples t-tests revealed that participants thought to have significantly more control regarding the use, recycling, and buying of products made from conventional plastic ($M = 4.53$, $SD = 1.20$) compared to bio-based plastic ($M = 4.16$, $SD = 1.42$), $t(507) = 6.81$, $p < .001$, $d = 0.30$. This was the case for all aspects of control measured: use $t(507) = 4.42$, $p < .001$, $d = 0.20$, recycling $t(507) = 6.86$, $p < .001$, $d = 0.31$, and buying $t(507) = 3.86$, $p < .001$, $d = 0.17$.

Correlational analysis revealed that perceived control for both conventional ($r(508) = 0.13$, $p = .003$) and bio-based plastic ($r(508)$ 0.15, $p < .001$) positively correlate to people's willingness to pay. Social norm did not relate significantly to people's willingness to pay, neither for conventional $r(504) = 0.067$, $p = .131$, nor for bio-based ($r(506) = 0.078$, $p = .081$) plastic.

Pro-Environmental Behaviour

The majority of research concerning pro-environmental behaviour is based on self-report and relies on participants' subjective accounts of their behaviour or its antecedents, such as intentions or attitudes (Lange et al., 2018). However, the relationship between reported behaviour (or intention) and actual behaviour is often incongruous.

We included a more broad and self-reported measure of pro-environmental behaviour in addition to the willingness to pay measures to see how these measures relate to one another. For this purpose, we adapted the Pro-Environmental Behaviour Questionnaire from Félonneau and Becker (2008). We used 12 of the original 19 items of the scale (1-6, 8, 9, 11, 12, 15, 16), rephrased two (item 18 into "I try to reduce my shower time to conserve water." and 19 into "If I were to buy a new car, I would prefer it to be a low emission vehicle."), and added an item of our own ("I try to make environmentally friendly food choices."). Our 15-item version of the scale had a reliability of $\alpha = .86$.

Results. Running a regression, we found people's self-reported pro-environmental behaviour to be related to their willingness to pay, $b = 0.131$, $t(506) = 2.97$, $p = .003$, 95% CI_B [0.027, 0.131]. However, it only explained 1.7% of the variance, $R^2 = 0.017$, $F(1, 506) = 8.83$, $p = .003$.

Bio-Based Plastic Network Analysis

When comparing the networks, the bio-based plastic network is more highly connected than the network describing attitudes towards conventional plastic, showing a connectivity score of 19.65 compared to conventional plastic's 25.66 (lower scores indicate higher connectivity). However, it is impossible to tell whether participants indeed have stronger attitudes about bio-based plastic compared to conventional plastic, or whether their attitudes towards bio-based plastic is based on misconceptions they hold.

Community Detection. As illustrated by Figure S2, which shows the bio-based plastic network after community detection, all negative emotions form a community. The positive emotions also form a cluster together with the behavioural node 'willingness to pay'. All the nodes describing the positive attributes of bio-based plastic form another community, as do the evaluative reactions concerning mainly negative aspects of plastic use together with the nodes 'safe' and 'recycling'. While the behavioural node was in a cluster with the negative emotions in the network concerning attitudes about conventional plastic, it appears to be most strongly connected to the positive emotions in the bio-based network.

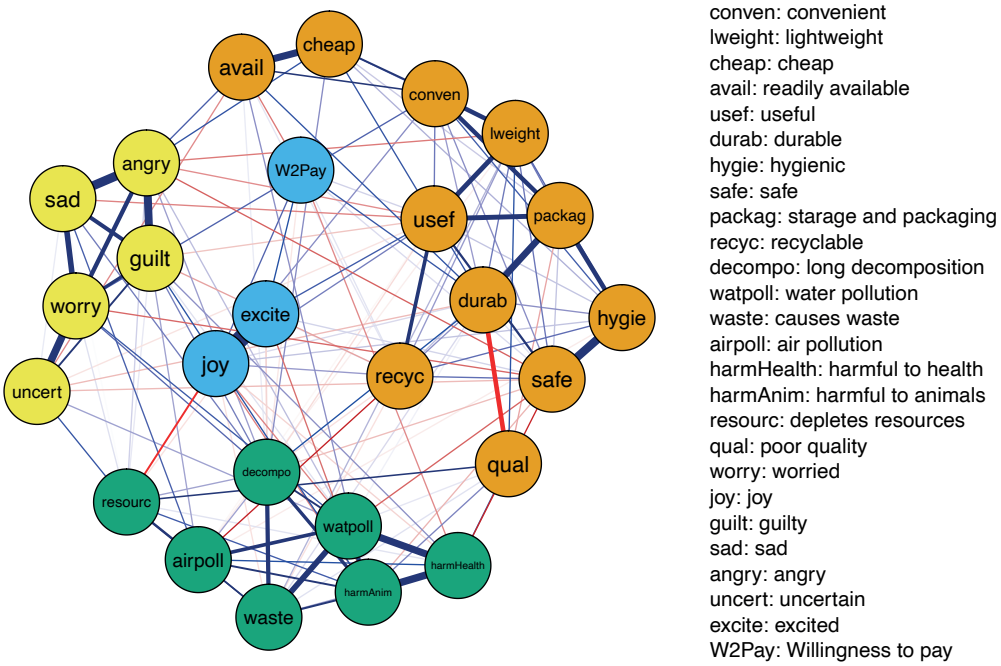


Figure S2. Partial Correlation Attitude Network of Evaluative Reactions Towards Bio-Based Plastic. No Partial Correlations Under 0.1 Are Displayed, and Edges that Have Higher than A 0.3 Partial Correlation are Plotted with Thickness According to their Magnitude. Closely Connected Attitude Elements are Placed Near to Each Other. The Different Colours Represent Different Clusters (Communities) of Nodes that Consist of Closely Connected Evaluative Reactions. The Yellow Nodes Represent the Negative Emotions, the Blue Nodes the Positive Emotions and the Behavioural Measure of Willingness to Pay, the Green Nodes Include all the Negative Aspects of Plastic, and the Orange Cluster Contains all the Possibly Positive Aspects about Plastic (Including Quality).

Node Centrality. Figure S3 displays the centrality measures for the plastic network. As in the network about conventional plastic, we focused on the strength measure of centrality, which represents the direct influence of a given node on the network. Centrality for the bio-based plastic networks paints a less clear picture than that for conventional plastic. 'Water pollution', 'harmful to animals', and 'angry' have the highest strength. None of these 'strong' evaluations appear to be connected to people's willingness to pay. These results are difficult to interpret, which might be caused by the misconceptions people hold towards bio-based plastic.

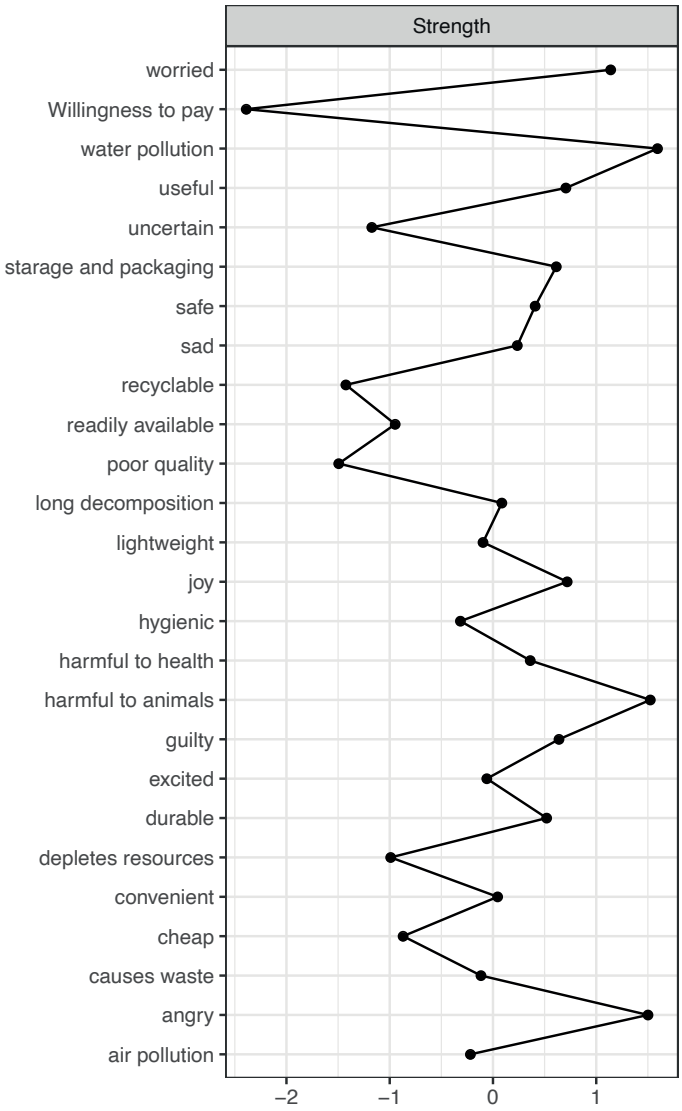


Figure S3. Strength Centrality Plots for the Bio-Based Plastic Network. The Strength Scores Represent Standardised Z-Scores. A Score of 1, for Example, thus Means that this Node Has a Strength Score 1 SD Higher than the Mean Strength Score of the Network.

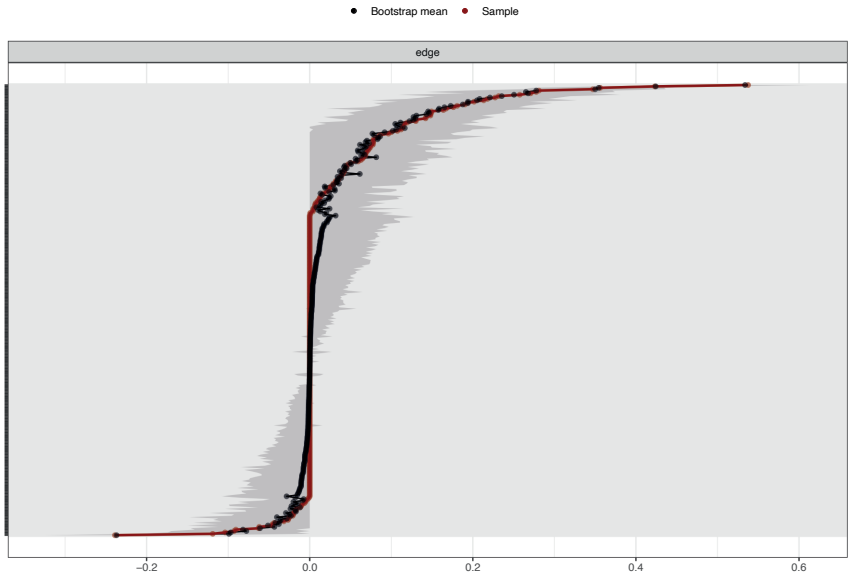
Comparing Networks. Just as in Dalege, Borsboom, van Harreveld, and van der Maas (2017), we used the Network Comparison Test (NetworkComparisonTest package in R; van Borkulo, Epskamp, Jones, Halsbeck, & Millner, 2016) to test whether the two networks

significantly differ from one another with regard to their global strength (that is, the sum of all edge weights) and network structure, as well as specific edge values (Dalege, Borsboom, van Harreveld, & van der Maas, 2017). The NCT suggests that the global strengths of the networks differed significantly (3.42, $p < .001$), with the bio-based plastic network showing greater global strength (11.33) than the regular plastic network (7.91). The structures of the networks and some specific edges also differed significantly. The structure of the networks was not invariant, as the maximum difference in edge weights of 0.28 was significant, $p < .001$. The specific edges that differed significantly between the two networks were: convenient – useful, useful – recyclable, waterPollution – airPollution, waterPollution – health, animals – sad, cheap – angry, available – angry, waterPollution – uncertain, guilty – will2pay. Note: we Bonferroni corrected the p-values for each edge - all p-values were below $p < .001$.

Network Stability Analysis

For more information about the stability analyses illustrated in Figure S4 and S5, their calculation and interpretation see (Epskamp et al., 2018).

A



B

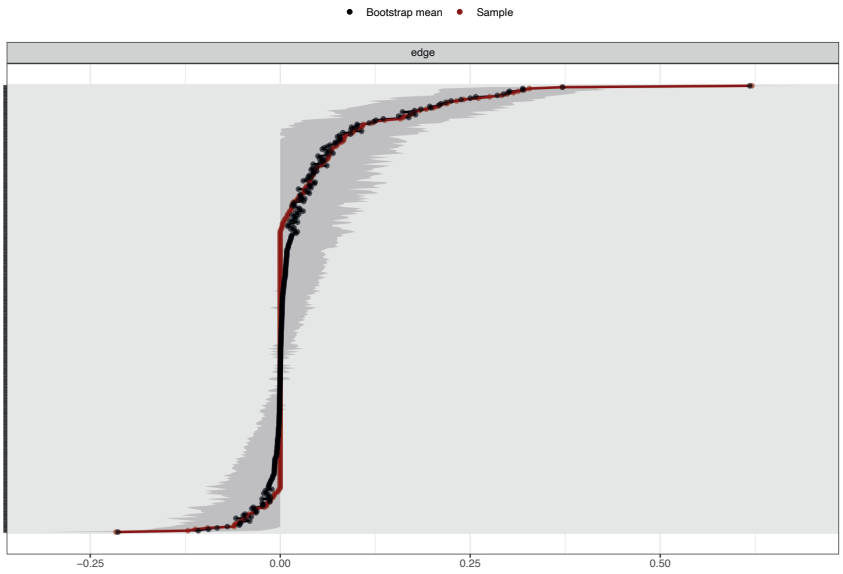


Figure S4. Bootstrapped Confidence Intervals of Estimated Edge-Weights for the 26 Nodes of the Conventional Plastic (A) and Bio-Based Plastic (B) Network. The *Red Line* Indicates the Sample Values, the *Black Line* the Bootstrap (1000) Mean, and the *Grey Area* the Bootstrapped 95% Confidence Intervals. The Edges of the Network are Represented by the Grey *Horizontal Line*, Ordered by the Size of their Edge-Weight. Where the Edge-Weights were of the Same Size, the Order was Determined by the Mean of the Bootstrap Samples. The Bootstrapped Confidence Interval is Relatively Narrow, Which Shows that the Networks are Fairly Stable.

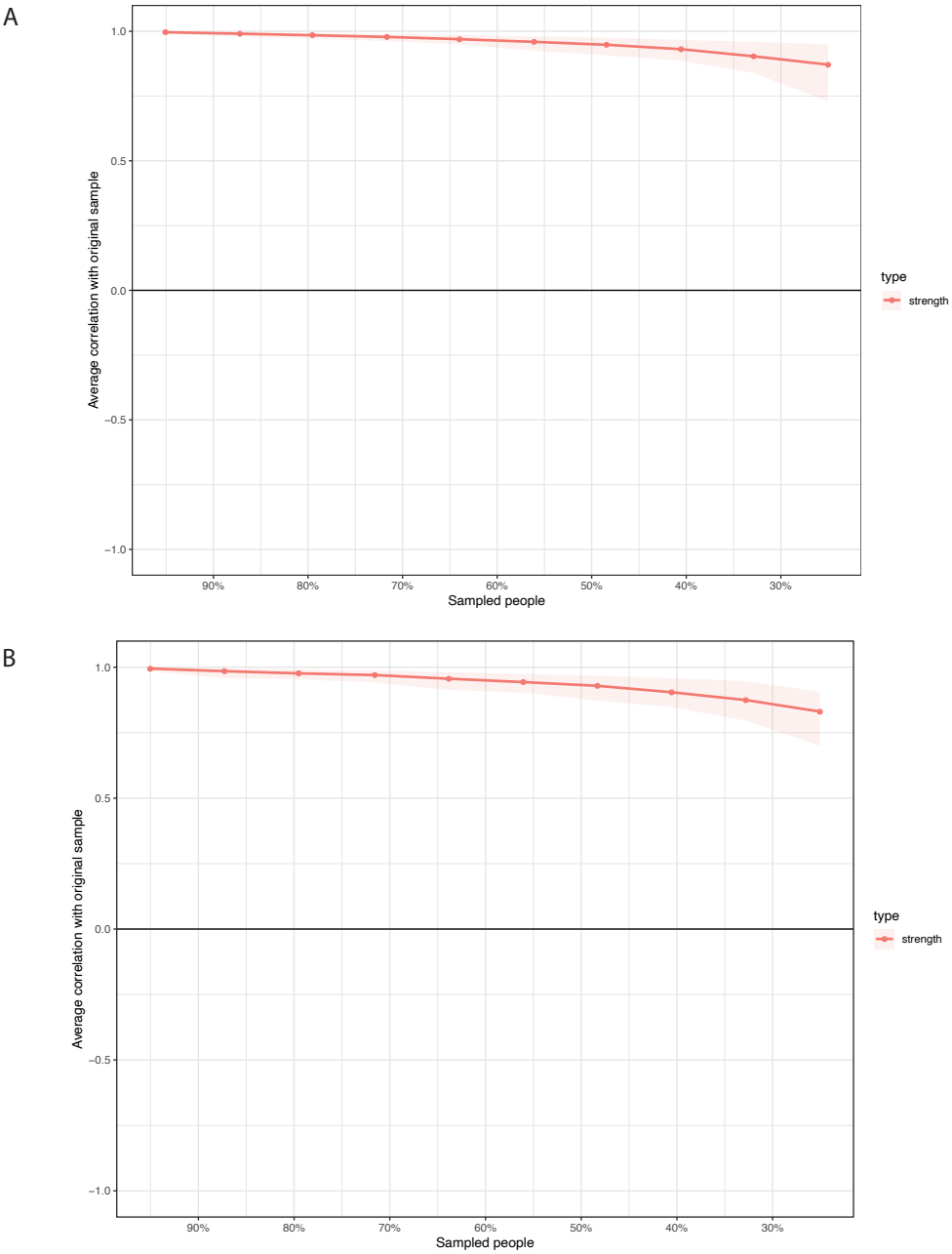


Figure S5. Average Correlations Between the Strength Centrality Index of the Conventional Plastic (A) and Bio-Based Plastic (B) Networks Sampled with Dropped Subjects and the Original Sample. The *Lines* Indicate the Means and the Shaded *Areas* Indicate the Range From the 2.5th Quantile to the 97.5th Quantile. The Correlation Between the Strength Estimates in the Whole Sample and Estimates in the Subsamples Remain High. Strength is Thus Estimated with High Accuracy.

PARAMETRIC VERSUS NON-PARAMETRIC TESTS

During the review process, we were made aware that the assumption of normally distributed data might not always be met when it comes to our willingness to pay measure. We display the level of skewedness and the alternative results obtained from using non-parametric tests below. We based our assessment of the interpretation of skewedness mainly on Bulmer (1979), who suggested that data with a skew of less than -1 or greater than +1 is considered highly skewed, skewedness between -1 and -0.5 or between 0.5 and 1 indicated a moderately skewed distribution and that skewedness between -0.5 and 0.5 are considered approximately symmetric. This is a more conservative view of skewedness, other guidelines set the acceptable range for skew from -2 to +2 (e.g., George & Mallery, 2010).

Study 2

In Study 2, the willingness to pay (bottle) data displayed skew value of 0.198, *SE* = 0.108, which suggests normal symmetry and does not justify non-parametric testing.

Study 3

The willingness to pay (bottle) data displayed a moderate skew of -0.660, *SE* = 0.144, which suggests a normal symmetry to moderate skew. A Mann-Whitney confirmed the results we found with tests assuming normal distribution; we again found no significant difference in people's willingness to pay for a bio-based bottle between conditions (guilt vs. control), $U = 9843.50$, $z = 0.899$, $p = .369$, $r = 0.053$.

The donation measure did show a significant skew of 1.411 SE = 0.1411 and thereby violated the assumption of the t-test originally used. We therefore conducted a Mann-Whitney test, which suggested that donation amount no longer differed significantly for the different conditions, $U = 10336$, $z = 1.754$, $p = .079$, $r = 0.104$. We decided to leave the complete (bootstrapped) mediation as the main analysis however, as we believe that even when employing the non-parametric tests, the influence of condition on behaviour remains meaningful enough to further probe with the bootstrapping analysis, which provides the most comprehensive picture of how condition, guilt and donation relate.

Supplementary Material Chapter 3

Please note that Studies 1–3 were parts of larger studies; see *Chapter 2* for the additional measures. The supplementary materials include additional information about the subject pool and potential skewness of the data, non-parametric analyses, descriptive texts describing (bio-based) plastic as seen by the participants, and additional analyses that did not make it into the final version of the paper.

Participants

All studies were made available to participants residing in the following Western countries: UK, USA, Ireland, Germany, France, Spain, Australia, Austria, Belgium, Canada, Denmark, Finland, Iceland, Italy, Lichtenstein, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland. Within these countries, only people who had a Prolific Academic approval rate of > 99% were allowed to participate.

STUDY 1

Attitudes

Because some of the attitude distributions displayed a slight skew (Table S1), we also performed a Wilcoxon rank-sum test (Table S2).

We also computed the overall holistic attitude scores by subtracting participants' negative attitudes from their positive ones. Conducting the same paired-samples t-test as before, we found that, overall, participants were more positive towards bio-based (M = 1.55, SD = 1.42) than conventional plastic (M = -0.19, SD = 2.15), $t(96) = -7.24$, $p < .001$, $d = -0.74$.

We did not find a significant difference in feelings of ambivalence towards the two types of plastic (M = 1.55, SD = 1.40 and M = 1.30, SD = 1.26 for conventional and bio-based plastic respectively), $t(96) = 1.36$, $p = .18$, $d = 0.14$.

Table S1. Descriptive Statistics and Skewness Information of Participants' Attitudes Toward Conventional and Bio-Based Plastic (Study 1, N = 97).

	Conventional plastic positive	Conventional plastic negative	Bio-based plastic positive	Bio-based plastic negative	Conventional plastic overall	Bio-based plastic overall
Mean	3.1	3.4	3.8	2.3	-0.2	1.6
SE mean	0.12	0.14	0.10	0.09	0.22	0.14
Median	3	3	4	2	0	2
Std. Dev.	1.2	1.4	1.0	0.9	2.2	1.4
Skewness	-0.25	-0.25	-0.51	0.69	0.27	-0.64
SE skew	0.25	0.25	0.25	0.25	0.25	0.25

Table S2. Wilcoxon Rank-Sum Test Results Comparing Participants' Attitudes Towards Conventional Plastic with their Attitudes Towards Bio-Based Plastics (Study 1, *N* = 97).

Relationship tested		T	SE	*p*- value	effect size (*r*)
P_Attitudes	BB_Attitudes	2895.5	211.27	< .001	0.59
P_positive	BB_positive	2021	162.68	< .001	0.51
P_negative	BB_negative	412.5	201.32	< .001	-0.59
P_positive	P_negative	1899	205.71	< .001	0.14
BB_positive	BB_negative	203.5	221.31	< .001	-0.73

Note. 'P_' stands for conventional plastic and 'BB_' indicates bio-based plastic.

STUDY 2

Willingness to Pay

The willingness to pay results for Study 2 are also reported in the Supplementary Materials and the results of Study 3 in the main manuscript of *Chapter 2*. However, the current paper focuses on the relationship between attitudes and willingness to pay, which was not covered in the previous paper.

Because the willingness to pay distribution for regular plastic was slightly skewed (0.65, *SE* = 0.33), we also conducted a Wilcoxon signed-rank test. The results remain unchanged, $T = 48.50$, $p < .001$, $r = -0.71$.

Attitudes

Due to a slight skew of some of the attitude distributions, we also performed Wilcoxon rank-sum tests. The skew information and the results for the non-parametric tests can be found in Table S3 and S4. The results did not differ from the parametric ones.

Table S3. Descriptive Statistics and Skewness Information of Participants' Attitudes, and Importance to Recycle with Regards to Conventional and Bio-Based Plastic (Study 2, *N* = 52).

	Conventional plastic positive	Conventional plastic negative	Bio-based plastic positive	Bio-based plastic negative	Conventional plastic overall	Bio-based plastic overall	Conventional plastic Recycle	Bio-based Conventional plastic Recycle
Mean	4.35	5.38	5.71	4.50	-1.04	1.21	6.79	6.40
Median	4.00	6.00	6.00	4.00	-1.00	1.00	7.00	7.00
Std. Dev	1.75	1.56	1.26	1.34	2.47	1.54	0.67	1.07
Skew	-0.31	-0.68	-0.72	0.078	-0.093	-0.27	-3.45	-2.18
SE skew	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Kurtosis	-0.79	-0.25	-0.44	0.018	-0.033	0.31	11.60	5.13
SE skew	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65

Table S4. Wilcoxon rank-sum test results comparing participants' attitudes towards conventional plastic with their attitudes towards bio-based plastics (Study 2, N = 52).

Relationship tested		*T*	*SE*	*p*- value	effect size (*r*)
P_Attitudes	BB_Attitudes	966	91.14	< .001	0.65
P_positive	BB_positive	600	60.42	< .001	0.65
P_negative	BB_negative	248.5	81.89	.006	-0.38
P_positive	P_negative	591	71.11	.005	0.39
BB_positive	BB_negative	82.5	70.80	< .001	-0.60

Note. 'P_' stands for conventional plastic and 'BB_' indicates bio-based plastic.

When comparing overall holistic attitudes we found participants to be more positive towards bio-based (M = 1.21, SD = 1.54) than conventional plastic (M = -1.04, SD = 2.47) plastic, $t(51) = -5.84$, $p < .001$, $d = -0.81$. As in first Study, we did not find a significant difference in feelings of ambivalence towards the two types of plastic (M = 1.55, SD = 1.40 and M = 1.30, SD = 1.26 for conventional and bio-based plastic respectively), $t(51) = -1.50$, $p = .139$, $d = -0.21$.

STUDY 3

Informational Texts About the Difference Between Conventional and Bio-Based Plastics

"In this study, we are interested in your opinions about plastic.
We are going to ask you questions about two different types of plastic: 'normal' plastic and 'bio-based' plastic.

The **'normal' plastic** that you know from your everyday life is made from fossil feedstocks such as petroleum and natural gas.

The defining feature of '**bio-based' plastic** is that it is made (entirely or partially) from 'biomass'. Biomass is material made from animals and plants, such as wood or crops. An example of a bio-based product is paper. Nowadays, plastic can also be made from biomass.

Bio-based plastic is often very similar in appearance to conventional 'normal' plastic. Both of these two types of plastic can be shaped and used for a great variety of products, including bottles, utensils, toys, shopping bags, packaging materials, clothes, and many other everyday items."

Attitudes

These results were also reported in *Chapter 2*.

That participants were more positive towards bio-based (M = 2.60, SD = 2.21) than conventional plastic (M = -0.38, SD = 2.47), was also shown when comparing overall attitudes, $t(507) = -21.33$, $p < .001$, $d = -0.95$. Contrary to the first two studies, we found a significant difference in feelings of ambivalence towards the two types of plastic (M = 3.02, SD = 2.23 and M = 1.77, SD = 2.24 for conventional and bio-based plastic respectively), $t(507) = 9.39$, $p < .001$, $d = 0.42$. This suggests that participants seem to have more mixed feelings towards conventional plastic, compared to its more sustainable alternative.

STUDY 4

We also measured attitude strength in the form of attitude certainty and importance. To reduce length, these results fall outside the scope of the manuscript. The items, analysis, and results can be found below.

Manipulation Texts

Control Condition

Bio-Based Plastic

In recent years, more and more technologies have been developed to help protect the environment and combat climate change. One of these new technologies is bio-based plastic. Bio-based plastic is identical to conventional plastic, but rather than being made from fossil feedstocks like oil, coal, or natural gas, **bio-based plastic is made** (entirely or partially) **from biomass.** Examples of biomass material are wood or crops that are not eligible for food or feed production.

Negative Condition

Bio-Based Plastic

In recent years, more and more technologies have been developed to help protect the environment and combat climate change. One of these new technologies is bio-based plastic. Bio-based plastic is identical to conventional plastic, but rather than being made from fossil feedstocks like oil, coal, or natural gas, **bio-based plastic is made** (entirely or partially) **from biomass.** Examples of biomass material are wood or crops that are not eligible for food or feed production.

Despite what many people believe, most **bio-based plastic is not biodegradable**. In other words, it is not easily broken down by microorganisms (e.g., bacteria). In that sense it is identical to conventional plastic in attributes and qualities. It therefore also does not

help with alleviating problems like the 'plastic soup', and it does not prevent the harm to marine animals caused by plastic waste in the ocean.

Balanced Condition

Bio-based plastic

In recent years, more and more technologies have been developed to help protect the environment and combat climate change. One of these new technologies is bio-based plastic. Bio-based plastic is identical to conventional plastic, but rather than being made from fossil feedstocks like oil, coal, or natural gas, **bio-based plastic is made** (entirely or partially) **from biomass.** Examples of biomass material are wood or crops that are not eligible for food or feed production.

Despite what many people believe, most **bio-based plastic is not biodegradable**. In other words, it is not easily broken down by microorganisms (e.g., bacteria). In that sense it is identical to conventional plastic in attributes and qualities. It therefore also does not help with alleviating problems like the 'plastic soup', and it does not prevent the harm to marine animals caused by plastic waste in the ocean.

What makes **bio-based plastic** more sustainable is that, unlike conventional plastic, it **does not contribute to global warming**. Throughout its life-cycle, conventional plastic contributes significantly to global warming by emitting large amounts of CO_2 that was previously stored underground in the form of fossil fuels. Bio-based plastic does not add any additional CO_2 to the atmosphere than was already present above ground.

Manipulation Check

Participants were given a manipulation check to test their knowledge about bio-based plastic after having read the different manipulation texts. On a 7-point Likert scale (*1 = completely untrue* to *7 = completely true*) they indicated how much they believed the following statements to be true: 1) "Bio-based plastic is biodegradable.", 2) "Unlike regular plastic, bio-based plastic does not add any additional CO_2 to the atmosphere." (reverse coded), 3) "Bio-based plastic does not contribute to the 'plastic soup' or marine pollution.", and 4) "Bio-based plastic still contributes to global warming." These statements were presented in a random order. Statements 1 and 3 concerned participants' knowledge about the bio-degradability of bio-based plastic, were strongly correlated $r(302) = 0.69$ $p < .001$ and were combined into one biodegradability score. Statements 2 and 4 assessed participants' knowledge about bio-based plastic's CO_2 footprint and were combined into a CO_2 score, $r(302) = -0.66$, $p < .001$. Higher values indicate less knowledge (misconception). Depending on condition, participants were expected to have different amounts of knowledge about bio-based plastic: see Table 4.

ATTITUDES

As some of the distributions were slightly skewed, we also ran related-samples Wilcoxon signed-rank tests (Table S5). The pattern of the results was the same.

Overall, participants were more positive towards bio-based (M = 1.39, SD = 2.4) than conventional plastic (M = -1.42, SD = 2.5), $t(303) = -16.02$, $p < .001$. As in Study 1 and 2, we found no significant difference in feelings of ambivalence towards the two types of plastic (M = 2.04, SD = 2.0 and M = 2.25, SD = 2.3 for conventional and bio-based plastic respectively), $t(303) = -1.36$, $p = .0174$.

Table S5 Wilcoxon Rank-Sum Test Results Comparing Participants' Attitudes Towards Conventional Plastic with their Attitudes Towards Bio-Based Plastics (Study 2, N = 52).

Relationship tested		*T*	*SE*	*p*- value	effect size (*r*)
P_Attitudes	BB_Attitudes	34130.5	1294.92	<.001	0.69
P_positive	BB_positive	28484	1124.7	<.001	0.66
P_negative	BB_negative	4737.5	1129.1	<.001	-0.55
P_positive	P_negative	27314.5	1213.5	<.001	0.48
BB_positive	BB_negative	6124	1192.1	<.001	-0.51

Note. 'P_' stands for conventional plastic and 'BB_' indicates bio-based plastic.

The Effect of Attitude on the Condition-Willingness to Pay Relationship

We expected more positive attitudes to lead to a higher willingness to pay than negative attitudes. We therefore predicted that attitudes would moderate the relationship between condition and willingness to pay, with participants with positive attitudes being willing to pay more, while participants with negative attitudes towards bio-based plastic would not. Alternatively, overall attitudes could also function as a mediator. Both the moderation and mediation hypotheses were pre-registered.

We hypothesised that attitude could potentially work as either a mediator or a moderator of the relationship between condition and willingness to pay. We therefore performed both analyses (5000 bootstraps) using PROCESS version 3 for SPSS (Hayes, 2017).

As condition only affected the willingness to pay for the bottle measure, the moderation analysis was only conducted for that measure. The analysis revealed that neither attitudes towards conventional, nor towards bio-based plastic moderated the relationship between the manipulated condition and willingness to pay (b = -0.001, 95% CI [-0.014, 0.012], t = -0.13, p = .90 and b = 0.009, 95% CI [-0.006, 0.024], t = 1.35, p = 0.18, respectively).

While we found a parametric null effect, the non-parametric results suggested a statistically significant relationship between condition and self-reported willingness to pay. We therefore ran a mediation analysis to determine whether attitude mediated this relationship. The results revealed that there was no indirect effect of condition on willingness to pay for bio-based plastic attitudes (b = -0.01, 95% CI [-0.02, 0.00]).

Attitude Strength

Besides overall (holistic) attitudes, we also measured attitude strength. In particular, we assessed two components of attitude strength: attitude certainty and attitude importance. Attitude certainty is an aspect of attitude strength and has been defined as the sense of conviction with which one holds one's attitude (Gross et al., 1995). In general, attitudes held with greater certainty have greater attitude-behaviour correspondence, and tend to be more persistent and resistant to persuasion attempts (for overview see Petrocelli et al., 2007). It has been argued that attitude certainty has two distinct aspects: attitude clarity and attitude correctness. Attitude clarity refers to a person's subjective sense that they know what their own attitude is and attitude correctness to the subjective sense that their attitude is correct or valid (Petrocelli et al., 2007). In this research we measured both attitude clarity and correctness and then combined the responses into one attitude clarity score. We expected that the manipulation would affect attitude certainty. Specifically, we predicted attitude certainty to be stronger the more information the participants received (i.e., most certain in the positive condition). We also pre-registered an exploratory analysis to test whether attitude certainty moderates the relationship between holistic attitude and willingness to pay.

Another aspect of attitude strength that we assessed is attitude importance, or the degree of priority or significance a person attaches to an attitude (Howe & Krosnick, 2017). We included attitude importance because more important attitudes tend to be more stable over time and tend to influence what kind of information people seek out, and how they react to messages aimed at persuading them (for a review see Howe & Krosnick, 2017). We expected importance to moderate the relationship between condition and willingness to pay, with those with greater attitude importance being willing to pay more.

Results. We tested whether the manipulation affected participants' attitude certainty. For that, we ran several one-way ANOVA's with condition as the independent and attitude as the dependent variable. We found that neither attitude certainty as a whole [$F(2, 301) = 0.61$, $p = .55$), nor the clarity [$F(2, 301) = 0.71$, $p = .50$) or correctness [$F(2, 301) = 0.41$, $p = .66$] subscales showed a significant effect of manipulation on attitude certainty.

To test whether attitude certainty moderates the relationship between holistic attitude towards bio-based plastic and willingness to pay, we ran a bootstrapped (5000

bootstraps) moderation analysis using model 1 of Hayes (2017)' PROCESS version 3. No significant interaction effect was found (b = -0.007, 95% CI [-0.017, 0.029], t = -1.39, p = .166), suggesting that attitude certainty does not moderate the relationship between condition and self-reported willingness to pay. When it comes to actual donation behaviour, attitude certainty appears to moderate the relationship between participants attitude towards bio-based plastic and their willingness to pay (b = -0.013, 95% CI [-0.023, -0.031], t = -2.56, p = .011). Specifically, those with low attitude certainty donate more the more positive their attitudes, while the opposite pattern is observed in those individuals with high attitude certainty (see Figure S1).

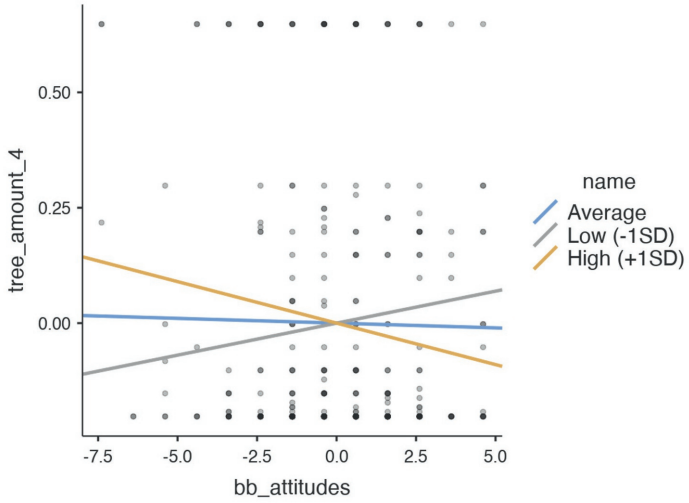


Figure S1. Simple Slopes Graph for The Moderating Effect of Attitude Certainty on the Relationship Between Holistic Attitude Towards Bio-Based Plastic and Participants' Willingness to Donate to a Sustainable Cause.

With regards to attitude importance, the results of the bootstrapped (5000 bootstraps) moderation analysis suggested that how important an attitude is to an individual did not seem to moderate the relationship between which condition they were in and their self-reported willingness to pay for a bio-based plastic product (b = 0.007, 95% CI [-0.015, 0.029], t = 0.64, p = .522). However, it did moderate the relationship between condition and donation behaviour (**b** = -.024, 95% CI [-0.046, -0.002], t = -2.15, p = .032). In particular, for those participants who do not attach a lot of significance to their plastic-related attitude, receiving more knowledge/information about bio-based plastic increases their willingness to donate (see Figure 7).

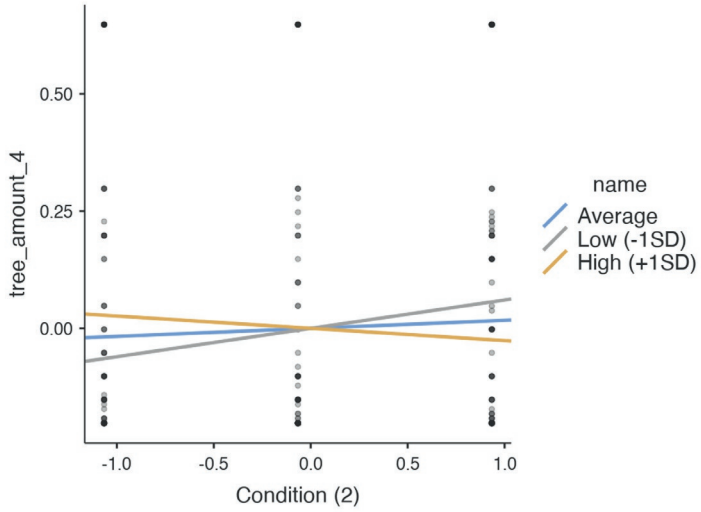


Figure S2. Simple Slopes Graph for the Moderating Effect of Attitude Importance on the Relationship Between Condition and Participants' Willingness to Donate to a Sustainable Cause.

Supplementary Material Chapter 4

These Supplementary Materials include additional information that was referred to in the main manuscript, as well as additional pre-registered hypotheses, analyses, and their results. All measures, data, and analysis code are available at the Open Science Framework https://osf.io/62xvj/.

PILOT STUDY

Demographics

Fifty-two Dutch participants took part in the pilot study, 28 males and 24 females, mean age 28.62 (*SD* = 10.80). Participants came from varied educational backgrounds with one person (1.9%) each completing primary and education trade/technical/ vocational training, 15 (28.8%) secondary education, 27 (51.9%) having completed undergraduate education, and 8 (15.4%) postgraduate education.

Coding

The coding was done by the first author and there was no pre-determined coding scheme, as the aim of the pilot was to reduce researcher bias when it came to selecting the social groups. The only pre-determined factor was, that the group 'family' would be excluded in the main study because people's relationships with their families vary greatly and that might influence the effectiveness of our manipulation.

First, the responses from twenty randomly selected participants were coded by colour-coding similar responses. This established the main categories of social groups then also applied to the remaining participants. We distilled 18 main social groups. These broad categories were later expanded to encompass 28 social groups, which enabled the inclusion of several higher-level groups that several participants mentioned being part of but rarely made it into the first five groups they mentioned (e.g., people from your country, fellow house owners). These were included as social groups that participants belong to, but that is of little importance to them (later 'least valued' condition). Expanding the number of groups also allows participants to make more specific group choices, enhancing the strength of the manipulation of group importance in the main study.

MAIN STUDY

Hypotheses

Pre-registered Hypotheses that are not (explicitly) part of the main manuscript. Many of the correlations results can be found in Table 8.

H7: Bottle choice will positively correlate with willingness to pay. Bottle choice will positively correlate with the willingness to pay for that bottle type.

H8: Bottle choice will positively correlate with the time-investment task. (Paper) PEF bottle choice will positively correlate with the number of rounds completed in the WEPT.

H9: Willingness to pay will positively correlate with the time-investment task.

H10: Identification as an environmentalist will correlate with political orientation. Liberal and more progressive participants will identify more as an environmentalist than those on the conservative end of the spectrum.

H11: We expect a negative correlation between right-wing/conservatism and pro-environmental behaviour:

a) willing to pay for bio-based bottles.
b) number of completed time-investment tasks.
c) likelihood of choosing a bio-based bottle (irrespective of condition).

H12: Explore how of intrinsic and extrinsic motivation relate to the other measures (i.e., WTP, time-investment, identification with being an environmentalist, political orientation etc).

H13: Explore the effects of attitude on willingness to pay.
More negative attitudes towards a type of plastic leads to a lower WTP for that type of plastic. More negative attitude towards PET could also lead to a higher WTP for the more sustainable plastics.

H14: Because socials norms appear to be uniquely powerful predictor of pro-environmental behaviour (Berger, 2019), we also assessed the perceived environmental norms of the group. Perceived environmental values of the group will correlate with bottle choice.
In the 'most important' condition, the bottle choice will align most with the perceived environmental values of the group.

Measures

More information about the measures mentioned in the main manuscript but that were not related to the main hypotheses.

Motivation

We assessed participants' intrinsic and extrinsic motivation for pro-environmental behaviour. Participants indicated on a 7-point Likert scale how much they agree to five statements assessing their explicit motivation (e.g., "I attempt to appear pro-environmental in order to avoid disapproval from others") and five items assessing their implicit motivation (e.g., "I attempt to behave pro-environmentally because it is personally important to me"). This measure was taken form Brick and Lai (2018), and both subscales showed good reliability with Cronbach's alphas of α = .79, .87 for the extrinsic and intrinsic subscales respectively.

Perceived Environmental Norms of the Group

Participants in the most valued and least valued condition were asked how important the environment was to their mentioned social group. This was done to gauge whether their choice of bottle might have been due to the perceived environmental values of the group .To this end we adapted the pro-environmental descriptive norm measure used by Bissing-Olson et al. (2016). Participants responded to the following three items (*1 = disagree strongly* to *7 = agree strongly)*: "Most members of this group act in environmentally friendly ways", "Most members of this group try to conserve resources", and "Most members of this group engage in environmentally-friendly behaviours". For both conditions, this scale showed an extremely high reliability of α = .96.

Results

There were no significant group differences between the conditions in demographics, prior knowledge, environmentalist identity, or political orientation. Table S1 shows the results of the one-way ANOVA comparing age, gender, education, prior knowledge, environmentalist identity, and political orientation between the three conditions.

Table S1. One-way ANOVA Assessing Potential Differences Between Conditions.

Variable		df	*F*	*p*-value
Age	Between Groups	2	.053	.948
	Within Groups	526		
	Total	528		
Gender	Between Groups	2	.319	.727
	Within Groups	526		
	Total	528		
education	Between Groups	2	.094	.910
	Within Groups	526		
	Total	528		
Prior knowledge	Between Groups	2	.103	.902
	Within Groups	526		
	Total	528		
Environmentalist identity	Between Groups	2	.039	.962
	Within Groups	526		
	Total	528		
Political orientation	Between Groups	2	.240	.786
	Within Groups	526		
	Total	528		

Table S2. Logistic Regression of Attitudes on Bottle Choice.

Bottle choice		Wald	*p*	Odds ratio
PEF plastic	Intercept	.064	.800	
	positive PET	**9.64**	**.002**	**.552**
	negative PET	1.74	.188	1.22
	positive PEF	**4.80**	**.029**	**1.73**
	negative PEF	2.02	.155	.683
	positive paper	1.97	.160	1.36
	negative paper	2.23	.136	1.36
Paper PEF	Intercept	.851	.356	
	positive PET	**16.6**	**.000**	**.460**
	negative PET	1.08	.300	1.17
	positive PEF	.785	.376	1.25
	negative PEF	.556	.456	.821
	positive paper	**22.9**	**.000**	**3.06**
	negative paper	.271	.603	1.11

Note. The reference category is PET plastic. Significant predictors are shown in bold.

Pre-registered Exploratory Analyses

Relationship Between Bottle Choice and WTP

We predicted that bottle choice would positively correlate with the willingness to pay (WTP) for that bottle type. The pre-registered correlational analysis revealed that both willingness to pay for PET plastic and for the paper PEF bottle correlate to bottle choice in general: $r(527) = -.10$, $p = .017$ and $r(527) = .21$, $p < .001$ respectively. WTP for PEF plastic did not relate to overall bottle choice, $r(527) = -.05$, $p = .279$. We also conducted a multinomial logistic regression, in which we regressed the WTP for the different types of bottles onto the different bottle choices. Those who chose the PEF plastic compared to PET bottle were willing to pay more for the PEF plastic bottle, $b = 4.57$, Wald $\chi^2 = 6.96$, $p = .008$. They were also willing to pay less for the PET plastic bottle (see Table S3). Participants who chose the paper PEF bottle indicated more willingness to pay for the paper PEF bottle, than those who chose the PET plastic bottle, $b = 3.35$, Wald $\chi^2 = 8.81$, $p = .003$. They were also willing to pay less for the PET plastic bottle. When setting Paper PEF as the reference category, those participants who chose the PET plastic bottle were willing to pay more for the PET plastic bottle, $b = 4.07$, Wald $\chi^2 = 10.96$, $p < .001$, and significantly less for the paper PEF bottle, $b = -3.35$, Wald $\chi^2 = 8.81$, $p = .003$.

Table S3. Multinomial Logistic Regression of WTP on Bottle Choice.

Bottle choice		Wald	Sig.	Odds ratio
PEF plastic	Intercept	5.07	.024	
	PET_WTP	9.49	.002	.022
	PEF_WTP	6.96	.008	96.86
	Paper_WTP	.66	.418	.41
Paper PEF	Intercept	10.28	.001	
	PET_WTP	10.96	<.001	.017
	PEF_WTP	.134	.714	1.89
	Paper_WTP	8.81	.003	128.49

Note. The reference category is PET plastic.

Bottle Choice and the WEPT

A bootstrapped (5000) Spearman correlation suggested that bottle choice was positively correlated with WEPT trials completed, $r(527) = .17$, $p < 001$, BCa 95% CI [.08, .25]. WEPT trials were also positively related to the choice of the bio-based bottles, $r(527) = .11$, $p = .012$, BCa 95% CI [.21, .20].

The Relationship Between WTP and the WEPT

We conducted bootstrapped (5000) Spearman correlational analyses to determine whether participants' willingness to pay for the different bottle types relates to their efforts in the WEPT. We found that effort in the WEPT was not correlated with willingness to pay for any of the bottles (see Table S3). Our hypothesis was therefore not supported.

Relationship Between Environmentalist Identity and Political Orientation

There was a moderate correlation between identification as an environmentalist and political orientation, $r(527) = -.345$, $p < .001$, suggesting that the more left-wing and progressive participants were, the more they identified as an environmentalists.

Political Orientation and Pro-environmental Behaviour

A correlation analysis (Table S4) revealed that the more right-wing/conservative participants were, the fewer WEPT trials they completed.

We ran a multinomial logistic regression (instead of the pre-registered regression) to determine whether likelihood of choosing a bio-based bottle related to political orientation. Results suggest that neither those who chose the PEF plastic bottle ($b = -.063$, Wald $\chi^2 = .26$, $p = .613$), nor those who chose the paper PEF bottle ($b = -.15$, Wald $\chi^2 = 1.63$, $p = .202$) were of different political orientations from those participants who chose the PET bottle (reference category).

Motivation

We ran a bootstrapped (5000) correlation matrix (Table S4) to determine whether and how extrinsic and intrinsic motivation related to the other variables measured: Willingness to pay for the different material types, bottle choice (a bio-based versus PET bottle), political orientation, environmentalist identity, number of WEPT trials completed, and attitudes towards the different materials.

Participants with higher extrinsic motivation tended to have lower intrinsic motivation, identified less with being an environmentalist, and had less positive attitudes towards paper PEF. They were however willing to pay more for the PET plastic bottle. None of the other correlations were significant

Participants high in intrinsic motivation were willing to pay less for PET plastic, had more negative attitudes towards PET, and tended to be more left-wing. They were also willingness to pay more for the paper PEF bottle, made a more sustainable bottle choice, completed more WEPT trials, and held positive attitudes towards paper PEF. This suggests that it is mainly internal motivation that is related to pro-environmental attitudes and behaviour.

Perceived Environmental Values and Bottle Choice

A Spearman correlation showed that perceived environmental group norms did not relate to bottle choice overall, $r = .05$, $p = .34$. Neither did they relate to bottle choice in the most valued condition, $r = .07$, $p = .33$, nor in the least valued condition, $r = .05$, $p = .51$. This suggests that bottle choice is not influence by the perceived environmental values of the social group present.

Table S4. Correlation Table Including Motivation

	1	2	3	4*	5	6*	7	8	9	10	11
1. PET WTP											
2. PEF plastic WTP	.76^{z}										
3. paper PEF WTP	.54^{z}	.76^{z}									
4. Bottle choice*	-.10^{x}	.03	.06								
5. Political Orientation	-.03	-.15^{z}	-.20^{z}	-.05							
6. WEPT trials*	-.05	.02	.04	.11^{x}	-.16^{z}						
7. Environmentalist ID	-.06	.09^{x}	.23^{z}	.11^{x}	-.35^{z}	.18^{z}					
8. PET overall attitude	.04	-.02	-.11^{x}	-.19^{z}	.12^{y}	-.04	-.11^{x}				
9. PEF plastic overall attitude	.05	.13^{y}	.01	-.09	-.08	.09	.06	-.03			
10. Paper PEF overall attitude	-.13^{y}	-.03	.09^{x}	.14^{y}	-.11^{y}	.14^{y}	.15^{z}	-.36^{z}	.29^{z}		
11. Extrinsic motivation	.09^{x}	-.002	-.30	-.01	.07	-.04	-.14^{y}	.06	-.07	-.13^{y}	
12. Intrinsic motivation	-.11^{x}	.07	.20^{z}	.13^{y}	-.40^{z}	.21^{z}	.70^{z}	-.21^{z}	.07	.24^{z}	-.15^{z}

^{x} $p < .05$; ^{y} $p < .01$; ^{z} $p < .001$
* Spearman correlation instead of Pearson correlation.
Note. Bio-based bottle choice combines the choices of the PEF plastic and the paper PEF bottle

Supplementary Material Chapter 5

Questionnaire items

(for other languages see https://osf.io/tjrg3/).

[information letter & consent form]

* * *

[Prior Knowledge About Fairphone]

First, we would like to ask you some questions about different companies that produce mobile phones.

* * *

1. Which of these companies strive(s) to use fair, recycled, and responsibly mined materials in their phones? Select all that apply.
   - Apple
   - Fairphone
   - Nokia
   - OnePlus
   - Samsung

2. Which of these companies has modular, easy-to-repair phones? Select all that apply.
   - Apple
   - Fairphone
   - Nokia
   - OnePlus
   - Samsung

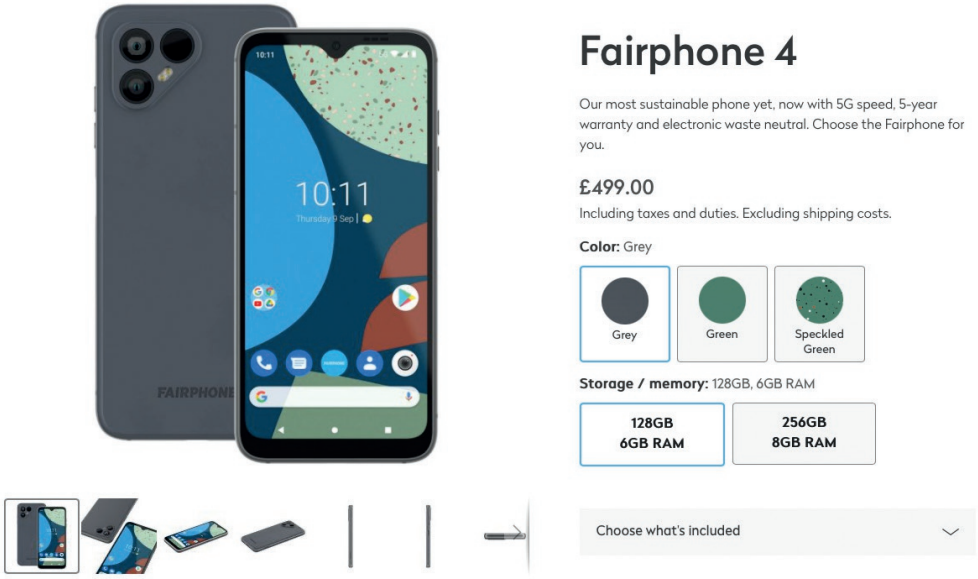
3. How familiar are you with the Fairphone brand?
   (1 = very unfamiliar to 7 = very familiar)

* * *

Please read the following carefully, as this information is important for the rest of the study.

Information About Fairphone

Fairphone was founded in Amsterdam in 2013 to create a more sustainable mobile phone. Fairphone strives for less harmful impact across the value chain in mining, design, manufacturing and life cycle. Their latest device, Fairphone 4 5G, is a modular device that allows easy repair. For instance, the battery is replaceable and it is made from fair and recycled materials in the supply chain, such as Fairtrade Gold or recycled plastics. It is also electronic-waste neutral and comes with a rare 5-year manufacturer warranty to support the longevity of the device.



* * *

The next questions ask about your feelings about the Fairphone.

* * *

[[Emotions About Fairphone]]

We are now going to ask you about your **feelings** about the Fairphone. Please indicate how much you agree with the following statements.

(7-point Likert-scale from *1 = completely disagree* to *7 = completely agree*)

When I think about buying or using a Fairphone, I feel….

… worried, joy, guilty, sad, angry, uncertain, excited, proud, in awe, hopeful, annoyed

* * *

[[Overall Attitude]]
[[7-Point Likert Scale - The Different Differentials Are The Scale Endpoints)]]

I think the Fairphone smartphone is...

bad - good
unreliable - reliable
untrustworthy - trustworthy
immoral - moral
ugly - beautiful
negative - positive
unjust - just

* * *

Next, we would like to ask you some questions about how much you trust Fairphone.

[[Trust]]
Please indicate how much you agree with the following statements.
(*1 = completely disagree, 7 = completely agree*)

- "I think the Fairphone organization is able to contribute to a more sustainable environment"(ability)
- "I think the Fairphone organization is guided by sound morals" (integrity)
- "I think the Fairphone organization aims to contribute to a better environment for people like myself." (benevolence).

"I consider the Fairphone smartphone to be a reliable product"

* * *

[[Dependent Variable (Intention to Buy a Fairphone]]

The next questions are about your willingness to consider buying a Fairphone. Please read carefully through the phone specifications and then answer the questions below.

Please indicate how much you agree with the following statements:
(*1 = completely disagree* to *7 = completely agree*)

"I am considering buying a Fairphone"
"I am willing to switch to Fairphone"
"The next time I am buying a new phone, I will buy a Fairphone"

* * *

This next section is more general. We would like to know more about your purchase decisions and what is important to you.

* * *

[[Product and Brand Characteristics]]

"How important is …. to you when you purchase a new phone"
(*1 = not very important* to *7 = very important*)
- Price
- Appearance
- Technical specifications
- Quality of the phone
- Size
- Camera
- Sustainability of the phone
- Treatment of the workforce
- The brand's reputation
- Customer service
- Sustainability of the company

* * *

[[Status]]
Please indicate what extent you agree with the following statements:
(1 = completely disagree, 7 = completely agree)

- I would buy a product just because it has status.
- I am interested in new products with status.
- I would pay more for a product if it had status.

- The status of a product is irrelevant for me. (R)
- A product is more valuable to me if it has some snob appeal to others.

* * *

[[Green Product Interest]]

(*1 = never true* to *7 = always true*)

- When there is a choice, I always choose the product that contributes to the least amount of environmental damage.
- I have switched products for environmental reasons.
- If I understand the potential damage to the environment that some products can cause, I do not purchase those products.
- I do not buy household products that harm the environment.
- Whenever possible, I buy products packaged in reusable or recyclable containers.
- I make every effort to buy paper products (toilet paper, tissues, etc.) made from recycled paper.
- I will not buy a product if I know that the company that sells it is socially irresponsible.
- I do not buy products from companies that I know use sweatshop labor, child labor, or other poor working conditions.
- I have paid more for environmentally friendly products when there is a cheaper alternative.
- I have paid more for socially responsible products when there is a cheaper alternative.

* * *

[[Environmentalist Identity]]

Please indicate what extent you agree with the following statements.

(1 = completely disagree, 7 = completely agree)

- "I see myself as an environmentalist"
- "I am pleased to be an environmentalist"
- "I feel strong ties with environmentalists"
- "I identify with other environmentalists"

* * *

[[Values]]

To what extent are the following values important as guiding principles in your life?
If possible, please vary scores as much as possible and rate no more than two values as extremely important.
(*1 = not important, to 7 = very important*)

1 social power
2 wealth
3 authority
4 being influential
5 being ambitious

* * *

[[Pro-Environmental Descriptive Norms]]

(1 = completely disagree to 7 = completely agree)

Please indicate how much you agree with the following statements

- Most people who are important to me act in environmentally-friendly ways.
- Most people who are important to me try to conserve resources.
- Most of my friends and peers engage in environmentally-friendly behaviors.

Please indicate how much you agree with the following statements

- Most people who are important to me expect me to act in environmentally-friendly ways.
- Most people who are important to me expect me to try to conserve resources.
- Most of my friends and peers expect me to engage in environmentally- friendly behaviors.

[[Demographics]]

[[Age]]

How old are you? Please indicate your age in years (whole numbers).

[[Gender]]

Please indicate your gender

- Male
- Female
- Other
- Prefer not to say

[[Education]]

How many years of education (starting from primary school) have you completed? (whole numbers)

[[Income]]

What is your household income? (in Euros)

Is that your household income per month or per year?

Per month

Per year

Is that your household income before or after taxes?

Before taxes ("gross")

After taxes ("net")

[[Rurality]]

Which best describes the area where you live?

1 = A big city

2 = The suburbs or outskirts of a big city

3 = A town or a small city

4 = A country village

5 = A farm or home in the countryside

[[Political Orientation]]

- "Please indicate where you are on the political spectrum using the left-right continuum below." (1 = *very left-wing*, 11 = *very right-wing*)
- "Are you more interested in promoting social change (progressive) or promoting tradition (conservative)?" (1 = *very progressive*, 11 = *very conservative*)
- "On the following issues/dimensions, how politically left or right are you?" (1 = *very left wing*, 11 = *very right-wing*)

Economic

- The political left is more socialist and usually emphasises income equality, higher tax rates on the wealthy, government spending on social programmes and infrastructure, and stronger regulations on business.
- The political right is more capitalist and usually emphasises lower taxes and less regulation on businesses, reduced government spending, and thereby more economic freedom

Social

- The political left values supporting those who cannot support themselves, and believe in equality
- The political right values tradition, self-reliance, and believe in personal responsibility

* * *

[[Actual Interest in Fairphone]]

Click to learn more about Fairphone, their mission, and their different phones: https://www.fairphone.com/en/ . The link will open in a new window, allowing you to come back to it after finishing the survey.

Open the new window if you want, but first stay on this page to complete the study and receive your payment!

* * *

[Debriefing]

Centrality

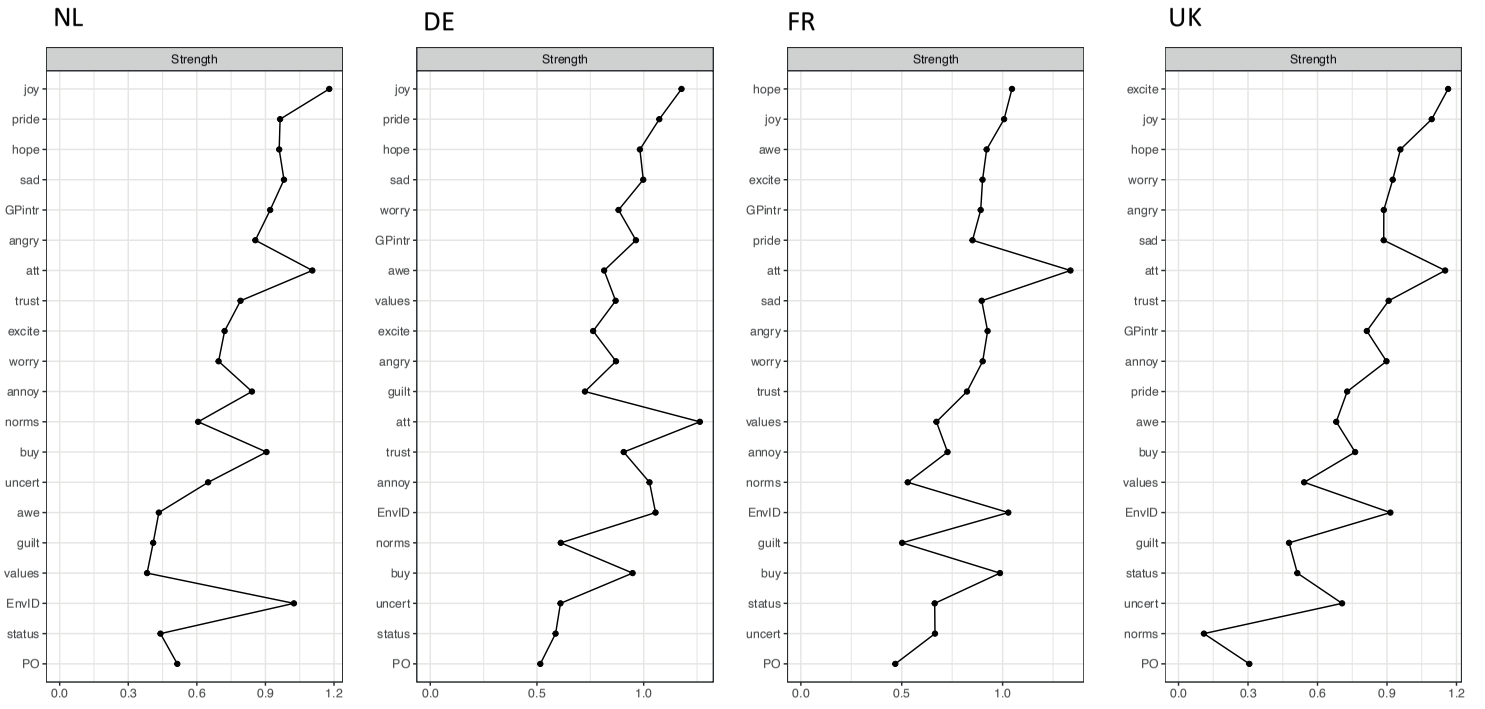


Figure S1. Node Centrality (Strength) Per Country

Measurement Invariance

Purchase Intention

The factor loadings of purchase intentions differed across countries. No weak invariance was found. The factor loadings differed the most for France (see Figure S2). When France was removed from the sample, a weak invariance but no (partial) strong invariance was found. Because no (partial) strong measurement invariance was found it is not recommended to compare the four countries on the purchase intention variable.

Other Variables

Measurement invariance was also tested for other scales that were frequently related to purchase intention in the network analyses. None of these scales reached strong or strict measurement invariance.

- For the status composition scale, configural invariance but no weak invariance was found. This means that the factor loadings for the status composition scale differ across the countries.
- The *semantic differential* scale showed poor fit for a confirmatory factor analysis (CFA) with one indicator. The fit had to be improved using modification indices. When testing for measurement invariance, the test for configural variance did not hold.
- The initial CFA for *green product interest* showed convergence problems due to highly correlated factors. After adjusting the CFA, the data of France still caused convergence problems. When France was removed, strong (but no strict) measurement invariance held.

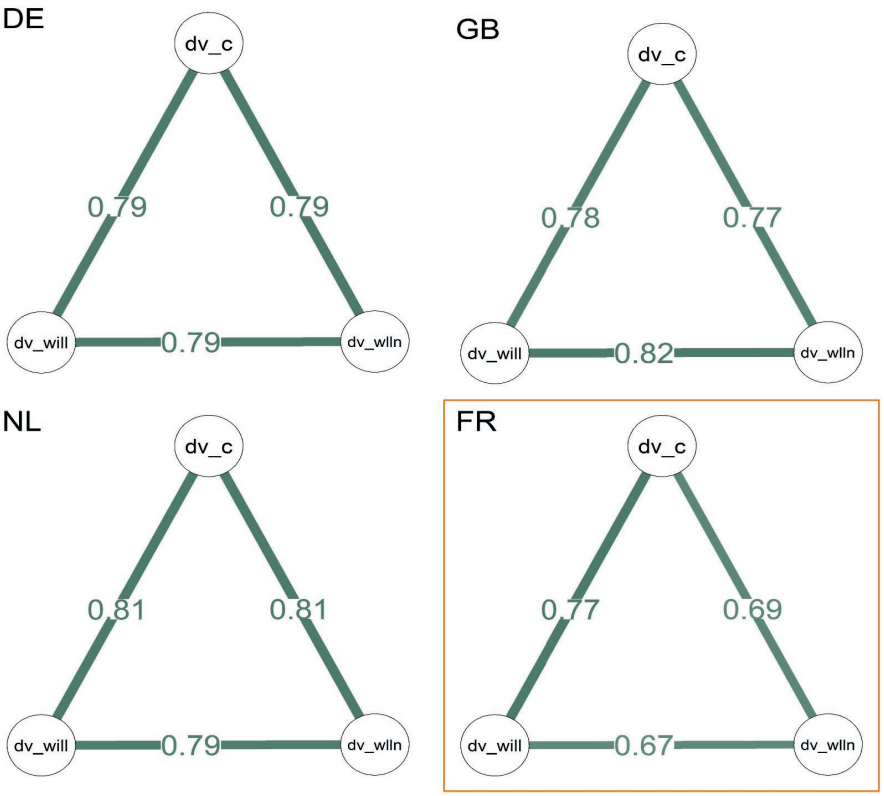


Figure S2. Measurement Invariance Network Graph for Purchase Intention Items Per Country.

Network Comparisons

The Network Comparison Test uses resampling-based permutation testing to compare network structures from two independent, cross-sectional data sets on three types of invariance: network structure, edge strength, and global network strength (van Borkulo et al., 2022). Comparing invariant network structure involves comparing all the edges in the networks as a whole, evaluating the null hypothesis that all the edges are equal. The multiple testing problem is controlled for using the FWER control (van Borkulo et al., 2022). Testing invariant edge strength compares the absolute difference in strength of a specific edge. Invariant global strength assumes the null hypothesis of the overall level connectivity being the same across networks. Overall connectivity is defined as the weighted absolute sum of all edges in the network. It is worth noting that no difference in global strength does not necessarily mean that the networks are similar (van Borkulo et al., 2022).

For all network comparisons we used 1000 iterations (permutations) to create a reference distribution (van Borkulo, 2018). The Network comparison was conducted on the networks shown in Figure 4, not including the product and brand characteristics.

Table S1. Network Comparisons

Country comparison	**Global strength invariance**		**Network invariance**	
	S	*p*-value	*M*	*p*-value
DE - FR	0.45	.55	**0.26**	.02
DE - NL	1.13	.06	0.16	.29
DE - UK	**1.11**	**.01**	0.22	.1
FR - NL	0.68	.27	**0.28**	**>.001**
FR - UK	0.66	.14	**0.29**	**.01**
NL - UK	0.021	.97	**0.28**	**.01**

Testing the invariance of global strength suggests that the overall connectivity of the networks is not significantly different across countries. The exception is a difference between Germany and the UK, with the German network showing higher connectivity (8.82) than the UK network (7.71). The network invariance test revealed at least one of the edges to be different between most networks (the exceptions being between the German and Dutch networks and between the German and UK networks).

English Summary

THE COMPLEXITY OF CONSUMER ATTITUDES TOWARDS SUSTAINABLE ALTERNATIVES

We need a systemic transformation of our way of life to limit climate change and stay within the planetary boundaries (Creutzig et al., 2022). Individuals play an important role in this transition, for example through their consumption choices. Consumers accepting and adopting sustainable alternatives over conventional products is crucial in creating market pull and driving widespread availability. However, green purchasing behaviour is very complex and influenced by a range of psychological and situational factors. In this dissertation, I took a multi-method and often descriptive approach to better understand the perceptions of and attitude towards two types of sustainable alternatives: bio-based plastic and a modular smartphone.

The first empirical chapter, **Chapter 2**, investigated which associations people have towards conventional and bio-based plastic in three studies. The qualitative first study (N = 97) helped distil 25 evaluative reactions (i.e., beliefs, emotions, and behaviours) describing people's attitudes towards using (bio-based) plastic. These were used to create a new scale, which was subsequently tested in Study 2 (N = 508), which built a network displaying relationships between participants' evaluative reactions regarding plastic use. Analyses of this network indicated that feelings of guilt about one's plastic use was most strongly connected to one's reported willingness to pay more for a bio-based plastic product. Guilt was subsequently experimentally manipulated in Study 3 (N = 285). Results showed that manipulating guilt can lead participants to donate more to a sustainable cause. These findings suggest two things: first, that guilt might be an effective way to encourage people to purchase bio-based products. Second, that network analysis is a useful tool for determining which factors are related to an attitude object of interest. These relationships can then be tested in an experimental study.

Chapter 3 served to gain further understanding of people's attitudes and perceptions about bio-based plastic and its attributes. In four studies, participants' attitudes towards fossil-based and bio-based plastic, their perceived importance of recycling both types of plastic, their willingness to pay, and their perceptions of bio-based plastic were examined (total N = 961). The fourth study also experimentally manipulated the information about bio-based plastic that participants received. Results showed that participants held very favourable attitudes and reported being willing to pay more for bio-based products. However, participants also harboured misconceptions, especially overestimating bio-based plastic's biodegradability, and found it less important to recycle bio-based than fossil-based plastic (this is incorrect). Study 4 provided evidence that educating consumers about the properties of bio-based plastic can dispel misconceptions and retain a favourable attitude and a high willingness to pay. This chapter therefore indicates that there is both a consumer demand for bio-based plastic, but also a lack of knowledge about its properties. It further shows that simple information can

improve knowledge while preserving demand.

The first two empirical chapters compared a conventional plastic bottle to a visually identical bio-based one and found positive attitudes and a higher willingness to pay for the bio-based bottle. We expanded on this in **Chapter 4** by including an additional, visually distinct bio-based bottle. In an online study (N = 529), we investigated psychological factors influencing preferences for three types of plastic bottles: a conventional fossil-based bottle, a visually identical bio-based bottle, and a visually distinct bio-based bottle. We also tested whether consumers' choices being visible to (valued) others affected participants' judgments. Participants reported positive attitudes towards bio-based plastic and were willing to pay more for it, especially for the visually distinct bio-based bottle. Irrespective of being observed, participants overwhelmingly preferred the bio-based bottles (96.8%). This suggests both consumer demand, and that designs that signal pro-environmental behaviour (e.g., sustainable products looking different from conventional products), might be a promising way to promote sustainable purchasing choices.

To expand beyond the plastic context and test the applicability of the network approach to other environmental decisions, **Chapter 5** investigated consumer attitudes and purchase intentions towards a modular smartphone (Fairphone). An online study (total N = 2,202) was conducted in four countries: the Netherlands, Germany, France, and the United Kingdom. Across countries, psychological factors were more important than product and brand characteristics when intending to buy a sustainable smartphone. Positive emotions, overall attitude, and green product interest related positively to purchase intentions, while the importance individuals placed on the status of a product and feelings of uncertainty about the product related negatively. This chapter demonstrates the complexity of people's attitudes and the value of a more descriptive network approach when studying infrequent behaviours (like purchasing a smartphone), or novel technologies. More descriptive research like this can illuminate which 'tools' we can add to our existing toolbox as we strive towards greater sustainability. It also illustrates that psychological factors seem to play a relatively central role compared to product and brand characteristics (like price, camera, or the reputation of the brand), when people think about buying a Fairphone.

Overall, these chapters demonstrate an apparent consumer demand for bio-based bottles and sustainable smartphones. Participants consistently had positive attitudes towards these products and indicated purchase intentions and a willingness to pay a price premium. However, they also displayed a general lack of knowledge about these sustainable alternatives. This research exemplifies the complexity of attitudes and perceptions towards sustainable alternatives, as a great variety of factors were related to purchase intentions. While this complexity is daunting, the fact that so many factors are relevant illustrates that there are many ways to reach the goal of more sustainable consumption.

Nederlandse samenvatting

DE COMPLEXITEIT VAN CONSUMENTENATTITUDES TEN AANZIEN VAN DUURZAME ALTERNATIEVEN

De mensheid heeft een systemische transformatie nodig in zijn manier van leven om de klimaatverandering te beperken en binnen de planetaire grenzen te blijven (Creutzig et al., 2022). Individuen spelen een belangrijke rol in deze transitie, bijvoorbeeld door hun consumptiekeuzes. Consumenten die duurzame alternatieven accepteren en aanvaarden zijn van cruciaal belang voor het creëren van *market pull* en om de algemene beschikbaarheid te stimuleren. Groen aankoopgedrag is echter zeer complex en wordt beïnvloed door een reeks psychologische- en omgevingsfactoren. In dit proefschrift hanteerde ik een multi-methodische en vaak beschrijvende aanpak om de percepties van en houdingen ten opzichte van twee soorten duurzame alternatieven beter te begrijpen: bio-based plastic en een modulaire smartphone.

Het eerste empirische hoofdstuk, **Hoofdstuk 2**, bevat drie studies waarin onderzocht werd welke associaties mensen hebben ten opzichte van conventioneel en bio-based plastic. In de kwalitatieve eerste studie (N = 97) werden 25 evaluatieve reacties (d.w.z. overtuigingen, emoties en gedragingen) gedestilleerd die de houding van mensen tegenover het gebruik van (bio-based) plastic beschrijven. Deze werden gebruikt om een nieuwe vragenlijst te creëren, die vervolgens werd getest in Studie 2 (N = 508). Hiermee bouwden we een netwerkmodel op dat relaties weergaf tussen de evaluatieve reacties van deelnemers met betrekking tot plasticgebruik. Analyses van dit netwerk gaven aan dat schuldgevoelens over iemands plasticgebruik het sterkst samenhingen met iemands gerapporteerde bereidheid om meer te betalen voor een product van bio-based plastic. Schuldgevoelens werden vervolgens experimenteel gemanipuleerd in studie 3 (N = 285). De resultaten toonden aan dat het manipuleren van schuldgevoel deelnemers ertoe kan brengen meer te doneren aan een duurzaam doel. Deze bevindingen suggereren twee dingen: ten eerste dat schuldgevoel een effectieve manier kan zijn om mensen aan te moedigen bio-based producten te kopen. Ten tweede, dat netwerkanalyse een nuttig instrument is om te bepalen welke factoren verband houden met een object van belangstelling. Deze relaties kunnen vervolgens worden getest in een experimentele studie.

Hoofdstuk 3 had als doel om meer inzicht te krijgen in de attitudes en percepties van mensen ten opzichte van bio-based plastic en de eigenschappen ervan. In vier studies werden de houdingen van deelnemers onderzocht ten opzichte van fossiel-plastic en bio-based plastic. Ook werden het belang dat zij hechtten aan de recycling van beide soorten plastic, hun betalingsbereidheid en hun perceptie van plastic op basis van biomassa onderzocht (totaal N = 961). In de vierde studie werd ook de informatie over bio-based plastic die deelnemers ontvingen experimenteel gemanipuleerd. Uit de resultaten bleek dat deelnemers een zeer positieve houding hadden ten aanzien van bio-based plastic en bereid waren meer te betalen voor bio-based producten. De

deelnemers hadden echter ook misvattingen over bio-based plastic. Zo overschatten ze de biologische afbreekbaarheid van bio-based plastic en vonden het minder belangrijk om bio-based plastic te recyclen dan fossiel plastic (wat onjuist is). Studie 4 leverde bewijs voor het feit dat voorlichting aan consumenten over de eigenschappen van bio-based plastic dergelijke misvattingen kan tegengaan en gelijktijdig de positieve attitude en hoge betalingsbereidheid kan stimuleren. Dit hoofdstuk geeft dus aan dat, hoewel er bij de consument vraag is naar bio-based plastic, er ook een gebrek is aan kennis over de eigenschappen ervan. Het laat verder zien dat voorlichting de kennis kan verbeteren en tegelijkertijd de positieve houding ten aanzien van het duurzame alternatief in stand kan houden.

De eerste twee empirische hoofdstukken vergeleken een conventionele plastic fles met een visueel identieke bio-based fles en vonden een positieve houding en een hogere bereidheid om te betalen voor de bio-based fles. In **Hoofdstuk 4** hebben we dit uitgebreid met een aanvullende, visueel onderscheidende bio-based fles. In een onlinestudie (N = 529) onderzochten we psychologische factoren die de voorkeur voor drie soorten plastic flessen beïnvloeden: een conventionele fles op fossiele basis, een visueel identieke bio-based fles en een visueel onderscheidende fles van bio-based plastic. Wij testten ook of de keuzes van consumenten die zichtbaar waren voor (gewaardeerde) anderen, de oordelen van de deelnemers beïnvloedden. Deelnemers hadden een positieve houding ten opzichte van bio-based plastic en waren bereid er meer voor te betalen, vooral voor de visueel onderscheidende bio-based fles. Ongeacht of ze werden geobserveerd, gaven de deelnemers in overweldigende aantallen (96,8%) een voorkeur aan de bio-based flessen. Dit suggereert dat zowel de consumentenbehoefte als ontwerpen die milieuvriendelijk gedrag signaleren (bv. duurzame producten die er anders uitzien dan conventionele producten) een veelbelovende manier kunnen zijn om duurzame aankoopkeuzes te bevorderen.

Om verder te kijken dan de plasticcontext en de toepasbaarheid van de netwerkbenadering op andere milieubeslissingen te toetsen, werden in **Hoofdstuk 5** de attitudes en aankoopintenties van consumenten ten aanzien van een modulaire smartphone (Fairphone) onderzocht. Een onlinestudie (totaal N = 2.202) werd uitgevoerd in vier landen: Nederland, Duitsland, Frankrijk en het Verenigd Koninkrijk. In alle landen bleken psychologische factoren meer dan product- en merkkenmerken samen te hangen met de intentie een duurzame smartphone te kopen. Positieve emoties, attitudes en belangstelling voor groene producten hingen positief samen met aankoopintenties, terwijl het belang dat mensen hechtten aan de status van een product en gevoelens van onzekerheid over het product er negatief mee samenhingen. Dit hoofdstuk toont de complexiteit aan van de attitudes van mensen en de waarde van een meer beschrijvende netwerkbenadering bij het bestuderen van minder vaak voorkomende gedragingen (zoals de aankoop van een smartphone) of nieuwe technologieën. Meer beschrijvend

onderzoek als dit kan duidelijk maken welke 'instrumenten' we aan onze bestaande gereedschapskist kunnen toevoegen in ons streven naar meer duurzaamheid. De bevindingen illustreren ook dat psychologische factoren een relatief centrale rol lijken te spelen in vergelijking met product- en merkkenmerken (zoals prijs, camera of de reputatie van het merk) wanneer mensen overwegen een Fairphone te kopen.

Kort samengevat, blijkt uit deze hoofdstukken dat er bij de consument een duidelijke behoefte bestaat aan bio-based flessen en duurzame smartphones. De deelnemers hadden consequent een positieve houding ten opzichte van deze producten, gaven aan positieve koopintenties te hebben en bleken bereid te zijn meer te betalen voor het duurzame alternatief. Ze toonden echter ook een algemeen gebrek aan kennis over deze duurzame alternatieven. Dit onderzoek toont de complexiteit aan van houdingen en percepties ten aanzien van duurzame alternatieven, aangezien een grote diversiteit aan factoren verband hield met aankoopintenties. Hoewel deze complexiteit wellicht in eerste instantie ontmoedigend is, illustreert het feit dat zoveel factoren relevant zijn dat er daarmee vele routes zijn om het doel van duurzamere consumptie te bereiken.

Contributions to Empirical Chapters

Chapter 2

Zwicker, M. V., Nohlen, H. U., Dalege, J., Gruter, G.-J. M., & van Harreveld, F. (2020). Applying an attitude network approach to consumer behaviour towards plastic. *Journal of Environmental Psychology*, *69*, 101433.

Maria V. Zwicker: Conceptualization, Methodology, Software, Formal analysis, Investigation, Visualization, Writing - original draft, Writing - review & editing. *Hannah U. Nohlen:* Conceptualization, Methodology, Writing - review & editing, Supervision. *Jonas Dalege:* Software, Resources, Visualization, Writing - review & editing. *Gert- Jan M. Gruter:* Funding acquisition, Writing - review & editing. *Frenk van Harreveld:* Conceptualization, Methodology, Supervision, Writing - review & editing.

Chapter 3

Zwicker, M. V., Brick, C., Gruter, G.-J. M., & van Harreveld, F. (2021). (Not) Doing the Right Things for the Wrong Reasons: An Investigation of Consumer Attitudes, Perceptions, and Willingness to Pay for Bio-Based Plastics. *Sustainability*, *13*(12), 6819.

Maria V. Zwicker: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data curation, Visualization, Project administration, Writing - original draft, Writing - review & editing*; Cameron Brick:* Validation, Writing - review & editing, Supervision*; Gert-Jan Gruter:* Funding acquisition, Writing - review & editing; *Frenk van Harreveld:* Conceptualization, Methodology, Validation, Project administration, Supervision, Writing - review & editing.

Chapter 4

Zwicker, M. V., Brick, C., Gruter, G.-J. M., & van Harreveld, F. (2023). Consumer attitudes and willingness to pay for novel bio-based products using hypothetical bottle choice. *Sustainable Production and Consumption*, *35*, 173-183.

Maria V. Zwicker: Conceptualization, Pre-registration, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing - original draft, Writing - review & editing. *Cameron Brick:* Conceptualization, Pre-registration, Formal analysis, Investigation, Methodology, Supervision, Writing - review & editing. *Gert-Jan Gruter:* Conceptualization, Funding acquisition, Methodology, Project administration, Writing - review & editing. *Frenk van Harreveld:* Conceptualization, Pre-registration, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing - review & editing.

Chapter 5

Zwicker, M. V., van Harreveld, F., Zickfeld, J., & Brick, C. (2023, February 3). Intentions to Purchase a Sustainable Mobile Phone by Network Analysis in Four European Countries.

Maria V. Zwicker: Conceptualization, Pre-registration, Data curation, Software, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Visualization, Writing - original draft, Writing - review & editing. *Frenk van Harreveld:* Conceptualization, Pre-registration, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing - review & editing. *Janis H. Zickfeld:* Resources, Software, Formal analysis, Visualization, Writing - review & editing. *Cameron Brick:* Conceptualization, Pre-registration, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing - review & editing.

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This thesis would not have been possible without my supervisors. Frenk, thank you for creating an informal and relaxed atmosphere starting at my first interview. And thank you for always showing how my somewhat niche projects fit into the bigger picture and encouraging me to see the positive (and not only focus on the limitations) of the studies we already conducted. Thank you, Hannah, for showing me that a supervisor can be cool and fun while also being incredibly smart and helpful. Cameron, I am so glad you agreed to become my second supervisor half way through my PhD. Your quick and detailed feedback alleviated so much stress and I will always be in awe of your ability to respond to emails in such a quick and thorough manner. And thanks for checking in on me now and then, especially during the pandemic. Thank you also for showing me the benefits of being part of a lab. I did not know what I was missing by not having the opportunity to brainstorm with people working on similar topics. I was very glad that I was able to experience that, even just for a short couple of months.

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