Sustainable materials choice experiment in six countries – headline findings

Underlagsrapport – spårning och märkning av metaller

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tillväxtanalys

Förord

Denna rapport är ett underlag till Tillväxtanalys regeringsuppdrag "Uppdrag att analysera möjligheter till spårbarhet och hållbarhetsmärkning av metaller och mineral" (N2018/01708/FÖF).

Underlaget är framtaget av Lorraine Whitmarsh, Dimitris Potoglou, Colin Whittle, Ian Harvey och Kieran Evans Cardiff University samt Tobias Persson Tillväxtanalys.

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1   Introduction

The environmental impacts of material production, processing and consumption are profound and increasing (Allwood et al., 2011). Commercialisation of sustainable materials and technologies is therefore critical for mitigating a range of environmental problems. Previous research indicates environmental considerations generally exert little salience in product choice (e.g., Haggar & Whitmarsh, 2017), whereas economic, pragmatic and social factors are typically more influential. However, for certain products, where economic and environmental factors are aligned (e.g., vehicle fuel efficiency) or sustainable products offer additional features (e.g., health benefits of organic food), consumers may be willing to pay more for greener options. This appears to vary cross-nationally; for example, one study found US consumers were more sensitive than Japanese consumers to fuel costs (Tanaka et al., 2014).

Much less is known about willingness to pay for sustainable materials used to produce different products, or even how aware consumers are about sustainability of materials used. The current study sought to explore this through a cross-cultural choice experiment focussing on two consumer products: cars and mobile phones. These have been selected because they include rare earth metals, graphite and steel, which have significant implications for climate change and other environmental problems.

1.1   Project aims

The purpose of this research ultimately is to inform decision-making about how government might stimulate demand for sustainably produced metals and minerals present in an international market. Growth Analysis commissioned Cardiff University to undertake a choice experiment in six countries reflecting major and growing markets for consumer products, as well as diverse cultural values (Schwartz & Bilsky, 1990). Specifically, we examine the UK, US, Sweden, Germany, India, and Japan. The aim then is to conduct two online experiments in these six countries to analyse consumers' preferences for sustainably manufactured (a) cars and (b) mobile phones.

Our research questions were:

1. To what extent are sustainable materials influential in consumers' car/phone purchases?

2. What type of consumer gives more attention to sustainable materials in their car/phone purchases?

This report presents initial results from the study. Further, detailed analysis will follow in future papers.

2   Methods

Prior to conducting the research, we obtained ethical approval for the research from Cardiff University's School of Psychology Ethics Committee. We then undertook a series of (N=10) qualitative consumer interviews with a UK convenience sample to explore awareness of material sustainability, factors shaping car and mobile phone purchasing, and understanding of key terminology (e.g., 'climate neutral') to be included in the choice experiment.

Drawing on these interviews and a review of the literature on factors influencing car and mobile phone consumer purchasing (e.g., Haggar & Whitmarsh, 2017; Sata, 2013), we designed a choice experiment and survey, and undertook cognitive interviews with a further UK convenience sample (N=10) to ensure terminology was understandable and all key variables were included. We identified quotas (using census data), screener questions and exclusion criteria to ensure data quality and model robustness.

The survey was then translated from English to Swedish, German, Hindi and Japanese, and the translations checked by native speakers and revised as appropriate. The choice experiment was then coded in Qualtrics, and survey items also input. Finally, after internal survey checks, we 'soft launched' the survey with 50 respondents in each of the six countries, to further check survey quality, before fully launching to achieve 1000 responses per country in October 2018.

2.1   Participants

Participants were recruited via Qualtrics online panel provider. A quota sample of around 1000 consumers per country was recruited to provide a representative national sample matched on age, gender and region of each country (based on census data). Participant details are shown in Table 1.

Table 1. Sample demographic details

	US	India	UK	Sweden	Germany	Japan
N	1,000	1,106	917	990	1,013	1,015
Mean completion time (mins)*	21.0	18.4	13.8	23.1	17.1	15.3
Age (mean; years)**	47.2	35.0	44.8	46.2	45.7	47.1
Gender (F)**	51.5%	47.8%	54.2%	50.0%	50.9%	53.5%
Have children	57.4%	56.3%	58.8%	59.6%	54.9%	51.4%

Respondents completing in less than half the median time were screened out

***We used census-derived quota sampling on age, gender and region*

2.2   Design & Measures

The questionnaire comprised two choice experiments (car and mobile phone), embedded in Qualtrics survey software, along with a series of survey items that allowed us to explore participants' attitudes, demographics, and other relevant background characteristics.

Participants answered initial background questions relating to purchase decisions then were given instructions on how to complete the choice experiment, including definitions of all terms used (see Appendix). They then saw five choice cards (Figure 1) for car purchasing and a further five for mobile phone purchasing. For cars, participants selected from four choices (petrol, electric, biofuel and hybrid), and for phones, they chose from two options (Mobile Phone A, Mobile Phone B). For both cars and mobile phones the choices had eight attributes with different levels which were varied randomly across the sample (see Table 2). Finally, remaining background and socio-psychological questions (using validated measures from previous research; e.g., Whitmarsh et al., 2017), including pro-environmental identity, innovativeness, and demographic items, were asked.

Figure 1. Screenshot of a choice card from the car choice experiment (left) and mobile phone choice experiment (right)

Scenario 1 out of 5

Thinking about your next car purchase, which car out of the following options would you choose?

	Petrol	Electric	Biofuel	Hybrid
Price ($)	350.00	490.00	455.00	350.00
Size	Large	Mid-Size	Mid-Size	Large
Autonomous driving	Driver assistance More info	High Automation More info	Driver assistance More info	Partial automation More info
Annual running cost ($)	985.00	788.00	886.50	886.50
Availability of fuel at existing petrol stations (%)	100	60	60	100
Memory	Conventional materials	Conventional materials, which are climate neutral	Conventional materials, which are climate neutral	Organic materials
Design	Conventional design	Conventional design	Conventional design	Conventional design
Acceleration (0-60mph in seconds)	8	12	12	6

I would choose

- Petrol
- Electric
- Biofuel
- Hybrid

Scenario 1 out of 5

Thinking about your next mobile-phone purchase (with unlimited minutes, unlimited texts and 4GB of data), which mobile phone out of the following options would you choose?

	Mobile phone A	Mobile phone B
Materials	Conventional materials	Conventional materials, which are ethically sourced
Price ($)	75.00	50.00
Performance	Standard 1 GHz 0.5GB RAM	Very Fast 2.39 GHz 6GB RAM
Display	4.7" LCD screen (326 pixels/inch)	5.8" OLED screen (458 pixels/inch)
Memory (GB)	32	256
Battery	5 hours talk time (1 day stand-by time)	16 hours talk-time (10 days stand-by time)
Exterior design	Unique design	Conventional design
Camera	Rear: 12MP Front: 8MP front Video: UHD (4K)	Rear: 5 MP Front: - Video: SD

I would choose

- Mobile phone A
- Mobile phone B

Participants were instructed that, apart from the attributes shown on the choice cards (Table 2), all other aspects of their purchase would be 'satisfactory to you'. For cars, this would include 'what colour they are, what the manufacturer/brand of the car is, and (if you are imagining second-hand cars during this task) what

the mileage is.' For phones, they were told 'both mobile phone options will be available with your preferred operating system.'

Table 2. Attributes and levels for choice experiments *(see Appendix 1 for full definitions)*

Car experiment		Mobile phone	
Attribute	Levels	Attribute	Levels
Materials	Conventional materials Conventional materials, which are ethically sourced Conventional materials, which are climate neutral Organic materials Organic materials, which are climate neutral Organic materials, which are ethically sourced	Materials	Conventional materials Conventional materials, which are ethically sourced Conventional materials, which are climate neutral Organic materials Organic materials, which are climate neutral Organic materials, which are ethically sourced
Exterior design	Conventional design Unique design	Exterior design	Conventional design Unique design
Annual running cost (multiplier of country average)	0.6 0.7 0.8 0.9 1	Performance	Standard (1 GHz, 0.5 GB RAM) Fast (1.4 GHz, 1 GB RAM) Very Fast (2.39 GHz, 6 GB RAM)
Availability of fuel at existing petrol stations	40% 60% 80% 100%	Camera	Rear: 5 MP; Front: - ; Video: SD Rear: 8MP; Front: 1.2MP; Video: HD video Rear: 12MP; Front: 8MP; Video: UHD (4K)
Acceleration (0 to 60 mph)	6 seconds 8 seconds 10 seconds 12 seconds	Display	3.5" LCD Screen (165 pixels/inch) 4.7" LCD screen (326 pixels/inch) 5.8" OLED screen (458 pixels/inch)
Autonomous driving	Zero automation Driver assistance Partial assistance Conditional automation High automation Full automation	Memory	32GB 64GB 128GB 256GB
Size	Small Mid-size Large	Battery	5 hours (1 day stand-by time) 8 hours (2 days stand-by time) 10 hours (5 days stand-by time) 16 hours (10 days stand-by time) 21 hours (12 days stand-by time)
Price (multiplier of stated preferred cost)	1.0 1.2 1.3 1.4	Price per month (£)	20 22 24 26 28 30

3   Results

Across the six countries, there are differences in how much consumers are willing to spend on both cars and mobile phones (Table 3). For cars, prices range from $18,185 in the UK to $33,356 in Japan. For mobile phones, monthly prices range from $41.94 in Sweden to $96.03 in India. With the exception of Japan, most consumers plan to buy a car in the next three years; in most cases (apart from the UK), this will be a new, rather than used, car.

Table 3.Car and mobile phone purchase results

	US	India	UK	Sweden	Germany	Japan
Car price (mean, USD)	28,800	25,743	18,185	24,530	24,149	33,356
Will buy car in next 3 years	71.5%	84.3%	67.4%	57.9%	58.6%	23.5%
Will buy new car (vs. used)	62.2%	96.1%	49.3%	52.2%	50.0%	74.2%
Weekly distance driven – mean (median), km	757 (160)	2250 (160)	702 (160)	888 (80)	1780 (200)	971 (48)
Max single trip – mean (median), km	1872 (480)	1725 (16)	470 (240)	2117 (500)	390 (30)	614 (20)
Mobile phone price / month (mean, USD)	61.12	96.03	55.18	41.94	44.96	52.31

There is also variation across countries in how long consumers expect products to last (Figure 2). Ideal life expectancy of cars ranges from 8.64 years in the UK to 11.70 years in Sweden. For mobile phones, life expectancy is lower than for cars, ranging from 5.03 in the UK to 6.16 in Sweden. Consistent with this, the importance of life expectancy is lower for mobile phones than for cars (Figure 2), with importance highest in India and lowest for Japan.

Across markets, most consumers feel attached to their cars and phones (Figure 3). In the US and India, consumers were particularly likely to indicate attachment to their cars and phones (e.g., say they are needed and valuable); while Japan showed least attachment.

In terms of innovativeness (Figure 4), Indians are most likely to consider themselves early adopters of new technology; whereas Japanese consumers see themselves as being more cautious later adopters.

Figure 2. Ideal life expectancy in years (top) and importance of life expectancy (bottom) of car and mobile phone
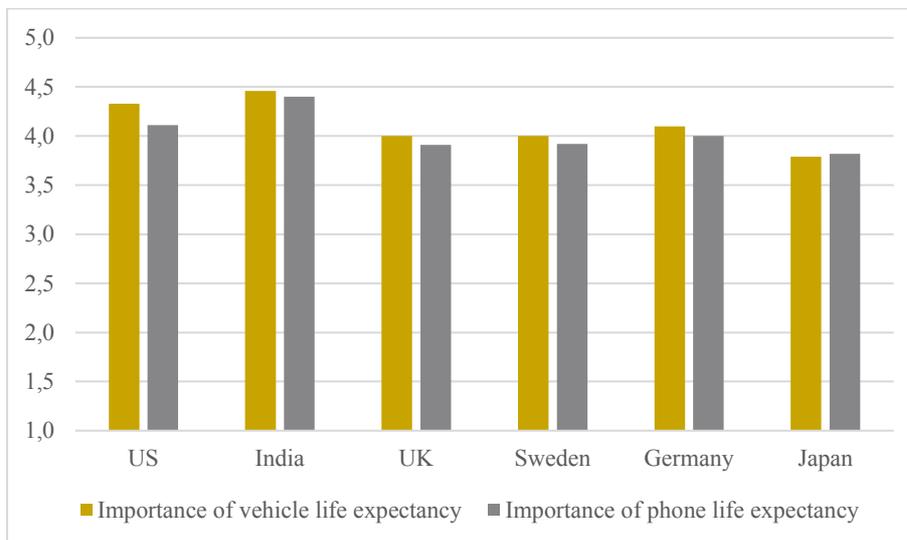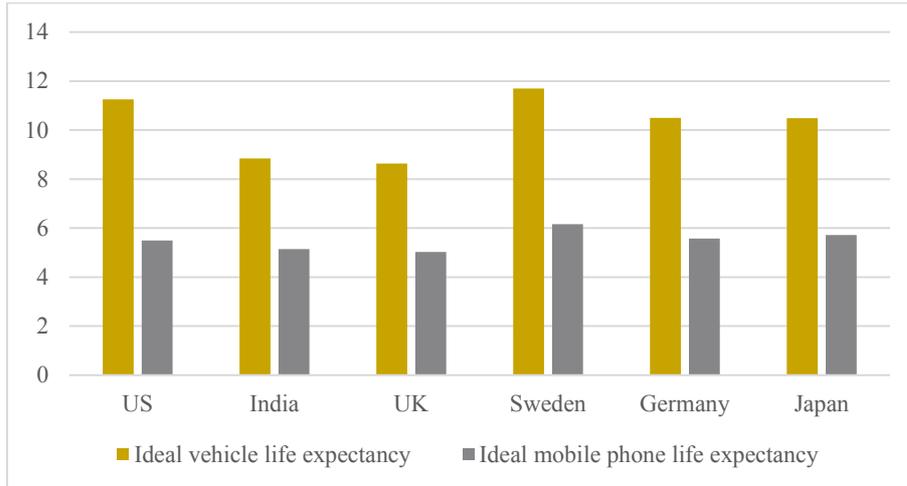
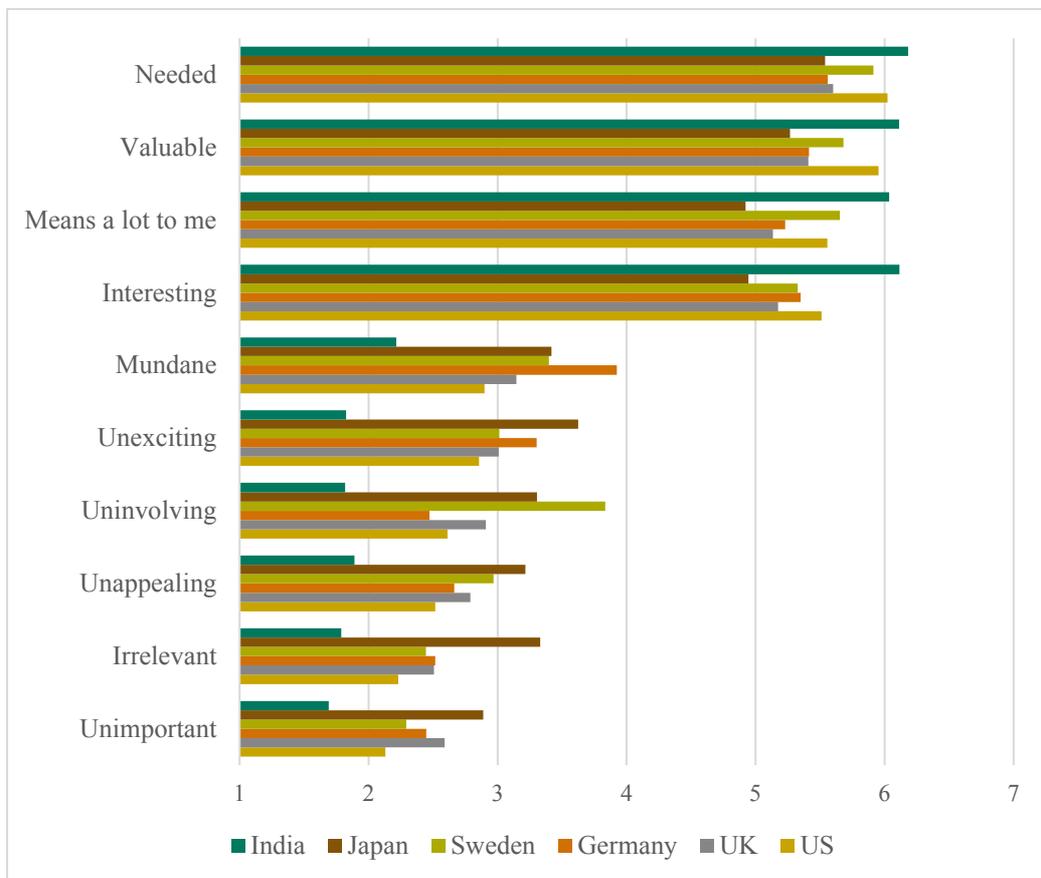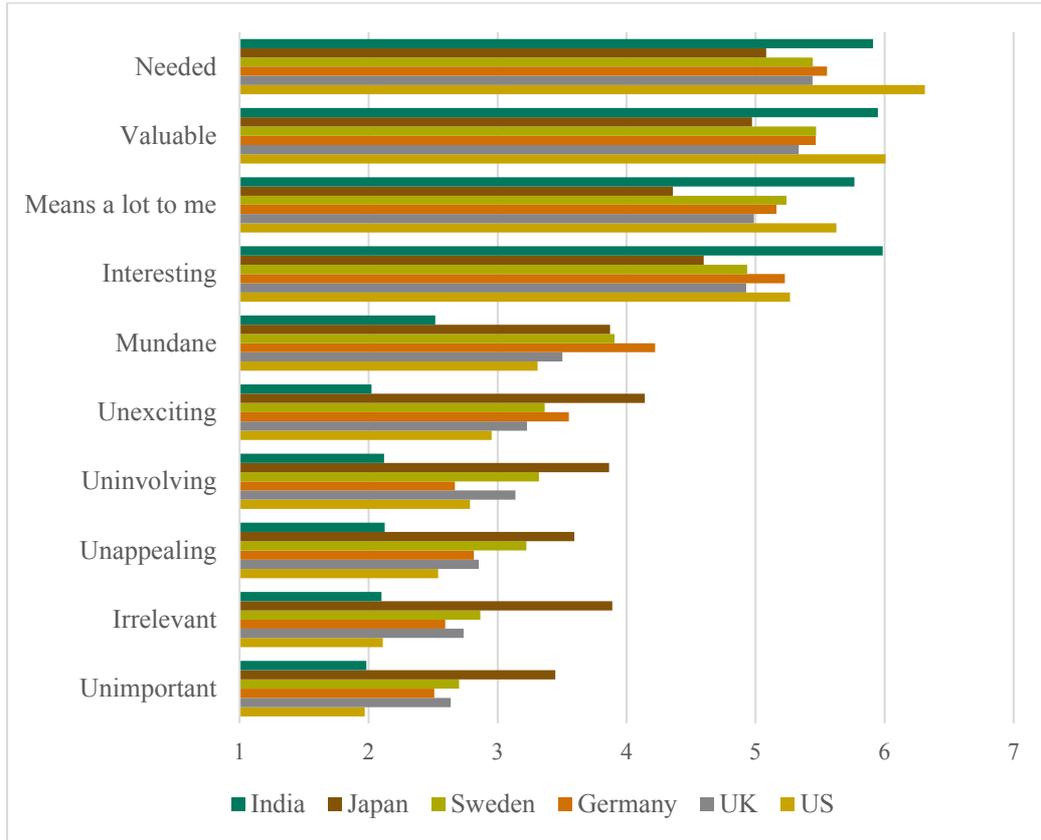Figure 3. Attachment to cars (top) and phones (bottom)

Figure 4. Technophilia and innovativeness in relation to cars (top) and phones (bottom)

■ I am the type of person who closely follows new technological developments and who dares taking risks by being the first to purchase an innovative car.

■ I am the type of person who envisions potential advantages in innovative cars and who is one of the first to make use of these advantages and to profit from those.

■ I am a type of person who is interested in innovative cars, but at the same time is pragmatic. First, I would like to take time and be persuaded by the advantages that an innovative car possesses. My decisions are (mainly) based on the recommendations of

■ I am the type of person who is not thrilled by innovative cars, but who rather appreciates security. It is safe to purchase an innovative car when it has been on the market for some while and offers obvious advantages.

■ I am the type of person who is traditional and has little affinity with innovative cars. I do not like changes in life and I purchase an innovative car only when the existing model I use is not produced anymore.

■ I am the type of person who closely follows new technological developments and who dares taking risks by being the first to purchase an innovative mobile phone.

■ I am the type of person who envisions potential advantages in innovative mobile phones and who is one of the first to make use of these advantages and to profit from those.

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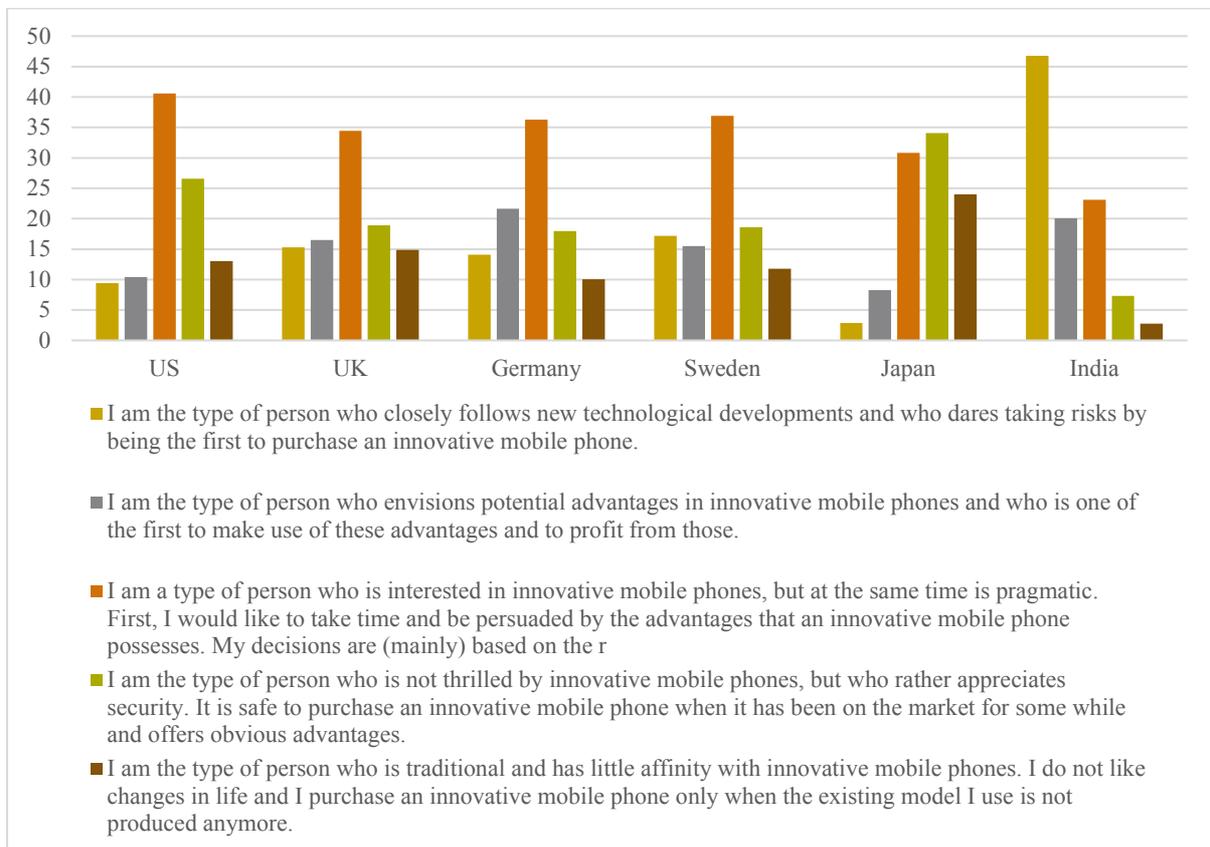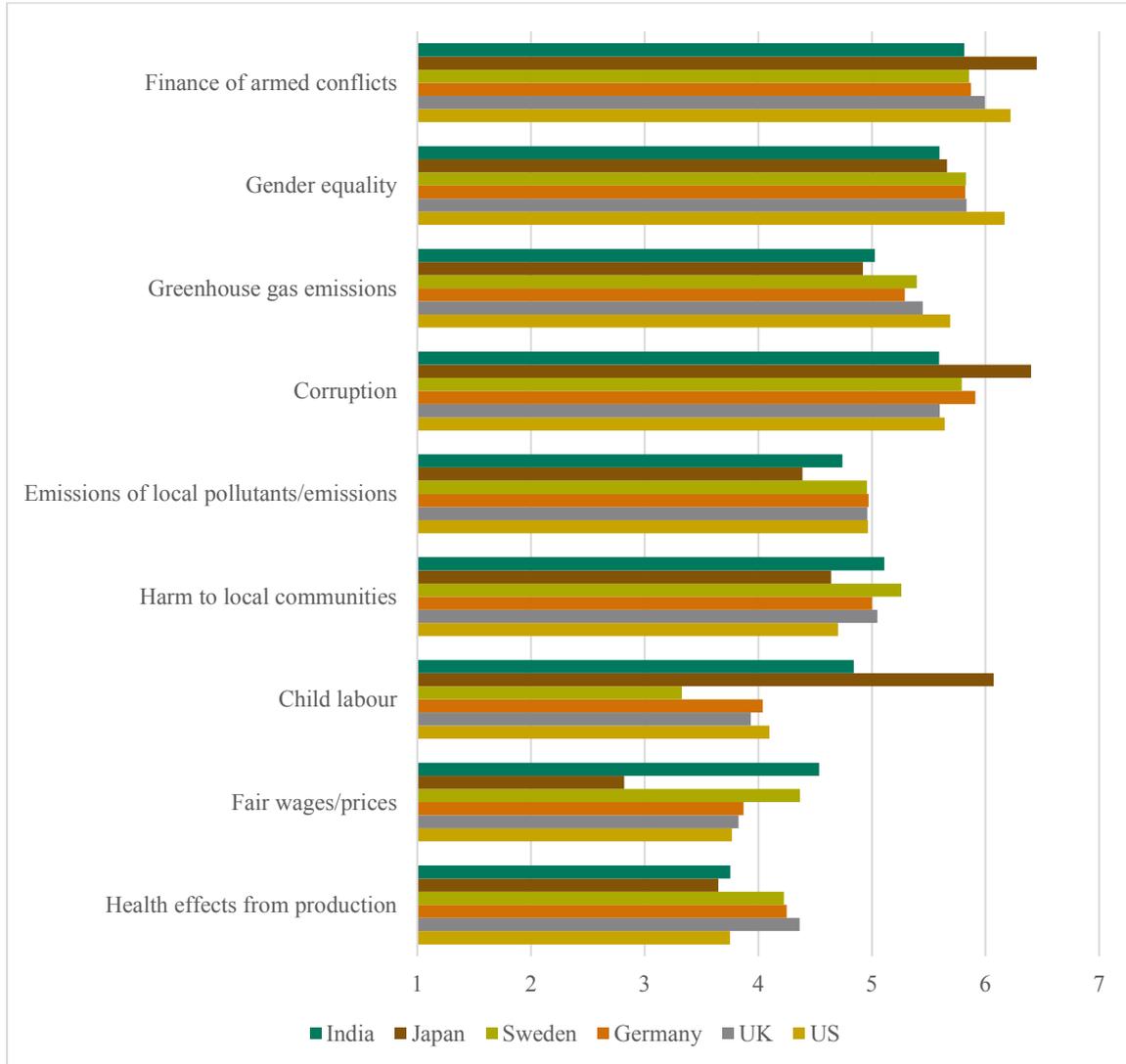
Figure 5. Ranking of different sustainability criteria when purchasing (1=most important)

Respondents were asked 'When purchasing a product, what information about its production do you think it is important to know about?' Figure 5 shows the relative importance of different sustainability criteria when choosing a product. The top ranked items were health effects from production and fair wages/prices; whereas finance of armed conflicts and gender equality were ranked lowest. There are some differences across cultures, with child labour ranked much less important in Japan and more important in Sweden than elsewhere; fair wages/prices was ranked higher in Japan than elsewhere.

In terms of environmental criteria, local pollution is ranked somewhat higher than greenhouse gases (GHGs). Both were ranked slightly more important in India and Japan, and (for GHGs) lowest in the US.

Consistent with the lower ranking of environmental than socio-economic sustainability criteria, consumers had generally given relatively little thought about the sustainability of their car and mobile phone, and tended not to have much knowledge about the materials either product was made from (Figure 6). Highest thought and knowledge about sustainability was observed in India and lowest in the UK and Japan. Consistent with this, Indian consumers were more likely to consider themselves an environmentally-friendly person (a measure of 'green identity'), while Japanese were least likely (Figure 7).

The survey asked participants which factor was most influential in their choices in the experiment. Figure 8 shows that for cars, price and fuel/engine type (e.g., petrol), followed by running costs, were most influential. Design and materials were least influential. Again, consistent with their other survey

responses, a higher proportion of Indian consumers than those from other countries chose materials as their most important attribute for cars (3.4%) and phones (4%).
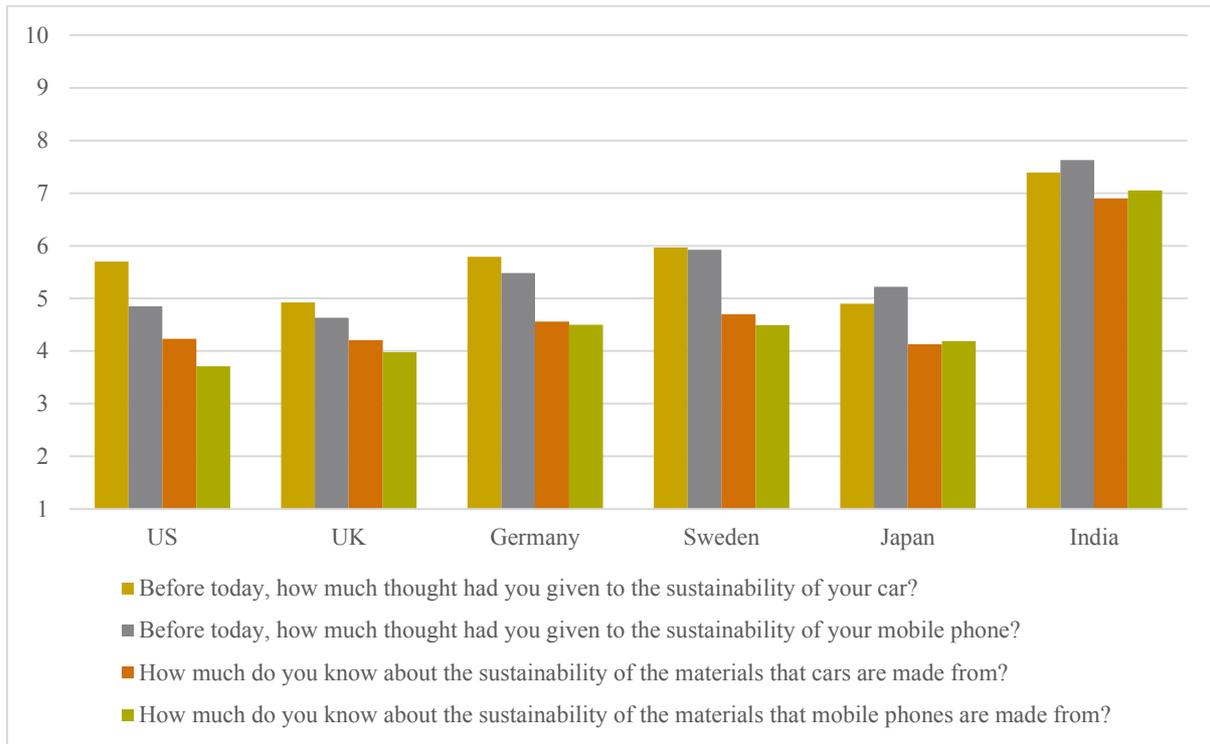
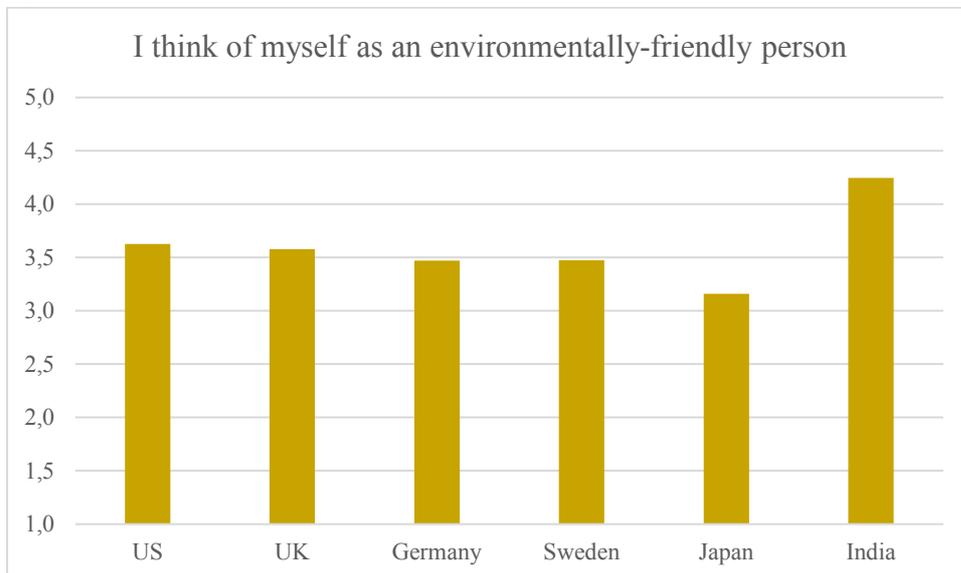Figure 6. Importance / knowledge of sustainability

Before today, how much thought had you given to the sustainability of your car?
Before today, how much thought had you given to the sustainability of your mobile phone?
How much do you know about the sustainability of the materials that cars are made from?
How much do you know about the sustainability of the materials that mobile phones are made from?

Figure 7. Environmental identity

I think of myself as an environmentally-friendly person

Figure 8. Which factors influence purchase decisions for cars (top) and phones (bottom)?
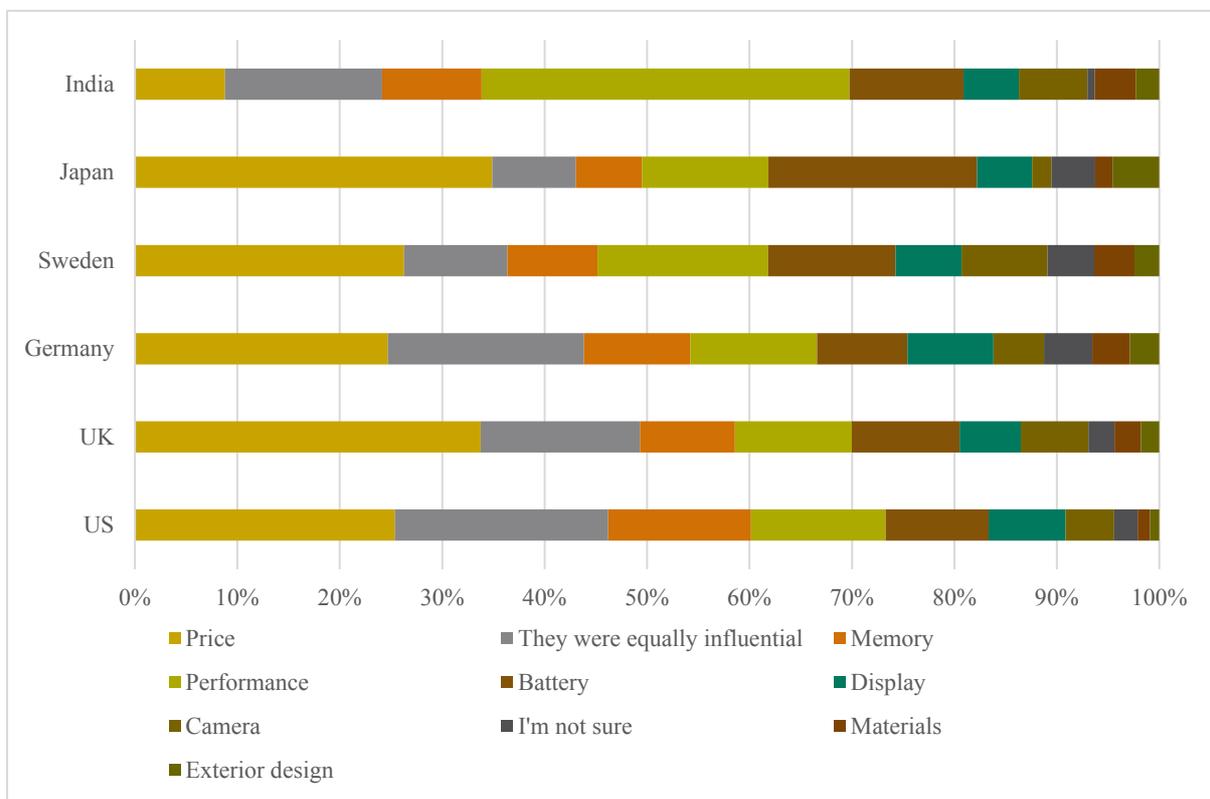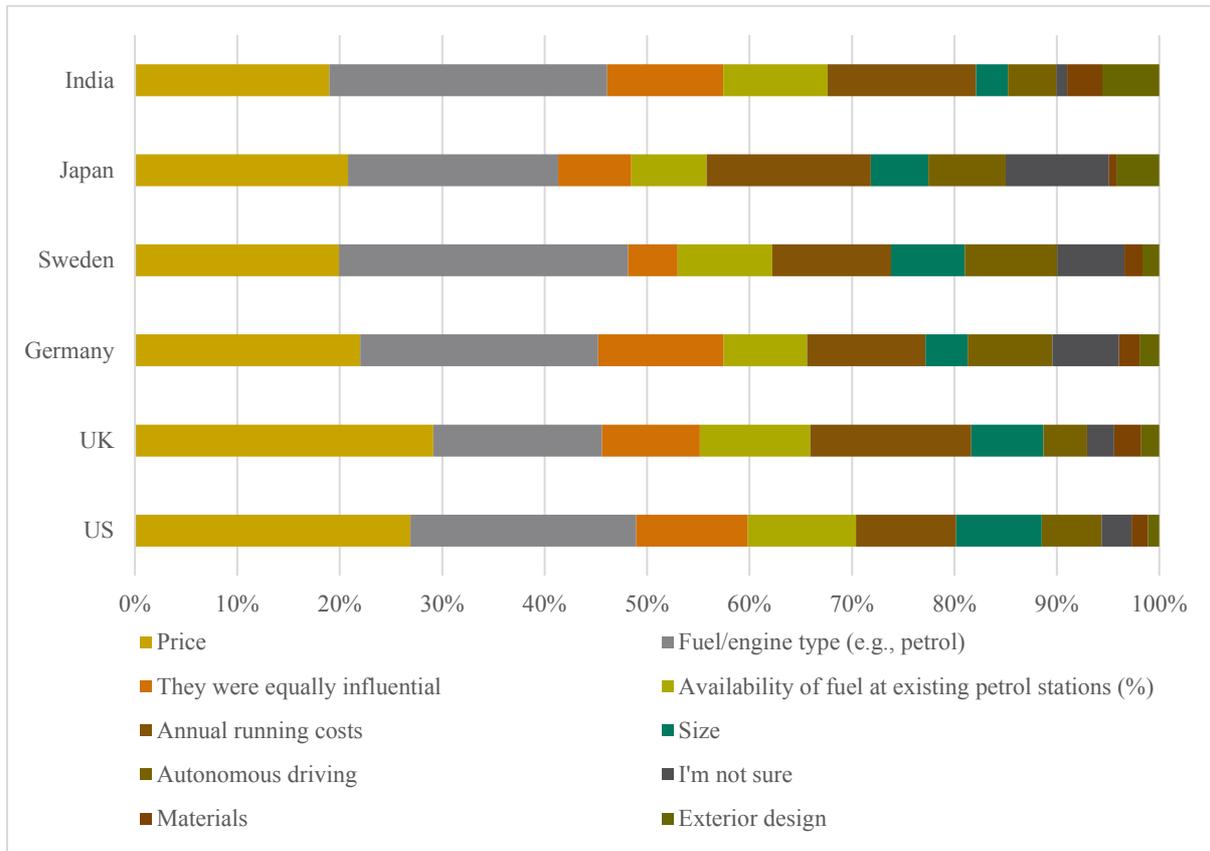
Consistent with these self-reported preferences, the choice experiment for cars (Table 4) showed that price was a significant negative predictor of vehicle choice in all countries: consumers generally prefer cheaper vehicles. Similarly, running costs are a negative predictor in all countries (significant in all cases except India).

Table 4. Car choice experiment (Multinomial logit model estimated parameters)

Attribute	UK	US	Sweden	Germany	Japan	India
Price (in country's currency) Scaled: UK, US / 10,000; Sweden / 100,000; Japan / 1000000; India/1000000	-0.588***	-0.642***	-0.211***	-0.352***	-0.164***	-0.281*
Running Cost (in country's currency) Scaled: UK, US, GERMANY/1000; Sweden /100,000; Japan / 100000; India / 10000	-1.654***	-1.527***	-0.043***	-1.284***	-0.406***	-0.066
Fuel Availability	0.009***	0.009***	0.004**	0.008***	0.003	0.007***
Vehicle Size: Small	Reference	Reference	Reference	Reference	Reference	Reference
- Medium	0.073	0.196***	0.149***	0.216***	0.057	0.187***
- Large	0.011	0.187***	0.131***	0.144***	-0.254***	0.152***
Acceleration	-0.002	-0.028***	-0.035***	0.008	-0.004	0.014*
Design: Unique (vs. Conventional)	0.025	-0.014	0.019	-0.035	-0.086**	0.096**
Autonomous Capability						
(1) Zero Automation	Reference	Reference	Reference	Reference	Reference	Reference
(2) Driver Assistance	-0.187***	-0.134*	-0.123**	-0.075	0.029	0.040
(3) Partial Automation	-0.165***	-0.154*	-0.084	-0.007	0.110	0.051
(4) Conditional Automation	-0.223***	-0.004	-0.069	0.032	0.133*	0.113*
(5) High Automation	-0.254***	-0.154 **	-0.114*	-0.165**	0.170**	0.028
(6) Full Automation	-0.144***	-0.267***	-0.202***	-0.090	0.104	0.076
Materials^						
(1) Conventional materials (CMs)	Reference	Reference	Reference	Reference	Reference	Reference
(2) Ethically sourced CMs	0.230***	-0.042	-0.016	0.084	-0.051	0.164*
(3) Climate neutral CMs	0.206***	0.134**	0.094	-0.078	-0.017	-0.055
(4) Organic materials (OMs)	0.201**	-0.033	0.074	0.083	-0.024	0.049
(5) Climate neutral Oms	0.204***	0.051	-0.030	0.065	-0.015	0.110*
(6) Ethically sourced Oms	0.390**	0.041	0.116*	0.083	0.016	0.096
Alternative Specific Constants						
Petrol	1.304***	1.326***	0.884***	1.693***	1.896***	0.983***
Hybrid	0.424***	0.188***	0.503***	0.561***	0.980***	0.270***
Biofuel	Reference	Reference	Reference	Reference	Reference	Reference
Electric	0.485***	0.643***	0.728***	0.612***	1.665***	0.280***
Number of observations (cases)	15760 (3940)	17172 (4293)	16108 (4027)	17384 (4346)	14764 (3691)	17012 (4253)
Log-likelihood at convergence	-4931.5	-4959.5	-5290.92	-5144.63	-4378.25	-5386.46

*** significant at 99% confidence level; ** significant at 95% confidence level; * significant at 90% confidence level

^ Conventional = steel, aluminium and plastic. Organic = wood fibre, soy beans and flax.

In all countries, petrol internal combustion engines vehicles are preferred, followed by electric and hybrid vehicles, compared to biofuel vehicles. Consistent with this, we see fuel availability is also a significant positive predictor in all countries, except Japan.

Vehicle design is a significant predictor of choice only in India and Japan, though in different directions: in India, consumers significantly prefer unique designs, whereas Japanese consumers prefer conventional ones.

In most countries, consumers prefer mid-size (and, to a lesser extent, large) cars, compared to small ones – with two exceptions: Japan and UK. In Japan, consumers significantly prefer small over large cars; and in the UK, consumers have no significant size preferences. Faster acceleration is less preferable in the US and Sweden, while it is more so in India.

Consumer preferences for autonomous vehicles (AVs) are negative in the UK, US, Sweden and Germany (though only significant at all levels of automation in the UK). In contrast, consumers in Japan have largely positive attitudes to AVs, though only significant at levels 4 and 5 automation; similarly, Indian consumers are positive, though only positive at level 4 (conditional automation).

The picture for sustainable materials is also mixed across countries. In the UK, there is a preference over conventional materials for all types of sustainable materials, with ethically sourced organic materials the most preferred. Swedish consumers also prefer ethically sourced organic materials over conventional materials (but no other sustainable materials). In the US, consumers only prefer climate neutral conventional materials over conventional materials; whereas in India, ethically sourced conventional materials are preferred over conventional material cars. In Germany and Japan, consumers do not significantly prefer any sustainable material vehicles over conventional ones.

In the mobile phone choice experiment (Table 5), again price is a significant negative predictor of choice, indicating cheaper phones are preferred.

Consumers in all countries significantly prefer more memory, better display, and longer battery life. Similarly, consumers in all countries prefer fast and very fast performance over standard performing phones. In most cases, the highest specification camera is also preferred, though this is not the case in Japan. In all countries, consumers significantly prefer conventional design phones over unique designs.

Again, the picture is mixed with regards sustainable materials. In all countries, ethically sourced conventional material phones are less preferable to conventional material phones (significantly so in US, Germany, India and Japan). In contrast, climate neutral conventional material phones are preferred over conventional ones (significantly so in UK, US and Sweden). With regards organic material phones, these are significantly preferred in Sweden, but significantly less preferred in Germany and Japan, relative to conventional material phones. Swedish consumers similarly prefer ethically sourced organic phones over conventional ones; whereas Japanese consumers prefer these significantly less than conventional material phones. However, all countries would significantly prefer a conventional materials phone over an organic, climate neutral phone.

Table 5. Mobile-phone experiment (Multinomial logit model estimated parameters)

|	UK	US	Sweden	Germany	Japan	India
Attribute						
Price (in country's currency)	-0.052***	-0.124***	-0.147***	-0.118***	-0.141***	-0.593***
Memory	0.001***	0.003***	0.0001***	0.001***	0.002***	0.001***
Display	0.204***	0.209***	0.171***	0.190***	0.123***	0.178***
Battery	0.039***	0.045***	0.041***	0.038***	0.057***	0.026***
Design: Unique (vs. Conventional)	-0.127***	-0.232***	-0.183***	-0.107**	-0.262***	-0.115***
Materials^						
(1) Conventional materials (CMs)	Reference	Reference	Reference	Reference	Reference	Reference
(2) Ethically sourced CMs	-0.114	-0.178**	0.019	-0.145*	-0.270***	-0.299***
(3) Climate neutral CMs	0.244***	0.199***	0.419***	0.026	-0.005	0.105
(4) Organic materials (OMs)	0.099	-0.0148	0.324***	-0.174**	-0.186**	0.011
(5) Climate neutral OMs	-0.173**	-0.250***	-0.176***	-0.248***	-0.358***	-0.222***
(6) Ethically sourced OMs	0.003	-0.057	0.127**	-0.032	-0.282***	0.023
Camera						
Rear: 5 MP Front: - Video: SD	Reference	Reference	Reference	Reference	Reference	Reference
Rear: 8MP Front: 1.2MP Video: HD video	0.127**	0.080	0.107***	0.068	0.005	0.088
Rear: 12MP Front: 8MP Video: UHD (4K)	0.296***	0.266***	0.148***	0.200***	-0.071	0.377***
Performance						
Standard (1 GHz 0.5GB RAM)	Reference	Reference	Reference	Reference	Reference	Reference
Fast (1.4 GHz 1GB RAM)	0.624***	0.568***	0.484***	0.570***	0.468***	0.503***
Very Fast (2.39 GHz 6GB RAM)	0.613***	0.466***	0.514***	0.526***	0.365***	0.675***
Number of observations (cases)	8752 (4376)	9224 (4612)	9698 (4849)	9774 (4887)	9636 (4818)	10976 (5488)
Log-likelihood at convergence	-2800.84	-2845.48	-3116.96	-3134.00	-3037.47	-3510.42

*** significant at 99% confidence level; ** significant at 95% confidence level; * significant at 90% confidence level

^ Conventional = glass, plastic aluminium and rare metals (e.g. gold, cobalt and tungsten). Organic = wood or flax casing as well as glass, aluminium and rare metals.

Initial analysis also explored which type of consumer was most likely to select materials as their most important attribute. Figure 9 shows that consumers with a higher green identity were significantly more likely to rank sustainable materials as most important in their mobile phone choice (compared to other attributes); but were no more likely to do so for their car choice.

The importance of different sustainability criteria in products was also examined in relation to whether sustainable materials was ranked as most important in the choice experiment. As shown in Figure 10, again we found no relationship for cars, but those selecting materials as the most important attribute rated local pollution as significantly *less* important than those choosing other attributes.
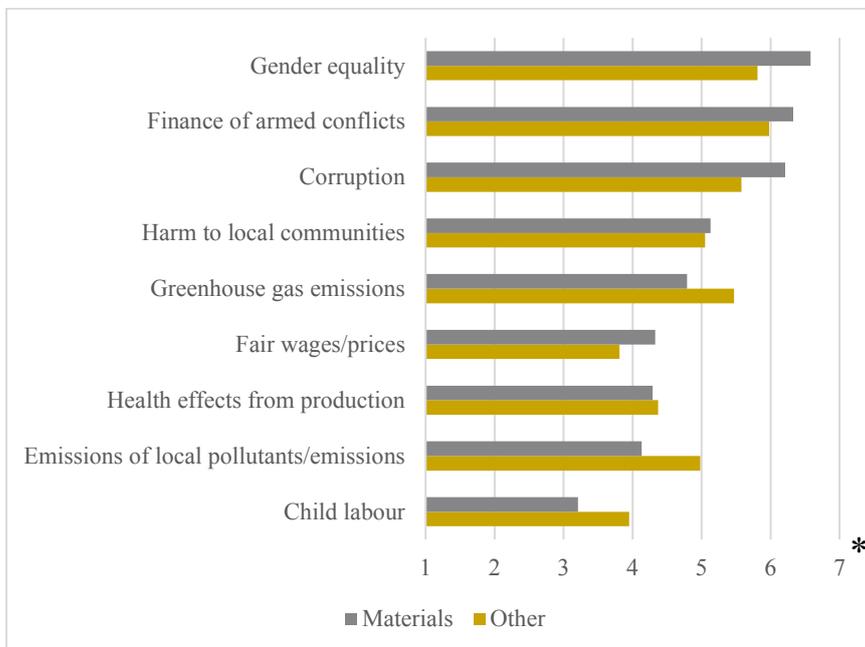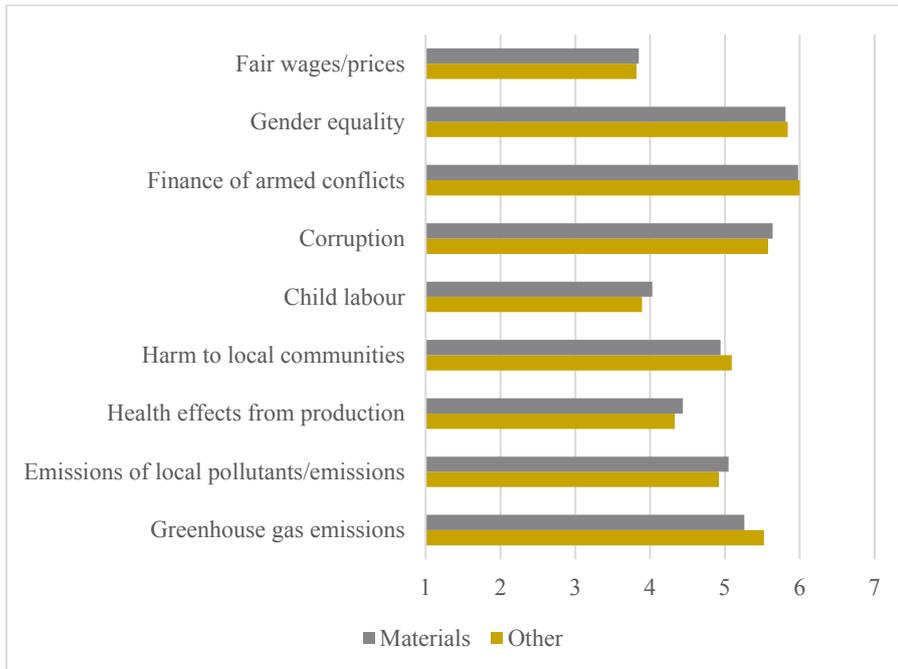
Figure 9. Does green identity influence choice?
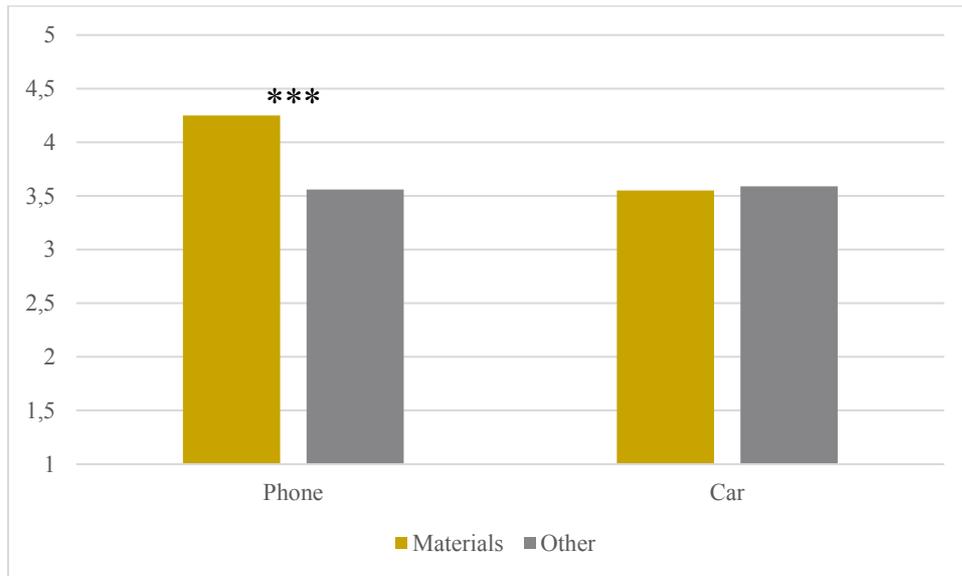
*** t(24,925)=3.79, p<.001 (UK dataset)

'Materials' indicates those who selected materials as the most important criterion in the respective choice experiment; 'Other' indicates those who selected all other criteria as most important.

Figure 10. Does concern about human rights or other sustainability issues influence choice of car (top) or phone (bottom)?

Materials ■ Other

Materials ■ Other

* t(24,901)=-2.14,p<.05

'Materials' indicates those who selected materials as the most important criterion in the respective choice experiment; 'Other' indicates those who selected all other criteria as most important.

4 Summary & Next Steps

We conducted two choice experiments (cars, mobile phones) and a survey with a total of around 6000 consumers in six countries: US, UK, Sweden, Germany, India and Japan, representing important consumer markets and diverse cultures. Across cultures and products, we found points of convergence and divergence in sustainability attitudes and product choices, as outlined here.

Cultural differences:

The survey questions show that consumers, particularly in the US and India, tend to feel attached to their cars and phones. Most are planning to buy a car (usually brand new) in the next three years. Despite this, degree of technological innovativeness varies across cultures, with Indians the most innovative, and Japanese the least. At the same time, Indian consumers also see themselves as most environmentally-friendly, while Japanese see themselves as least.

Durability:

There is also variation across countries in how long consumers expect products to last, with Swedes expecting cars and phones to last longer (11.7 and 6.2 years, respectively) than consumers in other countries. Importance of life expectancy is lower for mobile phones than for cars, with importance highest in India and lowest for Japan.

Sustainability criteria and knowledge:

In terms of the importance of different sustainability criteria when choosing a product, health and socio-economic criteria are more important than environmental ones (consistent with low priority typically given to environmental issues; e.g., Whitmarsh, 2009). Consumers rate health effects from production and fair wages/prices as most important, and finance of armed conflicts and gender equality as least. Child labour ranks as much less important in Japan and more important in Sweden than elsewhere; fair wages/prices ranks higher in Japan than elsewhere. Local pollution ranks somewhat higher than greenhouse gases (GHGs). Both were ranked slightly more important in India and Japan, and (for GHGs) lowest in the US.

Consistent with the lower ranking of environmental than socio-economic sustainability criteria, consumers have generally given relatively little thought to the sustainability of their car and mobile phone, and tend not to have much knowledge about the materials these products are made from. Highest thought and knowledge about sustainability is observed in India and lowest in Japan and the UK.

Car and mobile phone purchases:

Survey responses show that for cars, price and fuel/engine type (e.g., petrol), followed by running costs, are most influential in decision-making. Design and materials are least influential. A higher proportion of Indian consumers than those from other countries chose materials as their most important attribute for cars and phones.

Consistent with this, the choice experiment shows that price and certain pragmatic factors are important for both product choices. Consumers in all markets prefer cheaper cars and mobile phones; running costs for vehicles are also important. Also for vehicles, petrol internal combustion engines vehicles are preferred, followed by electric and hybrid

vehicles, compared to biofuel vehicles. Consistent with this, fuel availability is also important.

As regards performance factors, consumers prefer phones with more memory, better display, longer battery life, fast performance and generally highest specification camera. By contrast, for cars, faster acceleration is *less* preferable in the US and Sweden, while it is more so in India. In most countries, consumers prefer mid-size (and to a lesser extent large) cars, compared to small ones, except in Japan where small cars are preferred, and the UK where there is no size preference. Consumer preferences for autonomous vehicles are negative in European and US markets, whereas they are more positive (at least for conditional automation) in Asian markets.

In terms of design, there is generally a preference for conventional designs over unique ones. This is the case for mobile phones in all countries; and for cars in Japan. Only in India do consumers prefer unique car designs (perhaps reflective of their greater innovativeness; see above).

The picture for sustainable materials is mixed across countries and products. For cars, only UK consumers prefer all sustainable material vehicles over conventional ones (despite their relatively low knowledge of sustainable materials; see above). Swedish consumers only prefer ethically sourced organic materials over conventional materials. In the US, consumers only prefer climate neutral conventional materials over conventional materials; whereas in India, ethically sourced conventional materials are preferred over conventional material cars. In Germany and Japan, consumers do not significantly prefer any sustainable material vehicles over conventional ones. For phones, ethically sourced conventional material phones and organic, climate neutral phone are actually *less* preferable to conventional material phones. In contrast, climate neutral conventional material phones are preferred over conventional ones. With regards organic material phones, these are significantly preferred in Sweden, but significantly less preferred in Germany and Japan, relative to conventional material phones. Swedish consumers similarly prefer ethically sourced organic phones over conventional ones; whereas Japanese consumers prefer these significantly *less* than conventional material phones.

Conclusions and future work:

This research aimed to answer two questions: (1) To what extent are sustainable materials influential in consumers' car/phone purchases? and (2) What type of consumer gives more attention to sustainable materials in their car/phone purchases? In respect of the first question, and as expected from previous research, our analysis shows that economic and pragmatic factors dominate car and mobile phone purchase decisions, whereas sustainable materials are amongst the least important factors influencing purchases and – for phones – may actually be less preferred in many markets. There is an unclear pattern across markets as to whether organic materials, climate emissions, or ethical sourcing (or some combination) is preferred. Overall, it seems that instrumental motives dominate product choice, and tangible attributes are more important than less visible ones (e.g., material provenance).

There are interesting disparities between consumer concerns about sustainability, and those which industry may assume to be of concern to consumers. For example, armed conflict was the least concerning to consumers, though this is often thought to be a concern for

many material producers. Similarly, we observe a disparity between government and industry interest in autonomous vehicles compared to preference in many markets for conventional (human-driven) vehicles. Indeed, there is a general preference in many senses (design, self-driving, fuel/engine, materials) for what consumers are familiar with, as expected from the literature (e.g., Haggar &Whitmarsh, 2017).

In relation to our second research question, the identity and attitudinal variables we examined did not predict consumers' interest in sustainable vehicle choice, but did for mobile phone choice. Neither green identity nor product sustainability criteria influenced the priority given to sustainable materials in their car choice. On the other hand, consumers with a higher green identity were significantly more likely to rank sustainable materials as most important in their mobile phone choice; while those selecting materials as the most important phone attribute rated local pollution as significantly less important than those choosing other attributes. Further work will include conducting regression analyses (and potentially latent class models) using additional psychological and demographic predictors to examine relative influence on purchase decisions, particularly whether sustainable materials were prioritised. We will also undertake additional and more constrained logit models for the choice experiment data (e.g., collapsing attribute levels, limiting prices).

The choice experiment undertaken here did not provide sustainability information, for example about the social or ecological impacts of rare metal mining, supply chain workforce conditions or pay, or greenhouse gas emissions associated with production of mobile phones or cars. Thus, the choices made in the choice experiment were based on consumers' existing knowledge about sustainability, which the survey found to be modest at best. This raises the question of whether product choices would be different if relevant sustainability information were to be provided (and if so, which format or framing might be most effective). This could be a fruitful avenue for future work.

5   References

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6   Appendix – Full questionnaire (UK version)

Consumer choice study

Thank you for your interest in our study!

As researchers, we are interesting in finding out how people make choices between products that are quite similar.

To help us with our research, we'd like you to take part in this study. If you continue, then you will be asked to make some choices between different automobiles and different mobile phones. Don't worry: the task is easier to understand once you start doing it, and you'll be given full instructions about how to do it before you begin.

You will also be asked some questions about yourself and about your interests. You will never be asked for personal information that could be used to identify you or allow anyone to make contact with you. The data you give us will also never be shared with anyone else. This means that your participation is completely private and your data is anonymous.

If you would like any further information about this study, please contact: Lorraine Whitmarsh: WhitmarshLE@cardiff.ac.uk

This study has received ethical approval from the School Research Ethics Committee (SREC) at the School of Psychology, Cardiff University. Any complaints or queries should be sent to: psychethics@cardiff.ac.uk

The data controller is Cardiff University and the Data Protection Officer is Matt Cooper CooperM1@cardiff.ac.uk . The lawful basis for the processing of the data you provide is consent.

If you have read and understood the above information and are willing to participate in this study, please select this box and click the >> to progress:

I consent to participate in this study

Age (in years):

How do you self-identify? Male; Female; Neither of the above (if you wish, please state): Prefer not to say

What is your highest educational qualification: No formal qualification**;** GCSEs of equivalent**;** A-Levels or equivalent**;** First degree**;** Higher degree**;** Professional qualification

What is your approximate household income (before tax) per year?

How many adults (over 18 years old) live in your house?

Which region/county/state do you live in?

We care about the quality of our survey data and hope to receive the most accurate measures of your opinions, so it is important to us that you thoughtfully provide your best answer to each question in the survey.
Do you commit to providing your thoughtful and honest answers in this survey? I will provide my best answers; I will not provide my best answers**;** I can't promise either way

Thank you for agreeing to participate in this research.

As we explained in the introduction, we are interested in people's preferences for different products.

The first product we are going to ask you about is **cars**.

Before we explain how this is going to work, please answer these questions:

Are you planning to buy a new or used car... in the next 12 months; in 2 or 3 years' time**;** in 4 or 5 years' time; in more than 5 years' time; I do not plan to buy a car

If you buy a car, will you want ... A new car; A second-hand car

What price would you be willing to pay for this car? Please indicate, in pounds (£), below:

We will be showing you five different sets of cars. In each set there will be four cars to choose from. We want you to imagine that these are the options you are given when you go to buy a car. Don't worry about having to remember everything in these descriptions as they will be available to you throughout by clicking on the "click me" button located next to the text. This will then display the information to you while you are making your choices.

The four cars have different fuel types, which are:
 1. Petrol: uses unleaded petrol
 2. Electric: uses a battery that is charged with electricity.
 3. Biofuel: uses a fuel made from fermented grains, plant-based oils or wood.
 4. Hybrid: uses both a battery and petrol.

The cars will also vary on a number of their characteristics. These characteristics are shown in the table below. Please take your time to familiarise yourself with these characteristics and their explanations.

Characteristic	Description
Materials	This explains the materials the cars are made from. These can be either *conventional* (steel, aluminium and plastic) or *organic* (wood fibre, soy beans and flax)
Annual running cost	The estimated cost for you to fuel the vehicle for 10,000km and maintain your car for a year.
Exterior design	This can be *conventional* or *unique* design in terms of the car's shape and style.
Availability of fuel at existing petrol stations (%)	The percentage of the current petrol stations that can offer the necessary fuel for the car.
Autonomous driving	This refers to how able the car is to drive itself. It is divided into levels. At each level (except the "full automation" level) the automation can be turned off and the car can be driven as normal.
Level 0 - Zero automation	All vehicle functions are controlled by the driver.
Level 1 - Driver assistance	Normal driver control, but with some assisting features of either steering or acceleration/deceleration (e.g. cruise control).
Level 2 - Partial assistance	The driver must be present, monitoring the road and in control, but the *steering* and/or *acceleration/deceleration* can be automated (e.g. cruise control, lane-centering, etc.).
Level 3 - Conditional automation	The driver must be present, but they are not required to monitor the road. Under certain conditions (e.g. main roads, good weather conditions) all driving functions are automatic – the car drives itself. However, the driver must be able to take the controls manually (e.g., start steering, using the pedals) and will be alerted when they need to do this.
Level 4 - High automation	The driver does not need to control the vehicle or monitor the road and all driving functions are automated under certain conditions (e.g. main roads, good weather conditions). The driver has the option to control the vehicle, as normal, in conditions where the vehicle cannot drive itself in autonomous mode.
Level 5 - Full automation	The driver does not need to control the vehicle or monitor the road and all driving functions are automated under *all* conditions. The driver can direct the vehicle (e.g. change the destination, request it to stop), but the driver cannot operate the vehicle manually because this is unnecessary.
Size	The size of the car can be Small (4 seats, 3 doors, 2 suitcases), Medium (5 seats, 5 doors, 4 suitcases) or Large (5 seats, 5 doors, 6 suitcases).
Price	The money you would have to pay to buy the vehicle upfront.

Some other terms we use are *"climate neutral"* and *"ethically sourced"*:

Climate neutral means that efforts are made to avoid and reduce the release of greenhouse gas emissions (such as CO_2) during the extraction and processing of materials and the production of the product. Remaining greenhouse gas emissions are compensated for through such actions as investing in renewable energy projects.

Ethically sourced means that the extraction of the materials and the production process are conducted in a way which is fair, protects human rights and prevents negative social impacts.

In doing this task, please imagine that everything else about the cars is satisfactory to you, including what *colour* they are, what the *manufacturer/brand* of the car is, and (if you are imagining second-hand cars during this task) what the *mileage* is.

As we said earlier, these explanations will be displayed throughout the survey to aid with your decision - just click on the "click me" button located next to the text.

If you have read and understood these instructions and explanations, then you are ready to see the first set of cars!

Click >> to begin.

Great, thank you! That is all the car choices we have. Before moving on, we have some questions for you about your choices.

Were all of the characteristics easy to understand? Yes; No

Which characteristic was the least easy to understand? Size; Price; Availability of fuel at existing petrol stations (%); Autonomous driving; Exterior design; Materials; Annual running costs

Was there a characteristic which strongly influenced your decision? Size; Price; Availability of fuel at existing petrol stations (%); Autonomous driving; Exterior design; Materials; Annual running costs; They were equally influential; I'm not sure

Do you currently own a car Yes; No

Where do you mainly drive your car? In cities and towns; In rural areas; On motorways; An equal mix of the above

How many miles do you drive your car in a typical *week*?

What is the furthest distance you would use your car to make in a single journey? Please give a number in miles:

To me, a car is:

Important	Unimportant
Boring	Interesting
Relevant	Irrelevant
Exciting	Unexciting
Means nothing	Means a lot to me
Appealing	Unappealing
Fascinating	Mundane
Worthless	Valuable
Involving	Uninvolving
Not needed	Needed

What would the ideal life-expectancy be for a car you are thinking of purchasing (i.e. how long before it must be replaced)?

Years	

When purchasing a car, how important is the life-expectancy of the car to you? Not at all important; Not very important; Neither important nor unimportant; Quite important; Very Important

Please read the statements below and select the one you feel best describes you.
a) I am the type of person who closely follows new technological developments and who dares taking risks by being the first to purchase an innovative car. b) I am the type of person who envisions potential advantages in innovative cars and who is one of the first to make use of these advantages and to profit from those. c) I am a type of person who is interested in innovative cars, but at the same time is pragmatic. First, I would like to take time and be persuaded by the advantages that an innovative car possesses. My decisions are (mainly) based on the recommendations of existing users. d) I am the type of person who is not thrilled by innovative cars, but who rather appreciates security. It is safe to purchase an innovative car when it has been on the market for some while and offers obvious advantages. e) I am the type of person who is traditional and has little affinity with innovative cars. I do not like changes in life and I purchase an innovative car only when the existing model I use is not produced anymore.

Thank you, that is the end of our vehicle questions. Please click >> to move on to the mobile phone questions.

Are you planning to buy a new mobile phone... in the next 12 months; in 2 or 3 years' time; in 4 or 5 years' time; in more than 5 years' time; I do not plan to buy a mobile phone

If you get a new phone, will you want to: Buy the phone in monthly installments?; Buy the phone with a one-off payment?

In our choice task, we needed to assume that you will have a monthly phone contract. Whilst we understand that this may not be your own preference, please try to select an option that best represents what type of phone you would go for.

What price would you be willing to pay, each month, in pounds (£) for the phone?

We will be showing you five different sets of phones. In each set there will be two mobile phones to choose from. We want you to imagine that these are the options you are given when you go to buy your mobile phone. Both mobile phone options will be available with your preferred operating system.

The mobile phones will vary on a number of their characteristics. These characteristics are shown in the table below. Please take your time to familiarise yourself with these characteristics and their explanations.

Characteristics	Descriptions
Materials	This indicates what the phone is made of. These can be *conventional* such as glass, plastic aluminium and rare metals (e.g. gold, cobalt and tungsten) or *organic* such as wood or flax casing as well as glass, aluminium and rare metals.
Exterior design	The phone's shape, colour and style will either be *conventional* or *unique*
Performance	This characteristic refers to the phone's processing speed. It will either be: Standard (1 GHz, 0.5 GB of RAM). Fast (1.4 GHz, 1 GB RAM) or Very Fast (2.39 GHz, 6 GB RAM)
Camera	Describes whether the phone has a front and rear camera or only a rear camera and what quality the cameras are (in megapixels, MP). Also describes the quality of the video (SD = standard definition; HD=high definition; UHD= ultra-high definition). Rear: 5 MP Front: - Video: SD Rear: 8MP Front: 1.2MP Video: HD video Rear: 12MP Front: 8MP Video: UHD (4K)
Display	This refers to the phone's display – both its size, type and the number of pixels it can display per inch. 3.5" LCD screen (165 pixels/inch) 4.7" LCD screen (326 pixels/inch) 5.8" OLED screen (458 pixels/inch)
Memory	This is the phone's internal memory capacity in gigabytes (GB). 32GB, 64GB, 128GB, or 256GB.
Battery	The number of hours talk-time provided by a single charge: 5 hours, 8 hours, 10 hours, 16 hours, or 21 hours.
Price	This is the price of the phone, including the connection fees per month for a 24-month contract.

We will also be using the same two terms as in the previous part - *"climate neutral"* and *"ethically sourced"*:

Climate neutral means that efforts are made to avoid and reduce the release of greenhouse gas emissions (such as CO_2) during the extraction and processing of materials and the production of the product. Remaining greenhouse gas emissions are compensated for through such actions as investing in renewable energy projects.

Ethically sourced means that the extraction of the materials and the production process are conducted in a way which is fair, protects human rights, and prevents negative social impacts.

As before, these explanations will be displayed throughout the survey to aid with your decision making - just click on the "click me" button located next to the text.

If you have read and understood the above text, then you are ready to see the first set of mobile phones!

Click >> to begin.

Great, thank you so much! That's all the mobile phone choices we have for you. We just have some questions for you about your choices now.

Were all of the characteristics easy to understand? Yes; No

Which characteristic was the least easy to understand? Price; Materials; Exterior design; Performance; Camera; Display; Memory; Battery

Was there a characteristic which strongly influenced your decision? Price; Materials; Exterior design; Performance; Camera; Display; Memory; Battery; They were equally influential; I'm not sure

What type of mobile phone do you have currently? Apple; Android; Windows; Other (please specify); I do not currently own a mobile phone

Was compatibility with your other devices, applications or services important in your decision-making? Yes; No; Unsure

Please rank these phone uses in order of their importance to you by dragging and dropping them in to place (higher = more important) Phone calls: Messaging; Watching films/streaming services; Listening to music; Using maps and geo-location services**;** Playing games; Organising e.g. calendar, lists or alarm

To me, a mobile phone is:

Important			Unimportant
Boring			Interesting
Relevant			Irrelevant
Exciting			Unexciting
Means nothing			Means a lot to me
Appealing			Unappealing
Fascinating			Mundane
Worthless			Valuable
Involving			Uninvolving
Not needed			Needed

What would the ideal life-expectancy be for a mobile phone you are thinking of purchasing (i.e. how long before it must be replaced)?

Years	

When purchasing a mobile phone, how important is the life-expectancy of the mobile phone to you? Not at all important; Not very important; Neither important nor unimportant; Quite important; Very Important

Please read the statements below and select the one you feel best describes you. a) I am the type of person who closely follows new technological developments and who dares taking risks by being the first to purchase an innovative mobile phone. b) I am the type of person who envisions potential advantages in innovative mobile phones and who is one of the first to make use of these advantages and to profit from those. c) I am a type of person who is interested in innovative mobile phones, but at the same time is pragmatic. First, I would like to take time and be persuaded by the advantages that an innovative mobile phone possesses. My decisions are (mainly) based on the recommendations of existing users. d) I am the type of person who is not thrilled by innovative mobile phones, but who rather appreciates security. It is safe to purchase an innovative mobile phone when it has been on the market for some while and offers obvious advantages. e) I am the type of person who is traditional and has little affinity with innovative mobile phones. I do not like changes in life and I purchase an innovative mobile phone only when the existing model I use is not produced anymore.

Thank you, that is the end of the mobile phone questions. Please click >> to go to the last page.

Fantastic; this is the last page of questions before the end!

When purchasing a product, what information about its production do you think it is important to know about? Please rank the following impacts: Greenhouse gas emissions; Emissions of local pollutants/emissions; Health effects from production; Harm to local communities; Child labour; Corruption; Finance of armed conflicts; Gender equality; Fair wages/prices

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I think of myself as an environmentally-friendly person.					
I think of myself as someone who is very concerned with environmental issues.					
I would be embarrassed to be seen as having an environmentally friendly lifestyle.					
I would not want my family or friends to think of me as someone who is concerned about environmental issues.					

Do you have children? Yes; No; Prefer not to say

How many children do you have?

Great, thank you so much, that is all the questions.

YOU MUST PRESS THE '>>' BUTTON BELOW FOR YOUR ANSWERS TO BE RECORDED AND TO BE REWARDED FOR YOUR PARTICIPATION !

Consumer choice study

Thank you so much for completing our survey! Your responses will help us to understand what people find important when choosing a new car or mobile phone. We are particularly interested in whether the sustainability characteristics (such as having climate neutral materials) influence people's choices. We expect that these characteristics have more influence on the choices of people with higher levels of environmental concern.

As mentioned, all information provided by you is completely anonymous and will be retained indefinitely. If you have any questions about the research, please contact us for further details:

Prof. Lorraine Whitmarsh
whitmarshle@cardiff.ac.uk
Tel.: +44(0)29 2087 6972

Further contact in case of complaints:
Psychology Ethics Committee Secretary
Address: Cardiff University, Tower Building, Park Place, Cardiff, CF10 3AT, UK
Email: psychethics@cf.ac.uk
Phone: +44 (0)29 208 74007 Fax: +44 (0)29 2087 4858

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