

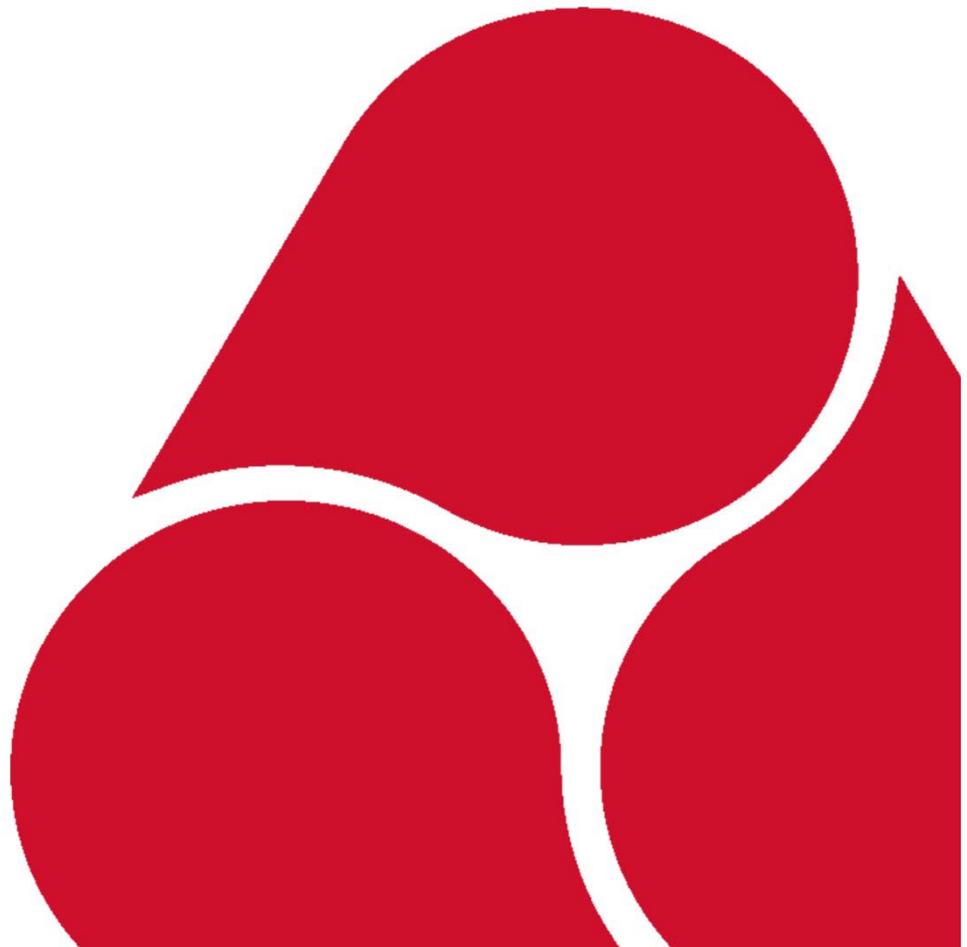


Office for Product
Safety & Standards

Understanding the Psychological Factors Underpinning Risk Perceptions of Consumer Products

Summary Report

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A report for the Office for Product Safety and Standards (OPSS) by Sarah C Jenkins (Centre for Decision Research, University of Leeds), Rob Lachlan (Department of Psychology, Royal Holloway University of London) and Magda Osman (Centre for Science and Policy, Judge Business School, University of Cambridge). The views expressed in this report are those of the authors, not necessarily those of OPSS or the Department for Business and Trade.

Executive Summary

Objectives: This research project was designed to examine public perceptions of risk in consumer products. Gaining a better understanding by examining *which* products are perceived as riskier than others, as well as *how* and *why* perceptions vary amongst consumers, provides valuable insights that can support future approaches to communicating risks to the public.

Methodology: To answer the question about which products are perceived as riskier than others, the project used a standard psychometric paradigm, which combines insights from cognitive psychology and statistics. This methodology uses a set of questions that have been validated, from which constructs (risk perceptions, risk tolerance) are derived from statistical modelling. In total, four studies were conducted (Study 1A, nationally representative, N = 978; Study 1B, N = 382; Study 2, N = 3255; Study 3, N = 1440). In Study 1A and Study 3, the psychometric methodology was used to develop a risk perceptions map of household consumer products (54 products), and a map of personal care and cosmetic products (54 products). In addition, the studies were also designed to validate and extend the methodology to answer how and why risk perceptions varied by (a) *individual characteristics* (socio-demographics: age, gender, being a parent; cultural worldview; personality [risk propensity]) (Study 1A, 2, 3); (b) *properties of the product* (e.g., age [old versus new], main purpose [household versus leisure], power/fuel [involves power/fuel or not], vulnerable groups [vulnerable groups use or interact with more than others/not]) (Study 1B) and (c) *context* (e.g., where product was bought [online versus bricks and mortar], harm cause [non-compliance versus user action], who was harmed [friend versus unknown other]) (Study 2).

Main Findings: The key findings are presented in relation to the core questions that this project was designed to address.

What products are riskier than others? Overall, both consumer (CM) products and personal care and cosmetic products (PCC) were mapped onto a risk space using two dimensions: The positive aspects (benefits) of the products subsumes responses to questions regarding familiarity with, judged usefulness of, and frequency of use of the product. The negative aspects (dread – a psychological risk term) of the products subsumes responses to questions regarding the severity of, likelihood of injury of, worry around, and known to those at risk of the product. The risk maps can be broadly divided into four quadrants using the dimensions of benefits and dread: high dread-high benefit (e.g., CM: oven, PCC: aerosol antiperspirant) high dread-low benefits (e.g., CM: fireworks, PCC: skin lightening cream), low dread-high benefit (e.g., CM: fridge/freezer, PCC: toothpaste) and low dread-low benefits (e.g., CM: musical greeting cards, PCC: hair gel).

How do consumers vary in their perceptions of risk? Overall, when taking into account benefits, dread, and responsibility, over 88% of the variance in public risk perceptions of CM and PCC products was accounted for. The responsibility aspect of products subsumes response to questions regarding responsibility for protection (such as regulators, manufacturers), blame (where the fault lies with external parties such as regulators, manufacturers), and level of control over being injured by the product.

Why do consumers vary in their perceptions of risk? Overall, individual factors (e.g., age, gender, being a parent, cultural worldviews [hierarchical/individualistic] and risk propensity) were informative in explaining patterns in the way consumers vary in their

perceptions. Higher benefits were associated with sample characteristics such as being female, young, a parent of children under 10 or high in risk propensity. Higher dread was associated with sample characteristics such as being female, young, a parent of children under 10 or having a communitarian/egalitarian worldview. Products that were attributed with high responsibility for third parties was associated with characteristics such as being female and younger.

However, an understanding of which products are perceived as riskier than others is incomplete without an understanding of tolerance. That is, risk tolerance will directly inform a consumer's actions, in that people make trade-offs that are informed by the costs and benefits of products. This project is the first of its kind to have examined public tolerance of risk with respect to consumer products.

Subsidiary Findings: Two other findings that should be highlighted concern contextual factors that inform risk perceptions, such as place of purchase of a product, and the cause of harm. Tolerance of risks was markedly reduced for products purchased online (versus in a bricks and mortar store), and when products were revealed to be non-compliant (compared with user misuse). Also, consumers were more likely to communicate to others about risks associated with products, depending on how dreaded or beneficial the products were. Demographics (age, gender, parental status), risk propensity and contextual characteristics (product, cause of harm, who experienced the harm) also predicted likelihood of seeking and sharing risk information with personal and impersonal sources.

Conclusions: This body of work demonstrates the importance of considering individual characteristics and the potential interaction with contextual characteristics when assessing perceptions and tolerance of risk. These characteristics influence how individuals seek and share risk information, and thus have implications our understanding of the spread of information, and the efficacy of risk management and communication strategies.

Recommendations: This body of work can be used as a baseline for determining the extent to which regulatory initiatives, and communication strategies directly impact, and improve the accuracy of consumer perceptions of risk. This is of particular value for instances where consumers attribute high risk for products that are safe, and low risk for products that require more care.

Background

The Office for Product Safety and Standards (OPSS) is responsible for regulating all consumer products (excluding vehicles, medicine and food) across the UK. As technology continues to advance, new consumer products are continually entering the market, bringing with them the potential of new risks which must be assessed and managed. Aside from identifying safety issues associated with new and emerging risks, OPSS must also continue to understand risks and investigate safety issues associated with current products and technologies. Incidents such as the Grenfell Tower fire have brought concerns regarding the safety of household appliances and consumer products to the forefront of the public's minds. However, little is known not just about *how* consumers perceived product risk but also *why* they do so.

One of the most frequently used methodologies to investigate *how* individuals perceive risk is the psychometric paradigm (Fischhoff *et al.*, 1978). In this paradigm, individuals are asked to characterise the 'personality of hazards' by rating hazards on a series of characteristics thought to influence perception and acceptance of risks, for instance, familiarity, level of personal/scientific knowledge and severity (Slovic, 2010). Research has consistently demonstrated that risk perceptions can primarily be explained by two components, termed dread risk and unknown risk. Dread risk relates to the potential of catastrophic, or fatal consequences, a lack of perceived control, and the uneven distribution of risks and benefits. Unknown risk relates to those risks which are poorly understood, new, unknown to science and to those exposed, unobservable and have delayed consequences. Hazards with the greatest perceived risk were associated with high levels of dread and low levels of knowledge/familiarity (Fischhoff *et al.*, 1978; Slovic, Fischhoff and Lichtenstein, 1986; Slovic, 2016).

The original psychometric study (Fischhoff *et al.*, 1978; replicated by Fox-Glassman and Weber, 2016) did feature some consumer products (e.g., home appliances, motor vehicles) though did not explicitly focus on them. The methodology has been used specifically within a product safety context, though much of this research is 30+ years old (Wogalter, Desaulniers and Brelsford, 1986, 1987; Vaubel and Young, 1992; Young, Wogalter and Brelsford, 1992; Oglethorpe and Monroe, 1994; Young and Laughery, 1994; Feng *et al.*, 2010) and thus cannot tell us about perceptions of newer products which have since entered the market. These studies have generally found two- or three-component solutions (e.g., consisting of dread, unknown, familiar) similar to research in other contexts, as outlined above. However, this approach cannot explain why one individual might perceive a risk as particularly severe, and another not, which formed the basis of alternative risk theories.

In a bid to address this, the cultural theory (CT) of risk (Douglas and Wildavsky, 1982; Thompson, Ellis and Wildavsky, 1990; Wildavsky and Dake, 1990) focuses largely on the social context in which risk perceptions are formed. Specifically, the theory proposes two dimensions: '*grid*' relates to prescribed social relations (i.e., how one might act given their gender, role etc) and '*group*' relates to the boundaries of relations (i.e., feelings of belonging or solidarity – 'us' versus 'them'), which give rise to different cultural worldviews. Increased risk is perceived when hazards threaten one's worldview. The evidence for the role of cultural worldviews in explaining risk perceptions is mixed (Brenot, Bonnefous and Marris, 1998; Marris, Langford and O'Riordan, 1998; Sjöberg, 1998, 2003) and the relative importance of worldview versus other individual differences (e.g., demographics, personality traits) is not known.

Individual difference theories of risk focus on person-specific factors, with many personality traits identified as being correlated with risk perceptions. These include: risk propensity (Sitkin and Weingart, 1995; Weber, Blais and Betz, 2002; Zhang, Highhouse and Nye, 2019), risk preference (Frey *et al.*, 2017), risk sensitivity (Sjöberg, 2000), openness to new experiences (Costa and McCrae, 1992) and emotional stability (Sjöberg, 2003; Chauvin, Hermand and Mullet, 2007). Socio-demographic characteristics such as age and gender have also been consistently associated with risk perceptions, with lower risk perceptions seen for young people and/or males (Flynn, Slovic and Mertz, 1994; Finucane *et al.*, 2000; Reniers *et al.*, 2016). However, similar to results from cultural theory, these person-specific factors have limited explanatory value. Coupled with the fact that attitudes towards risk are not always stable (Weber, Blais and Betz, 2002), a sole focus on individual characteristics risks overlooking other important influences on perceptions.

Up until now, the study of risk perceptions has typically been from one perspective – that is adopting either a cognitive, cultural or individual difference approach. In doing so, this research has neglected to consider the potential for interactions between cognitive and individual factors which could influence the formation and maintenance of risk perceptions. As a result, previous research may have been too hasty in minimising the role of certain factors (e.g., worldview, personality), when in fact they play a larger role, but rather in conjunction with other factors. The commissioned body of work therefore integrated these approaches for the first time, in order to provide a more holistic understanding of consumer risk perceptions.

We further extended prior research by considering the rich, social context in which risk perceptions are shaped and maintained. When assessing and making decisions about risk (e.g., those associated with use of a particular consumer product), individuals must (1) decide whether and where to seek information; (2) integrate contextual information with our existing knowledge/appraisals of the item; (3) decide whether and how to share their experiences with others. Drawing on cultural evolution literature, we investigate how and where individuals seek and communicate information about risk across three studies. We subsequently used these insights in the development of our agent-based model, to simulate the processes by which risk perceptions of a product culturally evolve.

Empirical Studies

We designed a series of three empirical studies to investigate consumer risk perceptions using our novel, integrative approach. **Study 1A** (nationally representative, n=978 following exclusions) measured risk perceptions and risk tolerance for 54 different consumer products, as well as measuring likelihood of seeking and sharing risk information. A follow-up study (**Study 1B**) was conducted, where we investigated how individuals perceive consumer products according to four characteristics hypothesised to be of relevance to risk perceptions: the (relative) *age* of the product; its *main purpose* (e.g., leisure versus household goods); whether it involves *power or fuel* and whether *vulnerable groups* (such as children or the elderly) use/interact with the product more than other groups. **Study 2** featured richer scenarios, where we measured the effect of contextual factors (place of purchase, type of harm, who experienced the harm) on risk perceptions and risk tolerance for six products (selected to be representative of the risk dimensions identified in Study 1A). **Study 3** (n= 1440 following exclusions) extended Study 1A, applying it to 54 personal care and cosmetic products (PCC), and additionally considered social media frequency as well as the personal importance of PCC products in shaping perceptions.

Modelling

The response of societies to new dangers is ultimately generated by the perceptions of its constituent individuals. But the relationship between individual psychology and social change is not straightforward – especially when individuals largely acquire their information from their social network. Different types of information may propagate in different ways through different social networks. In extreme cases, false information might, for example, not be very convincing to individuals, but still spread because something about it encourages people to share it with their peers: this is the scenario in which conspiracy theories might succeed. But even in more moderate circumstances, some individuals may not learn or be convinced about new risks until much later than policy makers would desire. One branch of social science that has investigated how new behaviour and beliefs are spread through populations is cultural evolution. Cultural evolution borrows the concepts of inheritance, transmission, novelty, and selection from biological evolution, and translates them to explain how traits that individuals learn from one another succeed or fail. It has successfully been applied to understand how, among others, human fashions and fads, technology, and language change over time. Cultural evolution relies heavily on computational models of populations. In such models, assumptions about individual processes of learning and social interactions are made, and their effects on the spread of behaviour through populations are measured. They therefore bridge the gap between individual psychology and population responses.

We applied this approach to examine how risk perceptions surrounding consumer items culturally evolves within populations. Our model was founded based on the precepts of risk perception drawn from the psychological literature, and on the results of our own empirical work in this project. We implemented a computationally efficient framework in Java for the agent-based modelling (in which the behaviour of each individual, or agent, in the model is explicitly simulated) of cultural evolution to achieve this. Our framework allows for the first time to our knowledge, agent-based modelling of cultural evolution in large populations: we have currently explored population sizes up to 500,000.

Summary of Main Findings

Empirical Studies

Components of Risk Perceptions

In Study 1A, essentially, products that were perceived as highly risky were those which had high benefits, were dreaded and for which the protection of harm was the responsibility of individuals. Figure 1 gives an overview of the relative differences in perceptions for each product, according to the benefits and dread components. Products such as fireworks, e-scooters and trampolines were perceived as highly dreaded, with relatively few benefits. Products such as fridge/freezers, washing machines and USB chargers were seen as highly beneficial and not particularly dreaded.

We observed a similar structure for risk perceptions of PCC products in Study 3. Products that were highlight risky were those that had high benefits, were dreaded and for which the individual had most responsibility. Figure 2 gives an overview of the relative differences in perceptions for each product, according to the benefits and dread components. Products such as skin lightening cream, facial skin peel and eyelash growth serum were perceived as dreaded, with relatively few benefits. Products such as toothpaste, facial moisturiser and conditioner were seen as beneficial and not particularly dreaded.

Predicting Risk Perceptions

In Study 1A, differences in benefits were primarily predicted by individual differences, specifically demographics and personality (risk propensity). There was some influence of product age and product purpose, but their effects differed according to individual differences. Dread was predicted by predicted by a combination of individual differences (demographics, risk propensity and cultural worldview), as well as product category membership. Products which were either old or leisure products more dreaded than newer or household products. Individual responsibility was less influenced by product category, instead being primarily predicted by individual differences (demographics, risk propensity and cultural worldview).

Predictors of the three dimensions of risk perceptions were found to be broadly similar in Study 3. Here, there was particular value in additionally considering frequency of social media engagement and the importance of the product to the consumer. The more frequently one engaged on social media and the more important the product, the greater the benefits perceived.

Risk perceptions were also influenced by the presence of additional contextual information (Study 2). After harm information was presented, products purchased online were perceived as less beneficial. Risk perceptions were particularly sensitive to information about cause of harm, specifically when the harm was caused by non-compliant products (as opposed to user misuse), with higher dread, and lower benefits perceived.

Predicting Risk Tolerance

Risk tolerance was conceptualised as the trade-off between perceived benefits and perceived dread (benefits – dread), with high values equivalent to high risk tolerance (high dread but still high benefits). An orthogonal measure risk intensity was created (benefits + dread), whereby high values were equivalent to high perceived intensity (whether positive [low dread, high benefits] or negative [high dread, low benefits]).

Across the three studies, perceived risk intensity was largely predicted by individual differences. In contrast, risk tolerance was consistently predicted by interactions between individual differences and product differences/presence of harm information. Indeed, characteristics such as age and parental status could be said to act as buffers in the presence of harm information.

Predicting Risk Communication

Across Studies 1A, 2 and 3, age, gender and risk propensity of an individual consistently predicted likelihood of risk communication. There was less of a clear influence of contextual factors (e.g., product and harm information), with their effects mostly as part of interactions with individual characteristics. Both positive and negative aspects of risk (benefits/dread) also strongly influenced likelihood of risk communication, though the direction of these effects differed according to whether these were with personal or impersonal sources.

Modelling

Drawing on cultural evolution research, we developed a novel model to simulate this process, applying it to the risk domain for the first time. This modelling enabled us to extrapolate from our individual level data to measure population level behaviour, in populations as big as 500,000. We demonstrated that individuals risk perceptions are sensitive to both positive and negative information about a product, though the extent and predictability of this influence depends on how social the network is.

Limitations

Aside from the nationally representative sample in Study 1A, the rest of our studies recruited participants from the online panel Prolific Academic (www.prolific.co). This has been shown to be a reliable source of high-quality data and whilst not nationally representative, home to a diverse set of participants (Peer *et al.*, 2017). It should however be noted that participation online generally means that participants are from relatively highly educated, higher socio-economic status groups. Our results in Study 2 and 3 were consistent with the findings in Study 1A, though to be sure our findings extend to other socio-economic groups, replicating these studies with a nationally representative sample would be desirable.

The findings from Study 1A and 1B highlight the added value of considering product categories when investigating risk perceptions. We hypothesise that the PCC products featured in Study 3 could also be grouped into categories of relevance to risk perceptions. For instance: the (relative) age of the product; its main purpose (e.g., personal hygiene versus cosmetic/beauty); frequency of usage (e.g., intended/typically used daily versus less frequently); syntheticity (e.g., contains large amounts of synthetic ingredients versus small amounts). Future research should seek to categorise products and validate them to draw further insights about the nature of consumer risk perceptions of chemicals.

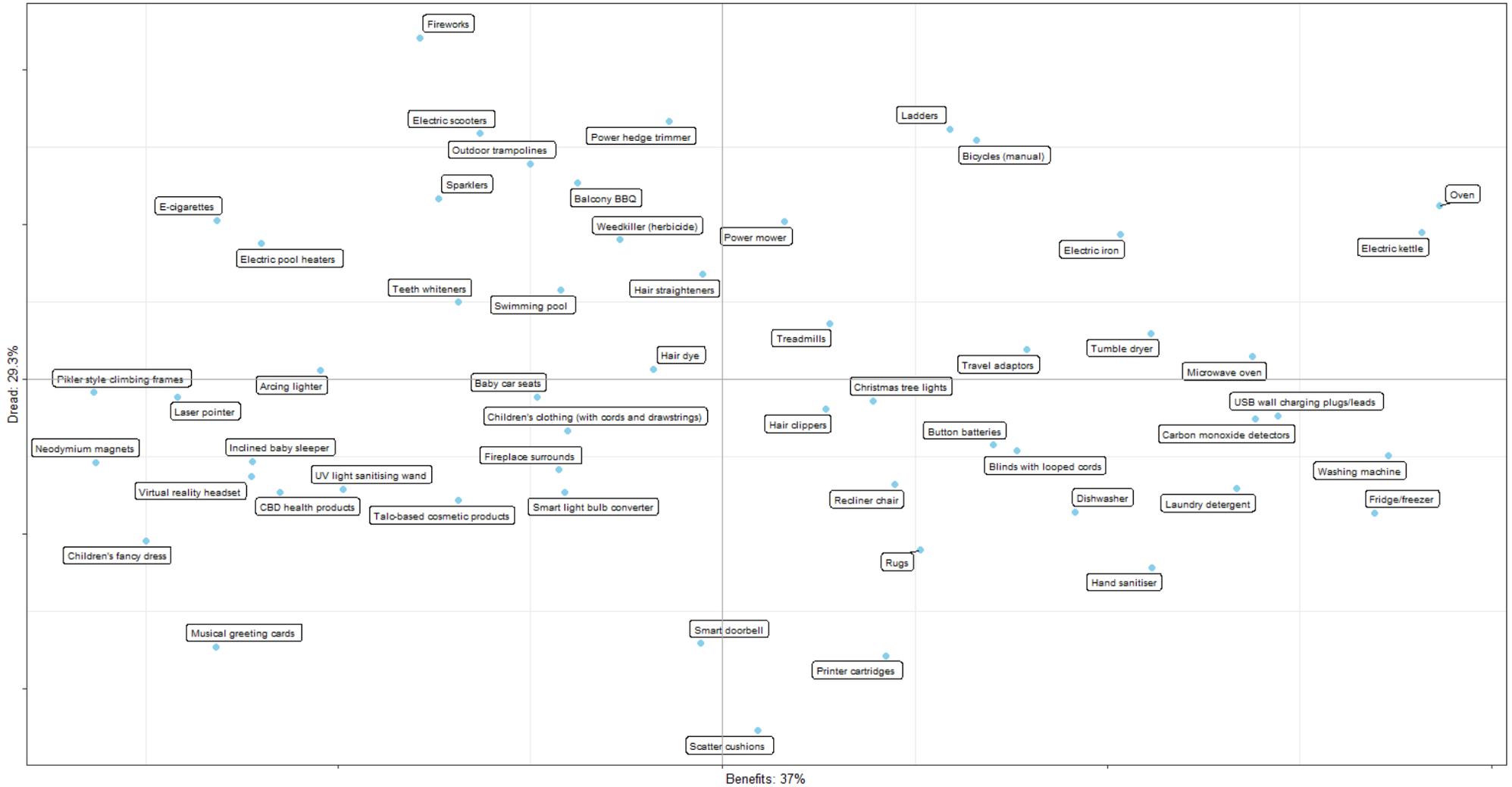


Figure 1. Study 1A - Location Of Products Within the Benefits and Dread Component Space

Conclusions

Consistent with previous literature using the psychometric paradigm, our findings highlight that risk perceptions are influenced by a variety of qualitative factors, which are not directly related to objective measures of risk (such as probability of occurrence). These include both contextual factors (e.g., product type, presence of harm information) as well as individual characteristics, such as demographic, personality and worldview measures. For the first time in the literature, we demonstrate that these factors interact with each other, influencing not just risk appraisals, but also the spread of risk information. It is therefore not simply enough to consider these factors individually; we posit that risk communication and management strategies will be most effective when they take account of these interactions.

Implications and recommendations

The work presented within this project provides an overview of public risk perceptions for over 100 consumer products, enabling one to assess which products are perceived as particularly risky relative to others. This data can be used as (a) a guide to identifying products where there may be a large divergence between expert and lay assessments of risks and (b) a benchmark against which to measure (i) generally how perceptions change over time and (ii) the extent to which perceptions change in response to regulatory initiatives/specific communication strategies.

The fact that we identify three dimensions underlying risk perceptions, which incorporate both positive (benefits) and negative (dread) aspects of risk is particularly pertinent within the context of product safety. For risk management and communication strategies to be successful, they should acknowledge not just the negative aspects of risk, but also the positive aspects; recognising that benefits gained from a product will directly influence how much risk consumers are willing to tolerate.

Our findings relating to the seeking and sharing of risk information at both an individual and population level emphasise the social nature of risk perceptions. In the absence of direct experience, individuals rely heavily on information from others when assessing product risk. The more interactions a population has, the more unpredictable and variable risk perceptions and behaviour are likely to be. Furthermore, the model developed here provides a way of being able to directly simulate and investigate the impact of communication strategies in far larger populations than traditional market research would allow for.

Supplementary Materials 1: Methodology of Studies

Study 1A – Underlying Risk Perceptions

Participants

In Study 1A, a nationally representative United Kingdom sample (on the basis of age, gender and ethnicity) of 1000 participants was recruited from Prolific Academic (www.prolific.ac). Participants were paid approximately £8 per hour. Participants were excluded for completing the study unreasonably quickly (<12 minutes) or if their responses for any of the products had a SD < 0.5, leaving a final sample of 978. For final sample characteristics, see Table 1.

Table 1. Characteristics of Samples Across Studies

Demographic		National Representative %	Study & Percentage			
			1A	1B	2	3
n			978	371	3255	1440
Gender	Male	49.2	48.2	50.9	49.5	25.0
	Female	50.8	50.9	48.0	49.7	74.8
	Other	N/A	0.6	0.3	0.4	0.1
	Prefer not to say	N/A	0.2	0.8	0.2	0.1
Age	Under 18	21.4	n/a	n/a	n/a	n/a
	18 - 24	9.4	12.8	54.5	11.7	13.4
	25 - 34	13.5	17.4	28.6	26.8	29.7
	35 - 44	14.0	18.6	10	23.5	22.7
	45 - 54	13.7	16.08	4.9	18.2	16.2
	55 - 64	11.6	24.4	1.1	14.0	13.3
	65+	16.3	10.3	0.8	5.3	4.6
	Prefer not to say	N/A	0.2	0.3	0.1	0.1
Ethnicity	White	85.4	83.4	70.6	88.4	80.2
	Mixed/ Multiple ethnic groups	2.3	2.6	6.5	2.7	5.3
	Asian/Asian British	7.8	7.9	1.6	4.7	9.4

	Black/African/ Caribbean/ Black British	3.5	3.7	13.5	3.0	4.2
	Other ethnic group	1.0	1.3	7.6	0.3	0.6
	Prefer not to say	N/A	16.5	0.3	0.6	0.4
Children under the age of 18	Yes – aged between 0 – 10	N/A	15.9	10.0	17.5	18.3
	Yes – aged between 11 – 18		10.1	4.0	10.7	12.7
	Yes – aged between 0-10 and 11-18		N/A	N/A	3.8	N/A
	No		73.2	84.9	66.8	68.6
	Prefer not to say/ Missing/ Incompatible options selected		0.7	1.1	0.9	0.6
View cosmetics/ personal care videos on social media	Daily	N/A	N/A	N/A	N/A	11.5
	Weekly					22.3
	Monthly					12.3
	Once every few months					26.8
	Never					22.3

Questionnaire

We selected fifty-four products from a combination of previous literature and those identified by OPSS as particular priorities for research. Each product was presented with a short descriptive sentence to provide context, though no mention of associated risks or benefits was made. These sentences were developed using the Delphi method (OPSS regulators and experts) and in reference to existing research. For the full list of products and associated descriptions, see Appendix A.

Before beginning the main task, participants were asked a series of demographic questions regarding age, gender and parental status. Participants were randomly presented with nine of the fifty-four products to rate. Each product was rated on a series of 11 risk characteristics, using a 7-point Likert scale. The complete list of characteristics and response scales can be found in Table 2. On the next page, participants were presented with a list of sources and asked to rate the likelihood of seeking and sharing information about the product, measured on a scale from 'Not at

all likely' to 'Extremely likely' (see Table 3). Participants were finally asked to give an overall hazard rating for each product ("How hazardous do you consider this product to be?" rated on a 7 point scale, from 'Not at all hazardous' to 'Extremely hazardous' (Young and Laughery, 1994). After rating all nine products, participants completed the General Risk Propensity Scale (Zhang, Highhouse and Nye, 2019) – an eight-item scale of risk propensity (see Table 4), as well as a shortened, amended version of the Cultural Cognition Worldview Scale (Kahan, 2012) (see Table 5).

Table 2. Study 1A & Study 3 – Product Characteristics

Characteristics
<p>Benefits</p> <p>How great are the benefits associated with the above product to you personally? (<i>No benefits at all, to Very great benefits</i>)</p>
<p>Severity</p> <p>How <i>severely</i> (i.e., degree, extent or magnitude) might you, or anyone else, be injured by the above product? (<i>Not at all severe to Extremely severe</i>)</p>
<p>Familiarity</p> <p>How <i>familiar</i> are you with the above product? (<i>Not at all familiar to Extremely familiar</i>)</p>
<p>Known to those at risk</p> <p>To what extent are the risks associated with the above product known precisely to the persons who are exposed to the risk? (<i>Completely unknown to Known precisely</i>)</p>
<p>Control</p> <p>If exposed to the product, to what extent can you, by personal skill, diligence or training, avoid the hazards associated with the above product? That is, how much control do you have over being injured by the above product? (<i>No control at all to Total control</i>)</p>
<p>Likelihood of injury</p> <p>How <i>likely</i> are you or anyone else to receive <i>any</i> injury from the above product, including all <i>minor</i> ones (requiring little or no first aid) and <i>major</i> ones (requiring emergency treatment)? (<i>Never to Extremely likely</i>).</p>
<p>Worry</p> <p>How worried are you about potential risks associated with use of the above product? (<i>Not worried at all, to Extremely worried</i>)</p>
<p>Blame</p> <p>To what extent would an injury associated with the above product be the fault of the individual or the fault of external parties, such as the retailer, manufacturer or government regulator? (<i>Completely the fault of the individual to Completely the fault of external parties</i>)</p>

Responsibility for protection

To what extent is it your responsibility, or the responsibility of others (such as the retailer, manufacturer or government regulator), to protect you from harm associated with the above product? *(Totally my responsibility to Totally the responsibility of external parties)*

Likelihood of use

If you own (or were to own) the above product, how *often* would you use it? *(Never to Very frequently) (Never to Daily)*

Usefulness

How useful would the above product be to you or a member of your household? *(Not at all useful to Extremely useful)*

Environmental impact

How much of a negative impact does use of the above product have on the natural environment? *(No negative impact at all to Extremely high negative impact)*

Note: Text/characteristics in blue were only presented in Study 3.

Table 3. Study 1A & Study 3 – Likelihood of Risk Communication

Risk Communication
<p>Seeking information</p> <p>If you wanted to know more information about the safety of [product], please rate how likely you would be to consult the following sources.... <i>(Not at all likely to Extremely likely)</i></p> <ul style="list-style-type: none"> - Friends/peers/family - News media (TV/radio/newspaper/news websites) - Social media (Twitter/Facebook/Instagram/Mumsnet/YouTube etc) and user review websites - Retailer/Manufacturer websites - Government/Consumer group (e.g., Which?)
<p>Sharing information (a)</p> <p>If you heard about or experienced a safety issue concerning [product], please rate how likely you would be communicate this to the following.... <i>(Not at all likely to Extremely likely)</i></p> <ul style="list-style-type: none"> - Friends/peers/Family - Social media (Twitter/Facebook/Instagram/Mumsnet/YouTube etc)/User review websites

Sharing information (b)

If you experienced a safety issue concerning [product], please rate how likely you would be communicate this to the following.... *(Not at all likely to Extremely likely)*

- News media (TV/radio/newspaper/news websites); Retailer/Manufacturer websites; Government/Consumer group websites (e.g. Which?)

(These were presented as three separate sources in Study 3)

Note: Text/characteristics in blue were only presented in Study 3.

Table 4. General Risk Propensity Scale Items**General Risk Propensity Scale (Shortened)**

1. Taking risks makes life more fun
2. My friends would say that I'm a risk taker
3. I enjoy taking risks in most aspects of my life
4. I would take a risk even if it meant I might get hurt
5. Taking risks is an important part of my life
6. I commonly make risky decisions
7. I am a believer of taking chances
8. I am attracted, rather than scared, by risk

Table 5. Cultural Cognition Worldview Scale Items

Shortened Cultural Cognition Worldview Scale
<p>Group or Individualism-Communitarianism (reverse code “C” items)</p> <p>People in our society often disagree about how far to let individuals go in making decisions for themselves. How strongly you agree or disagree with each of these statements? [<i>strongly disagree, moderately disagree, slightly disagree, slightly agree, moderately agree, strongly agree</i>]</p> <ol style="list-style-type: none"> 1. IINTRSTS. The government interferes far too much in our everyday lives. 2. CHARM. Sometimes government needs to make laws that keep people from hurting themselves. 3. IPROTECT. It's not the government's business to try to protect people from themselves. 4. IPRIVACY. The government should stop telling people how to live their lives. 5. CPROTECT. The government should do more to advance society's goals, even if that means limiting the freedom and choices of individuals. 6. CLIMCHOI. Government should put limits on the choices individuals can make so they don't get in the way of what's good for society.
<p>Grid or Hierarchy-Egalitarianism (reverse code “E” items)</p> <p>People in our society often disagree about issues of equality and discrimination. How strongly you agree or disagree with each of these statements? [<i>strongly disagree, moderately disagree, slightly disagree, slightly agree, moderately agree, strongly agree</i>]</p> <ol style="list-style-type: none"> 1. HEQUAL. We have gone too far in pushing equal rights in this country. 2. EWEALTH. <i>Our society would be better off if the distribution of wealth was more equal.</i> 3. ERADEQ. <i>We need to dramatically reduce inequalities between the rich and the poor, white people and people of color, and men and women.</i> 4. EDISCRIM. <i>Discrimination against minorities is still a very serious problem in our society.</i> 5. HREVDIS2. It seems like black people, women, LGBTQ+ people and other groups don't want equal rights, they want special rights just for them. 6. HFEMININ. Society as a whole has become too soft and feminine.

Study 1B – Categorisation of Consumer Products

Participants

A sample of 382 participants were recruited from Prolific Academic (www.prolific.ac) and were paid £0.85 for the study, which took around 8-10 minutes to complete. Participants were excluded if their responses for any of the products had a SD < 0.5, leaving a final sample of 371 participants. For final sample characteristics, see

Table 1.

Questionnaire

The fifty-four products featured in Study 1A were included in the study, presented with the same short descriptive sentences. Participants were randomly presented with nine of the fifty-four products to rate. Each product was rated on a series of four characteristics, using a 0 to 100 slider. The complete list of characteristics and questions can be found in Table 6.

Table 6. Over-arching Product Categories

Category
<p>Product Age</p> <p>To what extent do you agree that the above is a: an old, established product (versus a new product)? (<i>Completely disagree the above is old to Completely agree the above is old</i>)</p>
<p>Main Purpose</p> <p>To what extent do you agree that the above is designed as a: leisure, recreation or personal care product (versus a household good, appliance or healthcare product)? (<i>Completely disagree the above is designed as a leisure, recreation or personal care product to Completely agree the above is designed as a leisure, recreation or personal care product</i>).</p>
<p>Power/Fuel</p> <p>Does the above product involve electricity, batteries, fire or chemicals? (<i>Does not involve electricity, batteries, fire or chemicals at all to Involves electricity, batteries, fire or chemicals</i>)</p>
<p>Vulnerable Groups</p> <p>To what extent do you agree that vulnerable groups (such as children or the elderly) use or interact with the above product more than other groups of people? (<i>Completely disagree vulnerable groups use or interact with the above more than other groups to Completely agree vulnerable groups use or interact with the above more than other groups</i>)</p>

Study 2 – Risk Perceptions in Context

Participants

A sample of 3360 participants (balanced across sex) were recruited from Prolific Academic. Participants were paid approximately £7 per hour. Participants were excluded for completing the studies unreasonably quickly (<3.5 minutes) or if their responses for any of the products had a SD < 0.5. For final sample characteristics, see Table 1.

Stimuli and Procedure

Six products (e-scooter, musical greetings card, USB charging plug/cable, magnetic construction toy, electric iron, carbon monoxide detector) were selected – equivalent to a high and low scoring product on each component (benefits, dread and responsibility) in Study 1A. Participants were presented with one of these products and asked to imagine that they were considering purchasing this product at a fictional retailer, either online or in a high street shop. After reading this product purchase

scenario, they rated the product on five characteristics, using a 7-point Likert scale, see Figure 3. On the next page (see Figure 4 for an example), they were informed that the product had caused harm (either as a result of non-compliance or the user's actions), with the harm encountered by an unknown other, or friend (for full details, see Appendix B), and asked to re-rate the product on the five characteristics. Following this, they gave responsibility judgements for each agent and indicate how likely they would be to communicate this risk to various sources (see Table 7). Participants finally completed the General Risk Propensity Scale – an eight-item scale of risk propensity (see Table 4), as well as a shortened, amended version of the Cultural Cognition Worldview Scale (see Table 5).

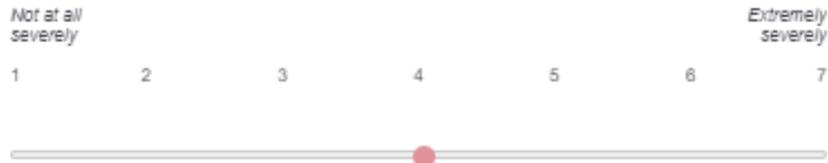
Figure 3. Study 2 – Initial Purchase Scenario (Carbon Monoxide Detector Shop Condition)

Imagine you are currently looking to purchase a carbon monoxide detector for yourself or a member of your household.

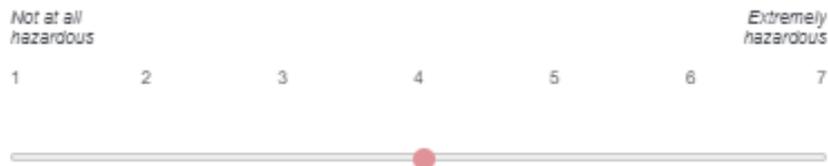
Whilst you are out shopping, you see the 'VULCAN Carbon Monoxide Detector' for sale at a reasonable price in Boyds, a shop on your local high street.

Given the above information, please answer the following questions:

How severely (i.e., degree, extent or magnitude) might you, or anyone else, be injured by the 'VULCAN Carbon Monoxide Detector'?



How hazardous do you consider the 'VULCAN Carbon Monoxide Detector' to be?



How great are the benefits associated with the 'VULCAN Carbon Monoxide Detector' to you personally?



If you were to buy the 'VULCAN Carbon Monoxide Detector', how likely would you be to use it?



How worried are you about potential risks associated with use of the 'VULCAN Carbon Monoxide Detector'?



Figure 4. Study 2 – Harm Information (Carbon Monoxide Detector Non-Compliance and Unknown Other Condition)

You decide to purchase the product.

However, having purchased the 'VULCAN Carbon Monoxide Detector', you subsequently see a media story about a consumer who owns the same product. They were inadvertently exposed to carbon monoxide for an excessive amount of time, and suffered carbon monoxide poisoning.

This story reports that the detector's batteries were low, such that it did not give an alarm promptly enough when exposed to low concentrations of carbon monoxide.

Table 7. Study 2 – Additional Post Harm Information Questions.

Additional Post Harm Information Questions
<i>Having now learned of the above risk(s) associated with the 'VULCAN Carbon Monoxide Detector', please answer the following questions:</i>
<p>Responsibility</p> <p>Please indicate the extent to which it was the responsibility of the following parties to protect the individual from harm associated with the Tour-X Electric Scooter:</p> <p><i>(0-100, Not at all their responsibility to Completely their responsibility)</i></p> <ul style="list-style-type: none"> - The product user - The retailer - The product manufacturer - The government regulator
<p>Communication of information</p> <p>Please rate how likely you would be communicate this risk information to the following: <i>(0-100, Not at all likely to Extremely likely)</i></p> <ul style="list-style-type: none"> - Friends/peers/family - Social media (Twitter/Facebook/Instagram/Mumsnet/YouTube etc)/User review websites - News media (TV/radio/newspaper/news websites) - Retailer - Product manufacturer - Government regulator - Consumer group (e.g. Which?)

Study 3 – Risk Perceptions for Personal Care and Cosmetic Products

Participants

We recruited 1502 adult UK nationals, living in the UK from Prolific Academic. Given the relatively high proportion of products featured in the study are specifically marketed at and/or predominantly used by females, we over-sampled females at a ratio of 3:1

(F:M). Additionally, given there were some products which are predominantly used by minority ethnic groups (e.g., skin lightening creams), we also oversampled from this group (~20% of the total sample). Participants were paid approximately £7.80 an hour. Participants were excluded for completing the study unreasonably quickly (< 720 seconds), or if their responses for any of the products had an SD of < 0.5, leaving a final sample of 1440. For final sample characteristics, see Table 1.

Questionnaire

We selected fifty-four personal care and cosmetic (PCC) products for inclusion in the study, for which there was little existing research and which had been identified by OPSS as particular priorities for research. As in Study 1A, each product was presented with a short descriptive sentence to provide context, though no mention of associated risks or benefits was made. The full list of products and descriptions can be found in Appendix C.

Before beginning the main task, participants were asked a series of demographic questions as well as how often they watched videos on cosmetics/personal care on social media as well as the importance of personal care products to their lives. Participants were randomly presented one of either: skin lightening cream or hair relaxer, and one of either: aftershave or aftershave balm, plus a random selection of seven of the remaining 50 products. Each product was rated on a series of 12 risk characteristics, using a 7-point Likert scale (see Table 2 for the complete list). On the next page, participants were presented with a list of sources and asked to rate the likelihood of seeking and sharing information about the safety of the product, measured on a scale from 'Not at all likely' to 'Extremely likely' (see Table 3). Participants were finally asked to give an overall hazard rating for each product ("How hazardous do you consider this product to be?" rated on a 7-point scale, from 'Not at all hazardous' to 'Extremely hazardous').

After rating all nine products, participants completed the General Risk Propensity Scale (see Table 4), as well as a shortened, amended version of the Cultural Cognition Worldview Scale (see Table 5).

Computational Model

The model we developed simulates the process by which risk perception of a consumer item culturally evolves. In each epoch (intended to correspond to a time period of one week), individuals in turn weigh up their current assessment of risk associated with the item, decide whether to acquire or get rid of the item, decide whether to use the item if they own it (and if so, acquire direct experience of the item), and decide whether to communicate about the item to peers in their social network (and if so, share their current assessment of the item). Models were run for 250 epochs, intended to correspond to approximately five years.

Individuals communicate within a social network that follows a power-law structure (using the Barabesi-Albert model). They possess a memory of the item based on discrete "events", each of which is characterised by an impression of dread, benefits and responsibility (following our empirical work in Studies 1A, 2 and 3). An event might be either a direct experience with the item, or a social interaction with a peer, or a news event (which could correspond to hearing about the item in a broadcast news piece, or reading a product recall notice). Memories of events have a salience or "closeness", such that direct experiences are perceived as closer than social experience, and social experience is perceived as closer than news experience. The information in an individual's memory is then integrated in order to make decisions about whether to acquire [get rid of] an item (if overall perceived benefits are clearly

larger [smaller] than dread) or to communicate about an item (if either benefits or dread are notably high).

Here we report the results from one example scenario, in which a new product entered the market with no-one in the population ($n= 10,000$) owning the product. This product was conceived of as a new household product, which had a 50% probability of being used within one epoch. An initial extremely positive event was generated at the 20th epoch, but then at epoch 100, an extremely negative event (associated with high dread levels) was generated. The trajectories of item ownership, dread, benefits and responsibility throughout the population were tracked and compared. By varying parameters related to social structure, communication and individual biases in cognition, we can examine how the results acquired in our empirical studies will shape societal patterns. Here, we present results for a model in which the population talked to each other a lot about the product (average of 38 social interactions per agent) versus a model where the population talked far less (average of 0.8 social interactions per agent).

Supplementary Materials 2: Detailed Summary of Findings

Latent Dimensions of Product Risk Perceptions

In Study 1A, we found that the public's risk perceptions are underpinned by three dimensions – 'benefits', 'dread' and 'responsibility', which explained 93.1% of the variance in perceptions. We termed the first dimension 'benefits', which consisted of 'benefits' (very great benefits), 'familiarity' (extremely familiar), 'likelihood of use' (very frequently) and 'usefulness' (extremely useful). The second dimension, labelled 'dread', consisted of 'severity' (extremely severe), likelihood of injury (extremely likely), 'worry' (extremely worried) and 'known to those at risk' (known precisely). The final dimension we termed 'responsibility', comprising of 'responsibility for protection' (responsibility of external parties), 'blame' (fault of external parties) and 'control' (no control at all).

We found a similar solution in Study 3, reflecting benefit, dread and individual responsibility dimensions, which explained 88.8% of the variance in perceptions of PCC products. The only difference to Study 1A was that 'known to those at risk' instead loaded on responsibility dimension and the newly added characteristic 'negative impact on environment' (extremely high negative impact) loaded on the dread dimension.

Predictors of Risk Perceptions

Having identified the three latent dimensions underlying risk perceptions in **Study 1A and Study 3**, we used structural equation modelling (SEM) to investigate which factors predicted these dimension scores. As well as including the individual difference measures, in Study 1A analysis, we also included four additional overarching product categories to the model: product age, main purpose, power/fuel and vulnerable groups, the categorisation of which was validated in Study 1B.

Study 1A

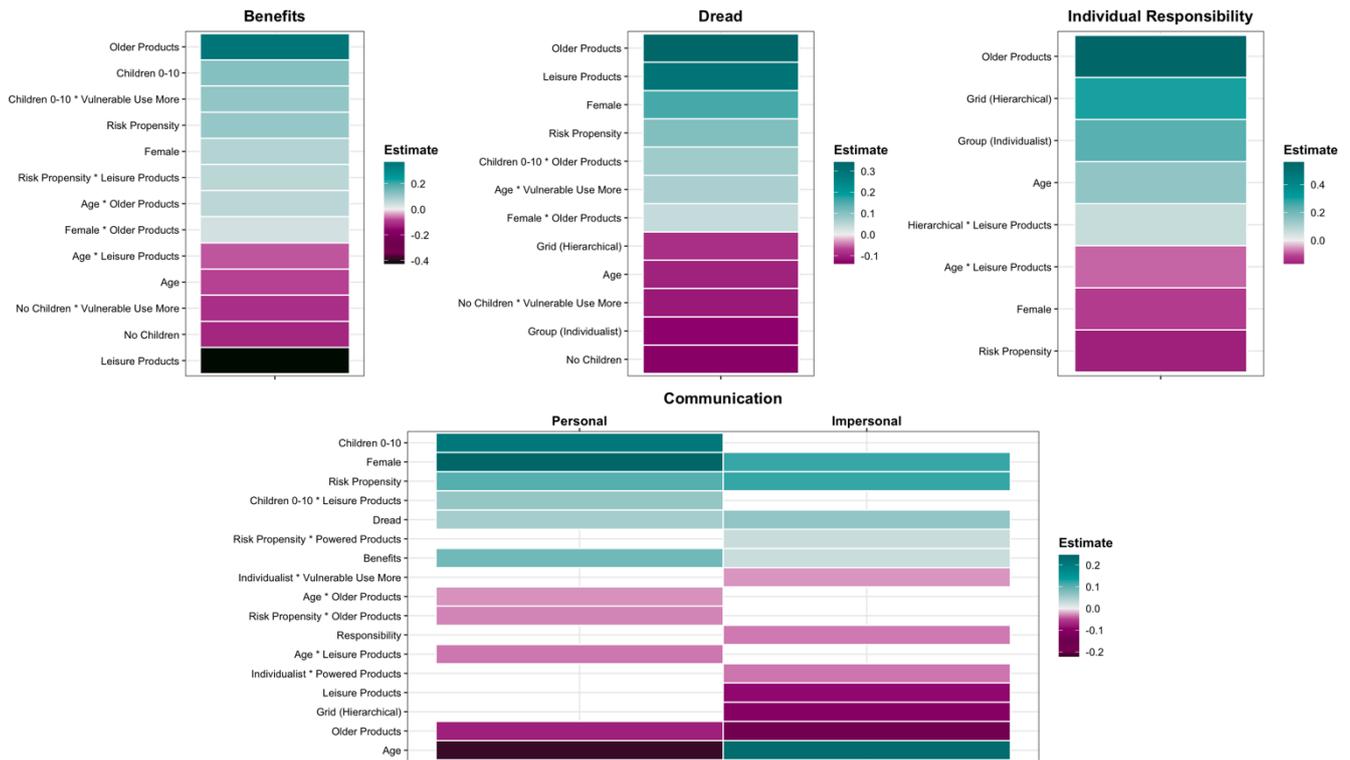
Differences in perceived benefits were primarily driven by individual differences, with demographics and personality (risk propensity) influencing levels of benefits (for an overview, see Figure 5). With regards to contextual factors (product category), only product age and main purpose categories consistently predicted perceived benefits, most often as part of interactions with individual differences.

Differences in perceived dread were predicted both by individual differences (demographics, risk propensity and cultural worldview) and product category membership. Characteristics such as being female, young, a parent of children under 10, having a high risk propensity or having a communitarian or egalitarian worldview were associated with higher dread levels. Similar to benefits, only product age and main purpose consistently predicted dread, with products which were either old or leisure products more dreaded than newer or household products.

Differences in perceived responsibility (of individual versus external parties) were primarily driven by individual differences (age, gender, risk propensity and cultural worldview). Characteristics such as being female, younger, a parent of children under 10, having an individualist or hierarchical worldview were associated with increased levels of perceived responsibility for external parties. The effect of

product category was seen less, though older products were perceived as more of the responsibility of individual parties versus newer products.

Figure 5. Clear ($\neq 0$) predictors of consumer risk perceptions – Study 1A. Estimates were derived from SEM, comprised of five models: Benefits, Dread, Responsibility, Communication – Personal/Impersonal \sim (Grid Worldview + Group Worldview + Risk Propensity + Age + Gender + Children) * (Product Age + Main Purpose + Power/Fuel + Vulnerable Groups) + (1+ Product Age + Main Purpose + Power/Fuel + Vulnerable Groups|ID) + (1|Product).



Note: Higher estimates indicate high benefits, high dread, high individual responsibility and high likelihood of communicating risk information (both seeking and sharing).

Study 3

Given the number of products included in the study, we present the results relating to product level effects (and associated interactions) for four exemplar products, for ease and clarity. These products were selected to be representative across the benefits and dread space: *aerosol antiperspirant* (high benefits, high dread); *toothpaste* (high benefits, low dread); *hair skin lightening cream* (low benefits, high dread) and *hair gel* (low benefits, low dread).

Both product differences and individual differences contributed to differences in perceived benefits and perceived dread. For instance, age, gender, ethnicity, risk propensity and cultural worldview influenced level of benefits (for an overview, see Figure 6). In addition, the more frequently one watched videos on personal care/cosmetics on social media (hereafter ‘social media frequency’) and the more important PCC products were to one’s daily routine, the greater the benefits perceived. Gender, ethnicity and risk propensity influenced levels of perceived dread, with similar results to Study 1A. Similarly, differences in perceived responsibility were predominantly driven by individual differences (demographics, cultural worldview and social media frequency).

The effect of context – Study 2

Risk perceptions in **Study 1A and 3** were measured in the absence of any contextual information – participants were given only the name of a product and a brief description, and then asked to rate them. In **Study 2**, we presented participants with richer product purchase scenarios, featuring more contextual information relating to: *where the product was bought from* (online versus bricks and mortar store), *the cause of the harm* (arising from product non-compliance versus the user’s actions), and *who experienced the harm* (friend [known] versus unknown other).

Here, we used structural equation modelling to investigate which factors predicted dread and benefit scores for each time point (Time 1 – initial perception, Time 2 – perception post-harm information). As expected, there was a strong effect of time, with increased dread and decreased benefits at Time 2.

Individual differences (demographics [age, gender, parental status] and risk propensity) did predict overall perceived benefits, though largely as part of interactions with time (for an overview, see Figure 7). Similarly, there were consistent interactions between the contextual factors (place of purchase, cause of harm, who experienced harm) and time, with reduced benefits at Time 2 when the product was bought online, harm caused by non-compliance, or a friend experienced the harm. There was also a clear effect of product.

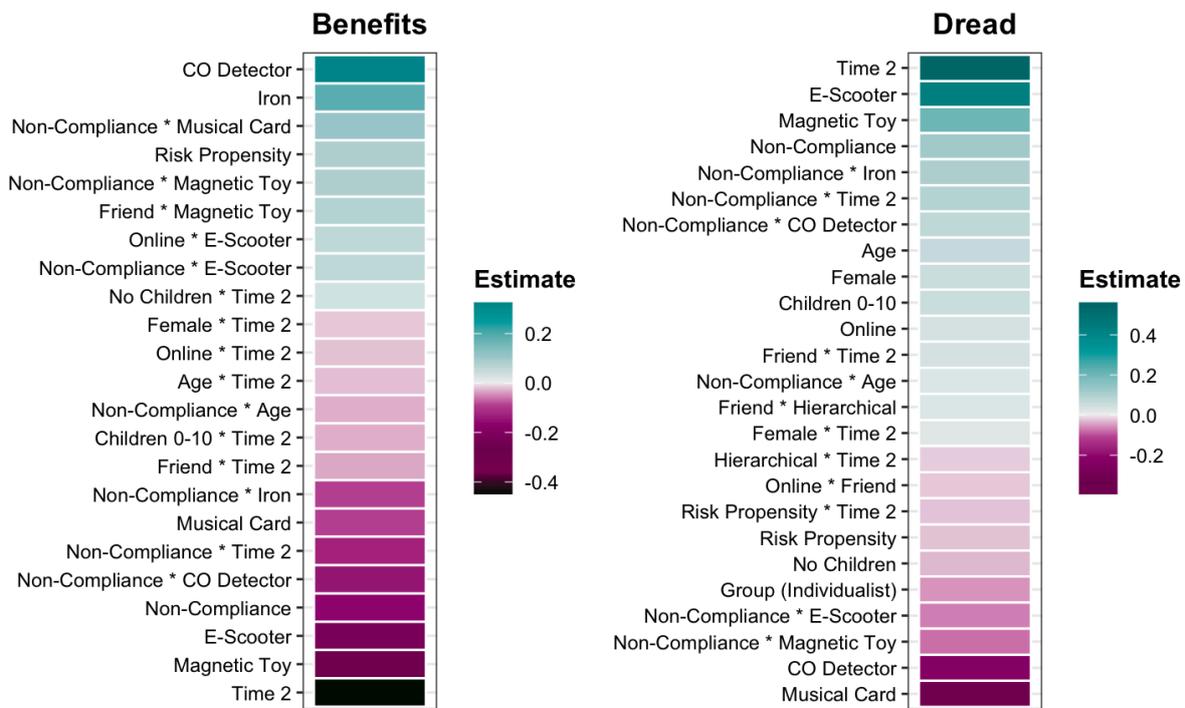
Differences in perceived dread were predicted by individual differences (demographics, risk propensity and cultural worldview), with similar findings to Study 1A. Contextual factors also predicted dread levels, with higher dread levels for products bought online, harm caused by non-compliance and if a friend experienced the harm. As seen for benefits, the specific product also influenced dread levels.

Figure 6. Clear ($\neq 0$) Predictors of Risk Perceptions and Communication – Study 3. The final models specified were: Benefits, Dread, Responsibility \sim Product Final * (Gender + Ethnicity) + (Age + Children + Grid Worldview + Group Worldview + Risk Propensity + Personal Care Social Media Frequency + Personal Care Importance) + (1|ID); Communication – Personal/Impersonal \sim Product Final * (Gender + Ethnicity) + (Age + Children + Grid Worldview + Group Worldview + Risk Propensity + Personal Care Social Media Frequency + Personal Care Importance) + (Benefits + Dread + Responsibility) + (1|ID).



Note: Higher estimates indicate high benefits, high dread, high individual responsibility and high likelihood of risk communication (both seeking and sharing).

Figure 7. Clear ($\neq 0$) predictors of overall risk perceptions – Study 2. Estimates were derived from the model: $\text{Dread, Benefits} \sim ((\text{Product} + \text{Place of Purchase} + \text{Harm Cause} + \text{Harm Experience})^2) + \text{Time} + (\text{Time} * \text{Harm Cause}) + (\text{Time} * \text{Harm Experience}) + (\text{Place of Purchase} * \text{Harm Cause} * \text{Time}) + (\text{Place of Purchase} * \text{Harm Experience} * \text{Time}) + (\text{Age} + \text{Gender} + \text{Children} + \text{Risk Propensity} + \text{Grid Worldview} + \text{Group Worldview}) * (\text{Place of Purchase} + \text{Harm Cause} + \text{Harm Experience} + \text{Time}) + (1||\text{ID})$.



Note: Higher estimates indicate higher dread and benefits.

Risk Tolerance and Risk Intensity

Whether an individual decides to take a risk or not is only partially a function of level of perceived risk. Overlooked in the psychological risk literature is the question of *how* individuals decide what an acceptable level of perceived risk is, that is, an individual's *risk tolerance*. We conceptualised this as the trade-off between perceived benefits and perceived dread – essentially, do individuals decide to use a product, even if they perceive a risk? In Study 1A and 3, risk tolerance was operationalised as the benefits dimension score [B] minus the dread dimension [D] score. In Study 2, the benefits dimension comprised of 'benefits + likelihood of use' and the dread dimension comprised of 'worry + severity + hazardousness', which were summed. High values indicate high risk tolerance (high levels of perceived dread, but still high benefits). We also created a related measure: 'perceived risk intensity', which was calculated as dread plus benefits. Here, high values indicate high perceived risk intensity, which could be either positive (low levels of dread and high levels of benefits) or negative (high levels of dread and low levels of benefits).

In Study 1A, perceived risk intensity was primarily predicted by individual differences, with only a small influence of product category. In contrast, risk tolerance was largely predicted by interactions between individual differences and product category. Results from Study 3 were slightly different for risk intensity, with it predicted

by both individual and product differences. However, similar to Study 1A, perceived risk tolerance was predicted by interactions between individual differences and specific product. Notably, higher social media frequency and greater importance of PCC products were associated with lower (higher) risk intensity (tolerance).

In Study 2, risk tolerance and intensity were captured at two time points (both pre and post presentation of the harm information). As expected, risk tolerance was reduced and perceived risk intensity greater at Time 2. Contextual and individual factors influenced change in risk tolerance. Older adults and parents of children under 10 showed reduced risk tolerance at Time 2. With regards to contextual factors, participants showed reduced tolerance for products purchased online and for those which turned out to be non-compliant, and when harm occurred to a friend. Changes in perceived risk intensity were predicted by both contextual and individual factors. Intensity varied by product, and females perceived greater levels of risk intensity overall. At Time 2, individuals perceived lower levels of risk intensity for products purchased online.

Likelihood of Risk Communication

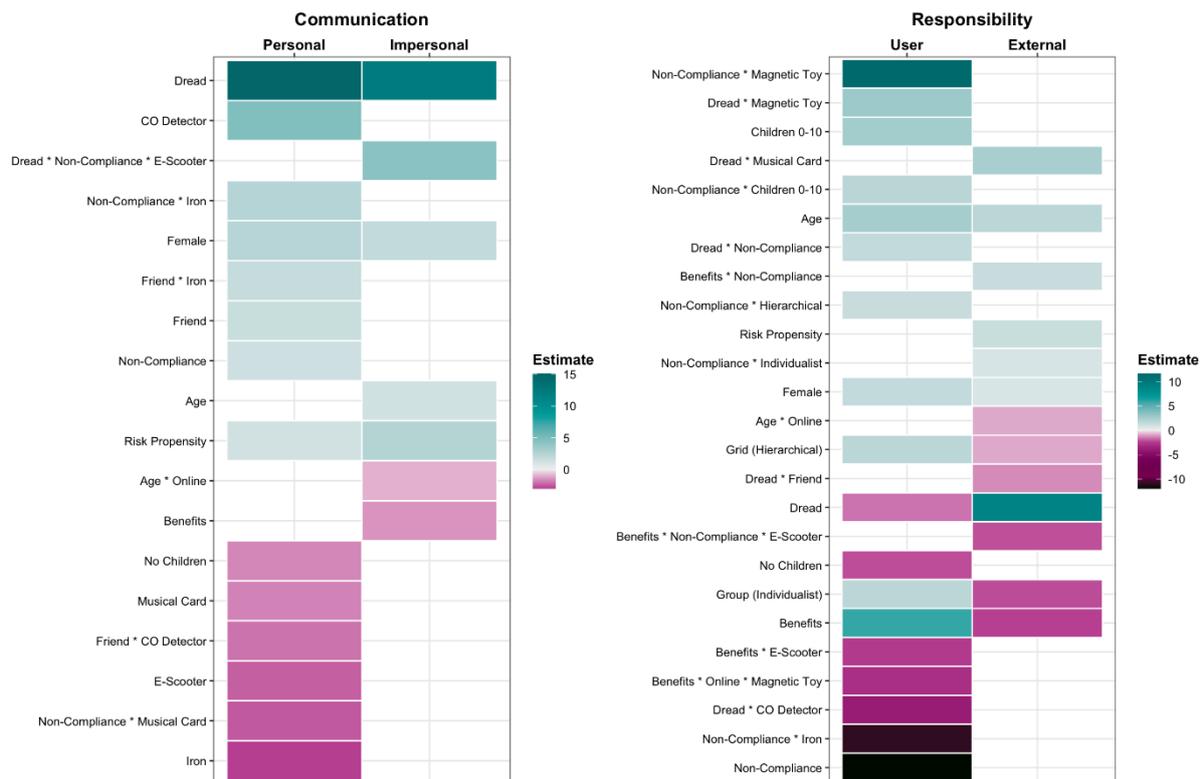
In Study 1A, we used SEM to investigate whether the identified three dimensions of risk, individual and product characteristics predicted likelihood of both seeking and sharing risk information to personal and impersonal sources¹. High benefit and dread levels consistently predicted increased likelihood of communication (see Figure 5). Differences in communication were largely driven by individual differences, namely age, gender and risk propensity. Contextual factors (product category membership) were far less influential, with effects mostly seen as part of interactions with individual factors. In Study 3, benefits and dread consistently predicted likelihood of communication, though in different directions for personal or impersonal sources (see Figure 6). Here, individual differences were far more predictive of risk communication likelihood compared to product differences, particularly for impersonal communication.

In Study 2, we only measured risk communication after presentation of the harm information. We thus performed SEM to predict (a) dread and benefit scores at Time 2, (b) personal and impersonal communication scores and (c) responsibility attributions to external parties and the user. High dread levels predicted increased likelihood of communication (see Figure 8). Individual differences, namely age, gender and risk propensity were also predictive of communication. There was some influence of contextual factors (place of purchase, cause of harm), though much of these effects related to the specific product in question.

Finally, both dread and benefits predicted attributions of responsibility (see Figure 8). Individual differences also consistently predicted attributions of responsibility, particularly for user responsibility. Of the contextual factors, cause of harm consistently predicted attributions, with clear differences by product.

¹ Risk communication was operationalised as two variables: personal (averaging seeking/sharing information responses across 'friends/peers/family' and 'social media/user review websites') and impersonal (averaging responses across 'news media', 'retailer', 'product manufacturer', 'government regulator' and 'consumer group').

Figure 8. Clear ($\neq 0$) predictors of Communication and Responsibility Attributions – Study 2. Estimates were derived from the final model specifications: Dread, Benefits $\sim ((\text{Product} + \text{Place of Purchase} + \text{Harm Cause} + \text{Harm Experience})^2) + (\text{Age} + \text{Gender} + \text{Children} + \text{Risk Propensity} + \text{Grid Worldview} + \text{Group Worldview}) * (\text{Place of Purchase} + \text{Harm Cause} + \text{Harm Experience})$. Communication – Personal/Impersonal, Responsibility – User/External $\sim ((\text{Product} + \text{Place of Purchase} + \text{Harm Cause} + \text{Harm Experience})^2) + (\text{Dread} + \text{Benefits}) + (\text{Age} + \text{Gender} + \text{Children} + \text{Risk Propensity} + \text{Grid Worldview} + \text{Group Worldview}) * (\text{Place of Purchase} + \text{Harm Cause} + \text{Harm Experience})$



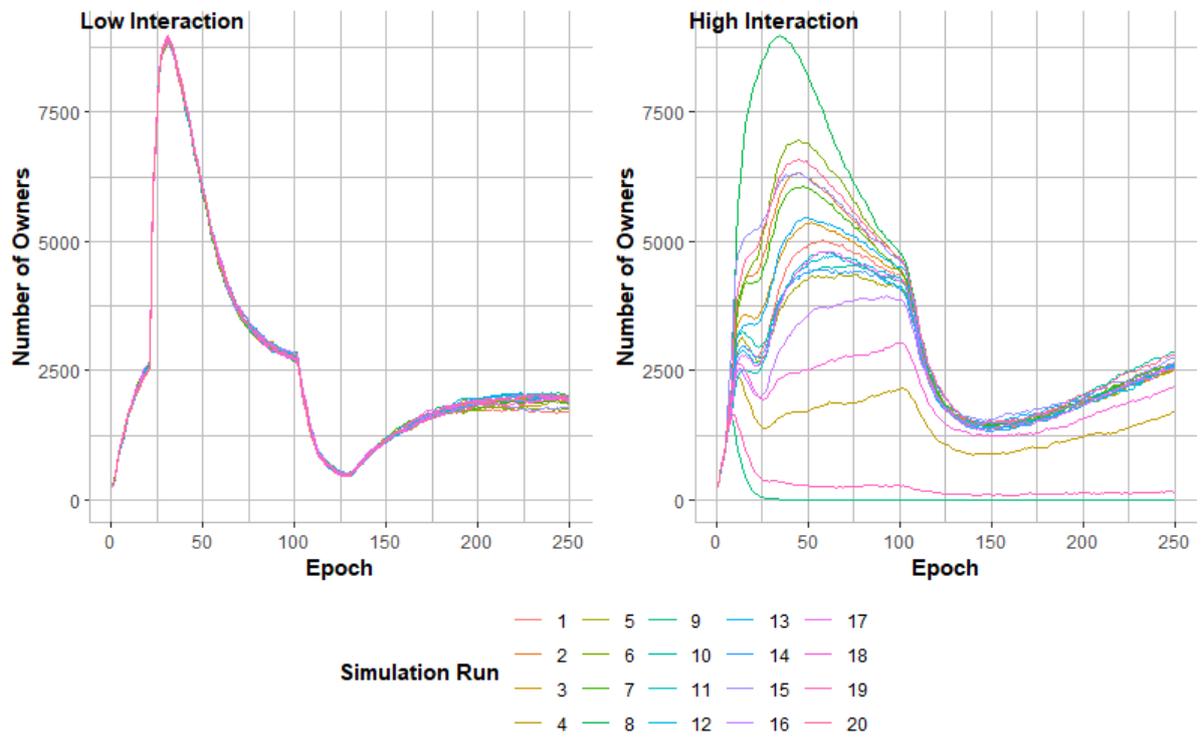
Note: Higher estimates indicate increased likelihood of communicating risk information and increased responsibility.

Modelling

We conducted 20 simulation runs for each model. Overall, we consistently found far more variation between simulation runs in the model where there were far higher levels of interactions between agents. This pattern of variation was found this across all types of outcome measures.

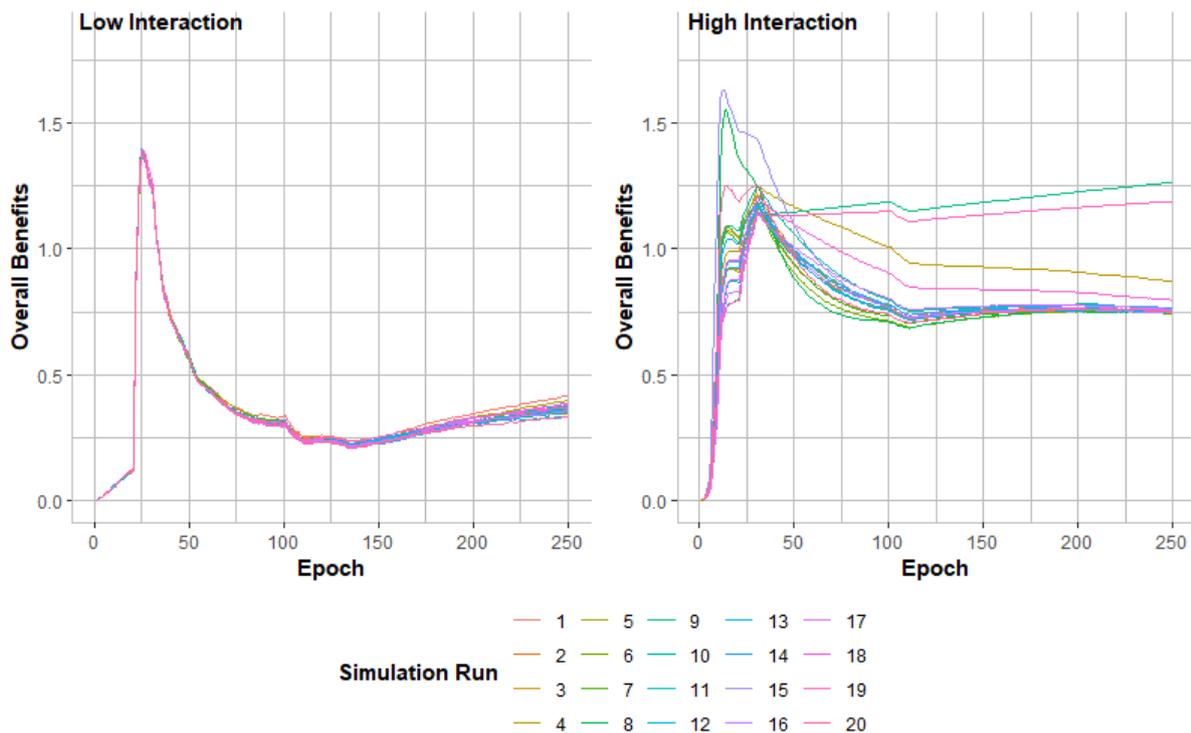
In both models, the occurrence of the positive event at epoch 20 led to increased product ownership, though consistently higher levels of ownership were observed in the low interaction model, with far more variation in overall ownership in the high social interaction model (see Figure 9). When the extremely negative event occurred at epoch 100, product ownership decreased, before increasing slightly again over time.

Figure 9. Comparison Of Overall Product Ownership Levels Between A Model With Low Levels Of Social Interactions And A Model With High Levels.



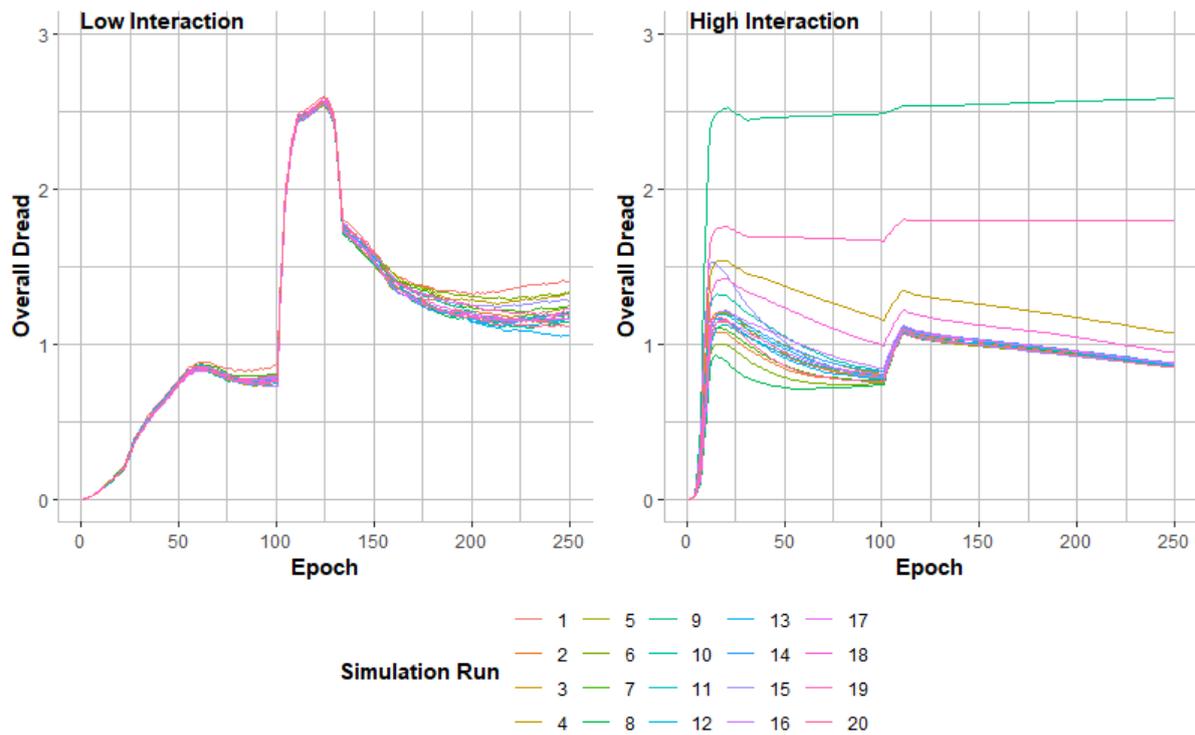
As to be expected, the occurrence of the positive event at epoch 20 had a positive effect on overall benefit perceptions, though the extent to which these were sustained over time varied by model (see Figure 10). Over time, prior to the negative event, benefit perceptions decreased to far lower levels in the model where there was less social interaction. In both models, benefit levels only decreased very slightly in response to the negative event occurring at epoch 100.

Figure 10. Comparison of Overall Perceived Benefit Levels Between a Model With Low Levels Of Social Interactions and a Model With High Levels.



Differences between the two models were most pronounced when considering overall dread levels (see Figure 11). In the high interaction model, far higher dread levels were observed at the beginning of the simulation. The positive event at epoch 20 had relatively little discernible effect on overall dread levels in either model. Dread levels increased far more dramatically in response to the negative event at epoch 100 in the low interaction model.

Figure 11. Comparison Of Overall Perceived Dread Levels Between a Model With Low Levels Of Social Interactions and a Model With High Levels.



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Appendix A. Study 1 - Products and Associated Descriptions.

See next page.

Note, products in blue were selected for Study 2.

Products

Arcing lighter

A flameless, battery powered electronic lighter, which produces heat using a small arc of high-voltage electrical current.

At home teeth whiteners

Teeth whitening done at home by the individual, using a kit to bleach teeth to make them lighter.

Baby car seat

A rearward-facing portable seat, secured to a car seat, with straps to buckle a baby in, used to transport babies between birth and 15 months.

Balcony BBQ

Used on a balcony or roof terrace, a grill for cooking food outdoors, using either gas or hot coals.

Bicycle (non-electric)

A human powered device, consisting of two wheels attached to a frame, handlebars, a saddle and pedals, used for personal transport.

Blind with looped cords

A window covering used for blocking light, which is operated using a pull-cord or chain.

Button battery

A small, single cell battery which is round and flat, typically used in watches, toys, hearing aids, car keys and other small devices.

Carbon monoxide detector

Devices which monitor and measure levels of carbon monoxide in the air, sounding an alarm if it detects the presence of carbon monoxide.

CBD health products

CBD (cannabidiol) is a chemical found within hemp and cannabis. CBD health products include nutritional supplements and cosmetic products (e.g., moisturisers, shampoo), used for health and beauty purposes.

Children's clothing with cords and drawstrings

Items of children's clothing (up to age 14) which contain cords or drawstrings to adjust or fasten something. Examples include those used in sweatshirt hoods, shorts and halter-necks.

Children's fancy dress

Costumes specifically designed for children to dress up in, often made from polyester and/or nylon.

Christmas tree lights

Lights used to decorate Christmas trees, which are powered by battery or mains electricity.

Dishwasher

An electrical appliance used to clean dishware and cutlery automatically, using hot water.

E-cigarettes

An electronic, battery powered device which is used to simulate the experience of smoking by heating a liquid into a vaporised solution, which the user inhales and exhales. This solution typically contains nicotine, flavourings and other chemicals.

Electric iron

An electrical appliance, which uses heat to press folds out of clothes.

Electric kettle

An electrical appliance, which uses a heating element to boil water.

Electric pool heater for paddling pools

A heating tank which brings cold water in and pumps warm water back into the pool, powered by electricity and used in paddling pools.

Electric scooter

A device consisting of two or three wheels, handlebars and a floorboard which is stood on while riding, powered by an electric motor. Used for personal transport.

Fireplace surround

An object which sticks out from the outer wall of a fireplace and surrounds the fireplace opening, typically made up of the sides and mantel.

Fireworks (personal use)

Low explosive pyrotechnic devices, which may be used for aesthetics, entertainment purposes and/or religious celebrations/ceremonies at one's home.

Fridge/freezer

An electrical appliance which comprises of a self-contained refrigerator and freezer, artificially kept cool to store food and drink.

Hair clippers

An electric tool used to cut human hair, featuring a motor, blade and guards, the latter of which attaches to the top of the blade. Guard size dictates how much hair is cut off.

Hair straighteners

An electric tool featuring two heated metal or ceramic plates, which are guided through the hair to straighten it.

Hair dye

Chemicals which are used to change the colour of human hair, either temporarily or permanently.

Hand sanitiser

A liquid or gel, typically containing alcohol and applied to the hands to kill viruses and bacteria.

Inclined baby sleeper

A freestanding, portable product with an inclined sleep surface, allowing babies to sleep at an angle between 10 and 30 degrees. These are sometimes called loungers, rockers or nappers.

Ladder

A piece of equipment used to reach high places, consisting of two long pieces of wood or metal, joined together by horizontal rungs.

Laser pointer

A small, pen-like device which uses a power source (typically a battery) and diode laser to produce an intense beam of visible, monochromatic light, usually to highlight a point of interest.

Laundry detergent

A cleaning agent used for washing dirty laundry, which comes in either powder or liquid form.

Microwave oven

An electric oven which uses high-frequency electromagnetic waves to cook food.

Musical greeting card

A greetings card which plays music when it is opened. Such cards typically contain a small device embedded in the card, powered by a small button battery.

Neodymium magnets in construction toys

Super strong, small spherical magnets, which can be separated and put together into various shapes and patterns.

Outdoor trampoline (personal use)

A piece of equipment consisting of a piece of taut, strong fabric stretched between a frame using coiled springs, which is jumped upon. Refers to those used at one's home for exercise or recreation.

Oven

An appliance for cooking food using heat.

Pikler triangle climbing frame

A wooden indoor climbing structure for babies and toddlers, designed to encourage the practise of motor development skills.

Power hedge trimmer

A gardening tool, consisting of a motor powered by gas, electricity or battery and a long, toothed blade, used to cut hedges and bushes.

Power mower

A motor driven lawn mower which is powered by gas or electric and used to cut grass.

Printer cartridge

A cartridge containing liquid ink which is inserted into an inkjet printer and used for printing.

Recliner chair

An armchair or sofa which has an adjustable back and footrest to allow the sitter to recline in it, either using a manual or electrical mechanism.

Rug

A floor covering, typically used for decorative purposes, consisting of a piece of thick, shaped fabric, not extending over the entire floor.

Scatter cushion

A small cushion, typically used for decorative purposes, consisting of a cover and a filling. Some scatter cushions have a removable cover and insert, accessed through a zipped or buttoned opening.

Smart doorbell

An internet-connected doorbell linked to a smartphone or electronic device which notifies the owner when a visitor arrives at the door.

Smart light bulb converter

A connector for changing a light bulb into a smart bulb, which can be linked to a smartphone or electronic device for remote operation.

Sparklers

A type of hand-held firework used for entertainment, made from a metal wire which is coated at the end with a flammable substance which, when lit, emits sparks as it burns.

Above ground swimming pool

A freestanding water retaining structure which sits on top of the ground, used for leisure and exercise purposes.

Talc-based cosmetic products

Talcum powder is a naturally occurring mineral, mined from the earth and used as an ingredient in many cosmetic products, such as make-up and baby powder.

Travel adaptor

A connector which changes the plug shape to match the electrical outlet. This allows use of equipment which cannot be directly inserted into the standard plug.

Treadmill

An exercise machine, consisting of a continuous moving belt used to walk or run on.

Tumble dryer

An electrical appliance which dries wet laundry using warm air.

USB charging plug/cable (purchased separately)

USB wall charging plugs or cables, purchased separately from the device they are intended to power/charge.

UV light sanitising wand

A handheld device containing lights which emit ultra-violet rays to kill/inactivate viruses and bacteria.

Virtual reality headset

A head-mounted device which covers the eyes and allows the user to interact with simulated environments.

Washing machine

An electrical appliance used to wash laundry using water and detergent.

Weedkiller (herbicide)

A chemical substance, used to kill or inhibit the growth of unwanted plants.

Appendix B. Study 2 - Products, Associated Descriptions and Risks

Product	Experience - Unknown Other (You decide to purchase the product. However, having purchased the PRODUCT, you subsequently see a media story about a consumer)		Experience - Friend (You decide to purchase the product. However, having purchased the PRODUCT...)	
	Non-Compliance	User Related	Non-Compliance	User Related
<p style="text-align: center;">TOUR-X Electric scooter (high dread)</p> <p>A device consisting of two or three wheels, handlebars and a floorboard which is stood on while riding, powered by an electric motor. Typically used for personal transport.</p>	<p>...who owns the same scooter but crashed on it, and suffered injuries after being unable to stop due to high speed.</p> <p>This story reports that the product does not meet the requirements of the Supply of Machinery Regulations 2008. The scooter goes over the maximum speed requirement due to the speed not being limited.</p>	<p>This story reports that the rider was exceeding the maximum speed limit.</p>	<p>... your friend tells you that they own the same scooter but crashed on it, and suffered injuries after being unable to stop due to high speed.</p> <p>Your friend subsequently found out that the product does not meet the requirements of the Supply of Machinery Regulations 2008. The scooter goes over the maximum speed requirement due to the speed not being limited.</p>	<p>Your friend tells you that they were exceeding the maximum speed limit.</p>

GREETIZE
Musical greetings card
(low dread)

A greetings card which plays music when it is opened. Such cards typically contain a small device embedded in the card, powered by one or more small button batteries.

...who bought the same musical greetings card, and their child placed the button cell batteries in their mouth and swallowed, causing damage to the gastrointestinal tract.

This story reports that the product does not meet the requirements of the Toys (Safety) Regulations 2011. According to regulations, the product makes the batteries too easy for children to access from their compartment.

This story reports that it is possible for children to be able to access the batteries from their compartment.

...you find out that a friend bought the same musical greetings card, and their child placed the button cell batteries in their mouth and swallowed, causing damage to the gastrointestinal tract.

Your friend subsequently found out that the product does not meet the requirements of the Toys (Safety) Regulations 2011. According to regulations, the product makes the batteries too easy for children to access from their compartment.

Your friend tells you that it is possible for children to be able to access the batteries from their compartment.

PLUG'D
USB wall charging plug and cable
(high benefits)

USB wall charging plug and cable, purchased separately from the device they are intended to power/charge.

...Who owns the same product, and suffered burns from a fire started by the wall charging plug.

This story reports that the product does not meet the requirements of the Plugs and Sockets etc. (Safety) Regulations 1994 –

This story reports that the plug socket was overloaded and the charger was left plugged in for a long period of time.

...Your friend tells you that they also own the same product, and suffered burns from a fire started by the wall charging plug.

Your friend subsequently found out that the product does not meet the requirements of the Plugs and Sockets etc. (Safety) Regulations 1994 – the

Your friend tells you that the plug socket was overloaded and the charger was left plugged in for a long period of time.

the plug does not incorporate a suitable protective fuse.

plug does not incorporate a suitable protective fuse.

**MAGNE-BUILD
Magnetic Construction
Toy**

(low benefits)

A toy made from neodymium magnets which are small, super strong, spherical magnets. These magnets can be separated and put together into various shapes and patterns.

...who owns the same construction toy. Their young child placed the magnets in their mouth and swallowed, causing internal injuries.

This story reports that the product does not meet the requirements of the Toys (Safety) Regulations 2011. The magnetic flux (strength of the magnet) is far greater than the legal maximum.

This story reports that the child's internal injuries were caused by the magnets being drawn together in their digestive system.

You find out that a friend owns the same construction toy. Their child placed the magnets in their mouth and swallowed, causing internal injuries.

Your friend subsequently found out the product does not meet the requirements of the Toys (Safety) Regulations 2011. The magnetic flux (strength of the magnet) is far greater than the legal maximum.

Your friend tells you that their child's internal injuries were caused by the magnets being drawn together in their digestive system.

**THERMA-STEAM -
Electric iron**

...Who owns the same product and suffered second-degree burns from the iron.

...Your friend tells you that they also own the same product and suffered second-degree burns from the iron.

(high individual responsibility)

An electrical appliance, which uses heat to press folds out of clothes.

This story reports that this product does not comply with the relevant European Standard EN 60335. The plastic part of the iron can overheat.

This story reports that the burns were caused by mishandling of the iron.

Your friend subsequently found out that the product does not comply with the relevant European Standard EN 60335. The plastic part of the iron can overheat.

Your friend tells you that the burns were caused by mishandling of the iron.

VULCAN - Carbon monoxide detector

(low individual responsibility)

A device which monitors and measures levels of carbon monoxide in the air, sounding an alarm if it detects the presence of carbon monoxide.

...Who owns the same product. They were inadvertently exposed to carbon monoxide for an excessive amount of time, and suffered carbon monoxide poisoning.

...Your friend tells you that they also own the same product. They were inadvertently exposed to carbon monoxide for an excessive amount of time, and suffered carbon monoxide poisoning.

This story reports that the product does not comply with the European Standard EN50291. The carbon monoxide detector does not give an alarm promptly enough when exposed to low concentrations of carbon monoxide.

This story reports that the detector's batteries were low, such that it did not give an alarm promptly enough when exposed to low concentrations of carbon monoxide.

Your friend subsequently found out that the product does not comply with the European Standard EN50291. The carbon monoxide detector does not give an alarm promptly enough when exposed to low concentrations of carbon monoxide.

Your friend tells you that the detector's batteries were low, such that it did not give an alarm promptly enough when exposed to low concentrations of carbon monoxide.

Appendix C. Study 3 - Products and Associated Descriptions.

Product

UV-cure gel nail polish

A liquid used to paint fingernails and toenails, which is applied similarly to traditional nail varnish, but does not dry. It is cured under an ultraviolet lamp.

Nail polish

A liquid used to paint fingernails and toenails.

Nail polish remover

A solvent-based substance, used to remove nail polish.

Mascara

A cosmetic used to darken, lengthen, curl, colour and/or thicken the eyelashes, applied with a brush.

Eyeliners

A cosmetic used around the eyes to define them, which comes in liquid or pencil form.

Eyelash growth serum

A serum applied to the eyelashes, used to thicken and lengthen lashes by prolonging the growth and increasing the number of eyelashes.

Permanent hair dye (at home)

Hair dye applied at home by the individual, which changes hair colour and hair structure. Lasts for around 6-8 weeks.

Demi-permanent hair dye (at home)

Hair dye applied at home by the individual, which changes hair colour. Lasts for around 15-30 washes.

Temporary hair dye (at home)

Wash-out colour, applied at home by the individual. Comes in various forms including rinses, shampoos, gels, sprays, and foams.

Facial moisturiser

A cream or lotion, applied to the face/neck to help hydrate and restore moisture to the skin.

Hand cream

A cream applied to the hands to help moisturise and protect the skin.

Body lotion

A lotion applied to the skin to help smooth, moisturise and/or perfume the skin.

Anti-ageing facial cream

A moisturiser-based cream, applied to the face/neck to help reduce, mask or prevent the signs of ageing (e.g., wrinkles, sagging, redness).

BB cream

Short for 'blemish balm' or 'beauty balm'. A multi-purpose cream applied to the face, to help moisturise, protect and cover skin blemishes.

Wrinkle filler

A cream applied to the face/neck to smooth wrinkles and make them less noticeable.

Make-up remover

A substance applied to the face, used to remove make-up.

Solid soap

A cleansing agent in a bar shape, used with water for washing and cleaning.

Liquid soap

A cleansing agent in liquid form, used with water for washing and cleaning.

Antibacterial soap

A cleansing agent that can kill bacteria, used with water for washing and cleaning.

Shampoo

A hair care product, typically in liquid form, used for cleaning hair.

Conditioner

A hair care product, typically in liquid form, used to moisturise, improve the texture, appearance or manageability of hair.

2-in-1 shampoo-conditioner

A hair care product, typically in liquid form, used to clean and moisturise hair,

Aerosol antiperspirant

A type of deodorant, applied with a spray to the armpits, which prevents sweating.

Roll on antiperspirant

A type of deodorant, applied with a ball-type applicator to the armpits, which prevents sweating.

Hair gels

A thick liquid substance, used to keep the hair in a particular shape or style.

Hair chalk

A temporary (wash-out) colourant applied to the hair to change its colour.

Dry shampoo

A shampoo in powder form, used to reduce hair greasiness without water. It is typically administered from an aerosol can.

Aerosol styling products such as hairspray

A hairstyling product, sprayed on to the hair to keep it in place. It is typically administered from an aerosol can.

Shaving foam

A cream applied to the body to soften and lubricate the skin before shaving.

Suntan lotion – aerosol

A lotion administered from an aerosol can and applied to the skin to protect the skin against sunburn.

Suntan lotion – body lotion

A lotion applied to the skin, to protect the skin against sunburn.

Fake tan – aerosol (at home)

A lotion administered from an aerosol can and applied to the skin at home by the individual. Used to give the look of a suntan and lasts for around 3-10 days.

Fake tan – body lotion (at home)

A lotion applied to the skin at home by the individual, used to give the look of a suntan. Lasts for around 3-10 days.

Aftersun

A moisturising lotion applied to the skin after exposure to the sun, used to soothe the skin.

Facial cleanser

A product applied to the face, used to remove make-up, dead skin cells, oil and dirt from the skin.

Face wipes (disposable)

Pre-moistened single-use cloths, used to cleanse the face and remove make-up, dead skin cells, oil and dirt and from the skin.

Aftershave balm

A cream applied to the skin after shaving, to hydrate and soothe the skin.

Aftershave liquid

An alcohol-based liquid applied to the skin after shaving, to soothe the skin.

Perfume

A mixture of fragrant oils, usually in liquid form, applied to the body to give a pleasant scent.

Mouthwash

A liquid (typically antiseptic) held in the mouth, used to clean the mouth and teeth/freshen breath.

Toothpaste

A paste or gel, used with a toothbrush to clean the teeth and freshen breath.

Mouth spray

A liquid sprayed into the mouth to freshen the breath.

Foaming body scrub

A skincare product which turns into a lather, used in the bath or shower to cleanse and exfoliate skin.

Anti-dandruff shampoo

A hair care product, typically in liquid form, used to prevent or treat dandruff.

Lip stick

A cosmetic used to apply colour, texture and/or protection to the lips.

Lip plumping lip gloss

A cosmetic applied to the lips, that causes a temporary fullness of the lips.

Lip balm

A cosmetic applied to the lips to moisturise and soothe chapped or dry lips.

Hair relaxers

A lotion or cream applied to the hair to straighten very curly hair.

Facial skin peels (at home)

A solution applied to the face by the individual at home. Skin peels are used to remove dead skin cells and stimulate the growth of new cells.

Facial mask

Clay, gel, cream or sheet masks are applied to the face and removed after a certain period of time, used to cleanse the skin

Skin lightening cream

A cream applied to the skin in order to lighten it, even out the colour and/or reduce the prominence of skin discolourations.

Hair removal cream

Depilatory cream containing chemicals, used to temporarily remove unwanted hair from the face and body.

Talcum powder

A powder applied to the body to dry skin and reduce rubbing.

Face powders/foundation

A cosmetic product applied to the face, used to change the appearance of the skin. They typically work by applying colour to the skin, even out skin tone, conceal blemishes, maximise coverage.

CBD Moisturiser

CBD (cannabidiol) is found within hemp and cannabis. A cream or lotion containing CBD, applied to the skin to help hydrate and restore moisture to the skin.

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