

Human exposure to micro- and (nano)plastics: What drives citizens' concern?

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University of Vienna & University of Plymouth



Picture credit: Juan Baztan

How concerned are
citizens about plastic
pollution?



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Concern about plastic pollution in the context of other environmental issues



Resources, Conservation and Recycling

Volume 147, August 2019, Pages 227-235



Full length article

Public attitudes towards plastics

Leela Sarena Dilkes-Hoffman , Steven Pratt, Bronwyn Laycock, Peta Ashworth, Paul Andrew Lant

Representative Australian sample

Table 1

Responses to 'please indicate how serious you think each of the following environmental issues are'.

Environmental Issue	Not serious										Extremely serious	Don't know
	1	2	3	4	5	6	7	8	9	10		

Environmental Issue	<i>M</i>	<i>SD</i>
Plastic in the ocean	8.9	1.49
The amount of plastic waste produced	8.59	1.58
The amount of general waste going to landfill ^a	8.45	1.61
Water pollution ^{a,b}	8.34	1.62
Endangered species and biodiversity ^{b,c}	8.26	1.71
Natural resource depletion (forest, water, energy) ^c	8.14	1.75
Air pollution ^{d,e}	7.93	1.78
Water shortages ^{d,f}	7.93	1.91
Climate change (global warming) ^{e,f}	7.73	2.34



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Concern about human health impacts of plastics in the context of marine threats

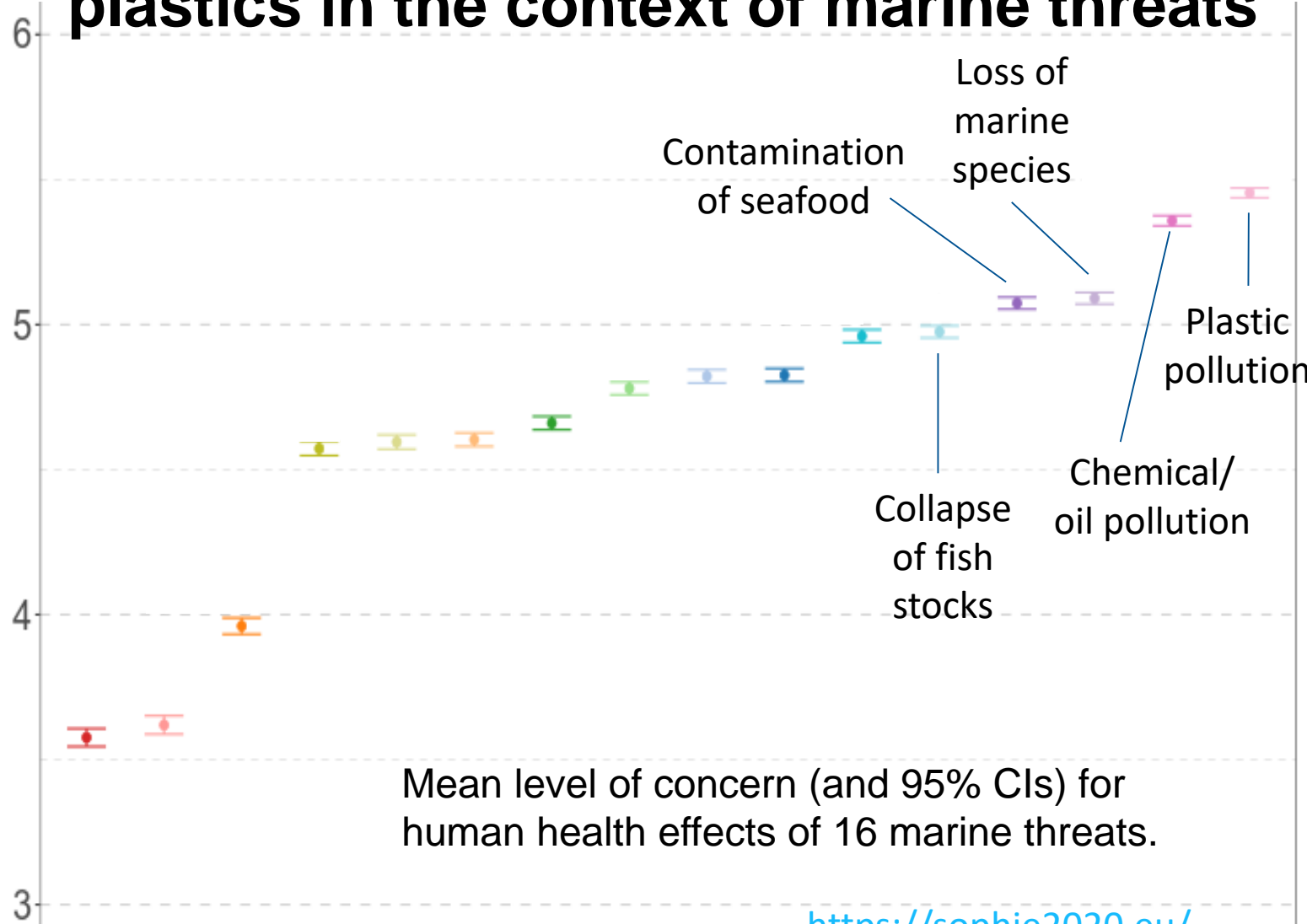
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0 = not at all concerned;
6 = extremely concerned

Same pattern across 13 countries; for Poland & Greece 1&2 reversed

Davison, White, Pahl et al., **rev. submitted**



N > 15,000
Europe +

Potential marine threat (highest to lowest in order of concern)

- 5 Plastic pollution
- 15 Chemical/oil pollution
- 3 Loss of marine species
- 14 Contamination of seafood
- 9 Collapse of fish stocks
- 1 Human & animal sewage in bathing waters
- 13 Drug-resistant microbes in seawater
- 4 Ocean acidification
- 11 Harmful algae
- 6 Coastal overdevelopment
- 12 Invasive marine species
- 2 Sea-level rise
- 16 Flooding & storms
- 10 Jellyfish swarms
- 8 Drowning
- 7 Sunburn & sunstroke

<https://sophie2020.eu/>



Linking the marine environment to human health: Microplastics in seafood

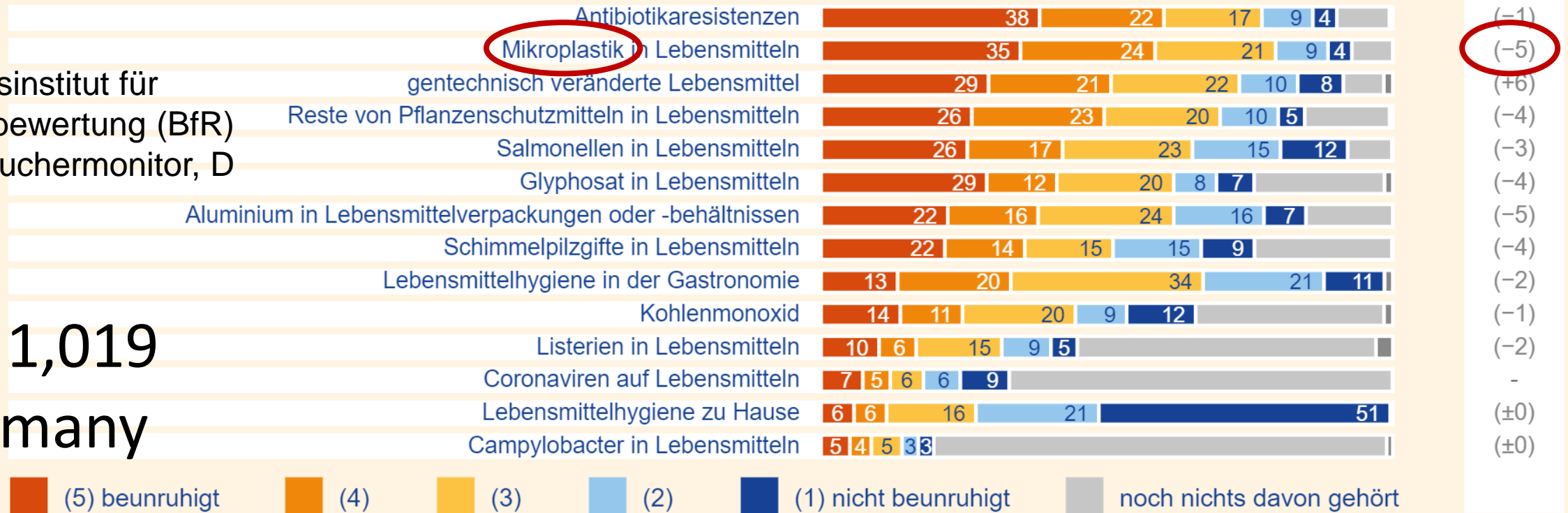
	Beauticians	Students	Environmentalists
First response	<i>"Oh my god"</i>	<i>"seems a bit fake"; "weird"</i>	<i>"Oh my god"; "Oh my goodness"</i>
Thoughts on general impact	<i>"it's quite dangerous for the world around us basically"</i>	<i>"Does it physically harm the fish? Obviously I know it's in their stomach but does it like poison them or something?"</i>	[already talked about impact before]
Thoughts on human health	n/a	<i>Concerns about MP in seafood: Get digested by animals. (S) And then you eat the animals. (S) You're eating those. (S) How do you know you can't afford to eat plastic can you? (S)</i>	<i>[...]so that was a moment for me of just thinking that zooplankton, that's the beginning of the food chain. (E)</i>

NEW – qual/quant mental models study with EFSA just started

Concern about microplastics compared to other food risks

Bundesinstitut für
Risikobewertung (BfR)
Verbrauchermonitor, D

N = 1,019
Germany



Basis: 1.019 Befragte
Angaben in Prozent (Vergleich zu 02/2020 bezieht sich auf die Anteile „beunruhigt“/ Skalawerte 4 + 5: Prozentpunkte)



Already in 2016 German representative survey, around 60% were worried about plastic particles in food and drinking water (reported in SAPEA, 2019)



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Expert concern and reasons for actions



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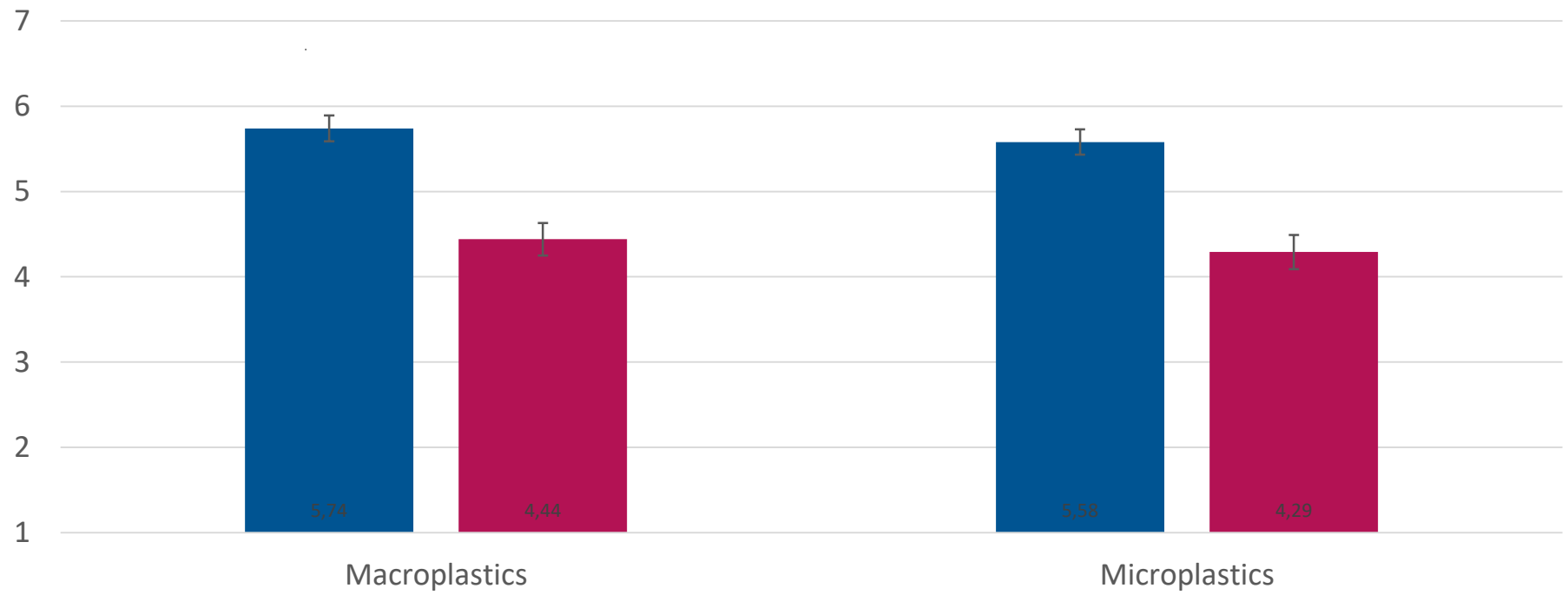


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Microplastics science experts

How worried, if at all, are you about the current impact of a) *everyday products made of plastic* / b) *microplastics* on a) *the natural environment* / b) *human health*?

■ Natural Environment ■ Human Health



Note. Scale from 1 (Not worried at all) to 7 (Extremely worried), N=73; Means and SE

Grünzner, Pahl, White & Thompson (2021), unpublished data – preliminary analysis

Please no sharing of unpublished data slides



Main effect of nat env vs. human health, $F(1,72) = 69.95, p < .001, n2 = .493$

Stocktake of global actions to reduce the flow of marine plastic and microplastic to the ocean

Pursuant to UNEA Resolution UNEP/EA.4/Res.6 OP 7a:
“Take stock of existing activities and actionwith the aim of the long-term elimination of discharge into the oceans”



Locations of at least one action (from survey)

Types of actions:

- 1) Legislative, standards, rules;
- 2) Working with people;
- 3) Technology & Processes;
- 4) Monitoring & Analysis

Snapshot of action now, non-exhaustive

Which type of impact or harm does the action target?

Please no sharing of unpublished data slides

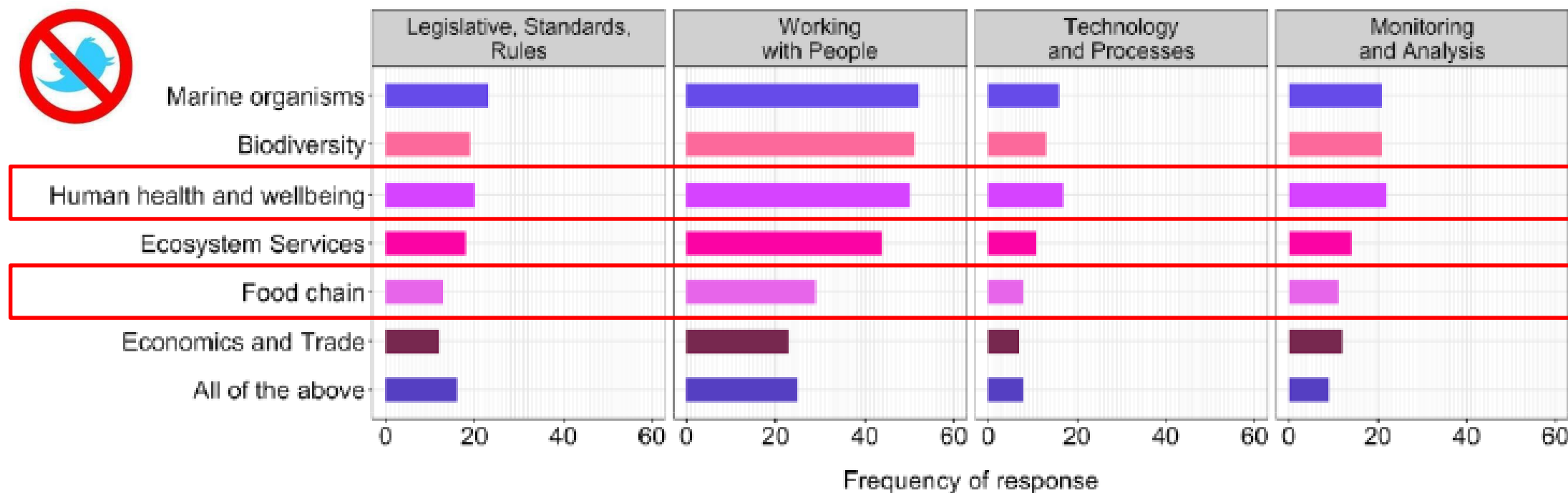


Figure 23: Types of impacts or harms that the action is related to. (Respondents were asked to choose all that applied.)

Evidence and lack of evidence

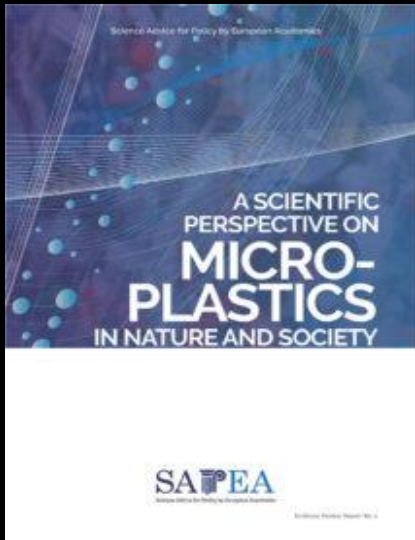


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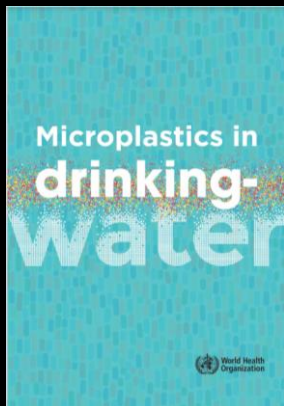
Communicating the absence of evidence



Summary →

The best available evidence suggests that microplastics and nanoplastics do not pose a widespread risk to humans or the environment, except in small pockets. But that evidence is limited, and the situation could change if pollution continues at the current rate.

<https://www.sapea.info/topics/microplastics/>



*Forthcoming
WHO report*

*NMP in air
and food*

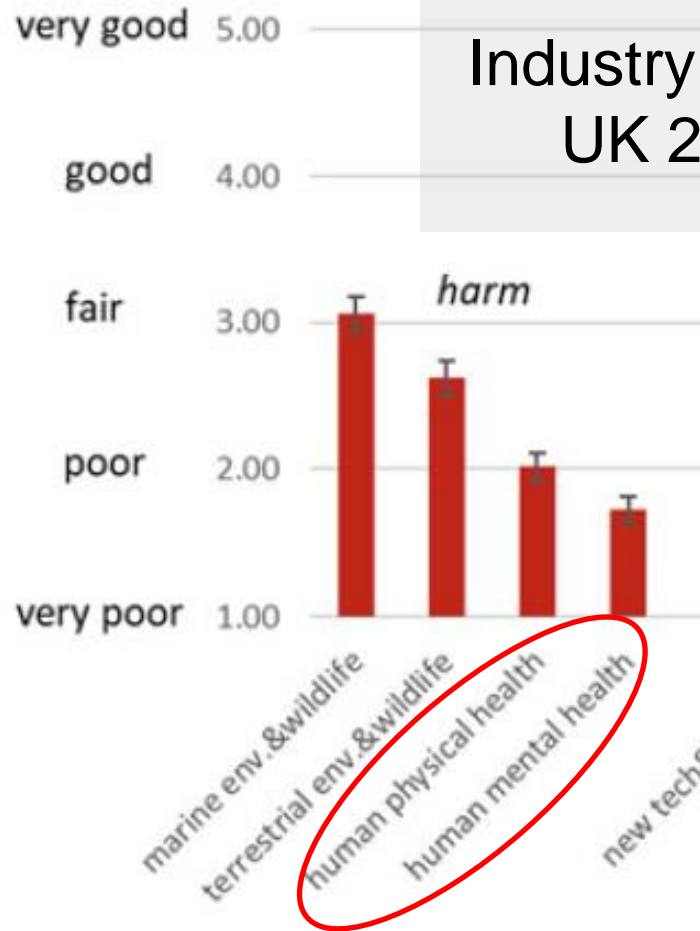


Response



**Response to
response**

State of the evidence regarding plastic pollution



Industry survey
UK 2018

Thompson & Pahl, University of Plymouth, July 2018

Reported in Pahl, Richter & Wyles, 2020

Science Magazine Feb 2021



Humans are exposed to different types of fibers and particles, including microplastics; the potential health effects of microplastics are largely unknown.

PERSPECTIVES

TOXICOLOGY

Microplastics and human health

Knowledge gaps should be addressed to ascertain the health risks of microplastics

By A. Dick Vethaak^{1,2} and Juliette Legler³

The ubiquity of microplastics (plastic particles <5 mm, including nano-sized plastics <1 μm) in the global biosphere raises increasing concerns about their implications for human health (1–3). Recent evidence indicates that humans constantly inhale and ingest microplastics; however, whether these contaminants pose a substantial risk to human health is far from understood. The lack of crucial data on exposure and hazard represents key knowledge gaps that need to be addressed to move forward.

Microplastics are created by the weathering and breakdown of plastic objects, car tires, clothing, paint coatings, and leakage

films growing on microplastics may be a source of harmful microorganisms (2, 7). Their ubiquity in the environment raises serious concerns about their effects on wildlife and ecosystems (1), but what are their effects on human health?

Microplastics may enter the human body through both inhalation and ingestion, potentially causing health effects (see the figure). A parallel can be drawn with particulate air pollution: Small particles (<2.5 μm), such as those from diesel exhaust, are capable of crossing cell membranes and triggering oxidative stress and inflammation, and have been linked with increased risk of death from cardiovascular and respiratory diseases or lung cancer (3). This parallel provides ample incentive to gather more information on the

10⁴ particles/liter, with generally greater particle counts for small-sized microplastics (8). The first atmospheric measurements of larger-sized, predominantly fibrous microplastics indicate that plastic particles are a relevant component of fine dust, with, for example, deposition rates in central London ranging between 575 and 1008 microplastics per square meter per day (9). Increased exposure through indoor air, direct swallowing of house dust or dust settling on food (10), and direct exposure to particles released from plastic food containers or bottles, such as polypropylene infant feeding bottles (11), are of special concern. Larger microplastics are likely excreted through feces, or after deposition in the respiratory tract or lungs through mucociliary clearance into the gut (1, 2). Given the methodological limitations and measurement bias toward larger particles, existing analyses probably underestimate human external exposure and generally do not include the fraction of smaller-sized particles <10 μm, which are likely more relevant to toxicity (1, 12). Notably, internal exposure measurements of plastic particles in human body fluids and



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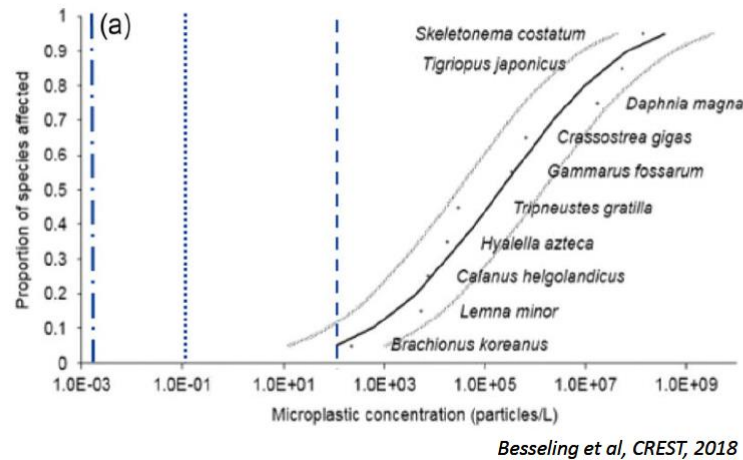


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Types of evidence communication – Some examples

Science

Evidence on quantitative risk assessments



Key to page sidebars

These sidebars are used in Chapter 2 only. They are not applied elsewhere in this report.

What is known

What is partially known

What is unknown

Plastics

- Single study vs. synthesis
- Presence vs. Impact
- Reporting uncertainty / variance

Media

Microplastics revealed in the placentas of unborn babies

Health impact is unknown but scientists say particles may cause long-term damage to fetuses



<https://www.thesun.co.uk/news/6871840/plastic-chemicals-food-packaging-make-penis-smaller/>

<https://news.sky.com/story/human-penises-are-shrinking-because-of-pollution-warns-scientist-12255106>

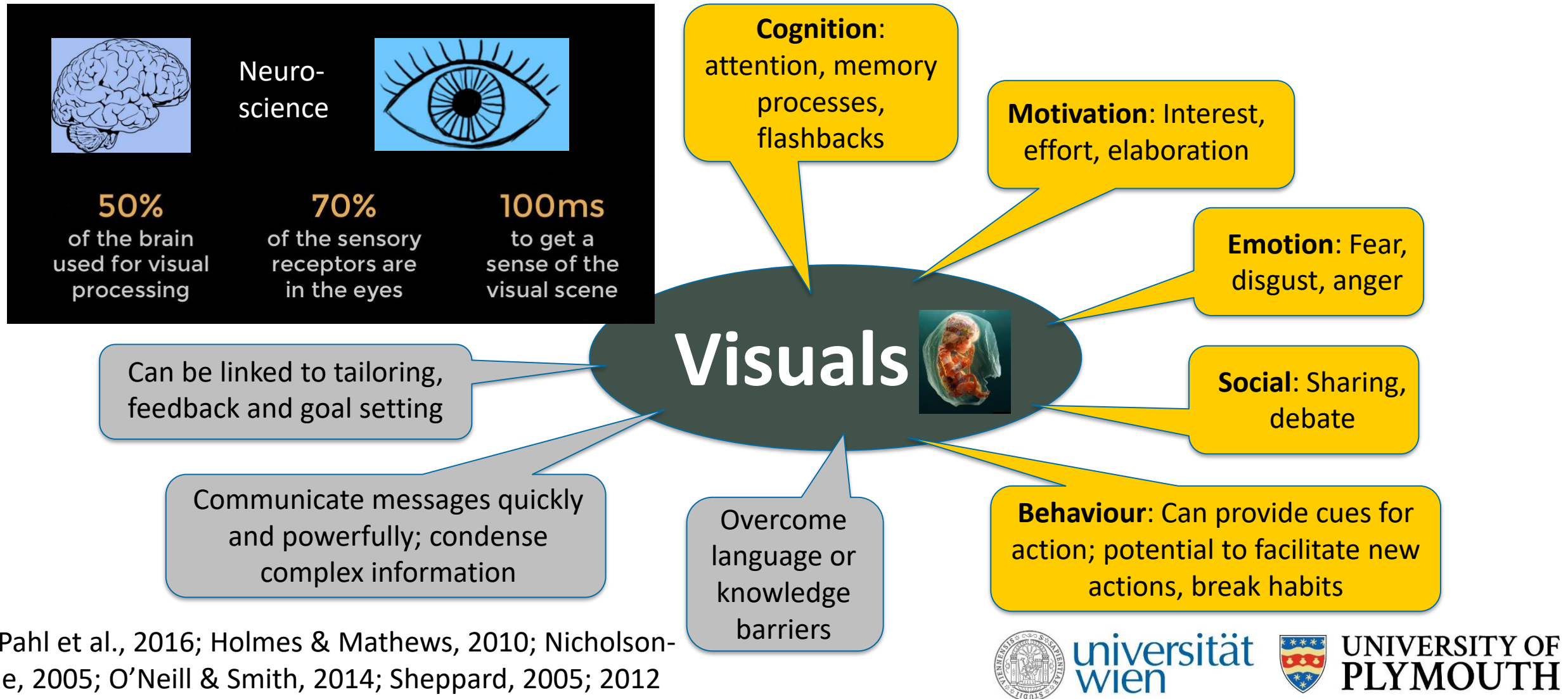
PLASTIC CAN CAUSE BIRTH DEFECTS



NGO campaign

The power of visual images

From the psychology, neuroscience and social science literature

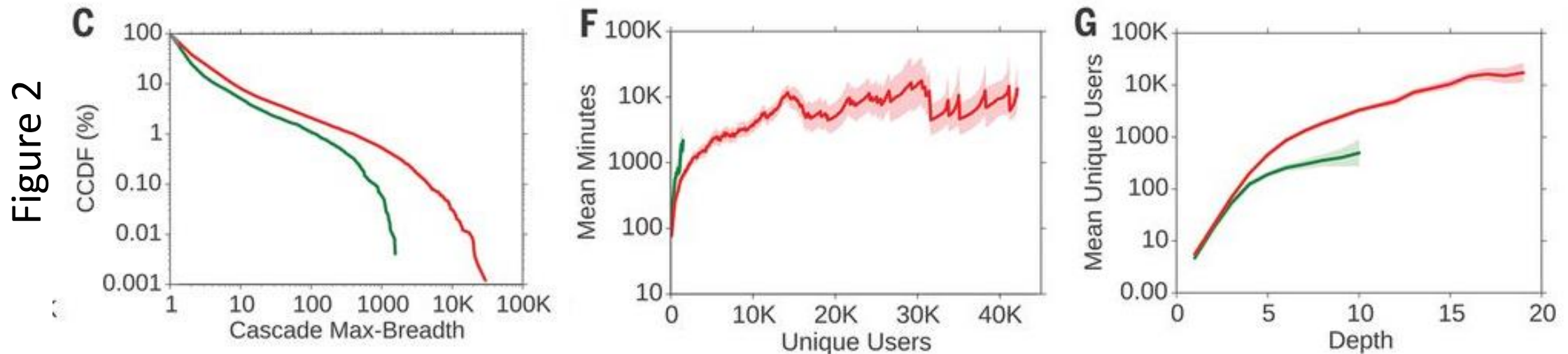


Beyond visuals: Impact and Spread

The stakes are high:

- Human health, (unborn) baby health
- Male sexuality / microplastics in the placenta
- Our food, the air we breathe, the water out of the tap

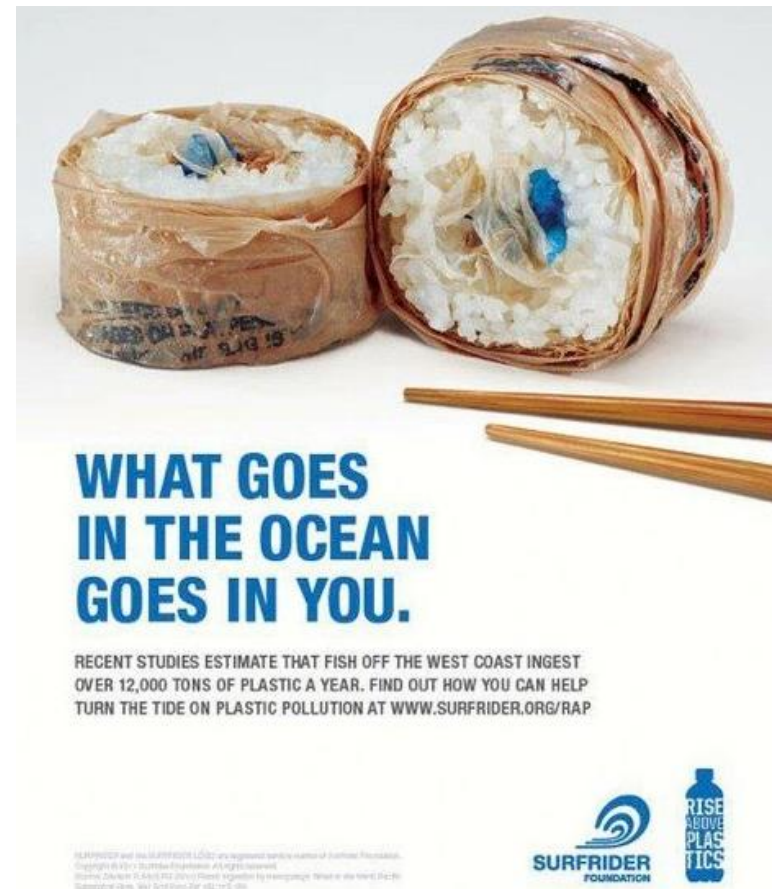
Vosoughi et al., the spread of true and false news online, Science, 2018



~126,000 stories tweeted by ~3 million people more than 4.5 million times

Factors that determine risk perception

- Technical > natural hazards
- Risk target
- Number of people affected
- Lack of controllability
- Delay
- Uncertainty / lack of knowledge (MNP)
- Correlation between risks and benefits
- Contamination?



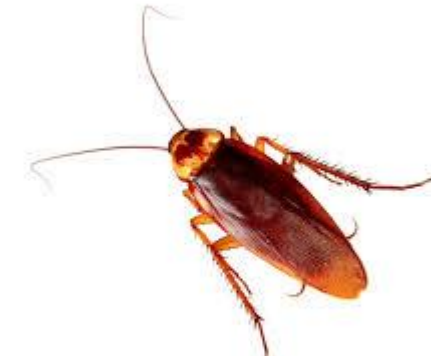
The power of strong emotions: disgust



Taste test

Contact, contagion

+

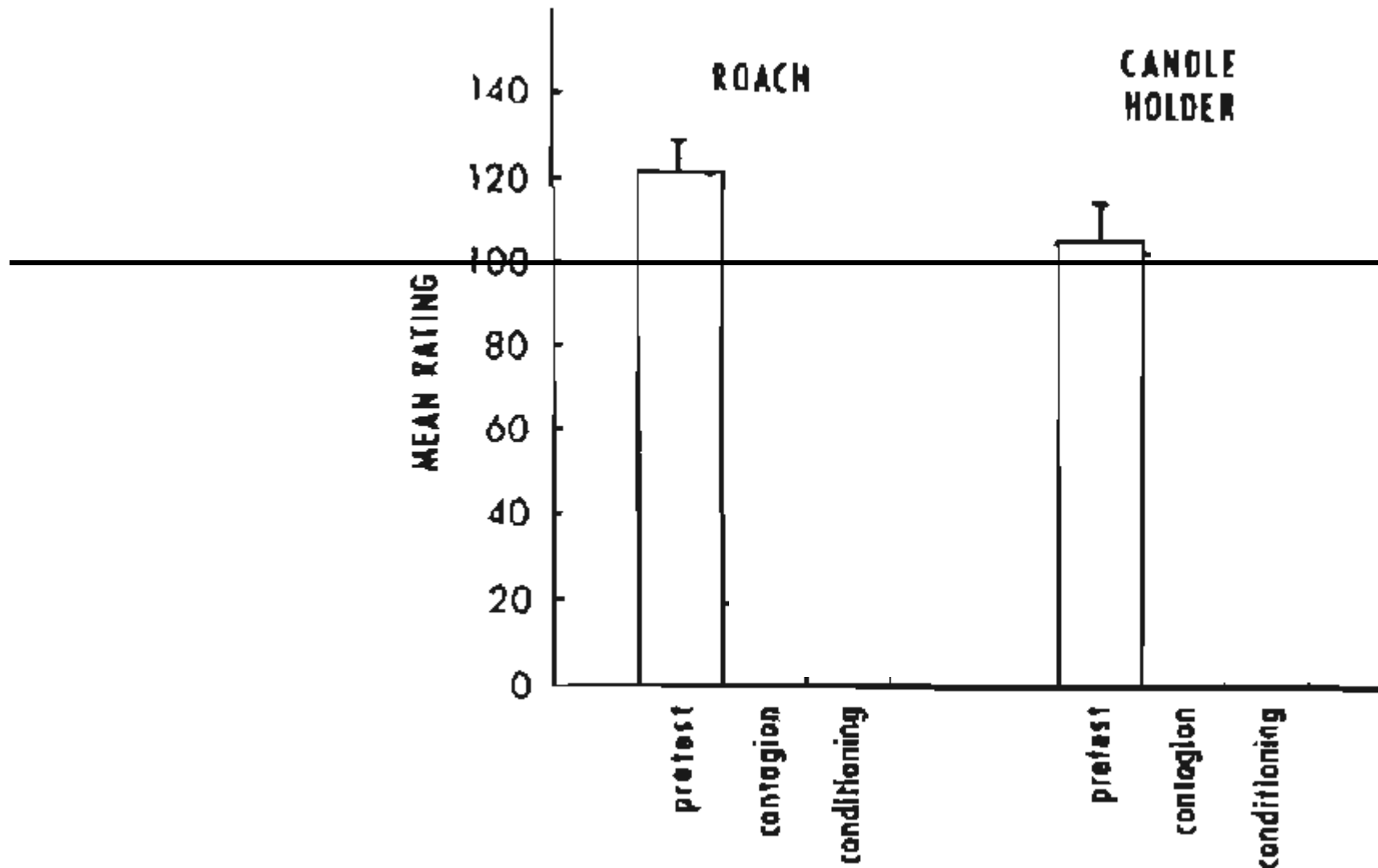


Dead,
sterilised

or

+



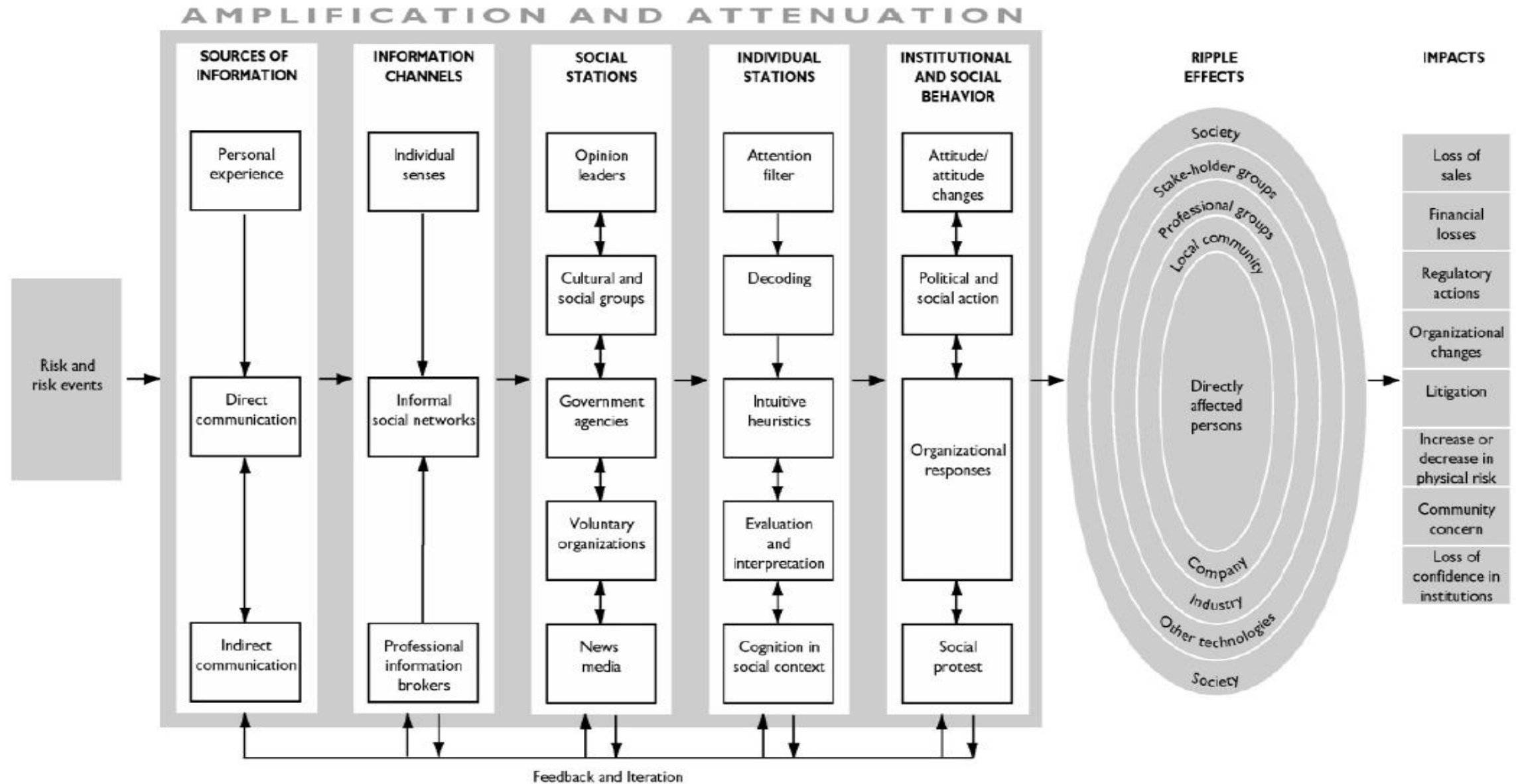


Direct disgust?

Moral disgust?

*No data on
(micro-)plastics
yet*

The social amplification of risk framework



Discussion



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Key messages

- High level of citizen concern about macro- and microplastic pollution including human health impacts
- Experts more concerned about environmental impact (?), but lack of scientific evidence & debate even among scientists
- People are exposed to different (social / media) messages including powerful visuals
- Psychological and social processes can explain responses and spreading of news -> *social amplification*
- Risk is a societal issue between ‘technical’ risk assessment and values, emotions, trust etc. (‘beyond mere facts’)
- We need to understand public concern and behaviour to ensure successful policy actions



Thank you

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Sophie Davison



Maja Grünzner



Mathew White



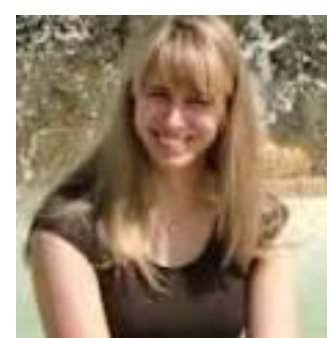
Julie Goodhew



Francesca Tiroto



Isabel Richter



Kayleigh Wyles

Analytical
Methods



TUTORIAL REVIEW

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Cite this: DOI: [10.1039/c6ay02647h](https://doi.org/10.1039/c6ay02647h)

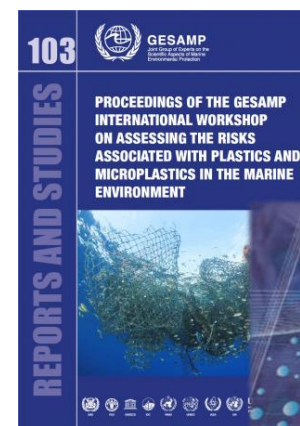
The human dimension: how social and behavioural research methods can help address microplastics in the environment

S. Pahl^{*ab} and K. J. Wyles^{cd}

The present paper illustrates the breadth of research methods in the Social and Behavioural Sciences and how these may be applied to the issue of environmental microplastics. Microplastics are a human-caused problem and we need to understand the human dimension in order to address it. Nine key points are emphasised in this paper and follow from the key observation that humans, through their perceptions, decisions and actions, are pivotal to the issue of primary and secondary microplastics in the environment: (1) human perception and behaviour can be subject to systematic and rigorous scientific study, using theory-based hypothesis testing, measurement and statistical analysis; (2) qualitative methods can explore new areas of research and provide novel, in-depth insights; (3) best practice and recommendations exist for measuring social data; (4) quantitative cross-sectional approaches can test how important social factors are for key outcomes (e.g. the role of perceived risk, values, social norms for behaviour); (5) experimental quantitative approaches can compare randomised groups and study cause-effect relations; (6) certain limitations and challenges are unique to research with people; (7) communications and interventions (e.g. change campaigns, new regulation, education programmes) should be developed based on scientific insights into human thought and behaviour and then evaluated systematically; (8) social researchers should work towards developing standardised tools and protocols; and (9) social research on microplastics and its determinants is in its



Richard Thompson



Acknowledgements: This work was made possible through funding from GESAMP/IMO, the EU's H2020 programme, and UNEP



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Received 23rd September 2016
Accepted 15th October 2016

DOI: [10.1039/c6ay02647h](https://doi.org/10.1039/c6ay02647h)

Additional slides if questions



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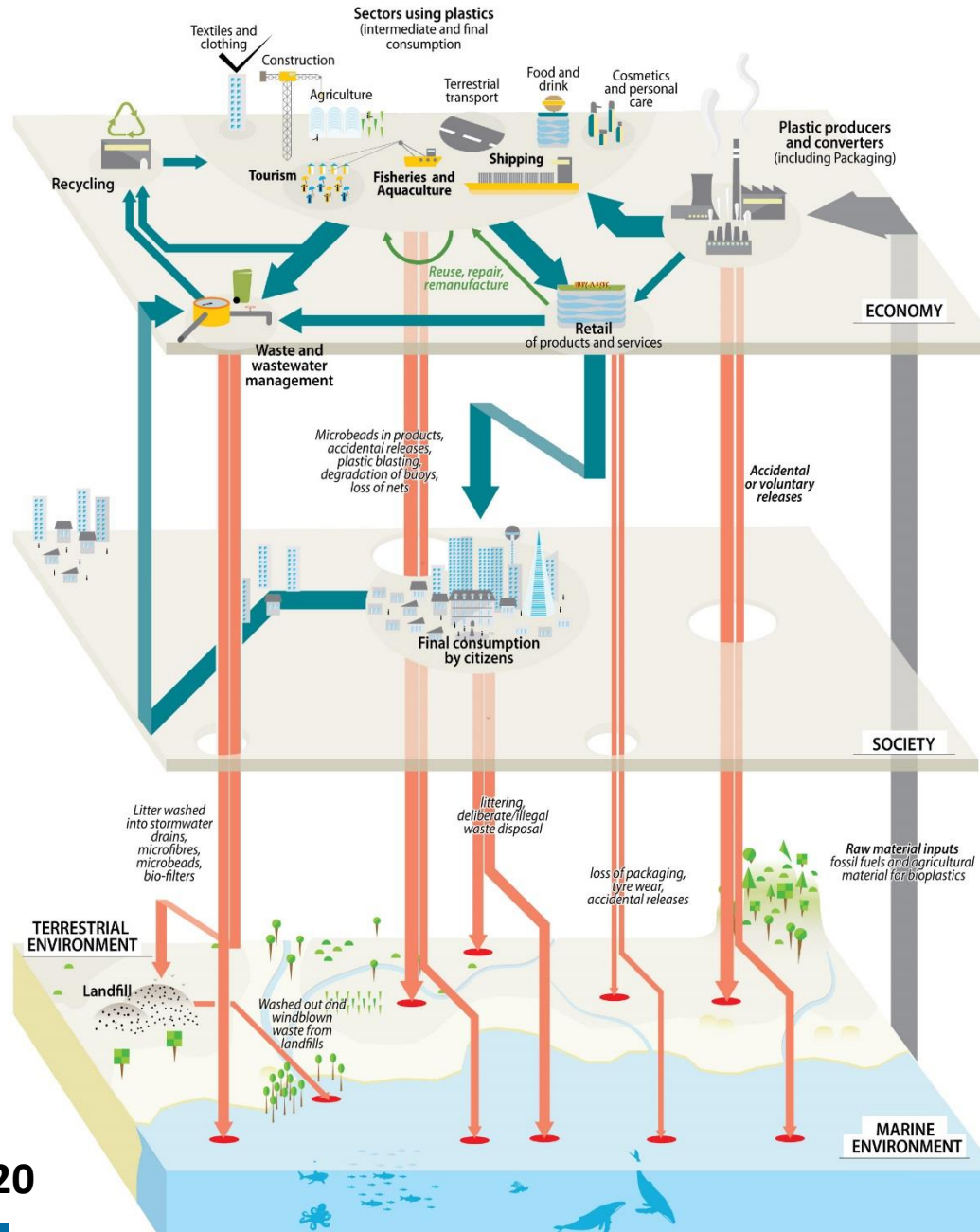
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The plastic system

Macro-, Micro- Nanoplastics

Perceptions & communications drive concern and action

Credit: GRID-Arendal and Maphoto/Riccardo Pravettoni
<http://www.grida.no/resources/6908>



Communications

Economic sectors

Society

Environment

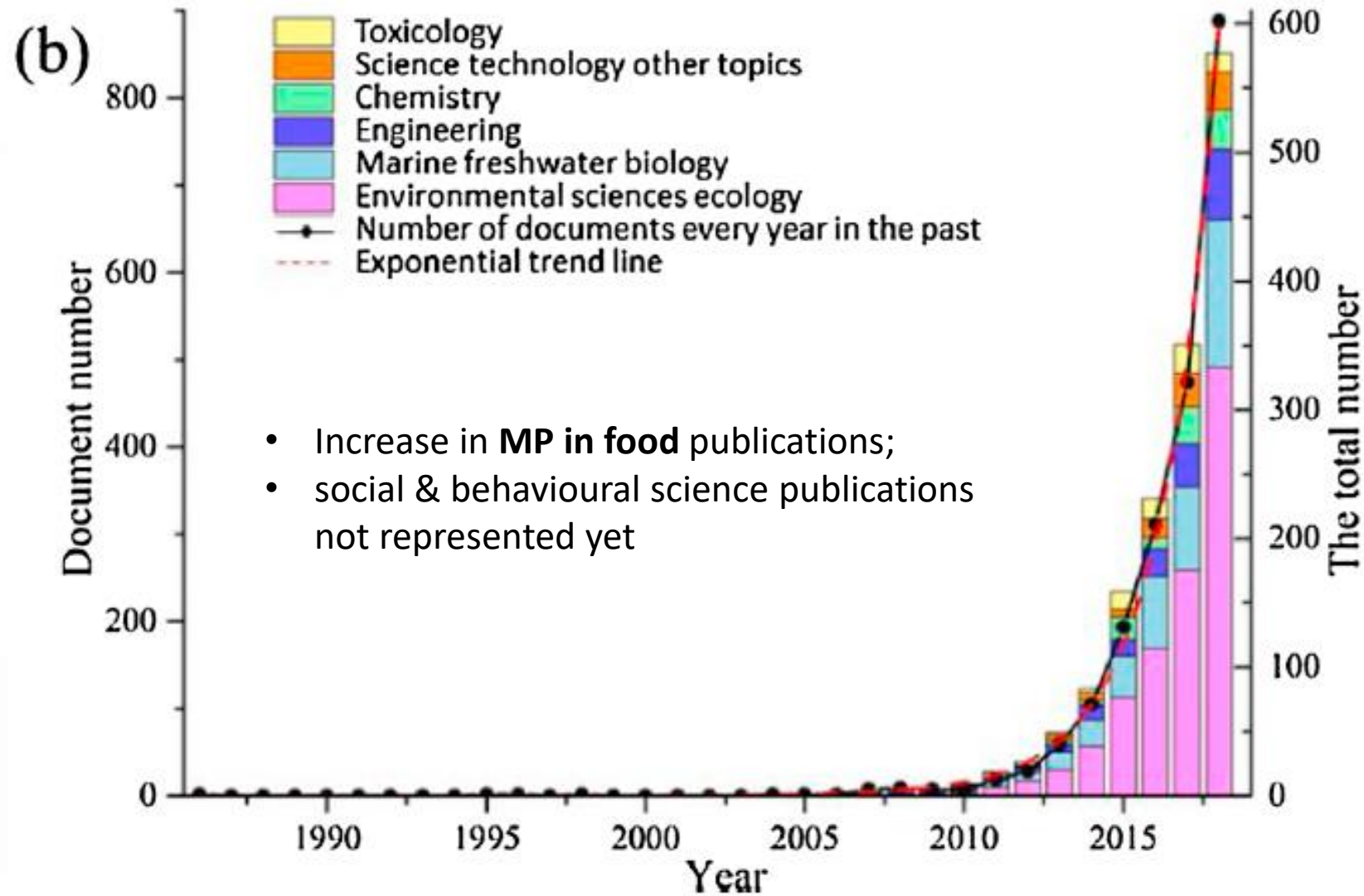


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Microplastics publication trends 1986 - 2019



Zhang et al., 2020, Journal of Hazardous Materials

(b) Distribution of different research directions and number of papers for MPs per year.



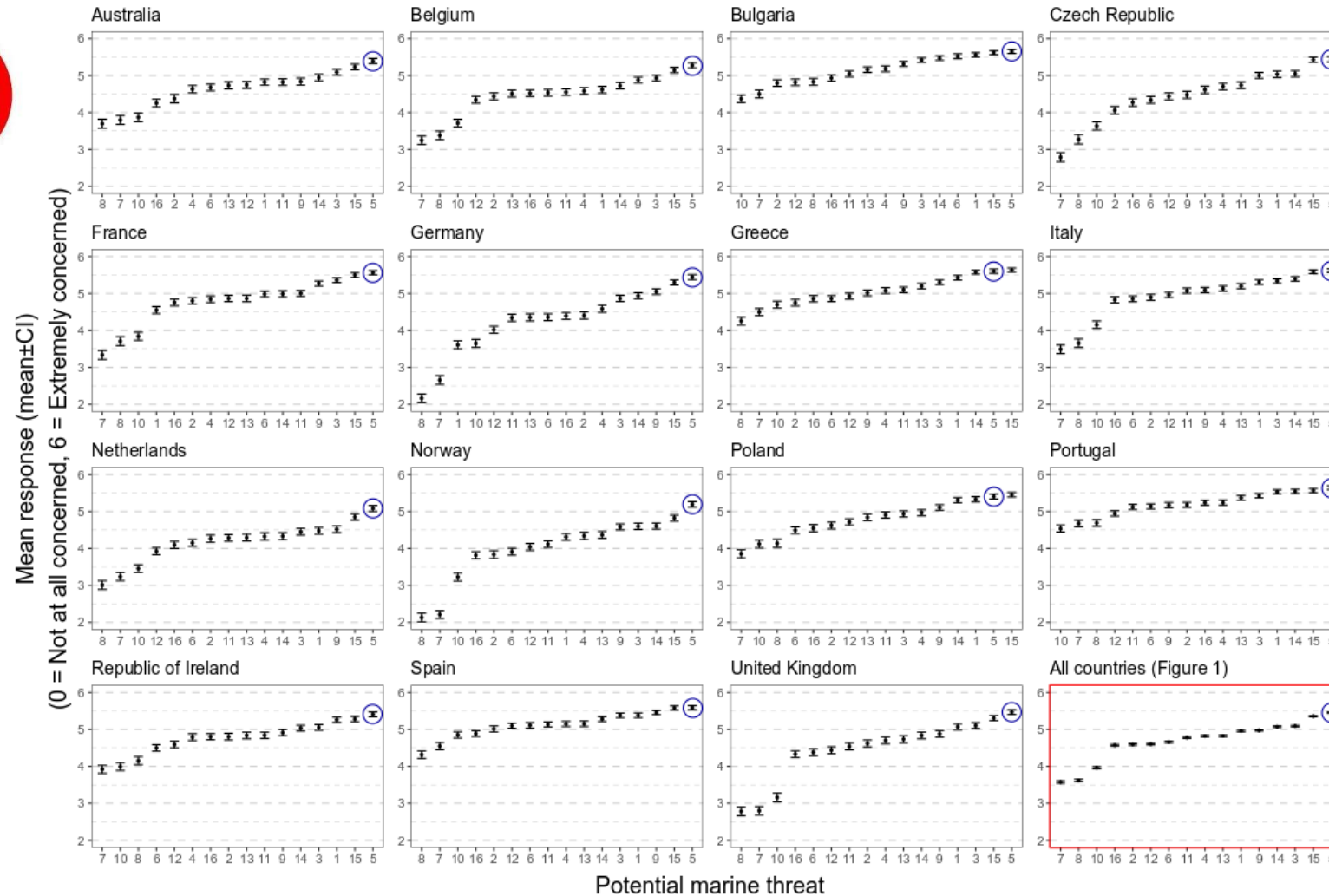
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Concern about human health impacts of plastics in the context of marine threats



**N > 13,000
Europe + Oz**



Potential marine threat

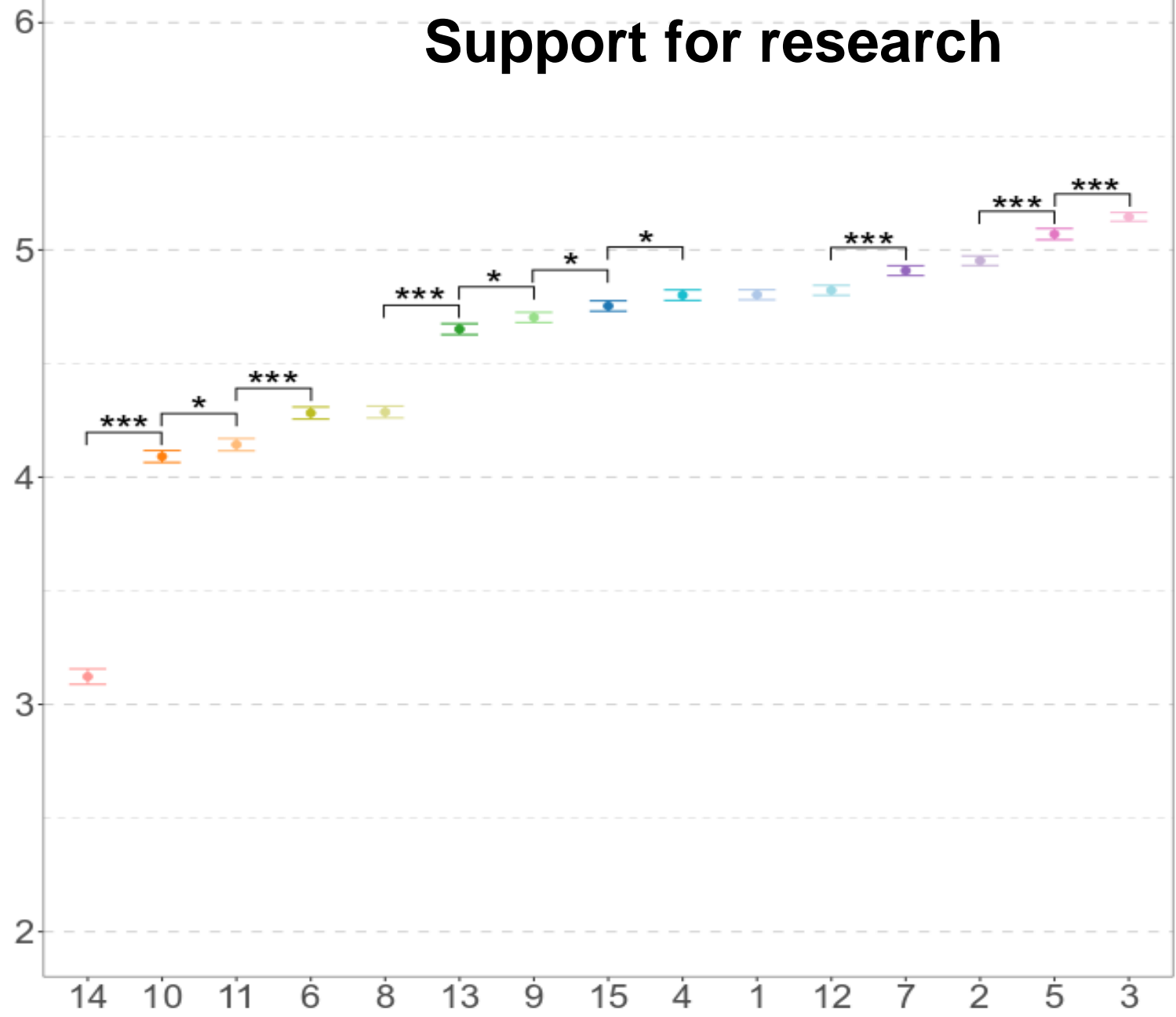
- 1 Human & animal sewage in bathing waters
- 2 Sea-level rise
- 3 Loss of marine species
- 4 Ocean acidification
- 5 Plastic pollution
- 6 Coastal overdevelopment
- 7 Sunburn & sunstroke
- 8 Drowning
- 9 Collapse of fish stocks
- 10 Jellyfish swarms
- 11 Harmful algae
- 12 Invasive marine species
- 13 Drug-resistant microbes in seawater
- 14 Contamination of seafood
- 15 Chemical/oil pollution
- 16 Flooding & storms

**Concern over
HH biggest
predictor of
desire for more
research
funding**

Figure 2: A country breakdown of mean concern (and 95% CIs) for 16 marine threats - plastic pollution indicated by circle.

Support for research

Mean response (mean±CI)
(0 = Not support at all, 6 = Strong support)



Marine research area (highest to lowest in order of support)

- 3 Marine species/wildlife protection
- 5 Plastic pollution in marine waters
- 2 Coastal protection/defences
- 7 Education and awareness raising
- 12 Marine renewable energy
- 1 Bathing water quality
- 4 Marine-climate change issues
- 15 Behaviour change to improve health/wellbeing
- 9 Sustainable aquaculture
- 13 Sustainable shipping
- 8 Health/wellbeing effects of spending leisure time in and around marine environments
- 6 Health/wellbeing effects of living by the sea
- 11 Biotechnology from marine organisms
- 10 Jellyfish swarms and algal growth
- 14 Deep-sea mining

Bostrom et al. (2018): Communicating risks: Principles and challenged

Shannon-Weaver Model of Communication: sender, message, receiver

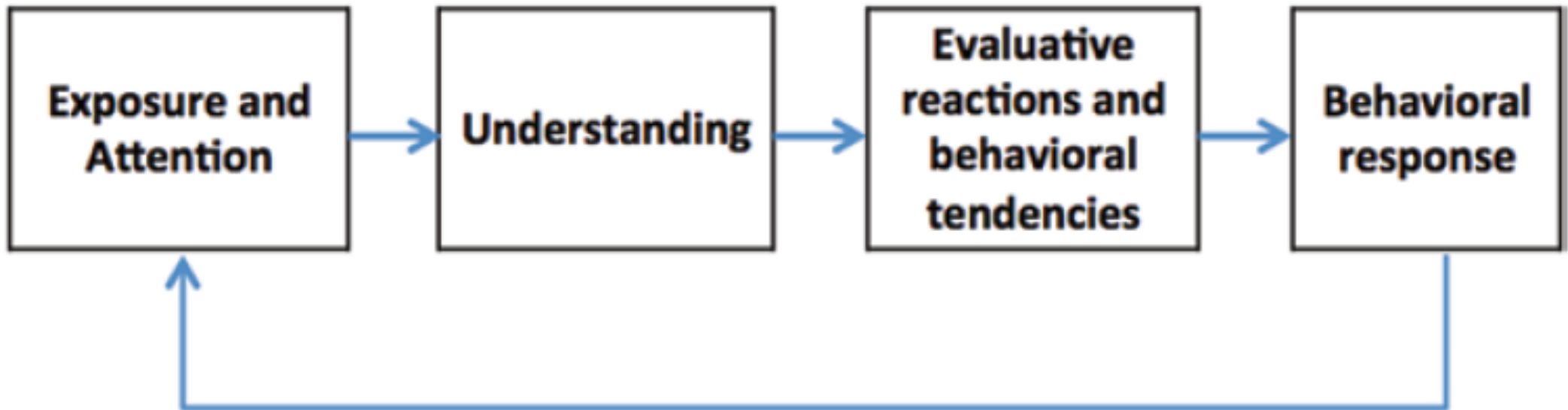


Fig. 11.1 Key components of risk information processing

Conversational implications / interpretation; nuance



Risk Perception and Communication Unplugged: Twenty Years of Process¹

Table I. Developmental Stages in Risk Management (Ontogeny Recapitulates Phylogeny)

-
- All we have to do is get the numbers right
 - All we have to do is tell them the numbers
 - All we have to do is explain what we mean by the numbers
 - All we have to do is show them that they've accepted similar risks in the past
 - All we have to do is show them that it's a good deal for them
 - All we have to do is treat them nice
 - All we have to do is make them partners
 - All of the above
-
- Empower 'them'
 - Co-create the future
 - Co-create science

On the Creation of Risk: Framing of Microplastics Risks in Science and Media

Carolyn Völker,* Johanna Kramm, and Martin Wagner

- Most scientific studies (67%) frame microplastics risks as hypothetical or uncertain, while 24% present them as established.
- In contrast, most media articles reporting on microplastic impacts (93%) imply that risks of microplastics exist and harmful consequences are highly probable.
- The creation of simple narratives (journalists) and the emphasis on potentially negative impacts (scientists) contribute to this inconsistency.

Monthly news items on microplastics 2017/18



PLASTIC CAN CAUSE BIRTH DEFECTS



Plastic can cause cancer, heart disease and Alzheimer's

Chemicals in plastic can cause cancer, heart disease, Alzheimer's, dementia, Parkinson's, arthritis, impotency and even harm babies in the womb.

Scientific evidence is piling up. It's becoming impossible to ignore, inevitably pointing in the same direction. Plastic is everywhere: plastic particles, nanoplastics, microplastics are in food, drinks (tap water and bottled water) and in the air we breathe. For example, from the wear from car tyres in the air and microfibres from synthetic clothes. Cosmetics also contain plastic: lipstick, mascara, nail polish, anti-aging cream... The list goes on and on and on.

How visual images may trigger behaviour

Impact visualisation



Immediate reaction

Viewer: That's awful! I ought to be more careful with plastics

Later consequences

(vivid image comes back)



End result: Reduced plastic waste

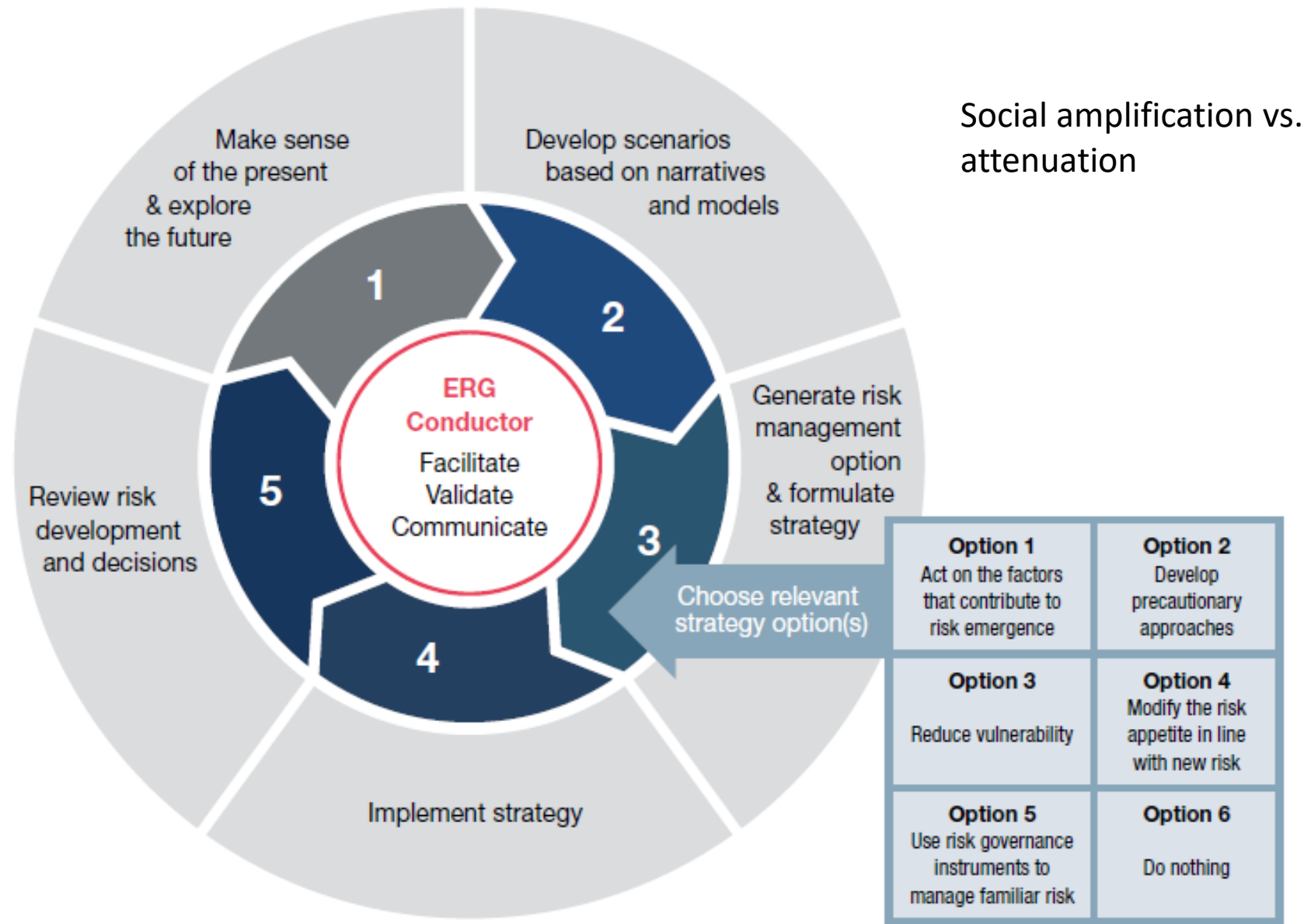
Cue: Person preparing for shopping trip

I must remember to take my own bags – that looked terrible

Cue: Person seeing plastic bag in the environment

I think I'll pick that up before it does more damage

Emerging Risk Governance



Social amplification vs. attenuation

IRGC (2015). Guidelines for Emerging Risk Governance. Lausanne: International Risk Governance Council (IRGC). Available from: www.irgc.org

Figure 3: IRGC Emerging Risk Governance Guidelines