Modules from the BIP FOOD INNOVATION AND THE CONSUMER

Editors: Ana Pinto de Moura
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CONSUMER DETERMINANTS OF ACCEPTANCE OF EMERGING TECHNOLOGIES

Ana Pinto de Moura

Luís M. Cunha

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2.1 The individual food choice process

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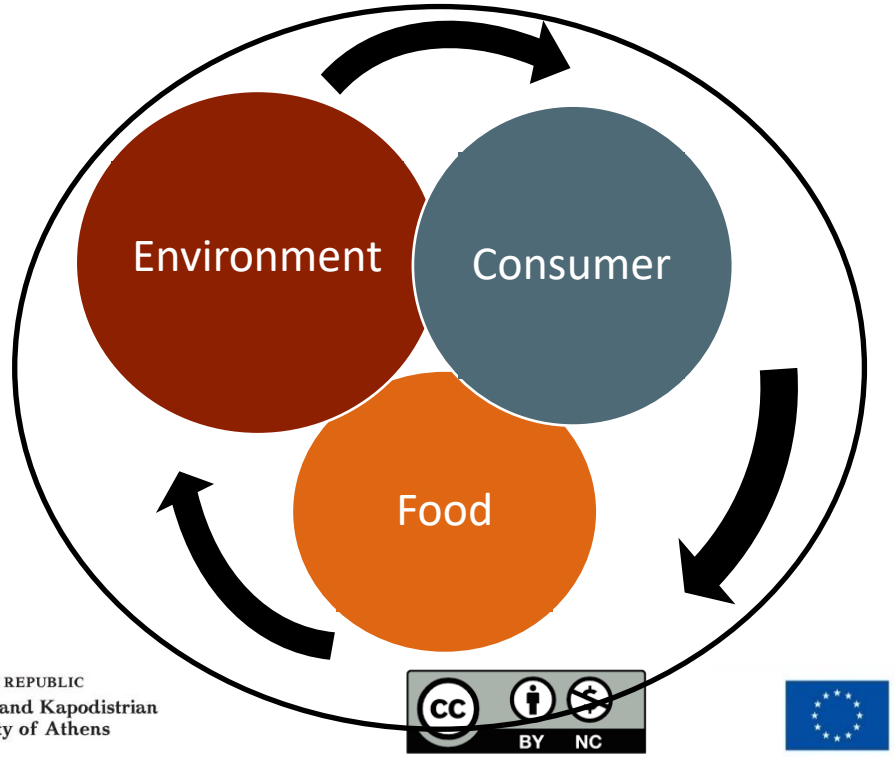
- **Food choice** is a complex behaviour influenced by many interrelating factors
- These factors may be categorised as those related to:
  - The **external economic and social environment** within which choice is made
  - **Food**
  - The **individual** making choice



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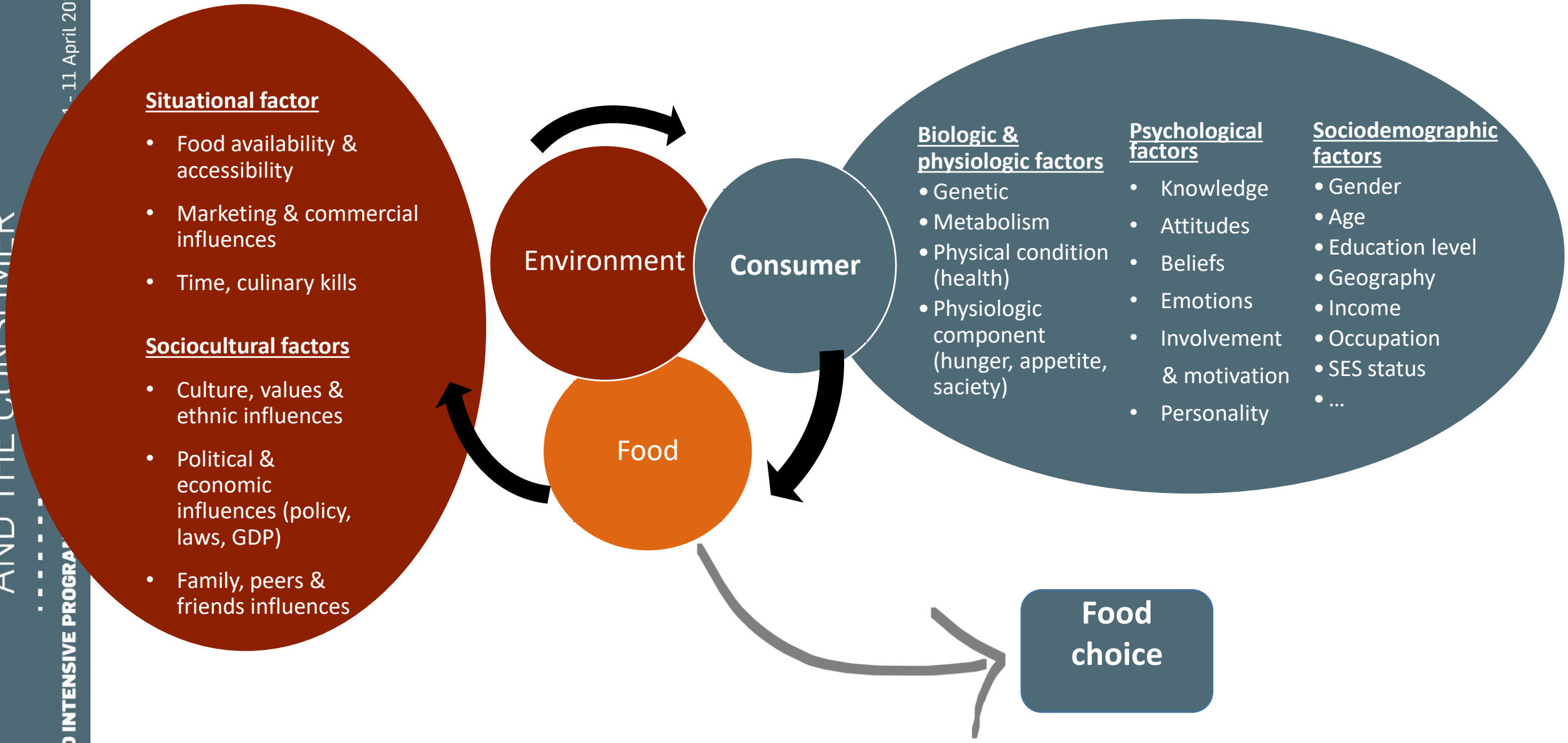

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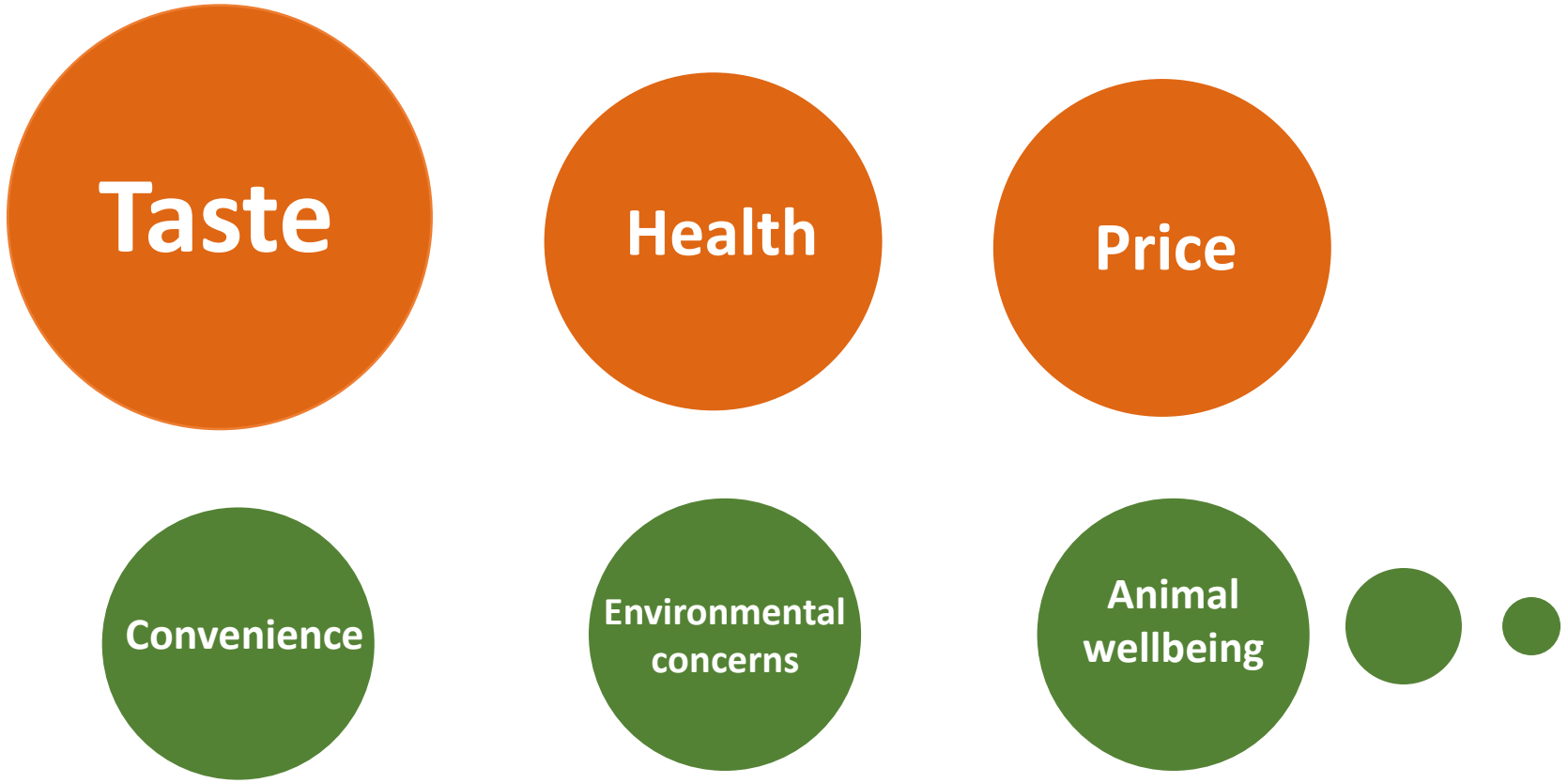
Drivers of food choice: the relevance of the **immediate food choice criteria** on the daily life



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Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

Application of the Food Choice Questionnaire across cultures: Systematic review of cross-cultural and single country studies

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Table 3
Ranking of importance for the different dimensions of the FCQ, in accordance with its mean values, from **1** – least important dimension, to **9** – most important dimension, for a set of cross-cultural studies applying all the original items from Steptoe et al. (1995) questionnaire.

Country*	Sensory appeal	Health	Price	Natural content	Convenience	Mood	Weight control	Ethical concern	Familiarity	References
Bosnia-Herzegovina	**9**	8	6	7	5	4	3	**1**	2	Milošević et al., 2012
Belgium (Flanders)	**9**	7	8	5	6	3	4	**1**	2	Eertmans et al. (2006)
Belgium (Flanders)	**9**	8	6	7	5	2	4	3	**1**	Januszewska et al. (2011)
Canada	**9**	8	6	3	7	4	5	**1**	2	Eertmans et al. (2006)
Germany	**9**	6	8	7	5	4	3	2	**1**	Markovina et al. (2015)
Spain	8	5	**9**	7	6	4	3	**1**	2	Markovina et al. (2015)
Greece	7	5	**9**	8	4	6	3	2	**1**	Markovina et al. (2015)
Croatia	**9**	8	6	7	5	4	3	**1**	2	Milošević et al. (2012)
Hungary	**9**	5	6	8	7	3	4	**1**	2	Januszewska et al. (2011)
Ireland	8	7	**9**	6	5	4	3	2	**1**	Markovina et al. (2015)
Italy	7	8	6	**9**	3	5	4	2	**1**	Eertmans et al. (2006)
Japan	5	7	**9**	8	4	2	3	6	**1**	Prescott, Young, O'Neill, Yau, and Stevens (2002)
Montenegro	**9**	8	5	7	6	3	4	**1**	2	Milošević et al. (2012)
Republic of Macedonia	**9**	8	6	7	5	4	3	**1**	2	Milošević et al. (2012)
Malaysia	4	**9**	5	8	6	3	7	2	**1**	Prescott, Young, O'Neill, Yau, and Stevens (2002)
Netherlands	8	7	**9**	4	6	5	3	**1**	2	Markovina et al. (2015)
Norway	**9**	7	6	5	8	4	3	2	**1**	Markovina et al. (2015)
New Zealand	**9**	7	8	4	6	3	5	2	**1**	Prescott, Young, O'Neill, Yau, and Stevens (2002)
Philippines	6	**9**	8	5	4	7	3	2	**1**	Januszewska et al. (2011)
Poland	7	4	8	**9**	6	5	3	**1**	2	Markovina et al. (2015)
Portugal	8	6	**9**	7	3	4	5	2	**1**	Markovina et al. (2015)
Romania	**9**	7	6	8	3	4	5	2	**1**	Januszewska et al. (2011)
Serbia	**9**	7	8	6	5	4	3	**1**	2	Milošević et al. (2012)
Slovenia	**9**	7	5	6	8	3	4	**1**	2	Milošević et al. (2012)
Taiwan	5	8	3	**9**	6	4	7	2	**1**	Prescott et al. (2002)
United Kingdom	**9**	7	8	6	5	3	4	2	**1**	Markovina et al. (2015)
Mean rank	*8,0*	*7,0*	*7,0*	*6,7*	*5,3*	*3,9*	*3,9*	*1,7*	*1,5*	

2.2. The role of technology on consumer food choice

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- **New food processing technologies** can contribute positively to the attainment of products presenting some of these advantages as they contribute to prolonging the shelf life of foods and enhancing their safety

- **Food preservation techniques** can be classified as:
  - **Traditional**: those based on heath transfer, the reduction of water activity or pH or addition of preservatives
  - **Emerging technologies**: pulsed electric fields, ultra high pressure, ohmic heating, or microwave processing, nanotechnology, 3D printing for improved food processing and/or preservation (**Activity 4**)
  - Microbial stability and the safety of many foods are based on **the combination of several preservation factors** leading to the hurdle concept

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Food risk: lay & expert perspectives

- Lay people and experts have different perceptions of food hazards: **lay people** valorised more the adverse consequences of the hazard and **experts** valorised more the probability of the hazard occurrence more

Lay people:

Probability of the hazard occurrence **x** **Adverse consequences of the hazard**

Experts:

Probability of the hazard occurrence **x** Probability of the hazard occurrence

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Psychometric paradigm

- According to the **psychometric paradigm**, an approach developed in the 1970s to investigate the public perception of technological risks (such as nuclear power, natural hazards, and chemicals), the risk is subjectively defined by individuals who may be influenced by a wide array of psychological, social, institutional, and cultural factors
- Research of psychometric paradigm has been successfully repeated in the food domain to examine lay people's perceptions of food hazards
- In the majority of these studies, variance in risk perception could be explained by two factors: "**Dread**" and "**Knowledge**" process (**slide 14**)

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Public perceptions of food-related hazards: an application to Portuguese consumers

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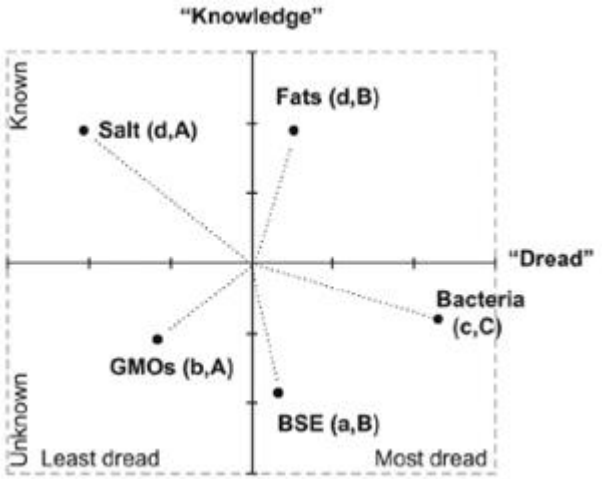
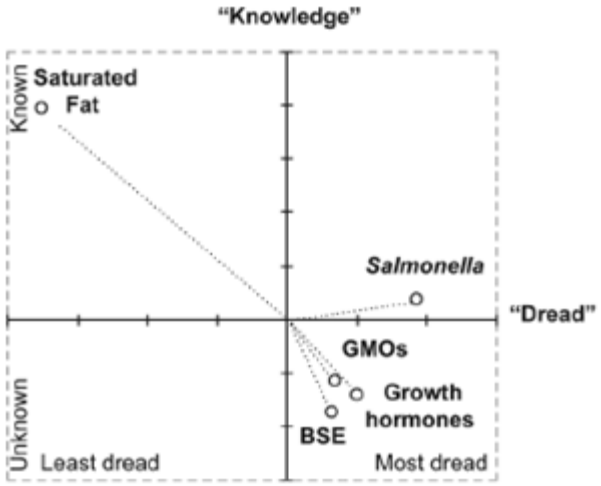
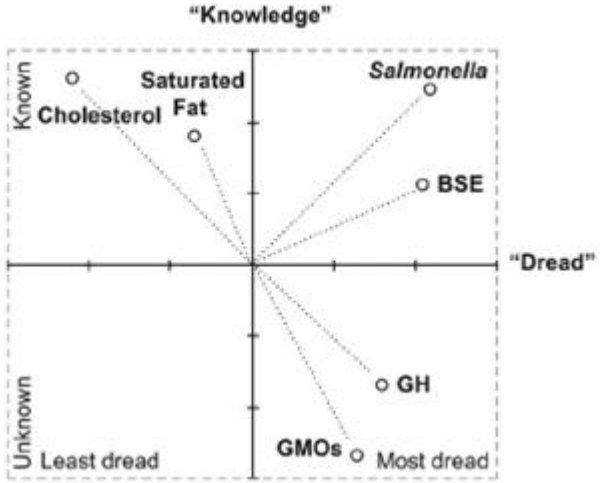
Consumers' perception of food hazards between "Knowledge" & "Dread" towards different food-related hazards



Cunha et al. (2010), PT



Adapted from Kirk et al. (2002), UK



Partial data on meat hazards, adapted from McCarthy and Henson (2004), IRL

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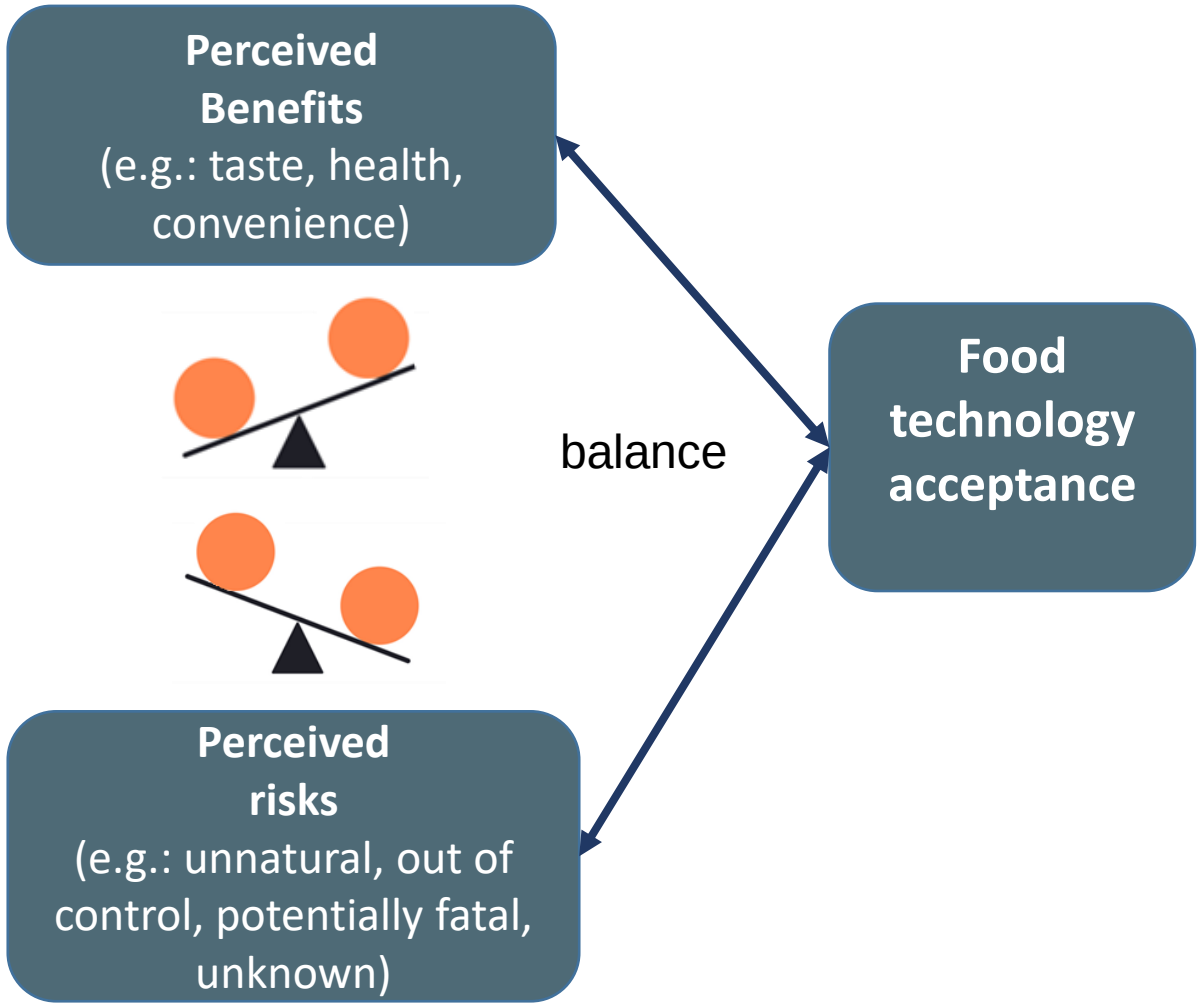
Trends of new food processing methods acceptance

- **Not all new food technologies have been accepted by the consumer**
- When a **new food technology** is introduced into the market, consumers do not focus on the processing method itself, but rather on the **benefits and risks** associated with them



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Sensory appeal/ Taste

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Consumer behaviour considerations

- Major influence on food behaviour, namely in **Greece**, **Portugal**, and **Spain** (Slide 8)
- **Taste:** basic sensations detected by our taste buds—sweet, sour, salty, bitter, and umami (this perception comes only from the tongue)
- **Flavour:** combination of taste, smell, texture, and even temperature. It is how we experience food more holistically
- **Example:** a strawberry's taste might be sweet and slightly sour, but its flavour includes its aroma, juiciness, and how it feels in the mouths (e.g.: unnatural, out of control, potentially fatal, unknown)

The **Mediterranean diet**

- Rich in flavour and diverse tastes, combining fresh, natural ingredients with aromatic herbs and healthy fats
- The diet incorporates all five basic tastes:

  Sweet – Found in fresh fruits (figs, oranges, grapes) and honey

  Sour – Present in citrus fruits, vinegar, and yogurt

  Salty – From olives, cheese (like feta and Manchego), and seafood

  Bitter – Found in leafy greens, olive oil, and some nuts

  Umami – Comes from tomatoes, mushrooms, aged cheese, and fish

Food technology considerations

- **Concerns** about technology influences flavour expectations:
  - The **flavour ratings are lower** when people know that the product is produced by a new food processed method
  - The **flavour ratings increase** when people are exposed to the new product, when statements about safety are made and when **benefits are described**

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Example: Nanotechnology applied to food

CHAPTER 15

Designing and development of food structure with high acceptance based on the consumer perception

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Food technology considerations

- **Nanotechnology:** emerging technology that involve the production, processing, and application of structures, devices and systems, by controlling their shape and nanoscale size (very small particles: scale between 1 and 100 nm)
- The use of nanostructures in the food industry can **increase** the **solubility** and **bioavailability** of compounds, change the sensory properties of food, or promote a controlled release of certain compounds, especially those that have low water solubility
- Major focus of nanotechnology applications in food: the development of nanostructured or nanotextured food ingredients and delivery systems for nutrients and supplements
- Food products resulting from the application of nanotechnologies can have intentional implications on consumers' sensorial experiences, through an **improved sensorial profile**, providing the same sensorial profile **with enhanced nutrition profile**, or **masking undesirable sensations**

Consumer behaviour considerations

- Consumer acceptance of new foods resulting from nanotechnologies, and other technologies resulting from modifications in the food structure has not been unanimous: carbohydrates, proteins, and lipids are major structural components of natural and processed foods and deliver several functional properties, contributing namely to the foods' appearance, aroma, taste, and texture
- Reducing these components affects not only taste but also aroma, texture, and appearance
- This is particularly relevant in occidental societies, as sensory appeal is reported as one of the most important factors that influence individual food choices (**slide 8**)
- Consumer low awareness of nanotechnology (**slide 20**)

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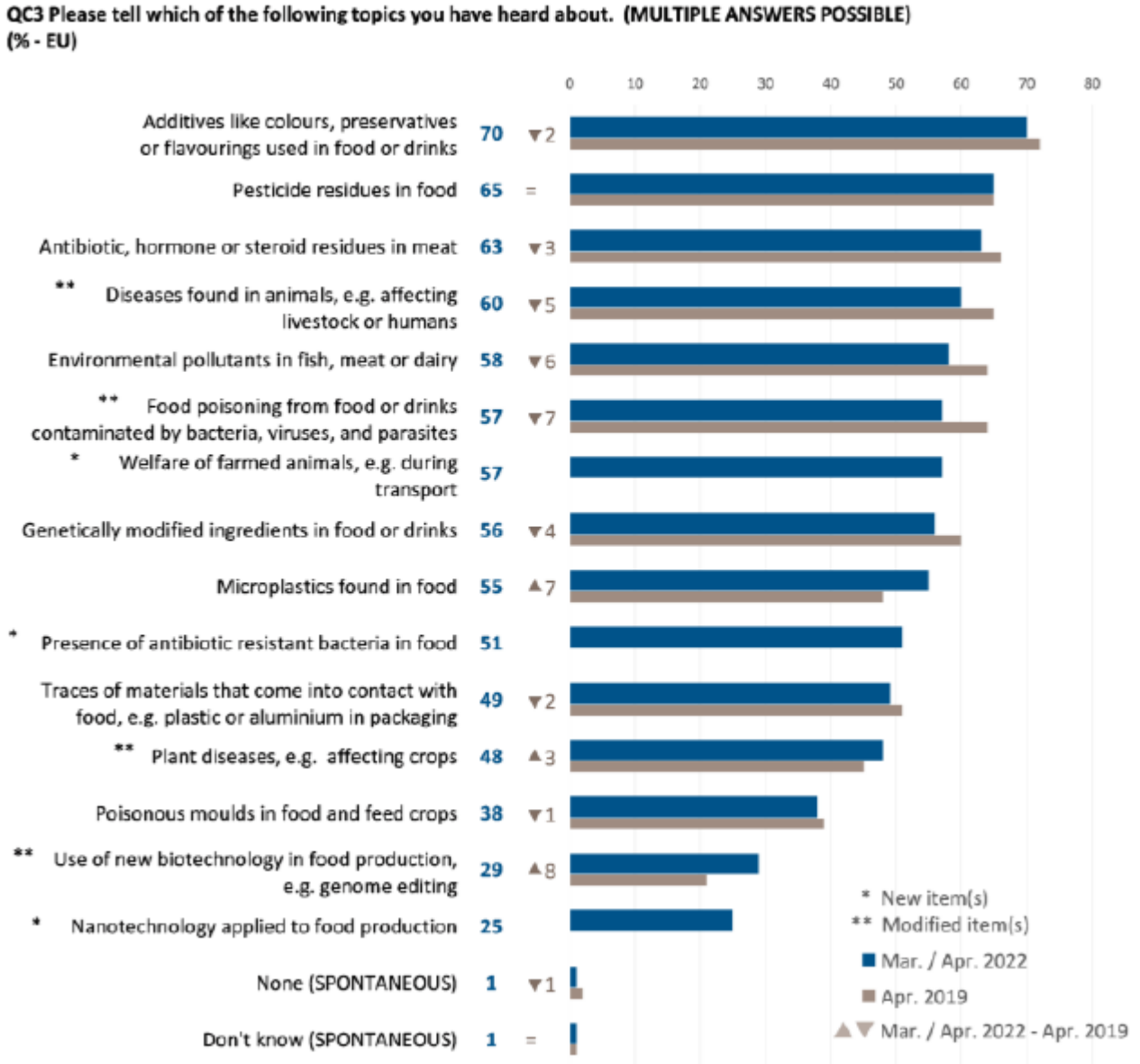
Awareness of food safety topics



Nanotechnology applied to food production register a low level of awareness (25%)

Source: Special Eurobarometer 97.2, Food safety in the EU, p. 22

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Health / Wellbeing

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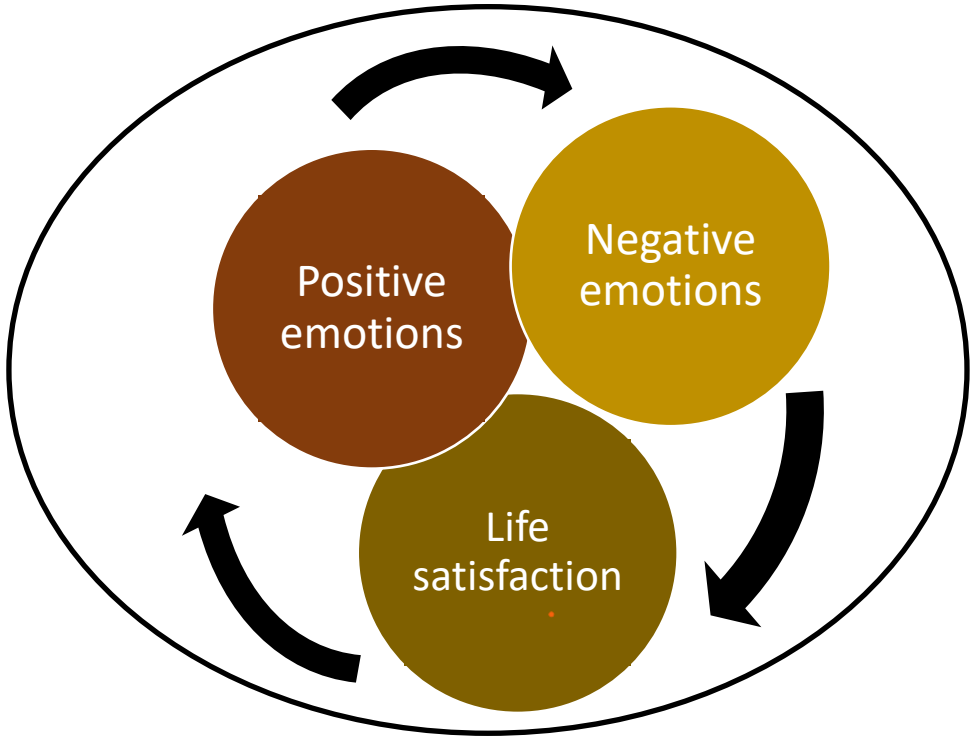
Wellbeing

Affective dimension



Cognitive dimension

Food & wellbeing

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Food Quality and Preference

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Consumers' associations with wellbeing in a food-related context: A cross-cultural study

Gastón Ares [a,*], Luis de Saldamando [a], Ana Giménez [a], Anna Claret [b], Luís M. Cunha [c], Luis Guerrero [b], Ana Pinto de Moura [d], Denize C.R. Oliveira [e], Ronan Symoneaux [f], Rosires Deliza [g]

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Wellbeing

Table 3
Frequency of mention of the dimensions identified when participants were asked to write down the first four words that came to their minds when thinking of wellbeing in the five countries, and results from chi-square per cell test.

Dimension	Example of the most relevant categories	Number of mentions				
		Brazil	France	Portugal	Spain	Uruguay
Psychological	Calm, Happiness, Comfort, Pleasure	194 (−)***	362 (+)***	281	287	259
Physical health	Health, Exercise, Rest	187 (+)***	72 (−)***	143	127	138 (+)*
Social	Family, Friendship, Sharing	58 (+)*	29 (−)*	52	53	26 (−)*
Foods	Specific foods, Dieting, Eating	63 (+)***	39	32	30	29
Environment	Nature, Environment, Warmth	24 (−)*	61 (+)***	42	25 (−)*	27
Economical	Money, Economic stability	27	3 (−)***	21	40 (+)***	6 (−)**
Global evaluation	Quality of life, Personal fulfilment	19	6 (−)*	7	16	15
Occupational	Work, Professional success	10	1 (−)**	12	20 (+)***	7
Intellectual	Mental performance, Intellectual development	14	6	8	5	16(+)**

Effect of the chi square per cell. (+) or (−) indicate that the observed value is higher or lower than the expected theoretical value: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

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Foods & Wellbeing

Table 4
Frequency of mention of the dimensions identified when participants were asked to write down the first four words that came to their minds when thinking of foods and wellbeing in the five countries, and results from chi-square per cell test.

Dimension	Example of the most relevant categories	Number of mentions				
		Brazil	France	Portugal	Spain	Uruguay
Specific foods	Fruits, Vegetables, Meat, Fish and seafood, Water	258 (+)***	119 (−)***	317 (+)***	79 (−)***	147
Characteristics of foods	Flavor, Quality, Natural, Organic, Freshness, Safety, Calories, Price, Fat content	126 (−)**	189 (+)***	89 (−)***	211 (+)***	125
Physical health	Health, Nourishment, Digestion	87	45 (−)***	46 (−)***	123 (+)***	90 (+)**
Psychological aspects	Pleasure, Relax, Equilibrium, Happiness, Vitality	42 (−)***	69	56	90 (+)***	69
Eating patterns	Diet, Balanced diet, Variety, Quantity	37	59 (+)***	34	37	41
Context	Environment, Sharing, Context	25	49 (+)***	28	37	5 (−)***
Food preparation	Cooking, Home-made food, Cooking methods	4 (−)*	12	13	9	9

Effect of the chi square per cell. (+) or (−) indicate that the observed value is higher or lower than the expected theoretical value: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

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Consumer behaviour considerations

- Many factors determine and influence health: a combination of **modifiable** and **non-modifiable** risk factors (**slide 22**)
- There still exits a **gap between dietary recommendations and actual food consumption patterns** at the general population level in many Western countries (WHO, 2003)
- Health factor has been of increasing importance for consumer choice (**slide 8**)
- Consumers more and more believe that eating healthy products may prevent nutrition-related diseases and improve physical and mental well being of the consumer

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Determinants of health

Non-modifiable factors:
- age
- sex
- genetic susceptibility

Determinants of health → Health, functioning and wellbeing

Modifiable factors:

Behavioural factors: diet
- physical inactivity
- tobacco use
- alcohol consumption

Biological factors:
- hypertension
- hiperinsulinaemia

Societal factors: social
- economical
- cultural
- political

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Food technology considerations

- Consumers connect **functional foods** with control over life and health, being better person and feelings of well being
- **Functional foods:**
  - Provide consumers a modern way to follow a healthy lifestyle, because they combine health and time saving benefits (e.g., they are easy to use and do not need previous preparation)
  - Main condition for consumers **acceptance** of functional foods: **to tasty**
  - **Dilemma for functional food designers**: potential occurrence of off flavours, resulting from enhancing food functionality with bioactive compounds or plant-based phytonutrients

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Functional food groups

- An **unaltered natural food** (e.g., oily fish)
- A food in which a **component has been increased through the production process** or other technologies
- A food to which a **component has been added, by technological or biotechnological means,** providing benefits (e.g., spreadable cream with the addition of phytosterols)
- A food from which a **component has been removed by technological or biotechnological means** so that the food provides a benefit that would otherwise not exist (e.g., yoghurt with reduced fat content)
- A food in which another has replaced one component with more favourable properties (e.g., soft drinks in which sweeteners have replaced sugar)
- A food whose **bioavailability of a component has been modified** (e.g., genetically modified rice in order to increase iron bioavailability)

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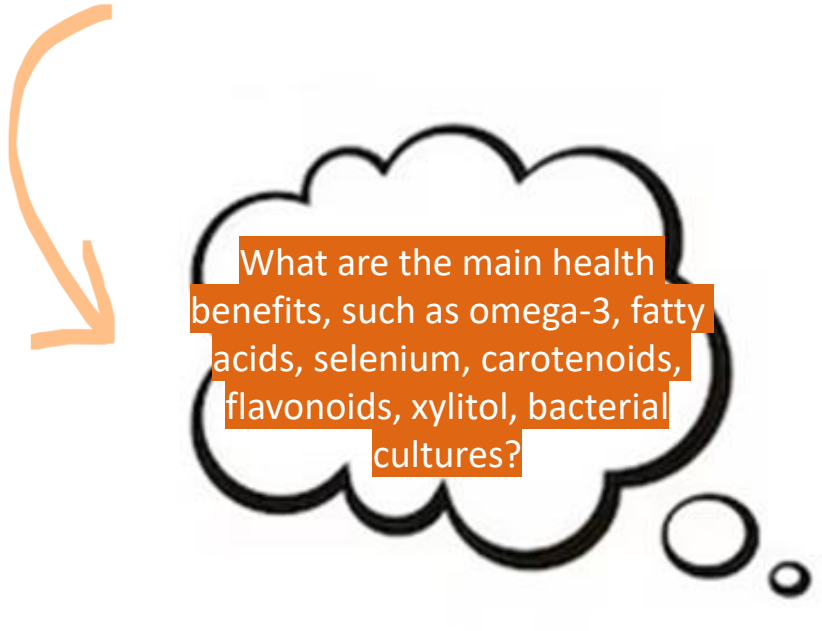
The relevance of health claims

- Food health benefits: **credence attributes** (they cannot be experienced directly)
- Food labelling: **draw attention to** the health benefits of the food product
- The message of health effect or of a specific compound should be communicated in an easy way, as the consumers have a limited awareness and knowledge regarding the development of functional compounds and their health benefits



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Convenience

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Consumer behaviour considerations

- Major concern in food purchase (**slide 8**)
- **Drivers of convenience**: the increasing number of women in the labour market and the change in family structures and lifestyles have reduced the chance to find an adult in the household with the time or the energy to prepare meals process (**slide 33**)
- **Multidimensional phenomenon**: some effort (time, physical energy or mental energy) is saved or reduced throughout the stages of consumption process (**slide 34**)
- Increased consumer demand for foods that have experienced fewer changes during processing and thus retain their natural flavour, colour, and texture and contain fewer additives

Food technology considerations

- Over the last century, advances in food technology have made major contributions to finding convenience food solutions through prolonging the shelf life of foods and enhancing their safety (e.g.: UHT milk treatment has a typical shelf life of six to nine months, until opened, as an alternative to pasteurized milk treatment)
- Nowadays, consumers no longer require a shelf life of several months at ambient temperature: changes in family lifestyle and increased ownership of freezers and microwave ovens are reflected in demands for foods that are convenient to prepare, are suitable for frozen storage, or have a moderate shelf life at ambient temperature
- Three-dimensional (3D) food printing: manufacturing of foods using a robotically controlled process, constructing a typical product layer-by-layer. (**Activity 4**)
- Traditional convenience solutions (thermal treatment) are perceived by consumers as unhealthy and as high-caloric diet

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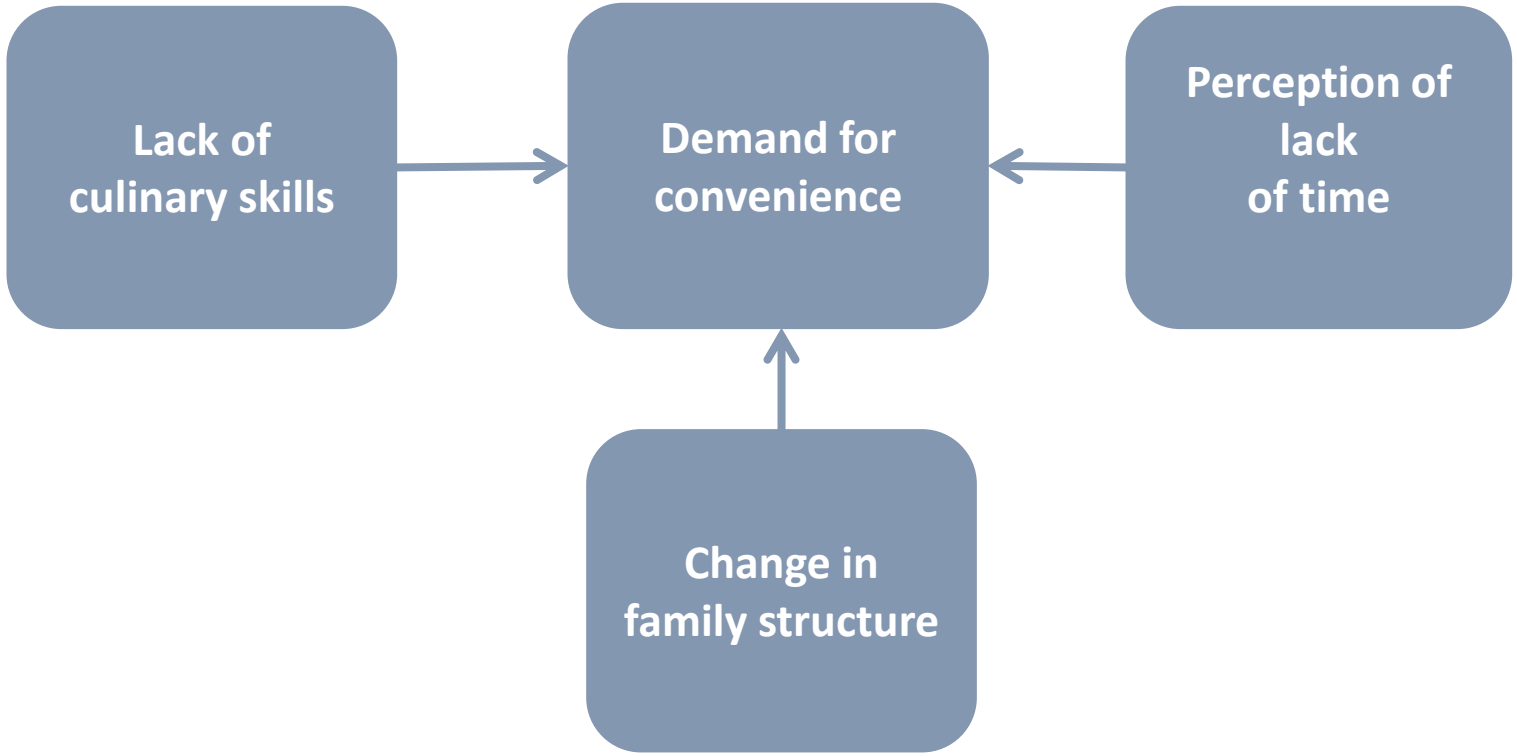
Drivers of convenience



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Dimensions of convenience

What is being saved?

- **Time**
- **Physical energy**
- (e.g., dish washer)
- **Mental energy** (e.g., planning the main course)

Stages of consumption process

Deciding what to eat
↓
Purchasing
↓
Preparation
↓
Consumption
↓
Cleaning up

Price

FOOD INNOVATION AND THE CONSUMER

BLENDED INTENSIVE PROGRAM | ONLINE: 10 - 31 March 2025 | **FACE-TO-FACE:** 4 - 11 April 2025

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- Consumer behaviour considerations
  - Price of food
  - Food affordability: function of **food price** and **household income** (slide 5, slide 36)
  - The **acceptability of new technologies** is that they **do not increase the price of the product**, namely, if they **do not deliver clear benefits as a trade-off**

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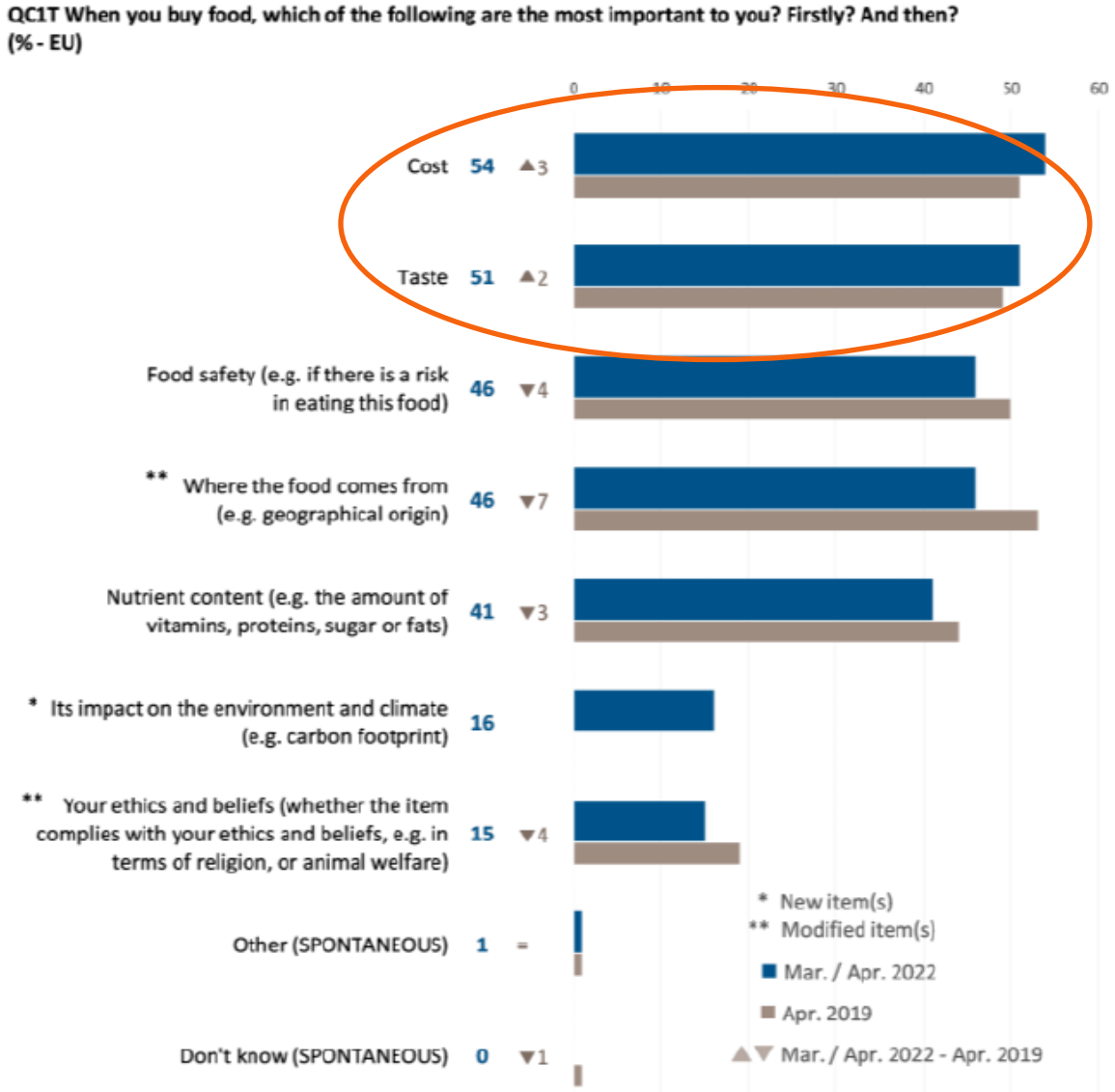
Factors affecting food-related decisions



Cost and taste are the most important factors affecting food-related decisions

Source: Special Eurobarometer 97.2, Food safety in the EU, p. 13

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Examples:

- For **British** and **German** consumers, the most important reasons for considering **buying high-pressure** processed products were that the product was not more expensive than the conventional counterpart and that it had health benefits (Butz et al., 2003)
- **Brazilian** consumers only buy a **high-pressure** pineapple juice if it is a good price for them (Deliza et al., 2003)
- For Turkish consumers, purchase intent of **irradiated foods** was highest when price is same as un-irradiated foods (Gunes & Tekin, 2006)
- **Italian** consumers considered **functional foods** to be more expensive and less easy to find than conventional products (Annunziata and Vecchio, 2011)

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Key messages

- Most consumers are not familiar with food technologies
- New food technologies may be used to produce food products **with benefits that cannot be directly experienced by the consumers**, reinforcing the idea that **trust** has an impact on perceived risk as well as on perceived benefit
- For instance, to **accept functional foods**, consumers must trust the **health claims** (credence attributes) provided by the producer
- For consumers, the **food system** has become more and more technical and abstract, thus, more and **more complex**
- **Main conclusion**: It may be difficult to change consumers´ attitudes toward food technologies because they are motivated to maintain their prior attitudes

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