

1



AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY

2

3

4

TITLE: Complexity and conundrums. Citizens' evaluations of potentially contentious novel food technologies using a deliberative discourse approach

5

6

7

AUTHORS: Gráinne M. Greehy, Mary B. McCarthy, Maeve M. Henchion, Emma J. Dillon and Sinéad N. McCarthy

8

9

10

This article is provided by the author(s) and Teagasc T-Stór in accordance with publisher policies.

Please cite the published version.

The correct citation is available in the T-Stór record for this article.

11

12

NOTICE: This is the author's version of a work that was accepted for publication in *Appetite*. Changes resulting from the publishing process, such as peer review, editing, corrections, structural formatting, and other quality control mechanisms may not be reflected in this document. Changes may have been made to this work since it was submitted for publication. A definitive version was subsequently published in *Appetite*, Vol. 70, November 2013, 37-46. DOI: 10.1016/j.appet.2013.06.083

13

14

15

This item is made available to you under the Creative Commons Attribution-Non commercial-No Derivatives 3.0 License.

16



17

1 **Complexity and conundrums. Citizens' evaluations of potentially contentious novel**
2 **food technologies using a deliberative discourse approach**

3
4 Gráinne M. Greehy¹, Mary B. McCarthy¹, Maeve M. Henchion², Emma J. Dillon² and
5 Sinéad N. McCarthy²

6
7 *1 Department of Food Business and Development, University College Cork, Ireland*

8 *2 Teagasc Food Research Centre, Dublin, Ireland*

9
10 **Corresponding Author:** Mary B. McCarthy, Department of Food Business and
11 Development, Room 2.29, O Rahilly Building, University College Cork, College Road,
12 Cork, Ireland.

13 Email: m.mccarthy@ucc.ie

14 Tel: 353-21-4902075

15 Fax: 353-21-4903358

16
17 **Acknowledgements**

18 We wish to thank the research advisory committee and the participating citizens and
19 scientists for their contributions to this work.

20
21 **Funding**

22 This research has been undertaken as part of a FIRM (Food Institutional Research
23 Measure) project funded through the Department of Agriculture, Food and the Marine
24 (Ireland) under the National Development Plan 2007-2013.

1 **Abstract**

2 This research considers the processes involved in the formation of attitudes by citizens
3 on potentially contentious novel food technologies (NFTs). Observations of one-to-one
4 deliberative discourses between food scientists and citizens, during which they
5 discussed these technologies, form the basis of this enquiry. This approach enables an
6 exploration of how individuals construct meaning around as well as interpret
7 information about the technologies. Thematic analysis identifies key features that
8 provide the frameworks for citizens' evaluations. How individuals make sense of these
9 technologies is shaped by their beliefs, values and personal characteristics; their
10 perceptions of power and control over the development and sale of NFT related
11 products; and, the extent to which these products are relevant to their personal lives.
12 Internal negotiations between these influences are evident, and evaluations are based on
13 the relative importance of each influence to the individual. Internal conflicts and
14 tensions are associated with citizens' evolving evaluative processes, which may in turn
15 present as attitude ambivalence and instability. Many challenges are linked with
16 engaging with the general public about these technologies, as levels of knowledge,
17 understanding and interest vary.

18

19 **Keywords**

20 Novel food technologies, citizen acceptance, attitude formation, risk communication,
21 deliberative discourse, thematic analysis.

1 **1. Introduction**

2 Novel food technologies (NFTs) are scientific and technological developments that
3 enhance the way food is produced or processed, which may or may not result in
4 differentiated products for consumers. The public perceive and evaluate both
5 technologies and food in numerous, and sometimes unexpected, ways based on
6 associated meanings that are socially constructed and strongly embedded, i.e. shaped by
7 prior beliefs and expectations. Given the wide array of influences that can intersect and
8 interact in the evaluations of NFTs, it is not surprising that they are not all equally
9 acceptable or homogeneously evaluated.

10 To date, these technologies have been met with mixed public responses. A review
11 commissioned by the FSA, UK (Fell et al., 2009) found that the majority of Europeans
12 tend to be undecided in their opinions or feel inadequately informed to establish
13 definitive opinions, while a minority are either strongly negative or positive. Negative
14 reactions to irradiated and genetically modified (GM) foods highlight that acceptance
15 cannot be assumed (Henson, 1995; Shaw, 2002) and lack of acceptance can result in
16 significant financial and other losses (Macoubrie, 2006). Public wariness of NFTs is
17 sometimes explained by the evaluative criteria applied, which Cardello et al. (2007)
18 describes as involving perceived rather than actual risks. In fact, Shepherd (2008: 236)
19 suggests that the public may have concerns about food related risks which are outside
20 the “*risk framings*” imposed by scientists and regulators. Communication based on
21 meaningful recognition of public concerns may enhance interaction and engagement

1 between stakeholders, in turn facilitating more informed public decision making about
2 NFTs (House of Lords, 2010). Many have argued the importance of identifying and
3 incorporating the views of the public at an early stage of technological and product
4 development (Siegrist et al., 2008), since their perspectives can directly (e.g. through
5 outright rejection) and indirectly (e.g. through the imposition of stricter regulations)
6 impact the progress of these technologies (Siegrist, 2010). Given the considerable scale
7 of investment required to develop these technologies, which is frequently funded by the
8 tax payer, it is important to determine the common features underpinning public
9 attitudes towards them, prior to their development/ commercialisation.

10 Public attitudes towards NFTs have been explored at length, predominately through
11 quantitative methods (e.g., Bredahl, 2001; Grunert et al., 2003; Gaskell et al., 2010);
12 which assume that the attitudes under investigation are stable. Several of these studies
13 have presented models which offer a valuable point of departure for this research. These
14 models suggest that attitudes to nature and technology, perceived knowledge of the
15 technology, social trust and the affect heuristic, among other determinants, are
16 significant predictors of risk and benefit perceptions, and in turn overall attitudes
17 towards and willingness to purchase GM and nano foods (e.g., Bredahl, 2001; Chen &
18 Li, 2007, Siegrist et al., 2007).

19 A considerable body of work exists that considers the issue of acceptance of NFTs.
20 This work suggests that citizen acceptance is influenced by factors such as knowledge
21 of the technology (Cardello et al., 2007); heuristics, particularly trust and perceived

1 control (Henson, 1995; Siegrist & Cvetkovich, 2000; López-Vázquez et al., 2012);
2 individuals' risk and benefit perceptions (Cardello, 2003); general attitudes and values;
3 concepts and images associated with the technology (Siegrist, 2008); product
4 characteristics including perceived taste, naturalness and price (Rozin, 2005); the
5 specific technology, application and product in question; and individuals' socio-
6 demographic characteristics (Fell et al., 2009; Rollin et al., 2011).

7 These influences can be classed as either top-down or bottom-up (Bredahl, 2001;
8 Grunert et al, 2003). Cultural and social norms (Ronteltap et al., 2007) and general
9 attitudes and values, including attitudes towards science and technology, nature and the
10 environment and ethical and moral concerns (Bredahl, 2001; Kahan et al., 2007; Rollin
11 et al., 2011) are commonly cited top-down influences that can shape risk and benefit
12 assessments and also directly shape evaluations of NFTs. Slovic (1987) notes that initial
13 evaluations, framed by these top-down influences, become a core part of final positions
14 taken on a technology, irrespective of any additional contra-evidence presented. That
15 said, information and the sources of such information can impact citizens' attitudes in a
16 variety of ways (Gunes & Tekin, 2006; Rollin et al., 2011).

17 Focusing on attitude formations, this research explores citizens' evaluations of NFTs
18 in an effort to understand emerging attitudes. Ajzen and Fishbien (1977: 889) argue that
19 "*a person's attitude represents his evaluation of the entity in question*"; however, the
20 operationalization of information processing and formation of attitudes are topics of on-
21 going debate. Broadly examining these issues, attitude formations are guided by the

1 processing of accessible information (Bohner & Dickel, 2011). Previously held attitudes
2 also influence how information on a new concept is processed and thus the formation of
3 new attitudes (Conrey & Smith, 2007).

4 Many authors within the area of social psychology define “*attitudes*” as relatively
5 stable entities formed based on associations and evaluations “*stored in memory*”, while
6 others define them as relatively unstable entities and focus on the “*temporary*
7 *constructions*” guiding attitude formations (see Bohner & Dickel, 2011). Cunningham
8 et al. (2007) consider attitudes to be relatively stable entities, while Conrey and Smith
9 (2007) stress the flexibility of attitude formations, supporting the “*distributed,*
10 *connectionist*” perspective, which assumes that attitudes occur from the reconstruction
11 of unique configurations of inputs (contextual cues) drawn upon within given contexts.
12 They argue that attitudes are “*time-dependent states of the system rather than as static*
13 *‘things’ that are ‘stored’ in memory*”, thereby supporting the premise that attitude
14 formations occur “*on the spot*” and are more open to change (*Ibid:* 718).

15 The provision of information is a key element in the formation of attitudes and thus
16 information processing. Ortony et al. (2005) outline how information processing can
17 occur at reactive, routine and reflective levels. A cognitive component, an emotional
18 component and a behavioural component can influence attitude formations at these
19 different levels (Kazemifard et al., 2005). Edwards (1990: 203) argues that as a result of
20 this “*diversity of attitudes’ origins (...) the process of changing an attitude presents a*
21 *formidable challenge*”.

1 Closely linked to the concepts of attitude formation and information processing, is
2 that of information framing, which is traditionally referred to from the perspective of
3 media (message) framing of an issue or topic (de Vreese, 2005), i.e. how information
4 senders frame or code a communicated message (Gamson et al., 1992; Scheufele, 2000).
5 Drawing on Reese's (2001) position, that the framing concept should not be restricted in
6 this way, this research focuses on how citizens decode information received and what
7 other information and wider environmental influences they draw on, in order to
8 "*construct meaning*" (Gamson et al., 1992: 373) and form, or change, attitudes.
9 Gamson et al. (1992: 375) highlight the importance of understanding how information is
10 decoded once received, as dominant meanings may not be "*passively accepted by*
11 *everybody*". Bearing in mind this context, this research explores the "*mentally stored*
12 *clusters of ideas that guide individuals' processing of information*" (Entman, 1993: 53);
13 in effect, the factors framing citizens' evaluations of potentially contentious NFTs.

14 This research contributes to an understanding of how citizens' evaluate (form
15 attitudes around and accept/reject) NFTs by considering responses to information about
16 irradiated foods, GM foods and nanofoods.¹ Factors such as novelty, moral and ethical
17 concerns, stage of development and proximity to the market place, potential types and
18 levels of risks and benefits and likelihood for public debate (Fell et al., 2009; Rollin et
19 al., 2011) guided the selection of these technologies. These technologies form a natural
20 grouping as each of them has the potential for contention and controversy from a public

1. For the purposes of this paper, "nanofoods" refer to foods and food packaging produced using nanotechnology.

1 acceptance perspective. Recent studies suggest that while there are relatively high levels
2 of public awareness of GM foods (Rollin et al., 2011), there are low levels of awareness
3 of food irradiation (Gunes & Tekin, 2006; Frewer et al., 2011) and nanotechnology
4 (Kahan et al., 2007; Gaskell et al., 2010). Although these technologies differ in terms of
5 public awareness, techniques applied and their duration of application, they face many
6 similar challenges in terms of gaining public (consumer) acceptance.

7 The primary aim of this research was to explore how citizens form evaluations on
8 (formations of attitudes around) NFTs. Individuals' construction of meanings around
9 and interpretation of information about NFTs is explored, i.e. how attitudes form and
10 change. This research therefore provides insights into how new information is used and
11 assimilated and the implications of this on attitudes and acceptance.

12 In the following sections, the methodological approach is summarised and the
13 research findings are presented. Drawing on these findings, the paper concludes with a
14 discussion regarding public evaluations of NFTs and implications for communication
15 strategies.

16

17 **2. Methodology**

18 This research applies a qualitative approach, which offers "*a multilayered view of the*
19 *nuances of social reality*" (Hesse-Biber, 2010: 456), to delve more deeply, and thus
20 provide greater insights into evaluative processes and reactionary responses towards

1 potentially contentious NFTs as information is presented to citizens. It thereby
2 illustrates the complexity and conundrums associated with these evaluative processes.

3 To appreciate the significance of the different features framing citizens' evaluations
4 of NFTs, a research approach that allows for the unfolding of participants' evaluative
5 processes was applied. Of particular interest was to ascertain how citizens form
6 opinions, i.e. their evolving perspectives, as information was presented. Thus,
7 observations of one-to-one deliberative discourses (a structured, interactive
8 conversation during which a question or issue is discussed in detail) between a food
9 scientist and citizens, where they discussed a NFT, formed the basis of this enquiry.

10 This approach was essentially a dialogue between those directly involved in the
11 production of knowledge and the audience for whom meanings associated with this
12 knowledge are just as, if not more, important than the knowledge itself. Scientists'
13 involvement in the process meant that any questions posed by participants about the
14 technology could be responded to and expanded upon. The scientist's involvement also
15 guided individuals towards more reflective types of responses. The discourse approach
16 enabled a detailed exploration of both the cognitive and affective responses framing
17 citizens' evaluations, rather than establishing overall general opinions about the
18 technologies across a large sample group. The approach therefore provided depth rather
19 than breadth in terms of examining citizens' evaluations.

20 As described by Merriam (2009: 13), researchers operating in the qualitative sphere
21 are primarily interested in "*understanding the meaning people have constructed, that is,*

1 *how people make sense of their world and the experiences they have in the world”.*
2 Posing explicit questions results in rational reason-based responses which may conceal
3 *“not only the symbolic but also the emotional and experiential material that drives*
4 *cognition and behaviour”* (Joffe, 2011: 212). This approach moves away from the
5 quantitative positivist approach as well as the more traditional in-depth interview, where
6 a direct “questioning and answering approach” often forces participants to provide
7 polarised answers. The discourse approach supported more reactive and reflective types
8 of responses by participants; it also facilitated two-way interaction with questioning by
9 participants, rather than just the interviewer.

10 For each technology, a scientist with relevant expertise was selected to participate;
11 each scientist participated in a minimum of five discourses. Citizens were recruited from
12 the general public based on pre-defined criteria presented in a screening questionnaire.
13 The sample included a mix of socio-demographic backgrounds; ages ranged from 20 to
14 64 and occupations ranged from students to retirees. Individuals were only recruited if
15 directly involved in food purchase decisions; as these individuals can influence the food
16 consumption decisions of their households and are more likely to have formed opinions
17 about food. Other recruitment criteria included not being employed within the food
18 sector and displaying moderate to high level of generalised self-confidence, thus
19 increasing the likelihood of good interaction with the scientist.² At screening, citizens
20 were also asked several questions about their levels of subjective knowledge and

2. Questions posed were adapted from a scales developed by Day and Hamblin (1964).

1 concern about food production and processing, to ensure a variety of perspectives
2 among participants. A monetary incentive (€50 payment) was provided to participate.
3 Ethical approval to undertake this research was received from UCC Social Research
4 Ethics Committee.

5 In total, 17 citizens participated; seven participated in the nanotechnology discourses,
6 five in the GM discourses and five in the irradiation discourses. The number of
7 participants was pre-defined at 17 to increase the likelihood of reaching theoretical
8 saturation, which Bertaux (1981) and Guest et al. (2006) suggest is reached by
9 analysing 15 and 12 in-depth interviews respectively. We found that having analysed 14
10 of the discourse transcripts, no additional themes emerged in terms of the common
11 features influencing and directing evaluations across the set of potentially contentious
12 NFTs, i.e. theoretical saturation was achieved.

13 In addition to the deliberative discourse, participants completed pre- and post-
14 discourse interviews (the latter averaging 25 minutes in length) with the researcher, to
15 determine their knowledge before and perspectives after participating in the discourse.
16 The post-discourse interview was an effective means of member checking participants'
17 views. Overall, this multi-method approach involved three interactions with each
18 participant. A detailed "discourse guide" was prepared for the scientists to help them to
19 navigate through the discourse process and to ensure consistency, i.e. a similar structure
20 and context, across the discourses. The guide provided the framework for the two-way

1 discussion, within the boundaries of ensuring certain information on the technology was
2 communicated.

3 A pre-discourse interview was undertaken with participating citizens to establish
4 their knowledge of and attitudes towards the relevant technology. Participants were not
5 informed about the technology in advance to control for proactive information
6 searching. As public awareness of NFTs is generally low (Macoubrie, 2006; Kahan et
7 al., 2007; Fell et al., 2009); the citizens were given a summary sheet to read,
8 immediately prior to the discourse. This summary sheet included some factual (neutral)
9 information about the technology, thereby ensuring that participants had a minimum
10 standard level of information and basic awareness about the technology in advance of
11 the discourse.³ During the discourse, the participant considered the initial information
12 provided and questioned the scientist regarding this. The scientist then added
13 information that the participant reacted to and reflected on. An excerpt from one of the
14 discourse transcripts is included in Appendix 1 to illustrate the format of the interaction.

15 In considering the influence of potential ‘bottom-up’ features on evaluations of
16 NFTs, the scientists presented a number of pre-defined hypothetical, albeit topical,
17 scenarios of applications of the relevant technology.^{4&5} Naturally, the focus of the

3. The summary sheets were piloted on a range of individuals from different socio-demographic backgrounds to ensure clarity and comprehension and circulated to the relevant participating scientist for review and comment. The summary sheets are available on request from the authors.

4. The scenarios were developed following a review of literature, project team deliberation and consultation with the participating scientists. The hypothetical scenarios are available on request from the authors.

5. The scientists stressed that the scenarios were hypothetical to ensure participants understood that the risks and benefits presented were only discussion points and some of the product examples are not available on the market at present.

1 discussion within each discourse group centred on the attributes most relevant to the
 2 scenarios presented. Importantly, all scenarios (summarised in Table 1) incorporated
 3 hypothetical benefits, negative aspects and known and unknown risks of different
 4 applications of the NFTs from a consumer, societal, environmental and industry
 5 perspective.

6 *Table 1: Overview of Scenarios of Food Applications of the Technologies Presented to Citizens*

	Nanotechnology Discourses	Genetic Modification Discourses	Food Irradiation Discourses
Scenario 1	Food processing: removing unhealthy ingredients without compromising taste	Food processing: using a GM processing aid in cheese production in place of rennet	Irradiating fresh fruits and vegetables (at low doses) to prolong shelf life
Scenario 2	Food processing: adding healthy ingredients without compromising taste	Agricultural production: growing GM wheat crops	Irradiating spices (at low-medium doses) to kill insects/ reduce micro-organisms and bacteria
Scenario 3	Food packaging: to increase shelf life and indicate food spoilage etc.	Animal production: breeding a GM pig that is healthier and more environmentally friendly	Applying irradiation (at medium doses) to meat products to kill disease causing micro-organisms (e.g. E-coli)
Scenario 4	Food production: nanocoatings on machinery to increase food safety and reduce the need for cleaning agents	Food production: enhancing food products (e.g. the shelf life and health characteristics of fruits) through genetic modification	Applying irradiation (at high doses) to sterilise foods for consumption by specific consumer groups

7
 8 Citizens were probed (see Table 2) at each stage of scenario expansion to ascertain
 9 their evolving evaluative processes in light of additional information.

1 *Table 2: Examples of Questions Posed to Citizens during the Presentation of the Scenarios of*
 2 *Different Applications of the Technology*

Based on this additional information:
<ul style="list-style-type: none"> • What is your opinion about using the technology in this way? Why do you feel like this? • Would you be open to the supply of this type of food product in Ireland? • Would you have any concerns about this type of food product? • What kinds of people do you think would be interested in such food products? • Has this additional information modified your views in any way? • How should such products be regulated in your opinion? • How important do you consider the labelling of these types of food products to be? • In your opinion, should industry adopt this technology?

3 The lead researcher observed the discourses, as a non-participant. Two pilot
 4 discourses were completed; debriefing interviews confirmed that the proposed format of
 5 the discourse was appropriate, i.e. elicited adequate information. As no significant
 6 alterations were made to the approach, the pilot data are included in this analysis. Each
 7 discourse, ranging from 40 to 65 minutes in length, was audio recorded and later
 8 transcribed verbatim by a commercial transcription company, including features
 9 potentially pertinent to interpretation of the transcripts (e.g. pauses and laughter).

10 Detailed thematic analysis was undertaken on the discourse and interview transcripts
 11 with the support of a qualitative software package (NVivo9), following the approach of
 12 Braun and Clarke (2006). Thematic analysis involves identifying, coding, analysing and
 13 reporting themes within the data and interpreting these emerging themes in the context
 14 of the research questions. Several transcripts were independently coded by members of

1 the research team to ensure that no relevant codes or themes common across the NFTs
2 had been overlooked. The involvement of researchers with a variety of perspectives (i.e.
3 backgrounds in consumer behaviour, risk communication, economics and nutrition)
4 strengthened the internal validity and reflexivity of the analytic process (Jootun et al.,
5 2009), minimising any potential interpretative bias. All codes and potential sub-themes
6 were grouped together and reviewed for consistency, variability and emergent patterns
7 as part of a consultative process. This iterative analytic process ultimately led to the
8 emergence of the themes outlined.

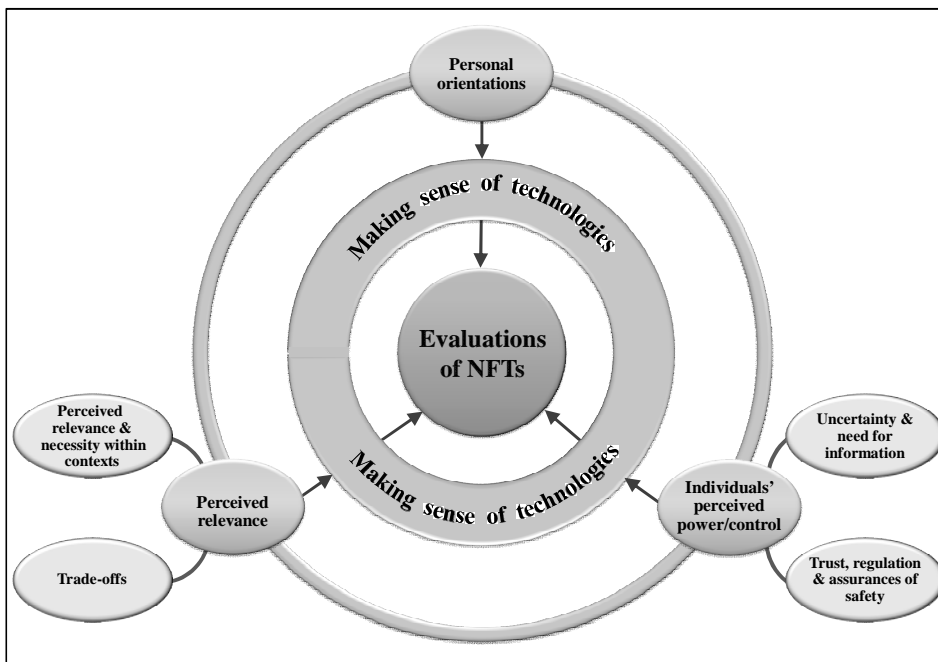
9

10 **3. Findings⁶**

11 Key themes, summarised in Figure 1, emerged in terms of the common features
12 influencing and directing evaluations across the NFTs. The first theme relates to the
13 personal orientations that provide the basic framework for individuals' interpretation of
14 information about and, in turn, evaluations of the technologies. The second theme
15 relates to individuals' perceptions of power and control; specifically how uncertainty,
16 information requirements, trust and regulation impact evaluations. The third theme,
17 "perceived relevance", concerns the impact of perceived benefits and risks on
18 evaluations. As a final stage of evaluations, "making sense of technologies" concerns

6. Quotations from the deliberative discourses and interviews have been edited and irrelevant exclamations and repetitions are omitted. The omission of words or sentences (undertaken to condense quotations and only when such editing did not alter the meaning of the quotation) is indicated with a bracketed ellipsis: (...). An ellipsis without brackets indicates a pause. Finally, text presented in square brackets represents implicit parts of the conversation, expressed in the preceding discussion.

1 the meanings and associations individuals construct when classifying and interpreting
2 information about the technologies. These “meanings” are formed and created by the
3 influences represented in the other themes.



4
5 *Figure 1: Features Influencing Evaluations of Novel Food Technologies*

6
7 ***Theme 1: Personal orientations***

8 This first theme, personal orientations, represents the expression of individuals' inner
9 sense of standards. Initial reflections on the technologies are based on what is valued
10 and whether or not the technologies violate these standards or undermine core values/
11 beliefs. Personality traits and value orientations provide the framework for responses to
12 information about the NFTs and are the foundations for both emotional reactions and

1 reasoned responses. In particular, attitudes to nature, science and technology and
2 general risk sensitivity play important, and sometimes conflicting, roles in forming
3 perspectives.

4 A protectionary stance in terms of man's relationship with nature aligns to general
5 risk sensitivity around food production. Furthermore, this can manifest as moral and
6 ethical objections to the technologies and as a form of food anxiety. Those who view
7 nature as fragile and value the protection of nature worry about the content of food and
8 the potential consequences of applying NFTs: "*Man is always trying to control things.
9 But there's always something that will actually out win us in the end you know...surpass
10 us some way or other. (...) We have a responsibility (...) so how far do you go? (...)
11 There's huge possibilities but there are huge issues. (...) "I think that extreme caution
12 has to be exercised"* (Nano3). The sense of unease around the development of the
13 technologies is evident in the precautionary stance displayed and questioning as to
14 where the limits lie in terms of humans' interference in nature.

15 In contrast, a strong belief about man's dominance over nature leads to open
16 enthusiasm for the technologies, less risk sensitivity and a more *lassiez-faire* perspective
17 in terms of evaluations: "*We will never get anywhere if we are just going to be afraid of
18 everything. (...) There's a risk with everything isn't there...*" (Nano4). Equally, focusing
19 on outlooks towards science and technology, those reacting positively towards the NFTs
20 often portray themselves as techno-enthusiasts, supportive of technological progress: "*I
21 think it's far better to have the technology than not. Because who knows what else it*

1 *will lead onto?"* (Nano1, Post-Discourse Interview). That said, for those whose beliefs
2 centre on maintaining traditions and natural processes, these beliefs are in conflict with
3 a desire to support the fostering of scientific progress and developments.

4 Life experiences offer a mechanism for processing information, and existing
5 understandings of one's social world is a platform for interpretation of the technologies.
6 Thus, the internalised sense of "standards" that supports initial evaluations is based on
7 factors such as work roles, educational experiences, family lifestyles and health
8 experiences. Here, evidence of professional experience aligns with value orientations
9 towards health and long term effects: "*You see that's my own [nursing]*
10 *background....my own profession. (...) I would be more kind of about (...) long term*
11 *health. So I would be kind of worried about that [GM foods]. (...)The long term effects*
12 *(...) I would mind if it [genetic modification] was in most of the food out there"* (GM1).

13 Individuals use technical terms associated with their professions to anchor their
14 evaluations, drawing on existing views from their "professional worlds" to create
15 meanings and associations. Specifically, business professionals (e.g. accountants) draw
16 on these prior experiences, referring to economic impacts of adopting the technologies
17 on food prices, suppliers, and stock and export levels; while caregivers (e.g. social
18 workers) focus on potential enhanced safety characteristics associated with their
19 application: "*I suppose from... the suppliers point of view they have a little bit longer to*
20 *get rid of the stock [by prolonging shelf life through food irradiation] (...) I suppose I*
21 *am just thinking like an accountant you know"* (Irradiation3).

1 Personal orientations, which represent expressions of an inner sense of standards, are
2 clearly drawn upon to form initial evaluations. Perceptions of the technologies violating
3 these “standards” may lead to the demand for both a precautionary approach and control
4 over exposure to the technologies.

6 ***Theme 2: Individuals’ perceived power/control***

7 Two types of uncertainty, knowledge and scientific, are observed that result in
8 distinct responses. While knowledge uncertainty results in the demand for further
9 information and impacts the stability of emerging attitudes, the existence of scientific
10 uncertainty is the basis for immediate reassessment of one’s position. Expressions of
11 dread are closely related to knowledge uncertainty and lack of personal control over
12 potential hazards. Trust in science and regulatory frameworks are therefore considered
13 important where personal control is perceived to be lacking.

14 *Uncertainty and need for information*

15 Scientific uncertainty communicated about potential hazards negatively influences
16 technology evaluations: “*I suppose that’s the reason why the whole world is half afraid*
17 *of those two words, genetically modified...that we don’t know what it’s going to bring*
18 *about*” (GM3). This uncertainty impacts the stability of attitudes: “*You see until you*
19 *told me about those particles...I was grand. But now that I am thinking about them.*
20 *(...) I wouldn’t deliberately buy something that I know would have particles that may*
21 *lodge in my body or my friends or my family’s*” (Nano3). Knowledge uncertainty clearly

1 moderates evaluations: *“I don’t think I would have a problem in eating it [irradiated*
2 *food]. But I suppose I am a bit ignorant to it in that I don’t understand it. (...) How it*
3 *could be harmful in some way?”* (Irradiation1). While initial evaluations are often
4 fashioned by personal orientations, a tendency towards lower concern is evident in cases
5 of low levels of perceived knowledge uncertainty. In particular, the prolonged debate
6 and media discourse around GM foods contribute to a less anxious response: *“10 years*
7 *ago I would have been horrified...I would have actually been very emotional about it. I*
8 *would have said ‘absolutely not’. (...) I mean as the years go on, I am getting less and*
9 *less against GM”* (GM3, Pre-Discourse Interview).

10 The lack of evidence of associated dangers supports positive evaluations: *“There’s*
11 *no stories coming out saying that these [GM] foods are harmful. (...) I don’t see the*
12 *harm in them at the moment”* (GM2). In the case of a long established NFT that has
13 received little media attention, the duration of its existence is taken into account: *“I*
14 *think after 30 years we might know that something was particularly bad”* (Irradiation2).
15 However, limited exposure to discussion about this technology results in a general sense
16 of dread around the technology. Overall, knowledge uncertainty results in a
17 precautionary stance being taken: *“You would need information on it. (...) If I just saw*
18 *nanotechnology I’d kind of...just wonder what’s it about”* (Nano2). A need for further
19 information is therefore evident; there is a general consensus that the public *“wouldn’t*
20 *have a clue”* (Irradiation1) about these NFTs and that accessible information is
21 therefore *“key (...) [in order to] take the fear and the uncertainty away”* (GM2).

1 The importance of openness and transparency is stressed in situations where
2 uncertainty persists about potential associated risks: *“If you don’t know...the
3 repercussions of certain things then you have to be honest with the public”* (Nano7). A
4 demand for personal control and freedom of choice frame evaluations. Thus,
5 acceptance, while not guaranteed, is conditional on the provision of comprehensive
6 information, such as label information, that allows individuals to make informed
7 voluntary choices: *“I would think a majority of consumers would want to know ...where
8 their food has come from like and what it’s gone through”* (Irradiation1, Post
9 Interview). However, it appears the demand for information may not be ubiquitous: *“It
10 wouldn’t bother me (...) the fact that it was...the food was irradiated (...) I wouldn’t see
11 a need for labels”* (Irradiation3). Therefore, while some attempt to limit knowledge
12 uncertainty through information seeking, others use heuristics and tend to display
13 emotional reactions.

14 *Trust, regulation and assurances of safety*

15 Trust in scientists and regulators to control any potential technological risk acts as a
16 heuristic in guiding evaluations: *“From a consumer point of view like, if I went into a
17 supermarket and something is on the shelf I would just presume that it has been passed
18 by all the... authorities that say right, this can be sold here, there’s nothing wrong with
19 it, it’s safe”* (Irradiation5). Individuals’ perceptions of low personal control/power are
20 offset, to varying degrees, by their trust in other stakeholders to ensure protection
21 against potential risks. Desiring personal control over exposure to such risks is tempered

1 with a recognition that this had to be ceded to regulators, due to perceived personal
2 inability to assess safety risks.

3 However, concerns with safety are pervasive and evidence of the need for a
4 precautionary approach is, once again, evident: “*It’s all about being tried and tested*”
5 (Nano4). The need for adequate regulation, transparency and risk assessments is
6 stressed and “*rigorous testing*” and safety assurances are demanded. In fact, positive
7 evaluations are based on the assumption that the NFTs will be adequately regulated.

8 Perceived uncertainty clearly impacts evaluations with knowledge uncertainty
9 influencing the stability of attitudes and scientific uncertainty forming the basis for a
10 cautious response. This uncertainty is closely linked to control in the context of
11 information requirements, trust and regulation.

12

13 ***Theme 3: Perceived relevance***

14 Individuals classify NFT products based on their views of the technologies and
15 benefits offered. Following this, they negotiate these products based on the prioritisation
16 of values in given contexts, in order to shape overall evaluations. While guided by
17 individuals’ personal orientations, the perceived relevance of benefits offered by foods
18 produced using NFTs also impacts perspectives. Foods classified as offering value on
19 dimensions considered important in given contexts are received more favourably: “*If*
20 *it’s prolonging the shelf life and (...) if there’s other health benefits there as well*
21 *then...I would be all for it [food irradiation]*” (Irradiation3). The most notable of these

1 are health, taste, price, safety and shelf life characteristics. Evaluations are generally
2 positive in cases where current offerings on the market place are seen as sub-optimal,
3 and the technologies offer an alternative that eliminates perceived sacrifices between
4 highly valued attributes, particularly health and taste. This theme addresses the concept
5 of perceived relevance and necessity within different contexts. Following this, it
6 examines the formation of perceived risk/benefit trade-offs and their impact on
7 evaluations.

8 *Perceived relevance and necessity within contexts*

9 The perceived relevance of related product benefits to the individual, their family,
10 society, the environment and other stakeholders, and the perceived necessity of the
11 technology applications, impacts openness to the technology. This openness, however,
12 depends on individuals' overall values and priorities. For example, some feel that,
13 subject to any associated risks being adequately addressed, NFT foods that can enhance
14 the health of the nation should be welcomed: *If it [a health promoting nanofood] will*
15 *improve people's lives, well and good"* (Nano3). In fact, if societal benefits are viewed
16 as great enough, personal reservations are set aside and, while not necessarily willing to
17 purchase such products, they believed that they should be made available: *"For myself*
18 *(...) I wouldn't like that [GM crops]. But again I am also aware of (...) the third world*
19 *countries...poverty and all that. (...) I can see how they would benefit...But I wouldn't*
20 *benefit from it really"* (GM3).

1 Those voicing concerns about the impacts of human behaviour on the environment
2 appear open to applications that offered environmental benefits. Furthermore, the
3 suggestion of any environmental risks causes these individuals to negatively reassess
4 their evaluations: *“If it did have negative effects on the surrounding environment (...) it
5 would put me off it...I would see that as dangerous”* (GM1). Those holding a more
6 *lassiez-faire* attitude towards the environment are less exercised about environmental
7 benefits and also less concerned about potential environmental risks. Finally, although
8 the potential impacts of these NFTs on other stakeholders, including food companies
9 and their employees and farmers were raised, such references are secondary to
10 individual and familial implications: *“It [potential impacts on food companies and their
11 employees] wouldn’t be as high on the list as knowing what I have on my plate
12 or...what I give to whoever in the family is safer. (...)...that they are not going to get E-
13 coli from me not cooking it very well”* (Irradiation2).

14 Not all applications are viewed as offering additional benefits, and in these cases,
15 their necessity is questioned, in part due to the perceived adequacy of current food
16 products. For example, some consider it unnecessary to enhance the health
17 characteristics of fruit and vegetables, while others view food safety levels and/or shelf
18 life to be at a satisfactorily high standard: *“I haven’t heard of anybody who is dying or
19 in serious trouble because of the way that they are producing food at the moment”*
20 (Irradiation3). Closely aligned to the concept of perceived necessity, is that of perceived
21 benefit distribution; benefits viewed as not accruing to individuals receive a more muted

1 response. For example, nano coating on equipment is perceived as “*really only of*
2 *benefit to the manufacturer*” (Nano5). Relevance and necessity are linked to perceived
3 trade-offs between benefits and risks and are context specific.

4 *Trade-offs*

5 Deliberation over potential risk/benefit trade-offs is central to product and
6 application specific evaluations. These trade-offs are particularly evident when
7 evaluating applications that offer increased food safety and extended shelf life. For
8 many, perceived losses in terms of naturalness, freshness and healthiness of NFT
9 products are weighed against the additional safety and/or shelf life benefits: “*I suppose*
10 *if you have something for longer, you are going to accept that it’s not going to be as*
11 *nutritious as something you eat straight from the garden*” (Irradiation2). Compounding
12 these trade-offs, and creating an element of tension, is the possibility of further benefits,
13 related to reducing waste, for the environment and their wallets.

14 Price is another key element used in trade-off negotiations. Price premiums are often
15 considered acceptable if related personal benefits are very apparent: “*In general, I*
16 *suppose if the health benefits [of the nanofood] far outweigh the other products on the*
17 *market then I think you would be happy to pay...*” (Nano1). These trade-offs are also
18 considered in the context of others: “*I suppose for me it [the price premium] wouldn’t*
19 *really be a big issue, but I would suspect that for many people (...) [the] cost factor*
20 *would be huge*” (Nano3). Some feel that although they might personally be willing to
21 pay a price premium to avoid NFT products, given their lack of knowledge of

1 associated risks, they could also “*see why other people would go for it...if it was 10% to*
2 *20% cheaper*” (GM1).

3 Tensions are also apparent concerning these perceived trade-offs, particularly in
4 terms of perceived benefits of such foods and concern over potential unknown future
5 consequences of interfering with nature: “*If a pro is a rasher [from a GM pig] that*
6 *tastes a little bit better (...) And the con is something really disastrous that we don’t*
7 *know about yet (...) It’s hard to measure up the two things*” (GM2).

8 The emerging trade-offs derive from individuals’ classifications of the technologies
9 and related product characteristics, which are more broadly impacted by the personal
10 orientations previously outlined. Furthermore, the dynamics of these trade-offs mould,
11 in turn, how individuals create “meanings” around the NFTs.

12

13 ***Theme 4: Making sense of technologies***

14 As a final stage of evaluations, “making sense of technologies” concerns the
15 meanings and associations individuals construct when classifying and interpreting
16 information about the technologies. These “meanings” are formed and created by a set
17 of influences represented in the three other themes. Interpretative schemas, a term used
18 by Scheufele and Tewksbury (2007) to describe knowledge structures that represent
19 salient concepts, appear to be used by individuals to “make sense” of the technologies;
20 essentially to shape evaluations. Both existing schemas, drawn upon from memory, and

1 newly formed schemas are created to provide links and associations and thus
2 frameworks for the contextualisation of information.

3 Reasoned thinking acts as one of the mechanism for forming/creating these schemas
4 around the technologies and prioritising risk and benefit assessments. In an effort to
5 place the NFTs within a context, comparisons are often made to risks and benefits
6 associated with other technologies and innovations. For example, comparisons are made
7 between food irradiation and chemical fumigation and between BSE and genetically
8 modifying animals: “...*definitely not [in favour of genetically modifying] my*
9 *meat...because especially with mad cow disease... (...) I just think that animals....that*
10 *meat could be even more dangerous for that reason*” (GM1). It should be noted that
11 reasoned thinking, based on such comparisons, does not necessarily result in citizens
12 reaching the same conclusions as scientists regarding their assessments of the
13 technologies.

14 Evaluations of these unfamiliar technologies seem to be based on what is known. In
15 fact, a tendency is evident to superimpose the NFTs on pre-existing interpretive
16 schemas, e.g. irradiation to x-rays and cancer. In some cases, this may result in
17 misinterpretation of the information presented. Word associations also support the
18 formation of interpretative schemas. Specific images are generated by individuals
19 around the technologies. For example, images conjured include: the “*injection of*
20 *substances into food*” (genetic modification), “*tiny robots*” and computers
21 (nanotechnology), and “*radiation*” (food irradiation). In fact, the image associations

1 and superimposed interpretative schemas are so strong for “irradiation” that they act as
2 a particular barrier to acceptance: “*The name would kind of put you off a small bit. (...) It’s just to get away from the...radiation...part of the name. (...) If it had a different*
3 *name I think (...) it could take off in a big way*” (Irradiation3).

5 The unknown consequences of adopting the NFTs clearly play on individuals’
6 minds: “*With technology like this...you have to go 30 years down the road before you*
7 *realise the consequences*” (Nano5). In fact, such concerns lead to comparisons to risks
8 now known to be associated with smoking, asbestos, excessive use of x-rays and some
9 food colourants; generally these comparisons raise concerns. That said, reflections
10 around established food technologies (e.g. microwave ovens) appear to cause a positive
11 re-evaluation of initial negative opinions and “intuitive” stances on the NFTs:

12 “*Microwaves seem safe enough (...) I suppose it’s a similar enough technology...in a*
13 *way. And if (...) it’s prolonging the shelf life (...) I would be all for it*” (Irradiation3).

14 In fact, an internal tension is evident, with concern about these technologies being set
15 against evidence of the success and benefits of more well-established food technologies:

16 “*Now...I would much prefer to buy pasteurised milk rather than unpasteurised milk. So*
17 *it [nanotechnology] may go the same way you know*” (Nano3, Post Interview). Indeed,

18 while desiring a precautionary approach, it is suggested that it is “*unfair*” that these
19 NFTs have to “*prove*” themselves through testing, while technologies already in use do
20 not: “*We don’t know the effects of the old stuff either (...) It would be slightly unfair to*
21 *suddenly say it’s the new stuff causing the problems*” (Nano6).

1 While evaluations often appear to be based on the use of interpretative schemas,
2 emotive reactions are also displayed in an effort to “make sense of technologies”,
3 particularly when personal orientations guide evaluations. Affective reactions appear
4 particularly dominant when individuals lack, or perceive themselves to lack, the ability
5 or motivation to understand the information presented, particularly the scientific
6 knowledge to justify their negative opinions: *“It’s lack of knowledge linked with this.
7 (...) So fear comes in or some pre-conditioning”* (Nano3). Individuals display both
8 “rational” and “logical” responses guided by reflective processing and also “emotional
9 response[s]” and “gut reactions”: *“I have no scientific basis. But...just an intuitive
10 sort of suspicion and fear...because you can do what you want to wheat but...when you
11 are getting closer to living things...”* (GM2).

12 Internal conflicts emerge when the aforementioned influences come together to
13 shape and support the construction of scaffolds of “meanings”. Specifically, tensions are
14 evident in terms of conflicting reactive (i.e. emotional) and reflective (i.e. reasoned)
15 responses. Concerns are voiced about the NFTs, while their applications are
16 concurrently viewed as “reasonable” and “rational” (Irradiation2). A further conflict is
17 evident in terms of adopting a precautionary position due to scientific uncertainty and
18 the desire to encourage technological process: *“Nobody can predict what’s going to
19 happen tomorrow let alone in 100 years time. So...it’s very unfair to put a stop on it
20 because someone says in 100 years time it could be bad”* (GM5).

1 The meanings constructed, and in turn evaluations of the technologies and associated
2 risks and benefits, are not homogenous across the sample. Unique “rule books” of
3 acceptance are formed, shaped by the influences represented in the other themes. A key
4 component of such rule books is individuals’ classification of the applications and
5 products and the associated meanings reflected upon when forming evaluations. For
6 example, individuals’ personal rule books may vary in terms of what they perceived as
7 natural; i.e., some consider GM foods to be an acceleration of a natural process “*just on*
8 *a more fundamental level*” (GM2), while others view it as unnatural: “*When you can*
9 *grow it [GM crops] anywhere (...) it’s not natural (...) I don’t think it’s right to have*
10 *wheat growing somewhere where you wouldn’t normally have it*” (GM1). Furthermore,
11 as part of this rule book, individuals display what Hallman (2000: 15) refers to as a
12 “*hierarchy of approval*” in terms of their acceptance of the applications, based on the
13 aforementioned influences. Specifically, irradiating meat to increase food safety is
14 generally considered more acceptable than irradiating fruit to prolong shelf life. GM
15 plant applications are also considered more acceptable than GM animal applications,
16 due, in part, to perceptions of unnaturalness. These rule books are an important “tool”
17 drawn upon to provide a scaffold for contextualising information and constructing
18 meanings around the technologies.

19

20

21

1 **4. Discussion and conclusion**

2 In this paper, we focused on how the processes involved in citizens' evaluations of
3 NFTs occur as information is assimilated. We contend that "making sense of
4 technologies" involves the use of interpretative schemas (Goffman, 1974), including
5 both existing schemas, drawn upon from long-term memory (Peter et al., 1999), and
6 newly formed schemas that are created to provide the framework for individuals'
7 contextualisation of information (Gamson et al., 1992). Personal orientations result in
8 the formation of inner "standards" which provide a strong basis for making sense of
9 technologies by providing existing schemas upon which to form opinions. Perceptions
10 of the technologies violating these standards may lead to the demand for a precautionary
11 approach. Perceived control and trust in science and regulators are a basis for attitudes
12 to change if any scientific or knowledge uncertainty transpires; if trust exists; the extent
13 of attitude changes due to new information may be moderated. Openness to the
14 technology is therefore influenced by trust and perceived control; the lower the trust
15 level, the more cautious a person is with regard to the technology. The perceived
16 relevance and necessity of the applications and associated products to a person's
17 everyday life and important values provides a platform for evaluations. Such relevance
18 and necessity are linked to perceived risk/benefit trade-offs within specific contexts.

19 Personal orientations and comparisons to other technologies are important in
20 providing what Burri (2009: 507) refers to as "*interpretative patterns that served as*
21 *tools in decision making*" in terms of evaluations of nanotechnology. We observe that

1 the processes through which citizens “make sense of technologies” occurs at both
2 reflective and shallow levels, depending on personal orientations, the specific
3 technology and perceived uncertainty and control. The impact and relevance of
4 information on evaluations varies, depending not only on the technology, but also the
5 specific application and product in question (as postulated by Fell et al., 2009 and Rollin
6 et al., 2011) and individuals’ characteristics and interpretations of information. Our
7 analysis suggests that personal orientations (top-down characteristics) impact
8 evaluations and in keeping with the work of Bredahl (2001) and Grunert et al. (2003),
9 specific product characteristics (bottom-up characteristics) are also influential. In the
10 context of classifying product characteristics, Furst et al. (1996) draw attention to the
11 processes enacted by individuals during the emergence of their food choice trajectories,
12 suggesting that individuals prioritise values; classify foods based on these values in
13 given contexts; and, then select foods in accordance with these. The product fit at a
14 practical and conceptual level within a person’s life will result in either an outright
15 rejection of the technology, acceptance of the technology but rejection of related
16 products, or acceptance of the technology and acceptance of resultant products.

17 Although individuals may form similar technology assessments, they often draw on
18 different rationalities and contexts in guiding their evaluations and interpreting
19 information. This highlights the need to understand, not only overall assessments but
20 also the processes contributing to such assessments. In terms of the evolution and
21 stability of attitude formations, some citizens appear to be stronger in their convictions

1 and initial attitudes, while the evaluations of others are more malleable. As a result of
2 this malleability, new information leads to re-evaluations. That said, initial attitudes
3 seem to guide further evaluations and bias the processing of subsequent information.

4 Need for cognition appears to vary, with some relying more on heuristics than others.
5 These individuals are, in effect, “*cognitive misers*” (Scheufele & Lewenstein, 2005:
6 660), exhibiting limited effort and interest in acquiring and processing relevant
7 information. While they recognise that they are unfamiliar with the processes that the
8 foods they consume undergo, they are not actively searching for information about these
9 processes, particularly if they place high levels of trust in the regulatory system.

10 This analysis highlights the complexities, conflicts, contradictions and conundrums
11 evident in terms of citizens’ evaluations, which may in some instances result in attitude
12 ambivalence. While minimal attention has been paid to the conflicts that manifest in
13 terms of elements associated with evaluations of NFTs, Rowe (2004) speaks of such
14 complexities, highlighting the challenges they create in terms of developing relevant
15 communication strategies. These internal conflicts are created, to a large degree, due to
16 personal orientations and product relevance anomalies. While embracing the related
17 benefits offered, a cautious stance is adopted about potential associated risks and the
18 necessity of some applications is questioned. Furthermore, internal conflicts are evident
19 in terms of reactive (linked to the emotions) and reflective (linked to cognitive
20 information processing) responses (Ortony et al., 2005); with the latter potentially

1 resulting in the former being “rationalised” to the point of internal dismissal. Such
2 internal conflicts appear on-going and there is a broad spectrum upon which they exist.

3 Perceived risks and uncertainty create a sense of dread which weighs considerably on
4 overall evaluations, often resulting in the adoption of a precautionary stance based on
5 “intuitive” (emotive) reactions. In spite of welcoming potential associated benefits,
6 citizens display a tendency to revert back to this precautionary position, due to lack of
7 knowledge and perceived uncertainty. Rollin et al. (2011) and Hagemann and
8 Scholderer (2009: 1043) speak to this when discussing the role that perceived
9 uncertainty can play as a “*driving force*” behind consumer evaluations, stating that
10 general perceived uncertainty, rather than specific risk perceptions, can lead to
11 technology resistance.

12 Acceptance appears an evolutionary rather than a revolutionary process. This is of
13 course, unless significant, unique, tangible benefits of relevance are apparent. As Bruhn
14 (2007) highlights, consumers seek products with explicit tangible benefits rather than
15 specific technologies. Therefore, if an objective of a communication is to successfully
16 market and sell related products, companies should anchor benefits of the products in
17 concrete examples of product characteristics relevant to individuals’ demands from food
18 (Siegrist, 2008).

19 Many challenges are associated with engaging with the general public about these
20 technologies (Bostrom & Löfstedt, 2010), as levels of knowledge, understanding and
21 interest vary considerably. Oversimplified assumptions about citizens’ attitude

1 formations and acceptance may lead to counterproductive communication strategies
2 (Wansink & Kim, 2001). Industry, policymakers and other institutions involved in food
3 communications should take account of the numerous and varied existing schemas
4 drawn upon when evaluating food applications and related products; which potentially
5 lead to misinterpretation of the processes that food undergoes.

6 Within any public communication about NFTs, openness and transparency are
7 necessary (Einsiedel & Goldenberg, 2004; House of Lords, 2010), particularly in the
8 face of uncertainty. As the findings indicate, public confidence in the implementation of
9 adequate regulations and risk assessments in order to guarantee safety is essential
10 (Simons et al., 2009). The media's continued role in influencing public attitudes, both
11 positively and negatively should not be underestimated (Scheufele & Lewenstein 2005;
12 Dudo et al., 2011). In addition to focusing on awareness and engagement, relevant
13 stakeholders, particularly policymakers, should take account of the broader
14 determinants influencing attitudes towards NFTs, including attitudes towards science,
15 technology and nature.

16 Although these findings are not generalizable, diversity and complexity in terms of
17 the features influencing citizens' evaluations is apparent. The outcomes observed may
18 be influenced to varying degrees by the information presented, i.e. the applications and
19 associated risks and benefits, and the interpersonal dynamics, i.e. rapport and trust,
20 between the scientists and citizens. However, the breadth of observations in terms of
21 citizens' responses militates against this eventuality. Not surprising, given the screening

1 for generalised self-confidence, all participants appeared to be relatively confident in
2 engaging with the scientist. Finally, citizens' reactions towards the hypothetical foods
3 discussed were situated in the absence of real life purchase/consumption decisions. This
4 interaction allowed for more deep information processing about abstract situations.

5 To conclude, a review commissioned by the FSA, UK (Fell et al., 2009: 54) stresses
6 *“the lack of good qualitative work examining the links between underlying values,*
7 *expressed attitudes and actual behaviours”* in terms of NFTs and the necessity to
8 understand how these elements interact in order to *“gain a full understanding of public*
9 *perceptions”*. This qualitative research contributes to the body of evidence within this
10 area. Specifically, it provides insights into citizens' evolving evaluative processes,
11 illustrating the complexity and conundrums in their thinking, which may in turn present
12 as attitude ambivalence. Furthermore, it draws attention to the on-going necessity to
13 qualitatively investigate, as well as quantitatively confirm, citizens' attitude formations
14 towards, in addition to assessments of, these technologies; as the stability of such
15 attitudes cannot be assumed.

16
17
18
19
20
21
22
23
24

1 *Appendix 1: An Excerpt from a Nanotechnology Discourse Transcript with a Female*
 2 *Participant (late 60s, retiree)*

Nano Scientist	I'll talk a bit about what...what I...I am doing and I have been doing so far. (...) Then I might ask you just to introduce yourself, what...what your background is. I'll give you a bit of an introduction on nanotechnology. And then Gráinne prepared four scenarios...imaginary really you know. And we just talk about that...and just want to get your opinion on it and ...positive or negative it doesn't...it doesn't really matter to me. It doesn't ...I am not advocating nanotechnology.
Nano Citizen 3	Yes.
Nano Scientist	I just try to inform you about it you know. And maybe pros and cons and...just get your opinion on it, you know. Is that OK with you?
Nano Citizen 3	That's grand.
(...)	<i>[The scientist and citizen then each give a brief introduction of their background (where they come from, their occupation etc.) to each other]</i>
Nano Scientist	Alright, so you read a little bit of the background [summary sheet] of nanotechnology?
Nano Citizen 3	I did...I read it...yes, yes.
Nano Scientist	Did you hear anything about ...what...what is your....knowledge before?...
Nano Citizen 3	Well I was telling Gráinne when I came in first nanotechnology...I thought it was something to do with computers and with mobile phones. Like I didn't know what it was after that.
Nano Scientist	Yes...yes...you are not far wrong...of....you know, you are not....
Nano Citizen 3	I thought...maybe first of all I thought it was a new game...you know. (...) I hate computer games...and all those things. It's like noise....Oh it is another gadget.
Nano Scientist	Yes, yes.
Nano Citizen 3	And I thought maybe it would be something a child would have now (...) ...another gadget you know. But I ...that...that was the limit. I would never read anything about it. I wouldn't read a magazine ora technical magazine or anything like that.
Nano Scientist	...you haven't heard of nanotechnology in food in one sentence have you?
Nano Citizen 3	No, I hadn't really no.
Nano Scientist	Yes, yes. Like in principle you are ...not far off there. Because in the mainstream media that wouldn't be mentioned in one sentence really. Nanotechnology ...as in nano...and the technology really...it comes from the technology background. Nano...do you know what nano is...did you ever hear?
Nano Citizen 3	It's tiny.
Nano Scientist	Tiny, yes, that's right. (...) I can give you a bit of background there. So a metre...you know what a metre is? Right?
Nano Citizen 3	Yes, yes.
Nano Scientist	...really a nanometre is one billionth of a metre. And nanotechnology, that's technology as such...or nanoscience, is the science of the small. That means it's nano scale. Anything from nanometre to micrometer....
Nano Citizen 3	How are you going to see it? What do you see it with?
Nano Scientist	You would see it in microscopy.
(...)	<i>[Following further discussion about nanotechnology and its potential applications, the scientist presented the four pre-defined hypothetical scenarios to the citizen]</i>

3
4

1
2
3 **References**

- 4 Ajzen, I. & Fishbein, M. (1977). Attitude-behavior relations: A theoretical analysis and review of
5 empirical research. *Psychological Bulletin*, 84 (5), 888-918.
- 6 Bertaux, D. (1981). From the life-history approach to the transformation of sociological practice. In
7 D. Bertaux (Ed.). *Biography and society: The life history approach in the social sciences* (pp. 29-
8 45). London: Sage.
- 9 Bohner, G. & Dickel, N. (2011). Attitudes and attitude change. *Annual Review of Psychology*, 62,
10 391-417.
- 11 Bostrom, A. & Lofstedt, R.E. (2010). Nanotechnology risk communication past and prologue. *Risk*
12 *Analysis*, 30(11), 1645-1662.
- 13 Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in*
14 *Psychology*, 3, 77-101.
- 15 Bredahl, L. (2001). Determinants of consumer attitudes and purchase intentions with regard to
16 genetically modified foods - Results of a cross-national survey. *Journal of Consumer Policy*, 24,
17 23-61.
- 18 Bruhn, C.M. (2007). Enhancing consumer acceptance of new processing technologies. *Innovative*
19 *Food Science and Emerging Technologies*, 8, 555-558.
- 20 Burri, R.V. (2009). Coping with uncertainty: Assessing nanotechnologies in a citizen panel in
21 Switzerland. *Public Understanding of Science*, 18(5), 498-511.
- 22 Cardello, A.V. (2003). Consumer concerns and expectations about novel food processing
23 technologies: Effects on product liking. *Appetite*, 40(3), 217-233.
- 24 Cardello, A.V., Schutz, H.G. & Leshner, L.L. (2007). Consumer perceptions of foods processed by
25 innovative and emerging technologies: A conjoint analytic study. *Innovative Food Science and*
26 *Emerging Technologies*, 8, 73-83.
- 27 Chen, M-F & Li, H-L. (2007). The consumer's attitude toward genetically modified foods in
28 Taiwan. *Food Quality and Preference*, 18(4), 662-674.
- 29 Conrey, F.R. & Smith, E.R. (2007). Attitude representation: attitudes as patterns in a distributed,
30 connectionist representational system. *Social Cognition*, 25, 718-35.
- 31 Cunningham, W.A., Zelazo, P.D., Packer, D.J. & van Bavel, J.J. (2007). The iterative reprocessing
32 model: A multilevel framework for attitudes and evaluation. *Social Cognition*, 25(5), 736-760
- 33 Day, R.C. & Hamblin, R.L. (1964). Some effects of close and punitive styles of supervision.
34 *American Journal of Psychology*, 69(5), 499-510.
- 35 de Vreese, C.H. (2005). News framing: Theory and typology. *Information Design Journal &*
36 *Document Design*, 13(1), 52-61.
- 37 Dudo, A., Choi, D.H. & Scheufele, D.A. (2011). Food nanotechnology in the news. Coverage
38 patterns and thematic emphases during the last decade. *Appetite*, 56, 78-89.

- 1 Edwards, K. (1990). The interplay of affect and cognition in attitude formation and change.
2 *Personality and Social Psychology*, 59(2), 202-216.
- 3 Einsiedel, E.F. & Goldenberg, L. (2004). Dwarfing the social? Nanotechnology lessons from the
4 biotechnology front. *Bulletin of Science, Technology & Society*, 24(1), 28-33.
- 5 Entman, R.M. (1993). Framing: Toward clarification of a fractured paradigm. *Journal of*
6 *Communication*, 43(4), 51-58.
- 7 Fell, D., Wilkins, C., Kivinen, E., Austin, A. & Fernandez, M. (2009). *An evidence review of public*
8 *attitudes to emerging food technologies*. A Brook Lyndhurst Report for the Food Standards
9 Agency, UK. Available at www.food.gov.uk/multimedia/pdfs/emergingfoodtech.pdf
- 10 Frewer, L.J., Bergmann, K., Brennan, M., Lion, R., Meertens, R., Rowe, G., Siegrist, M. &
11 Vereijken, C. (2011). Consumer response to novel agri-food technologies: Implications for
12 predicting consumer acceptance of emerging food technologies. *Trends in Food Science and*
13 *Technology*, 22, 442-456.
- 14 Furst, T., Connors, M., Bisogni, C.A., Sobal, J. & Winter Falk, L. (1996). Food choice: A
15 conceptual model of the process. *Appetite*, 26, 247-266.
- 16 Gamson, W.A., Croteau, D., Hoynes, W. & Sasson, T. (1992). Media images and the social
17 construction of reality. *Annu. Rev. Sociol.*, 18, 373-393.
- 18 Gaskell, G., Stares, S., Allansdottir, A., Allum, N., Castro, P., Esmer, Y. et al. ...Wagner, W.
19 (2010). *Europeans and Biotechnology in 2010: Winds of change? A report to the European*
20 *Commission's Directorate-General for Research*. Available at
21 http://ec.europa.eu/public_opinion/archives/ebs/ebs_341_winds_en.pdf
- 22 Goffman, E. (1974). *Frame analysis: An essay on the organization of experience*. New York:
23 Harper & Row.
- 24 Grunert, K.G., Bredahl, L. & Scholderer, J. (2003). Four questions on European consumers'
25 attitudes toward the use of genetic modification in food production. *Innovative Food Science &*
26 *Emerging Technologies*, 4, 435-445.
- 27 Guest, G., Bunce, A. & Johnson, L. (2006). How many interviews are enough? An experiment with
28 data saturation and variability. *Field Methods*, 18(1), 59-82.
- 29 Gunes, G. & Tekin, M.D. (2006). Consumer awareness and acceptance of irradiated foods: Results
30 of a survey conducted on Turkish consumers. *LWT*, 39, 443-447.
- 31 Hagemann, K.S. & Scholderer, J. (2009). Hot potato: Expert-consumer differences in the
32 perception of a second-generation novel food. *Risk Analysis*, 29(7), 1041-1055.
- 33 Hallman, W.K. (2000). *Consumer concerns about biotechnology: International perspectives*. Food
34 Policy Institute, Publication No. RR-0602-003. The State University of New Jersey: Rutgers.
- 35 Henson, S. (1995). Demand-side constraints on the introduction of new food technologies: The
36 case of food irradiation. *Food Policy*, 20(2), 111-127.
- 37 Hesse-Biber, S. (2010). Qualitative Approaches to Mixed Methods Practice. *Qualitative Inquiry*,
38 16, 455-468.

- 1 House of Lords Science and Technology Committee. (2010). *Nanotechnologies and food, Volume*
2 *I: Report. 1st Report of Session 2009-10*. Authority of the House of Lords. London: The
3 Stationery Office Limited. Available at [http://eur-](http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:304:0018:0063:EN:PDF)
4 [lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:304:0018:0063:EN:PDF](http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:304:0018:0063:EN:PDF)
- 5 Joffe, H. (2011). Thematic analysis. In D. Harper and A.R. Thompson (Eds.). *Qualitative methods*
6 *in mental health and psychotherapy: A guide for students and practitioners* (pp. 209-223).
7 Chichester: Wiley.
- 8 Jootun, D., McGhee, G. & Marland, G.R. (2009). Reflexivity: Promoting rigour in qualitative
9 research. *Nursing Standard*, 23(23), 42-46.
- 10 Kahan, D.M., Slovic, P., Braman, D., Gastil, J. & Cohen, G.L. (2007). *Affect, values, and*
11 *nanotechnology risk perceptions: An experimental investigation*. GWU Legal Studies Research
12 Paper No. 261; Yale Law School, Public Law Working Paper No. 155; GWU Law School Public
13 Law Research Paper No. 261; 2nd Annual Conference on Empirical Legal Studies Paper.
14 Available at <http://ssrn.com/abstract=968652>
- 15 Kazemifard, M., Ghasem-Aghae, N. & Ören, T.I. (2012). Emotive and cognitive simulations by
16 agents: Roles of three levels of information processing. *Cognitive Systems Research*, 13(1), 24-
17 38.
- 18 López-Vázquez, E., Brunner, T.A. & Siegrist, M. (2012). Perceived risks and benefits of
19 nanotechnology applied to the food and packaging sector in México. *British Food Journal*,
20 114(2), 197-205.
- 21 Macoubrie, J. (2006). Nanotechnology: Public concerns, reasoning and trust in government. *Public*
22 *Understanding of Science*, 15, 221-241.
- 23 Merriam, S.B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco:
24 Jossey-Bass.
- 25 Ortony, A., Norman, D. & Revelle, W. (2005). Affect and proto-affect in effective functioning. In J.
26 Fellous & M. Arbib (Eds.). *Who needs emotions: The brain meets the machine* (pp. 173-202).
27 New York: Oxford University Press.
- 28 Peter, J.P., Olsen, J.C. & Grunert, K.G. (1999). *Consumer behaviour and marketing strategy*.
29 European edition. London: McGraw-Hill.
- 30 Reese, S.D. (2001). Framing public life: A bridging model for media research. In S.D. Reese, O.H.
31 Gandy Jr. & A.E. Grant (Eds.). *Framing public life: Perspectives on media and our*
32 *understanding of the social world* (pp. 7-31). Mahwah, N.J.: Lawrence Erlbaum.
- 33 Rollin, F., Kennedy, J. & Wills, J. (2011). Consumers and new food technologies. *Trends in Food*
34 *Science & Technology*, 22, 99-111.
- 35 Ronteltap, A., van Trijp, J.C.M., Renes, R.J. & Frewer, L.J. (2007). Consumer acceptance of
36 technology-based food innovations: Lessons for the future of nutrigenomics. *Appetite*, 49, 1-17.

- 1 Rowe, G. (2004). How can genetically modified foods be made publicly acceptable? *Trends in*
2 *Biotechnology*, 22(3), 107-109.
- 3 Rozin, P. (2005). The meaning of “natural”. Process more important than content. *Psychological*
4 *Science*, 16(8), 652-658.
- 5 Scheufele, D.A. & Lewenstein, B.V. (2005). The public and nanotechnology: How citizens make
6 sense of emerging technologies. *Journal of Nanoparticle Research*, 7, 659-667.
- 7 Scheufele, D.A. & Tewksbury, D. (2007). Framing, agenda setting, and priming: The evolution of
8 three media effects models. *Journal of Communication*, 57, 9-20.
- 9 Scheufele, D.A. (2000). Agenda-setting, priming, and framing revisited: Another look at cognitive
10 effects of political communication. *Mass Communications & Society*, 3(2&3), 297-316.
- 11 Shaw, A. (2002). “It just goes against the grain”. Public understandings of genetically modified
12 (GM) food in the UK. *Public Understanding of Science*, 11, 273-291.
- 13 Shepherd, R. (2008). Involving the public and stakeholders in the evaluation of food risks. *Trends*
14 *in Food Science & Technology*, 19, 234-239.
- 15 Siegrist, M. & Cvetkovich, G. (2000). Perception of hazards: The role of social trust and
16 knowledge. *Risk Analysis*, 20, 713-719.
- 17 Siegrist, M. (2008). Factors influencing public acceptance of innovative food technologies and
18 products. *Trends in Food Science & Technology*, 19, 603-608.
- 19 Siegrist, M. (2010). Predicting the future: Review of public perception studies of nanotechnology.
20 *Human and Ecological Risk Assessment*, 16, 837-846.
- 21 Siegrist, M., Cousin, M.-E., Kastenholz, H. & Wiek, A. (2007). Public acceptance of
22 nanotechnology foods and food packaging: The influence of affect and trust. *Appetite*, 49, 459-
23 466.
- 24 Siegrist, M., Stampfli, N., Kastenholz, H. & Keller, C. (2008). Perceived risks and perceived
25 benefits of different nanotechnology foods and nanotechnology food packaging. *Appetite*, 51,
26 283-290.
- 27 Simons, J., Zimmer, R., Vierboom, C., Härten, I., Hertel, R. & Böhl, G.F. (2009). The slings and
28 arrows of communication on nanotechnology. *Journal of Nanoparticle Research*, 11, 1555-1571.
- 29 Slovic, P. (1987). Perception of risk. *Science*, 23, 280-286.
- 30 Wansink, B. & Kim, J. (2001). The marketing battle over genetically modified foods: False
31 assumptions about consumer behavior. *American Behavioral Scientist*, 44(8), 1405-1417.