CHAPTER

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Consumer attitude toward nonconventional breeding

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1 Introduction

The global population grows, and welfare has been increasing, hence there is an subsequent growing demand in high quality foods (FAO, 2009). In addition, increasing effects of global warming are creating problems with current cropping systems as existing plants may not be sufficiently prepared to deal with heat stress of raising temperatures and with droughts and other extreme patterns caused by global warming. This has resulted in the call for new breeds of plants that can deliver sufficiently high yields under increasingly adverse weather conditions (Harbinson et al., 2021). Such a techno-centric approach may be essential in assuring long-term food security to produce foods in general. Consumer attitudes toward products created through using such technologies are, however, relevant in this context as negative consumer attitudes may lead to societal protest. This is even more important when considering nonconventional breeding techniques where major protest was triggered by the initial introduction of GM crops (O'Brien, 2021), which possibly resulted in consumers refusing to buy the products (Costa-Font et al., 2008). Thus next to technology developments moving toward the breeding of plants including (pseudo)cereals created through nonconventional breeding techniques consumer attitudes are important to consider.

While considering consumer attitudes, the context of application is important to keep in mind. In this case, the special place cereals and pseudocereals have for consumers. Much of our daily nutrition depends on cereals such as wheat, maize, and rice or pseudocereals like quinoa and buckwheat. Cereals and pseudocereals are central to much of our nutritional intake. For example, it has been estimated that dietary energy originating from cereals accounts for about 30% of all energy intake in Poland, and cereals are responsible for over 45% of daily intake of dietary fibers, and that cereals account for more than 20% of daily intake of proteins (Laskowski et al., 2019). Hence the functional value of cereals is undoubted. Cereals are rarely consumed whole or raw. They are often ground, for example into semolina (coarsely ground as a base for couscous), meal or the even finer flour. The grains or their lightly processed derivatives are processed into porridges, bread, or meal ingredients. Cereals are also used for more hedonic purposes as they form the bases of many alcoholic beverages such as beer (often barley based), sake (rice based), and spirits like Gin, Jenever, and Whisk(*e*)y. The other main use of cereals is in animal feed. Large quantities of maize and barley are grown to feed animals to produce the dairy products and meat that are then consumed by humans.

Given this widespread usage, it should not come as surprise that cereals have a deeply embedded cultural meaning. They have been among the first plant families to be domesticated allowing the settling of continuous agricultural production to take place in emerging agricultural societies. Ancient texts refer to cereal products, and cereal products like bread have become part of religious rituals. The national pride the Scots gain from their whisky (and the Irish from their whiskey) is enormous, and bread has found its way into the most central prayer of Christianity, the "our father" where the deity is asked to "Give us each day our daily bread."

This embeddedness in culture, daily food, and pleasurable drinks makes cereals and any attitudes to cereal multifaceted. This means that it will be difficult to come up with a simple answer to what constitutes consumer attitude toward nonconventional bred cereals and pseudocereals. On the one hand, the historical, cultural connection with

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cereal may make it more likely that consumers will reject changes in cereal production, as consumers may be reluctant to accept novel technology that distorts perceptions of historical and cultural crops. On the other hand, due to the ubiquity of cereal products, consumers can automatically and habitually obtain and consume cereal products. In this case, they may not even notice that the product purchased and consumed contains cereals or is produced almost exclusively from cereals. This lack of awareness might lead to the absence of any large-scale objections.

It becomes even more complicated if we consider that besides the cultural embedding of (pseudo)cereals as a valuable source of nutrition (and pleasure in the case of alcoholic beverages), some cereals and their carbohydrates, in general, have been recently looked at with suspicion.

There is a persistent group of consumers who follow a range of differently named diets that focus on reducing carbohydrate intake (low-carb diets). Given the high proportion of carbohydrates in cereals, many of these "low carb" diets emphasize the reduction of cereal products such as bread. Low-carb approaches such as the Atkins diet (high fat, high protein) have been marketed very successfully (Maresco, 2005; Saxelby, 2005). Among those approaches is the extreme ketogenic diet (high fat, moderate protein), which was originally developed for epileptic patients and was applied with some success for that medical purpose (Wheless, 2008). However, critical reviews show that these diets are not more effective and in some aspects even less safe than other diets for most people who try to lose weight (O'Neill & Raggi, 2020). Although there is no scientific evidence that these diets have any long-term significance for weight loss, low-carbohydrate diets have attracted the attention of consumers and the growing attention to reducing sugar intake has led to the perception that carbohydrates should be avoided, at least in some parts of the populations (Webster & Sollid, 2018).

In addition to the idea of avoiding carbohydrates in a low-carb diet, consumers have recently been looking for cleaner labels, meaning products with fewer ingredients (Asioli et al., 2017). The movement of cleaning labels is related to a growing caution about processed and ultra-processed foods. It is often assumed that foods created with fewer ingredients and less processing are preferred by consumers. In an effort to clarify what constitutes processed and ultra-processed foods, the NOVA classification schedule has been developed (Monteiro et al., 2019). Some traditional products, such as bread, are difficult to place on this schedule due to the many processing steps required to make the bread and the multitude of ingredients depending on the recipe. This can cause some confusion and negative associations even for staple foods like bread. Although bread is not generally considered to be ultra-processed (Ares et al., 2016), confusion over processing can make consumers suspicious and lead to negative perceptions of high processing levels (Fischer et al., 2022), which in turn can contribute to a negative attitude toward cereal product in general. The extent to which consumers consider nonconventional breeding to contribute to ultra-processing remains to be seen, but as such technologies are considered unnatural (Nales & Fischer, 2022) and unnatural processes are disliked (Siegrist & Hartmann, 2020) this may play a role.

In addition, consumers are paying attention to gluten intolerance. While actual gluten intolerance and the associated Celiac disease is a serious medical condition, the perceptions of consumers that they are gluten intolerant surpass the real prevalence of the disease itself. The associated discussion has become a reason for consumers who suspect to be gluten intolerant to perceive gluten as negative and avoid gluten-containing cereals (Sielicka-Różyńska et al., 2021), in particular wheat. This holds even for consumers for whom gluten intolerance was never medically established. Many of those who reject wheat still desire cereal-based products and turn to ancient cereal species such as spelt or pseudocereals, such as buckwheat. They perceive those to be healthier and thus less likely to cause negative responses, justified or not. These old breeds are classified as "superfoods." Superfoods are assumed to have some kind of superior property. More recently, the imported ancient breeds like quinoa are also perceived as superfood (Kahlon & Chiu, 2015; Shah et al., 2021).

The issues raised with pseudocereals and cereals in the consumer perception show that understanding consumer reactions to cereals and their use as human food is already a challenge. Most concerns refer to human consumption, while other uses of cereals, such as animal feed or raw material for industrial use, are less sensitive areas. Energy crops may raise a food-for-fuel debate (European Biotechnology Science and Industry News, 2008). This is due to the fact that animal feed and industrial use are more remote from consumers actually consuming the product, which is in line with previous findings in that more distant situations are less immediately important in consumer decision making (cf. Trope & Liberman, 2010) including food decisions (Steenis & Fischer, 2016), more generally.

After having introduced cereals as a group of crops with many complexities in the consumers' minds, the main issue to address in this chapter is how consumers form attitudes toward the use of new breeding technologies to improve these cereals.

To investigate that issue two literatures will be considered. First, the psychological literature on the formation and changes of attitudes is specifically tailored to the complexities relevant to the ambivalence surrounding cereals in general, and hence to applying new technologies. The fact that cereals are so well embedded in our culture makes

it relevant to consider that people are likely to make automatic inferences than relying on conscious thought when making up their minds.

Second (first generation) genetically modified (GM) crops that relied on cisgenesis and transgenesis as main technologies will be introduced and how their introduction to the European market resulted in widespread protest. Some of the consequences thereof and where we stand now in the societal debate are discussed. Findings will be framed in the fundamental understanding of consumer attitudes presented before. In this section some of the currently developing debate will be introduced that deals with the more precise new breeding technologies often relying on gene-editing techniques. Based on the emerging findings on those techniques and the experience on first generation genetic modification, the similarities and differences of the present situation will be introduced from that when cis and trans-genetic crops were first marketed.

This chapter will be concluded with interpreting these findings toward the specifics of cereals and pseudocereals.

2 Consumer attitudes

Consumer attitude is a widely used term to indicate some kind of consumer opinion or response to a product or technology. Although widespread nowadays, the use of the term attitude in the meaning of a stable evaluative response, as currently used in the social sciences, only emerged from the early 20th century onward.[a] Particularly, the early twentieth-century work of Thurstone and Likert (Churchill, 1991) in developing standardized methods to measure attitudes, and the integration of early insights in attitude research by Allport (1935), laid the groundwork for the use of this term. Attitude research, originally largely focused on interpersonal, behavioral, and political opinions, emerged in the field of social psychology. In the 1940s the idea that attitudes could also be used to understand consumer response to products was embraced. While these foundations place the concept of attitude firmly within the domain of social psychology, the uptake by consumer science brought it into the domains of economic psychology and product design. Since then, the use of attitude has grown to refer to almost any kind of public or consumer response and many scientific domains apply this idea. This includes domains like communication science, human computer interaction, design, (micro)economics, policy, and governance studies. There is now a broad use of the term attitude across many fundamental and applied sciences. In addition, there is a continuing discussion within psychology on how to conceptualize attitude. This combination makes some confusion about what is precisely meant with attitude almost unavoidable. During the review it becomes apparent that approaches to conceptualization and measurement of the attitude construct have even become inconsistent across studies (Reinders et al., 2013). This was not helped by the vast number of practitioners who use attitudes in their work. The situation is only exacerbated by the fact that it is relatively easy to create a survey as a research tool and the freedom to call almost any group of questions in such a survey an attitude. This has led to problematic comparison and aggregation of social scientific work, and a severe problem for its robust uptake. A problem already identified over 4 decades ago (Churchill, 1979).

While it is not feasible to align the many thousands of self-proclaimed attitude researchers as a reader, it is worth trying to understand what the term attitude really means. This consideration may help to interpret the term when come across a scientific paper or chapter, like this one. Here I will provide some reflection on what I consider important in discussing attitudes, at least in the context of this chapter. Providing such a delineation makes it possible to draw boundaries about what an attitude is and what is not. This, in turn, will make it possible to look at the specific properties of nonconventional breeding technologies applied to cereals and pseudocereals.

Following one of the few agreements in almost all scientific literature, a definition of an attitude should refer to evaluation in terms of good-bad, favorable-unfavorable. One of the few agreements at least in psychology is that an attitude is a summary evaluation of a product, service, or other object in terms of favorability or dislike (Eagly & Chaiken, 1993). While this definition seems clear, it raises the immediate question of what an attitude is a summary of and whether it is always possible and meaningful to create summary evaluations. The question also arises as to exactly what the relevant evaluations are. In some cases, such evaluation may seem more of a perception than an evaluation. For example, risk and benefit perceptions suggest they are perceptions. However, focusing on the benefits and risks involves assessing how good or bad an object is. It is hence not surprising that risk-benefit perceptions are sometimes considered attitude components (e.g., Schenk et al., 2008). Perceptions of pleasure can also be considered attitude components.

[a] Before that time attitude was used to describe the orientation of the body not the mind, e.g., in paintings and sculptures. Attitude is still used with this meaning when, for example, orienting satellites in space.

But not all perceptions are attitude components. Nonevaluated perceptions, such as how green, salty, or chewy a product is, are not attitude components. Although arguably it could be that, for example, green color or saltiness carries an implied value to the consumer (cf. Fiske & Pavelchak, 1986). To link products' properties and their perception to attitudes, it was proposed that the link between perception and attitude could be captured by combining a belief and evaluation of specific attributes of a product. For example, the belief that using nonconventional breeding technology will increase cereal yield and the evaluation to what extent that a consumer considers yield increase is positive or negative would represent the attribute yield increase in an attitude. If all relevant attributes are assessed in this way, the sum of these evaluations would be the attitude (Fishbein & Ajzen, 1975). This approach combines an evaluative "good-bad" component with perceptions.

Another important delineation is that an attitude is a position or an opinion. While an attitude is suggested to lead to intentions or behavior (cf. Ajzen, 1991), behavior itself is not an attitude. Here the literature on another commonly used term, acceptance, is even more ill-defined (Fischer & Reinders, 2022). Acceptance is sometimes used as the perception or evaluation of consumers (cf. Siegrist, 2000). Used in this way, acceptance is for all practical purposes synonymous with attitude or at least an attitude component. Acceptance is, however, in some literatures used to indicate the extent to which a product or service has been adopted by the market (Fischer & Reinders, 2022; Rogers, 2003). As acceptance in this way indicates behavior rather than an opinion, it cannot be considered an attitude.

While these delineations, albeit implicit, are common in most literature referring to attitudes, they primarily say what is not an attitude, but not so much what an attitude specifically is. The question what exactly is an attitude has been perennial in (social) psychology for decades (Gawronski, 2007). While psychology still has not reached a unanimous agreement on how to conceptualize an attitude, the ongoing discussion has yielded many points of view that can help us determine what to consider when discussing attitude to nonconventional breeding technologies.

Early approaches have focused on "unpacking" the summarized attitudes of an object by considering an attitude as a summed evaluation of an object. This sum is then presented by considering the object as a bundle of attributes (Lancaster, 1966), e.g., color, taste, price. If each attribute is then perceived and evaluated separately (Brunswik, 1966), their evaluation can be combined into a summary evaluation that gives the overall value or attitude of the object. This approach aligns very well with expected utility approaches from economy used to determine the optimal situation. While such a rational approach may seem very appealing, it immediately becomes clear that it is impractical to consider all product attributes (which can run into the thousands if examined in sufficient detail). Therefore attitude formation requires a bounded rationality approach to find a satisfactory (Simon, 1955) rather than an optimizing solution. This was adopted in Fishbein's influential attitude model that only focuses on evaluating and combining "salient" attributes (Fishbein & Ajzen, 1975). Salient attributes are those that are top of mind of the individual consumer while forming a judgment. This is a relevant limitation of the rational actor model, which was inherent to underlying earlier approaches (and remained influential in the subjective expected utility approach in economic psychology). It also brings up a new complexity. The fact that which attributes of an object stand out may differ from one consumer to another. For some consumers, the specific type of cereal, wheat, rye, spelt, oats may be top of mind when purchasing bakery. For others they may not be relevant at all. This makes it hard to determine which attributes are relevant. In practice therefore, most researchers following Fishbein's original ideas have focused on presenting participants with a limited set of attributes. Claiming these would be the salient ones as these provide the only relevant information on which the consumer can pay attention to in the experiment or survey.

There is a further deviation from the rational actor paradigm and the associated subjective expected utility. In most of the psychological attitude research, researchers agree that to understand attitudes it is important to include both cognitive and affective evaluations. The cognitive evaluations bear resemblance to utilitarian-based assessment of the technology and are often framed in terms like "worthwhile/worthless," "valuable/useless," and other such dichotomies. The affective evaluation comprises of feelings and emotions evoked toward the product or technology. These may be in general terms such as "pleasant/unpleasant" (e.g., Ajzen, 1991) or as specific emotions, e.g., "love/hate," "fear/relaxation" (e.g., Crites et al., 1994). It is generally agreed that both cognition and affect play a role in attitudes. Whether these are the components that together form the attitude (e.g., Crites et al., 1994) or that they are subsequent stages in responding to a topic (e.g., in the hierarchical view on emotions, Alexandris et al., 2012) is still under debate. In addition, emotion theorists claim that fully fledged emotions have a role that is distinct from that of attitudes (e.g., Frijda, 1986; Scherer, 1993). Their claim is that emotions have the primary role to create action readiness, that is, to set the body in a state for imminent action (behavior). In that role emotions go beyond the mere evaluative function of attitudes. Emotion theorists argue that emotion-based choice takes prominence in personally important situations over cognitions. While this is generally the case for fully fledged emotional responses such as fear and anger, the more basic emotional response of feeling or affect can exist without immediately triggering behavior (Oatley & Jenkins, 1996). It is such affect, rather than fully fledged emotions, that is generally considered

in attitude research. Within the domain of food innovations, affect has been studied in relation to the more rational cognitions, both as components of a larger attitude construct (see e.g., Bekker et al., 2021) and as separate elements that together inform an overall evaluation (e.g., Van Giesen et al., 2015, 2018).

Another attitude component that is frequently mentioned is the "conative" or behavioral component of attitude. The conative component refers to any behavioral association with an object. It hence refers to both behavioral intention toward the future and past behavior (Bamberg et al., 2003; Fishbein & Ajzen, 1975). Much of human behavior is repeated past behavior and hence the conative component plays a key role in routine behavior. Yet, the individual nature of past behaviors makes it hard to include it into attitude models. In addition, the way in which past behavior influences future behavior may go through automatic and habitual processes that need not be attitudes (Aarts & Dijksterhuis, 2000a, 2000b). On another practical level, the inclusion of the conative component makes it harder to delineate attitudes in research. This is because the addition of the conative component makes the distinction between attitude, intention, and behavior somewhat blurred. It was the addition of exactly the construct of intention to earlier attitude models, such as the Theory of Reasoned Action, that showed to be a fruitful expansion of attitude models (Fishbein & Ajzen, 1975). Hence for theoretical, conceptual, and practical reasons it is not always suitable to include the conative component in the definition of attitude. For the current chapter, this is even more prevalent as it is unlikely that consumers already have experienced behavior toward specific nonconventional breeding techniques. As this makes it less relevant to focus on the conative component and harder to distinguish between attitude and intention, in our working definition of attitude we will not consider conation. A lock-in in past behavior and habits may favor conventional techniques about which consumers do have experience.

Another way of looking at attitude is by distinguishing risk and benefit perception. This way the psychology of risk (e.g., Slovic, 1987), which played an important role in assessing consumer perception toward first generation GMOs (e.g., but not limited to, Frewer, van der Lans, et al., 2013; Schenk et al., 2008; Schenk et al., 2011; Siegrist, 1999), can be integrated into the assessment of nonconventional breeding technologies. By trading off perceived risks and benefits, the summary evaluation that is an attitude is created (e.g., Schenk et al., 2008; Siegrist, 2000; van Dijk et al., 2011). On first sight it may appear that a focus on risk-benefit perception suggests that attitudes follow a rational actor paradigm on attitudes, which contradicts the role of affect. However, risk perception itself is considered to have a strong emotional component (Finucane et al., 2000; Loewenstein et al., 2001; Siegrist et al., 2006; Slovic et al., 2004). The inclusion of affect as an additional element to the analysis of risk-benefit perceptions suggests there is no contradiction per se between the risk-benefit and the affect-cognition approach to attitudes (Siegrist et al., 2006). In addition, the trade-off itself is not a trivial addition of pros and cons. While it has often been claimed that risks loom larger than benefits (Ariely et al., 2005; Kahneman & Tversky, 1979), for the formation of consumer attitude toward new technologies it was found that across studies sometimes perceived benefits, sometimes risks count more toward the final attitude (Bearth & Siegrist, 2016). Personal benefits seem partially capable in overcoming the negative feeling associated with experienced risks (Schenk et al., 2011). Risks that are closer to the end user are more influential in the decision than removed risks, but the closeness of a benefit does not seem to matter that much (Steenis & Fischer, 2016). These findings suggest that trading off perceived risks and benefits is not as simple as sometimes claimed.

3 Attitude and attitude change

So far, I have reflected on attitude as a stable, more or less conscious, albeit emotionally loaded, reflection on an object. Much of the literature considers attitude change or formation. Particularly in the context of nonconventional breeding technology where consumers are confronted with a new breed of cereal and may be influenced by communication about the breeding technology it is important to understand how attitude emerges and changes over time.

To understand how attitude may change, it is important to consider that some attitudes are strong, while others are weak (Krosnick & Smith, 1994). While strong attitudes are resistant to change, their strength may erode over time, in particular when exposed to repeated communication (Tormala & Petty, 2002). Since such changes may not be immediately apparent, it may unfreeze a polarized debate and lead to slow return to a more neutral attitude, which might open up a past debate (as suggested to be the case for genetic modification by van Dijk et al., 2012).

Communication science has realized that when people are not motivated to think about a topic in detail or when they do not have the psychological resources to do so, for example because they are tired or distracted, communication effort on facts is unlikely to cause a lasting change in attitude (Chaiken, 1980; Petty & Cacioppo, 1986). In such cases, heuristics (rules of thumb) or peripheral cues, such as specific wording or even the layout or color scheme of a message, may temporarily inform attitude change. This reliance on peripheral cues may account for some of the inconsistencies in consumer response when they respond differently in different situations, depending on what

peripheral cues are present or what heuristics are used. A take-home message from this research is that it is not sufficient to measure efficacy of a communication on short term when peripheral cue effects likely dominate. Instead, attitude change and stability should be studied in the longer term. In addition, it should also be considered that providing consumers with technical information requires them to build up a stable attitude in a cognitive, effortful way. It is important to realize that even if there has been a long-term attitude change based on such fact, peripheral cues may still influence response at any given time, resulting in seemingly inconsistent consumer responses.

Besides integrating facts in an elaborate way, stable attitudes can also emerge based on personal experience where consumers are repeatedly exposed to a new product or technology. Through that exposure they form an opinion about that product. When exposure to the product or technology is not isolated from, but actively accompanied by a positive or negative effect on the consumer, people are likely to change their opinion in the direction of the consequences associated with the exposure. Such conditioning and in particular evaluative conditioning can create positive or negative attitudes about a new technology, even without consumers realizing they are creating such attitude (Hofmann et al., 2010). Even the absence of any feedback can lead to attitude formation to a new product or technology. Exposure to new objects without any consequence, labeled the mere-exposure effect (cf. Zajonc, 1980), is over time likely cause a somewhat positive outlook. However, and this is a sometimes overlooked precondition, this mere-exposure effect is only relevant if neither positive or negative consequences are experienced when being exposed to the product or technology.

The realization that consumers can deal with situations through in-depth reflections that lead to lasting attitude change, but also in a quick and frugal ways depending on peripheral cues and related automatic associations, has been commonly accepted. This realization resulted in much attention to how in-depth reasoning and automatic responses interact and when which kind of response is dominant. Automatic associations are triggered by specifics of the message, which include not only a response to the contents (facts), but also spontaneous associations with the words, images, and other elements in the message. This can easily lead to stereotypical or biased responses, as has been shown for initial automatically negative responses to black people or the bias in relating males more with technical sciences than females (Greenwald & Banaji, 1995). Whether such implicit, automatically, activated attitudes are stored evaluations that are recalled, if they fit a given situation (Fazio, 2007) or that they are automatically constructed on the spot (Schwarz, 2007) is open for debate. It makes sense the truth is somewhere in the middle. At some level an evaluation needs to be stored, but these probably need to be (re)combined on the spot to fit the specifics of each situation.

The frugal, intuitive system remains poorly understood (Glöckner & Witteman, 2010). In a simplified way it has been argued that emotions are more prominent in the intuitive system and cognitions in the deliberate system (e.g., Kahneman, 2011). However, some emotions involve deep experiences (van Giesen et al., 2016), and some cognitive heuristics are applied automatically. The intuitive system has been argued to consist of several distinct systems (Glöckner & Witteman, 2010) that interact with each other and the deliberate system (Gawronski & Bodenhausen, 2006). At the most basic level it can be argued that reflexes are the immediate level of the intuitive system. Reflexes do not even require any awareness. While reflexes are relevant to predict behavior, they are unlikely to influence attitudes. Other intuitive processes can influence attitude. Despite the differences, all intuitions can be characterized as associative processing, where elements of the new technology activate spontaneous associations, which will then inform initial attitude formation.

In reality, human responses are infrequently, completely, and solely based on a first intuitive feeling. While the fast implicit associations will always be activated first, they may be followed by the slower cognitive reflection. These cognitive reflections can overrule the first intuition if initial associations are deemed not relevant or not true (Gawronski & Bodenhausen, 2006). In many cases automatically activated opinions and more deliberate reflection will align (Greenwald et al., 2009), which makes the cognitive reflection nonessential to change a response. It is in cases of obvious bias (such as racial or gender stereotyping) that the interplay between automatic associations that form intuition and cognition becomes important. Such interplay between automatic associations and the more deliberate, yet slower cognition is complex. In general, consumers will only engage in deliberate thought if they feel that the intuitive opinion may be off. This creates a feeling of dissonance between the automatic associations and what people think their opinion should be. The motivation is then to resolve the feeling of incongruency. This will not always lead to the prominence of rational reasoning. When automatically activated attitudes are at odds with cognitive reasoning it is more likely that the cognitive reasoning is adjusted to confirm the automatically activated attitude than the other way around (cf. Festinger, 1957; Gawronski & Bodenhausen, 2006).

This points at a more widespread problem that to change an attitude, the counter-attitudinal information needs to matter. That means it first needs to be perceived by consumers and then needs to be used by those consumers in their attitude formation. In using counter-attitudinal information, consumers are confronted with an internally

inconsistent set of arguments: the prior attitude against the counter-attitudinal information. The counter-attitudinal information makes for cognitive dissonance, which is the realization by consumers that their opinion is internally inconsistent. A first way to solve this inconsistency is by simply discounting the new information that is discounted (Albarracin & Kumkale, 2003). Even if we manage to bring new arguments into consideration, this will put consumers in a state of attitudinal ambivalence where at the same time both positive and negative evaluations are present in the consumers' mind (van Harreveld et al., 2009). As long as consumers are not required to make a final judgment on a case, this is not necessarily problematic and the ambivalence is latent (Van Harreveld et al., 2015), but when a judgment has to be made consumers become aware that their thoughts are inherently conflicting, which tends to give a negative feeling.

To solve this dissonance between initial associations and the arguments, consumers often look for information that confirms their initial associations rather than information that helps them overcome them. This is an effect called confirmation bias (Folkes, 1988; Kahneman et al., 1982). Even if consumers are provided with balanced positive and negative information about a nonconventional technology, consumers tend to use either the positive or negative elements of the information that strengthens their initial attitude (Fischer et al., 2013). In other words, provided with exactly the same information people who were initially more positive become even more positive, while those starting out more negative become even more negative. In practice thus consumers often use information that confirms their preconceived opinion rather than those which refute it. In the genetic modification debate, a similar effect occurs for trust in stakeholders. Instead of using information of a trusted source, even if this was counter-attitudinal, it was shown that consumers selected information from stakeholders that was in accordance with the initial opinion and trusted those stakeholders who shared a similar opinion with their own (Eiser et al., 2002; Poortinga & Pidgeon, 2006). This is where the naturalness heuristic comes into play. Consumers generally think that natural products are safer, healthier, and overall better than alternatives (Siegrist & Hartmann, 2020) in spite of the obvious examples of lethal natural substances such as snake venom or plants like monkshood or the death cap mushroom.

After summarizing some main points on attitude, in the next section, I will recount how consumers responded and formed attitudes toward first generation genetic modification keeping in mind that we consider that an attitude

- is a summary evaluation of a consumer opinion to an object.
- is based on emotional and cognitive evaluations, and/or risk and benefit perceptions.
- has automatic, heuristic, or implicit components and explicit or deliberate components.
- can be changed by communication either for a short duration using peripheral cues or in the long term that requires in-depth thought of the consumer.
- when there is inconsistency in arguments in the mind consumers are likely to resolve this, with a preference of defending prior opinion, even if this means discarding facts.

4 Response to genetic modification

To set the stage how consumers respond to nonconventional breeding it is worthwhile to consider consumer response to breeding in general. Plant breeding is deeply rooted in the consumers' minds. Classroom biology has introduced most consumers to the basics of conventional breeding and the proverbial relation between flowers and bees is strongly ingrained in cultural ideas about plant breeding. Hence when the topic of breeding is raised, consumers will automatically associate that with conventional breeding and almost certainly with cross-pollination by insects (Nales & Fischer, 2022). This idyllic association is likely to color, at least to some extent, attitudes toward all breeding approaches.

While insect pollination is most relevant to flowering plants, wind pollination, as for cereals, would also be considered as natural. To some extent human-induced hybridization through manual pollination would probably also be considered conventional by many if not most consumers. In these cases, it is likely that consumers will use their reasoning to construe a meaning why these breeding approaches are still natural and conventional although different from insect breeding.

When discussing attitudes to nonconventional breeding, consumers will likely consider these techniques to be nonnatural and new. Consumers tend to be somewhat neophobic when confronted with new foods in general (Pliner & Hobden, 1992), for example exhibited in the dislike of new protein sources such as insects (Fischer & Steenbekkers, 2018), algae, and duckweed (de Beukelaar et al., 2019). There is also specific food technology neophobia (Cox & Evans, 2008), which may be even more relevant to nonconventional breeding. Food technology neophobia has been observed in nonconventional breeding techniques but also in food processing developments such as food irradiation

or nanotechnology. Thus it is to be expected that all food innovations, including nonconventional breeding technology, will start with a slightly negative consumer view compared to conventionally perceived techniques. It is, however, important to realize that today's conventional is yesterday's nonconventional. Once upon a time the idea of shifting from hunter-gatherer to agriculture must have seemed highly innovative and nonconventional, even revolutionary. At one time moldboard plows and windmills will have been nonconventional. The first cars had to be preceded by a flag waiver to warn citizens of this invention passing their streets, and the first mechanized tractors and harvesters replacing animal-drawn appliances must have looked alien in the fields at first. Mechanization does not fit the highly idealized and romanticized outlook on agriculture, which is prominent in 19th century romantic paintings and for example the 1880's books about Heidi. Nevertheless, these farm technologies have long found their way into children's books and have become part of the good farm life. It can be assumed that most consumers will consider mechanized farming and the use of tractors conventional.

This shift from nonconventional to conventional seems not to have occurred so much with plant breeding and chemicals. Fertilizers and pesticides are still considered with suspicion and are seen as unnatural (Ray, 2000). In the light of the general perception about foods, natural is better (see e.g. Siegrist & Hartmann, 2020) and fertilizers and pesticides are not considered favorably. The response to chemical and DNA-based more advanced breeding techniques, including mutagenesis that has been around for almost a century on the other, will still be considered nonconventional, nonnatural, and even nonnovel by many consumers (Nair et al., 2022).

To further complicate issues, when discussing nonconventional breeding with consumers, most consumers will likely interpret this as a discussion on first generation genetic modification or even transgenesis that was first marketed in the 1990s. This may be due to use of jargon like "gene" or "DNA" (Nales & Fischer, 2022), which has strongly become linked to these techniques and have dominated the public debate. Not only the most critically viewed transgenesis, but also other variants such as cisgenesis (where a compatible plant gene is inserted instead of an alien gene), and the more recently developed precision techniques such as CRISPR-Cas, Tilling, zinc finger nuclease, are often framed in terms of the consumer response to first generation genetic modification transgenesis techniques.

The way in which gene technology became associated with such negative response shows the importance of keeping track of associations, biases, as well as emotional attitudes of consumers. The first genetically modified food approved for market, FLAVR SAVR tomato, was not met with societal resistance, when it first came on the market in 1994 (Kramer & Redenbaugh, 1994). A ripened tomato had a longer shelf life after ripening on the plant, which resulted in better taste at a fair price. FLAVR SAVR tomato puree was marketed in UK supermarkets in the mid-1990s in cans clearly labeled to be "made with genetically modified tomatoes." While sales never soared, it had a modest success. There were no protests. Despite this absence of widespread protest, it is conceivable that food technology neophobia put several consumers off from this product, contributing to limiting the success.

The tide did, however, soon turn against genetic modification when Roundup Ready soybeans became available in 1996. The FLAVR SAVR tomato held some immediate taste and price benefits to consumers. Roundup Ready was not marketed to consumers but only to farmers. Roundup Ready was sold to support farmers to control weeds, as the technology allowed the use of the herbicide Roundup, to which the Roundup Ready crops were made resistant. The claim that this would reduce herbicide use, thus providing a societal, environmental benefit seemed fickle from the start, as the herbicide-resistant crops would allow for more intense use of the chemical (which turned out to be the case indeed). The claim that the glyphosate-based herbicide would be safe for humans and the environment was also met with some cynicism as similar claims were originally made for other herbicides and pesticides that proved to be much more dangerous in the long term than claimed.

To aggravate the situation, even if the claim of reduced herbicide use would be proven to be true, from a consumer and societal point of view this benefit would not be very interesting (cf. Schenk et al., 2011). The Monsanto marketing strategy even claimed that the final products (e.g., soybeans, maize, wheat) were substantially equivalent and hence no different from those grown from conventionally bred varieties from a consumer point of view. This lack of any direct and tangible consumer benefits is a first cause for consumers to form, at the very best, a lackluster, but at worst a negative attitude. The new technology emphasized the use of chemical herbicides, which results in unnaturalness perceptions contributing to negative attitude formation, and further emphasized there would be no consumer benefits whatsoever.

That Roundup Ready crops and the Roundup herbicide were sold as package deals by the multinational Monsanto did not support acceptance of the crops. Monsanto had long been criticized by nongovernmental organizations (NGOs) on their past involvement with Agent Orange, a defoliation chemical, which is also hazardous to humans (Rebière & Mavoori, 2020). In addition, provisions under contemporary GATT (General Agreement on Tariffs and Trade, the predecessor of the World Trade Organization—WTO) allowed Monsanto to take patents on the new plants. This spurred the debate, to which extent it would be ok to patent nature (Law & Liability, 1994) which went against

the moral idea in population that nature is a shared resource and cannot be owned by companies. Monsanto also created licensing contracts to safeguard these patents and assigned itself extreme liberties to check for violations of those, which resulted in protest in farming communities (Mauro & McLachlan, 2008). This resulted in additional negative associations with genetically modified organisms in general, not only Roundup Ready. The negative attitude toward genetic modification can thus be in part be assigned to the bad reputation and lack of consumer insight of Monsanto, the dominant producer and most aggressive marketer.

This provided for a negative start. Following through on the substantial equivalence claim, Monsanto argued that since the Roundup Ready consumer products were equivalent, they did not need to be labeled. This allowed conventional and nonconventional food chains to be merged, which makes them more efficient from the point of view of supply-chain management. Supported by GATT agreements they then entered these products in the EU market, claiming the law on their side (Fernandez, 2006). European NGOs managed to galvanize public protest by focusing on the loophole in GATT agreements that health risks could lead to an exemption from the rules. While in my view, the objection of NGOs was only in part about health risks and possibly to a larger extent about environmental risks, and their moral objection to multinationals in general and Monsanto specifically, public health was the way to limit trade under GATT. NGOs appealed to moral outrage, emotions like fear and anger, and managed to spark the lingering feeling of unrest that European consumer freedom of choice could so easily be taken away by a multinational. This once more resulted in the entire concept of genetic modification being loaded with negative associations: those of a multinational using the law for its own benefit regardless of the interest of society. Perhaps more damaging was the strong relation to health risks created by NGOs aimed at the exceptions from GATT. The campaigns of the NGOs were successful to further load the genetic modification concept with negative emotions, through using emotional images of "killer tomatoes" and metaphors like "Frankenfood." Thus the campaigns of NGOs managed to reinforce negative associations, the perceived health risk and negative attitude components with the public.

EU officials responded in a technocratic way. Their initial response was that, bound by GATT agreements, they could not honor demands of their own populations and had to favor a multinational company. Given that trust in governments around food safety had already been damaged after the mishandling of BSE outbreaks (Frewer et al., 1999), this low trust made it easy for consumers to reject arguments of the EU and in doing so, even further reduce trust in their governments. The technocratic approaches the EU took toward health issues, the one exception under GATT also showed the lack of empathy and understanding of public concern. For example, questions about generation spanning effects in humans were answered that there was no cause for concern as the legally approved rodent tests showed no negative effect after 60 days. How exactly a 60-day rodent trial would generalize to several generations of human use was never clearly justified to the public other than that this was the generally accepted test and that there was science behind it. Public communication campaigns then went on explaining why the gene transfer with either trans- or cisgenesis techniques was safe, foregoing the fact that this further confused consumers who had only basic understanding of genetics. These technocratic responses tried to appeal to the ratio of the public, but foregoing the role of negative associations and emotions the lack of trust made it easy for the public to ignore this information and even trust the governments less (Eiser et al., 2002; Poortinga & Pidgeon, 2006).

This created a perfect storm for first generation genetically modified organisms that resulted in generally negative attitudes as supporters failed to see that

- the attitudes to newly introduced technologies generally start negative due to neophobia.
- the lack of tangible end-user benefits would be insufficient to overcome any risk, however small.
- lack of trust or even active distrust in the involved companies and governments allows consumer to ignore anything communicated by these stakeholders.
- emphasizing legal justification over moral objections is not a relevant argument toward public attitude change.
- emphasizing technical procedures without being able to justify their validity, even against baselines they were never developed for, is no relevant argument toward attitude change.
- factual information will almost never prevail over emotional communication where they contradict.
- once a negative association forms with the technology, these associations will lastingly influence attitude formation.

5 What makes GM more acceptable?

Although the polarization between stakeholders has paralyzed the debate within the EU, the opinion with the public in general maybe less negative than one might think (van Dijk et al., 2012). At least by 2012 the debate had calmed down to a level that attitudes were reverting to a more neutral state. Nevertheless, the negative offset toward

GM as a new technology in food remains and is remains somewhat enhanced by the debate in the 1990s. This debate has been more between NGOs objecting to GM applications and governments and industry promoting it then that the silent majority of consumers was actually involved or surveyed. Accusations that NGOs were completely wrong and used irrelevant or incorrect arguments (as e.g., argued in Miller & Conko, 2005) have led to debate the relevance of NGO involvement (Teel, 2002). The fierce debate between supporters and opponents has resulted in an entrenched polarization of these groups where neither could change position without losing believability with their constituencies. Given that the public may not be as radically against genetic modification, in general, also does not mean they are in favor. Throughout the genetic modification debate, research has shown that consumers weigh societal context heavily when determining in what situations and for what purpose genetic modification is less problematic, and that policy makers struggle to make rules that manage to anchor these intangible societal needs in a straightforward way.

The societal context relates to the finding that different usages of GM are considered differently problematic (Frewer & Shepherd, 1995). Across all application domains, food applications of genetic modification are perceived most negatively (Christoph et al., 2008). Pharmaceutical and medical applications are seen as least problematic (Frewer, Kleter, et al., 2013). Industrial applications rank somewhere in the middle. From studies into other novel technologies, this could be explained by the realization that, at least in high-income countries, food security is not at stake. In these countries any high-tech crop innovations is deemed more of a luxury than a necessity, while advances in medicine or pharma could be considered important for quality of life of people or even lifesaving (van Dijk et al., 2017). Although it is too early to be certain, it is conceivable this opinion may shift in the coming years as effects of climate change are expected to increase pressure on food production and genetic engineering may provide part of the solution to this (Cornelissen et al., 2021; Harbinson et al., 2021).

It also appears that the (perceived) intrusiveness of the nonconventional breeding technique matters. These results can be subtle, and in general conventional breeding is highly favored over all nonconventional techniques. Techniques developed to support breeding such as (DNA) marker-assisted breeding do not lead to objections (Nales & Fischer, 2022). Gene-editing techniques, such as CRISPR-Cas that is less intrusive and more precise, appear to lead to somewhat less objections compared to earlier less precise techniques (Muringai et al., 2020; Yang & Hobbs, 2020), although this difference is sometimes too small to matter (Shew et al., 2018). In this context the difference may lie, at least to some extent, to the specific application of the gene-editing technique, where we suspect that if these techniques are merely used to block genes, they may be more acceptable then, when alien genes are introduced (Nales & Fischer, 2022). Among the older genetic modification techniques there appears to be a slight preference of the less intrusive cisgenesis that relies on introducing species relevant genes over transgenesis that insert species alien genes (e.g., Schenk et al., 2008). Synthetic biology, where entirely new genetic material is created, is liked the least (Nales & Fischer, 2022). While these findings suggest the public to be more open to modern gene technologies, the overall preference for conventional breeding remains strong and the difference in appreciation of the different technologies small.

The organism to which genetic techniques are applied matters. The global debate about the ethics of the first human babies influenced by gene technology (Raposo, 2019) shows that application to human being is considered with considerable concern. A meta-analysis of GM applications shows that application to animals is also seen as most problematic (Frewer, van der Lans, et al., 2013), up to three times less desirable than to plant (Novoselova et al., 2005). Modification of bacteria is considered least problematic (Sparks et al., 1994). This may, for example, explain the apparently inconsistent finding that consumers do have many issues with consuming cheese created with GM-based rennet (Grunert et al., 2001; Siegrist, 2000). Industrially produced rennet reduces the need to slaughter animals for rennet production, making this an inherently ambivalent issue, as animal rights protesters often share personality traits with anti-GM people.

In addition, it matters how close the application comes to the individual. Objection to using GM as animal feed is much lower than to human consumption of an animal or plant that is modified itself (Ardebili & Rickertsen, 2020). Such a distancing effect is common in consumer science and has been combined in the construal level framework (Trope & Liberman, 2010), where any application that is temporarily, socially, geographically distant, or less certain/more hypothetical results in a different, more abstract view on the matter. This explains why application of new food technologies is considered less problematic in production, compared to the same technology embedded in a product (Steenis & Fischer, 2016). To what extent the more subtle differences between unprocessed plants and processed oils or other materials differ on this has not been shown in detail so far, but it can be argued that processed oils or dairy alternatives are likely to be more acceptable than unprocessed GM plants.

Another issue is the distribution of risks and benefits. Consistent with social distance, consumers tend to reject applications less frequently, to which they themselves benefit most. It was, for example, shown that apple cultivars with reduced allergenicity were accepted relatively well by consumers suffering from fruit allergy, while improved

sustainability through eliminating the need for pesticide use only marginally reduced objections (Schenk et al., 2011). The same results showed that for people not suffering from fruit allergy, the reduced allergenicity did reduce objections to a similar amount as improving sustainability. Consumers considered both allergenicity reduction and lower pesticide use to carry a societal benefit, but not so much a personal benefit. Improvements that support economy, earning power of multinationals are most likely to be considered of no value to consumers and among some consumers even be considered negative. In this context it is also of relevance to include the moral values of those not directly involved or empowered in the debate. This includes consideration of the benefits, damage, and risk to, for example, animals and nature (Frewer, Kleter, et al., 2013). The risk for nature would, in the context of cereals and pseudocereals, be relevant in the context of monocultures facilitated by herbicide-resistant crops. Monoculture field is irrelevant to biodiversity and may hardly facilitate insects and birds, which is why these monocultures are sometimes labeled as green deserts. In addition, the escape of the nonconventionally bred plants into nature, where they can compete with wild plants, can threaten biodiversity beyond the fields itself. These effects on nature can also be considered in the context of who benefits and who is at risk.

Besides all these properties inherent to nonconventionally bred plants, consumers also take a broader stance in that the breeding and use of such plants should be responsible. They require that checks and balances are put in place to assure this responsibility as they do not blindly trust producers and governments to do the right thing. Consumers ask for precaution, as adopted in regulatory frameworks, to ensure that promised benefits are met and no unexpected risks emerge (Mayer & Stirling, 2002). They ask for clear labeling of products created with biotechnologies (Frewer et al., 2011), and they require an independent organization to be established, which tracks the use of the new plant breeds for the long term (Nair et al., n.d.). While such requirements are difficult to fulfill it reflects an ongoing tension between techno-optimism and techno-pessimism (Heinrichs, 1999). Developers of new plants are often techno-optimistic. Society at large (Gutteling et al., 2006), but also farmers, even those who might apply the new plants, tends to be much more pessimistic (Gardezi & Arbuckle, 2020). Techno-pessimism or skepticism about the value of technology to society at large is understandable, if we consider the promises made when technologies are introduced. Most of such promises are not fully met. Unexpected risks that do materialize, such as monocultures in GM soy plantations, allowing among others transforming large swaths of the Amazon Forest into soy plantations, tend to remain unmentioned at introduction. Neither extreme optimism about technology nor extreme pessimism seems warranted and a more pragmatic approach is probably the best way forward (Scott, 2018). This may not be easy as this may require a substantial change in claims made by researchers and companies promoting biotechnology.

In summary there are several dimensions that determine the extent to which nonconventional breeding techniques are more or less acceptable.

These techniques tend to be most acceptable if

- they are not used for human food production
- are perceived as less intrusive
- are applied to organisms further removed from humans
- are not applied to fresh food, but to processed foods or even further removed animal feeds
- there is a fair distribution of risks and benefits to all of society
- there are sufficient, transparent checks and balances, and promises at introduction are met (if not surpassed).

6 Where to with cereals and pseudocereals—Concluding remarks

In this chapter I have outlined how consumers might look at nonconventional breeding and how consumer attitudes relate to this. While to date there is little empirical evidence on consumer response to cereals and pseudocereals created with nonconventional breeding technologies, based on the previously made analyses some predictions can be made.

Given that we are talking about nonconventional technologies it is to be expected that consumers will have an initial, negative tendency to these products. This should neither be ignored nor ridiculed. That technologists have often been overoptimistic about their innovation does not help, as this has only reconfirmed consumers that their initial negative tendency was not so far off.

When creating cereals and pseudocereals, consumers will form opinions based on existing associations, emotions, next to the information they receive. When combining specific (pseudo)cereals with information about nonconventional breeding this may result in conflicting perceptions. For example, one would expect that the promotion

of quinoa, marketed as authentic and historical "Inca superfood" (Loyer & Knight, 2018), is difficult to align with next-generation quinoa through nonconventional breeding. This may even be the case if the nonconventionally bred quinoa itself is not promoted as authentic. The mere association already attached to quinoa in general may cause such inconsistency in the mind of consumers. The inconsistency of the message could create attitudinal ambivalence, which at best is likely to lead to unpredictable and unstable response.

A lesson from the introduction of trans- and cisgenesis is that the application of new breeding to cereals and pseudocereals will be considered with some suspicion. The response might not be as negative as for nonconventional animal breeding, but more so than if these techniques are applied to bacteria and yeasts. In addition, it will be important for what purpose these plants are bred. Research suggests that as long as societal goals, in particular the creation of crops resilient to climate change is central, and if there is a guarantee that the focus on societal goals remains central in the long run, public opinion need not necessarily be opposed (Nair et al., n.d.). A promising way forward could be in developing wheats that are antiallergenic, but those will lead to the most positive attitude for patients with gluten intolerance and likely only be considered with some favor by others.

The use of the cereal and pseudocereals will also matter. It is likely that the use of these plants for fuel or the creation of biochemicals will lead to less resistance than the use as human food (Verbeke, 2007). Although the creation of fuel plants will introduce the debate on whether to prioritize food or fuel production in a world looking for more sustainable food source (Katz, 2008). Other ways to make nonconventionally grown cereals more acceptable could be through use as feed (which is currently already common) or more speculative in processed products that are far removed from the perception of the base product.

As it is now, it is hard to predict how societal response toward nonconventional breeding including those of pseudocereals will develop. On the one hand, we can expect neophobic feelings as for all food technology. At the same time there is a yearning for natural, authentic foods that are hard to align with nonconventional breeding techniques. On the other hand, there is growing realization that to maintain food supply there is a need for future crops, which may require the use of nonconventional techniques.

Climate change is putting pressure on agriculture worldwide. Climate change thus plays a role in the increased migration into Europe and Northern America from southern countries. It also creates extreme weather on a global scale (extreme droughts and extreme rainfall) as well as salinization of low-lying agricultural areas, including those of high-income countries. The restrictions in trade in the 2019 COVID pandemic, and even more strikingly the disruption of wheat and sunflower oil exports following the 2022 war in Ukraine, show the vulnerability in relying on a globalized cereal production system. Creating plants, including cereals and pseudocereals, that can withstand local conditions, that can grow with reduced pesticide and herbicide protection, and reduce dependency on other regions may be essential for a good future in large parts of the world. It is this changed dynamic in society and the feeling of urgency to improve food resources together with the more precise techniques developed that may allow for positive opinions to nonconventional techniques for (pseudo)cereals. However, mishandling and ignoring the broad, ethical concerns of the public, combined with denying that emotions inform consumer attitude, may also cause a renewed protest. To avoid protest and make for positive attitudes toward cereals and pseudocereals bred through nonconventional technologies, it is up to plant breeders to create technologies and applications that are inherently most acceptable, to governments to balance moral concerns of their constituencies against economic interests in developing national and international policy, and to consumer-centered product developers to ensure consumers receive desirable products with clear benefits to them.

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