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Freedom of Choice—Organic Consumers' Discourses on New Plant Breeding Techniques

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Abstract: In recent years, there have been significant developments in biotechnology, specifically regarding New Plant Breeding Techniques (NPBTs). Such advancements have been driven by the need to develop improved and more sustainable crops while reducing pesticides and fertilisers. NPBTs include a heterogeneous group of methods that allow performing plant mutations more precisely than in genetically modified (GM) technologies, saving time and effort. Although some experts consider NPBTs an opportunity for organic farming expansion, the European Court of Justice in 2018 pronounced against their use in organic farming since all plants obtained by NPBTs should follow the same regulations as Genetically Modified Organisms (GMOs). This study aims to understand consumers' attitudes and viewpoints towards new breeding techniques. Focus groups and Q methodological approach were used to uncover consensus and divergence among organic consumers in seven selected European countries (Germany, Italy, Latvia, the Netherlands, Spain, Switzerland, United Kingdom). Results of qualitative studies suggest that organic consumers are generally hostile towards NPBTs in organic farming. Using Q methodology, three distinct factors were identified: the "Risk Averse", the "Technological Optimists", and the "Socially Concerned". The results highlight that consumers' subjective knowledge and understanding of NPBTs diverge from the discourse of NPBTs lobbyists and proponents.

Keywords: organic food; consumer attitudes; GMO; genetic engineering; Q methodology

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1. Introduction

New Plant Breeding Techniques (NPBTs), shortly referred to as New Breeding Techniques (NBTs), include a heterogeneous group of methods such as cisgenesis, genome editing, reverse breeding, CRISPR/Cas9 system (the short abbreviation of clustered regularly interspaced short palindromic repeats and CRISPR-associated protein 9), etc. [1]. According to the literature, NPBTs enable mutations to be performed more precisely than in first-generation genetic engineering techniques, reducing the risk of unpredictable gene alteration and the time and efforts required to produce varieties with new desired traits [1–4]. Furthermore, proponents of these biotechnologies claim that they reduce the need for pesticides and fertilisers and positively affect biodiversity and the environment [2,5]. According to the International Federation of Organic Agriculture Movements (IFOAM) principles, organic agriculture should promote only those production systems that protect "*the health of soils, ecosystems and people, by relying on ecological processes, biodiversity and cycles adapted to local conditions*", and refrain from the use of chemicals and Genetically Modified Organisms (GMOs) [3,6]. Such values were confirmed in the 90s when IFOAM officially incorporated the ban of GMOs in the "Basic Standards for Organic Production and Processing" [7]. Lammerts Van Bueren and colleagues [8] reported that organic farming must avoid genetic engineering according to the "*precautionary principle*". Therefore, NPBTs methods would violate the concept of "*naturalness*", leading to unpredictable environmental and human health risks. Additionally, many NPBTs are protected by patents contrasting the "Fairness" principle of organic farming, which promotes free access to genetic resources and ensures the independence of farmers in their choice of seeds [3]. Royalties may increase the cost of NPBT seeds, but this applies to hybrid seeds too, which are used by many organic farmers.

In Europe, where a strict regulatory framework limits the use of GMOs, consumers' attitudes toward genetic manipulation of foods are generally accompanied by considerable scepticism and negative perceptions [1,9–12]. Different studies confirm that EU consumers (not only organic) have a strong aversion toward GMOs and genetic engineering [2,9,11,13,14] and consider human manipulation of living organisms—both animals and plants—as "*unnatural*" [9,12]. Limited knowledge, low familiarity, lack of trust, low perceived benefits and high perceived risks for health and the environment are crucial barriers to applications of genetic engineering in farming and food production [3,9,15].

However, the rapid population growth and climate change require developing more efficient and sustainable food production systems [7,9,15,16]. In this context, some experts pointed to improvements in breeding techniques, including genetic modification, to control and contain negative impacts on natural resources and maintain yield levels [9,13,15,17].

Although in 2018, NPBTs were ruled similar to GMOs by the European Court of Justice (Directive 18/2001/EC in 2018), some experts criticised the recent decision to label NPBT products as "*genetically modified*" as being too rigid. They believe these modern techniques are more compatible with organic farming than conventional ones [6,11,17,18]. The scientific debate on whether NPBTs are similar to GMOs is still ongoing, and there are different viewpoints on their suitability in organic farming [9,10,18,19]. For example, according to Lombardo and Zelasco [17], NPBTs do not contradict the standards of organic agriculture since genome manipulation happens in a way that cannot be distinguished from those in natural processes.

Most existing studies focus on the potential of genetic engineering in farming in general and the debate on the role of NPBTs in the development of the organic sector [2,3,6,8,11,18,20–24]. Only a few research studies examined the consumer acceptance of these biotechnologies, and several aspects remain unexplored [4,5,9,12–15,25–27]. Despite consumers' general reluctance toward GMOs, recent studies have found that consumers may prefer some new breeding techniques, such as cisgenesis, CRISPR or gene editing, over transgenesis [5,9,12,13,15,25]. Tanaka [4], who explored the acceptability of NPBT crops in Japan, also found that consumer preferences toward NPBT crops are relatively higher than GM crops. This study also suggests that psychological factors, mainly trust and anxiety, can influence individual and public acceptance of these novel breeding methods. Delwaide et al. [13], exploring European consumers' willingness to pay (WTP) for rice labelled as GM or cisgenic with environmental benefits, report that cisgenesis is preferred to the GM technique in all countries investigated (Belgium, France, the Netherlands, and the United Kingdom), except Spain.

Similarly, using focus groups, Mielby et al. [12] established that cisgenic crops are more acceptable than transgenic ones. Shew et al. [15], investigating consumers' willingness to consume (WTC) and willingness to pay (WTP) for CRISPR-produced food, report that consumers in Australia, Belgium, Canada, France, and the USA, are more willing to consume CRISPR foods as compared to GM foods. More specifically, this study argued the importance of specific aspects such as familiarity and consumers' knowledge (e.g., perspectives on safety or potential environmental benefits) to increase consumers' acceptance of new breeding methods [15]. Communication strategies also have a relevant role in facilitating or not the acceptance of genetic engineering in the food sector [1,15,26].

Given the controversies on the use of NPBTs in organic farming, very little is known about how organic consumers respond to this new type of genetic engineering [5,14,23,25]. Available studies confirmed that organic consumers, compared to conventional consumers, have a stronger negative perception of transgenic products [14,25] and do not differentiate between transgenesis and cisgenesis [5]. However, according to Edenbrandt [25], when a relevant positive attribute of a product, such as "pesticide-free", is combined with a new breeding technology, consumers' willingness to purchase the product increases, even for the regular organic consumers.

This study aims to investigate consumers' attitudes, discourses, and viewpoints towards new plant breeding techniques. This study combines two methodologies, focus groups and Q methodology. It is influenced by Foucault's discourse theory, suggesting that people act upon discursive changes in social constructions more than on hard facts or rules [28]. Understanding organic consumer discourses about NPBTs in farming and food is of utmost importance to create a knowledge base that may guide policy action on these matters. Q methodology [29–31] offers a means to understand the alternative understandings of these biotechnologies being adopted by the consumers, but "*it also provides a stimulus to conjecture about the reasons why different groups [of consumers] may adopt different explanations*" [32]. In the words of Wendy Stainton Rogers, "*we can never have any independent knowledge about 'the world' of things and events [. . .], no means of knowing things-as-they-really-are. All knowledge is a human product: all the apparent phenomena, processes, events, and things that we observe around us and happening to us and to others, exist only in the sense that have been 'knowledge into being*'" [32]. Focus groups [33] complement Q in providing textual exemplification of the discourse (and concourse) regarding consumers' knowledge and understating of NPBTs.

2. Materials and Methods

2.1. Focus Group

At least one focus group was conducted in each of the seven selected countries: Germany, Italy, Latvia, the Netherlands, Spain, Switzerland, and the United Kingdom, between November 2019 and February 2020. Participants were carefully selected to achieve a target segmentation of the groups according to the aim of the study. Participants were responsible for their food shopping and aged between 18 and 70. A total of 102 organic consumers were recruited using existing datasets and, in some cases, via a professional recruitment agency.

Female and male respondents were almost balanced (female 53.92% of the sample). Regular organic consumers, defined as anyone purchasing more than 50% of their food for home cooking as organic and purchasing at least two organic food categories once per week, were 52%. Occasional consumers were all others, excluding those who either never consciously purchased organic food or were indifferent/contrary to organic food and farming. Concerning age, the '18–45′ category was the largest group (61%), and the '46–70′ category (39%) followed. People working in research institutes or farms and the food sector were not included in the sample. The detailed description of the focus group participants is presented in Table 1.

Table 1. Description of FG participants (n = 102) for each country (IT: Italy, DE: Germany, LT: Latvia, NL: Netherlands, ES: Spain, CH: Switzerland, United Kingdom: UK).

Attribute	Details	IT	DE	LT	NL	ES	CH	UK	Total
Sex	Male	3	12	3	7	11	6	5	47
	Female	7	8	5	8	13	8	6	55
Age	18–45	7	10	6	6	14	10	9	62
	46–70	3	10	2	9	10	4	2	40
Type	Regular	5	11	5	8	12	7	5	53
	Occasional	5	9	3	7	12	7	6	49
Total Participants		10	20	8	15	24	14	11	102

Focus group research was selected to investigate organic consumers' current knowledge, attitudes, and perceptions of new breeding techniques in organic farming. It allows revealing experiences, perspectives, and perceptions that would not be accessible without group interaction [34]. Focus group (FG) discussions were conducted following common and agreed guidelines. The discussion guidelines were pre-tested by carrying out three pilot focus groups.

The discussion guide included an introductory section designed to create a pleasant and workable atmosphere among the participants. The moderator started presenting himself and introducing the purpose of the focus group discussion. Then, the discussion opened by exploring participants' knowledge and perceptions about the NPBTs. To avoid biasing participants, no additional explanations or comments about those terms were provided. When referring to NPBTs, the term "gene" or "genetic" was excluded in all languages to avoid biases. Next, participants were shown a short cartoon video introducing three breeding techniques: gene editing, cisgenesis (both NPBTs) and one GMO technique, transgenesis. The cartoon was built to describe, visually and with sentences, the gene-editing, cisgenesis and transgenesis techniques in a neutral way. Each sentence was agreed with a psychologist to avoid influencing participants. After the video, some probing questions were asked to explore any perceived differences between the three techniques and investigate feelings, attitudes, and level of acceptance (or not) of NPBTs in organic farming. Finally, participants were asked to complete a Q sorting task (described below). Participants received a small compensation for their participation in the study.

Each focus group was recorded, and each country partner produced the related verbatim transcript. All verbatim were directly provided in English to reduce translation costs and time. Verbatim were anonymised, data were coded, and content was centrally analysed [35].

2.2. Q Methodology

Q methodology allows the researcher to discover shared viewpoints across individuals and it is particularly suited for exploring discourses around a specific topic [32]. Based on William Stephenson's theory known as Q methodology [36], this method has been increasingly used in very different areas of interest, social sciences [37–39], landscape assessment [40], novel foods [39], agricultural research [29,41], organic agriculture [42], and in many others. In a Q study, subjective opinions are revealed by analysing patterns across a sample of individuals [39]. Participants of a Q study are asked to rank statements on a specific topic in a quasi-normal distribution (see Figure 1) [43]. This ranking procedure, known as 'Q sorting process', generates an individual Q sort, that reflects the subjective viewpoint of the participant. This Q sort is like a picture and represents "*individual's conception of the way things stand*" [44]. This approach makes subjectivity become measurable [45] and "operantly" defined by each individual during the data collection [29,39]. Then, correlating these Q sorts and applying factor analysis make it possible to synthesise perspectives into a manageable number of views and focus on similarities and differences between individuals in a specific domain [44].

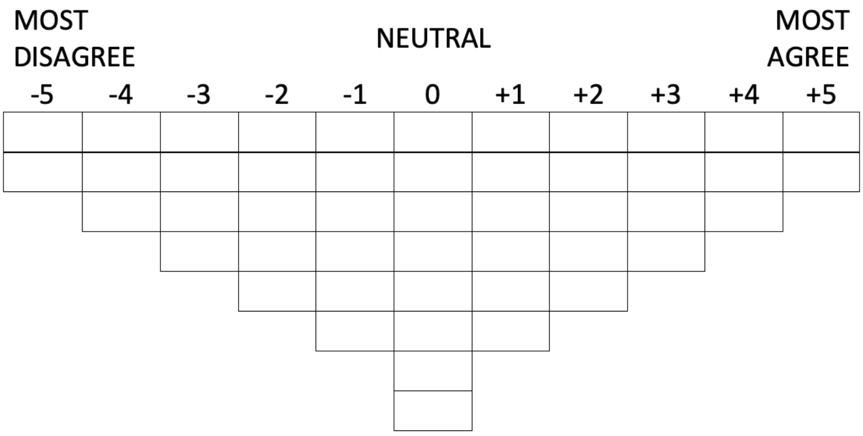

Figure 1. The quasi-normal distribution (shape of a "Q sort").

A Q study traditionally consists of five steps: (1) the collection of the "concourse"; (2) the selection of statements that form the "Q sample"; (3) the selection of the participant sample ("P sample"); (4) the Q sorting process; and finally, (5) the statistical analysis of Q sorts that allows the factor extraction.

To elicit participants' viewpoints about NPBTs in a "*structured and statistically interpretable form*" [31,37], Q sorts were administered to participants at the end of the focus groups. A *by-person* factor analysis allowed obtaining different "discourse", "viewpoints" about NPBTs in the form of factors [46]. In the following paragraphs, a description of each step is presented.

2.3. Building the Concourse

Data collection begins with the construction of the concourse, i.e., the "*universe of statements for (and about) any situation or context*" [47]. Brown [48] defines the concourse as "*the flow of communicability surrounding any topic*". Stainton-Rogers relates the concourse to discourses [32]. To make the concourse "*broadly representative*" [43] and sufficiently cover the topic under investigation (consumers' viewpoints towards the use of New Plant Breeding Techniques in the organic market), any relevant statements were gathered from different sources: naturalistic (e.g., interviews, blogs, direct communication), ready-made (e.g., scientific literature, media reports) or hybrid [49]. Most of the "naturalistic" statements were collected during the BIOFACH Congress (2019) and from social media (e.g., Twitter), while the "ready-made" statements were found from other popular sources using specific keywords like "New breeding tech", "CRISPR", "GMO 2.0" and similar. Scientific literature was excluded to facilitate understanding of all statements and increase participants' engagement. Statements were collected in English, but some Italian statements were also included and translated. The collection of new statements ended when the "*saturation point*" was reached, coinciding with finding statements or themes already collected [49]. Around 138 statements formed the final exhaustive concourse.

2.4. Selection of the Statements

The concourse was then reduced to a manageable and representative number of statements for the ranking process [43]. A structured sampling approach was followed to extract the so-called "Q sample" [49]. Although there is no optimal size for a Q sample, Q methodological studies usually use a range between 40 to 80 items [43]. This reduction, usually done following Fisher's experimental design approach [50], was aimed to obtain a balanced Q sample and classify the statements into four a priori theoretical categories [51]: Environment, Health, Regulations and Ethics, and Competitiveness and Technology. Statements were organised according to a 4×2 matrix of four thematic areas with two levels ("Pro": favourable and "Con": contrary statements). Then, six statements were selected for every cell to obtain the final Q sample, and redundant items were removed, defining the 48-statement Q sample.

2.5. Participant Sample

According to the Q method, the participant sample, known as "P sample", was not randomly selected but theoretically defined [43]. Consistently with the aim of the study, only organic consumers were recruited, including both regular and occasional consumers of organic food. To avoid neglecting any relevant viewpoint, different organic consumers participated in the focus group discussions and ranked the statements related to NPBTs, generating their Q sorts [52,53]. Since the representativeness of the sample and the number of the respondents are of minimum importance, compared to the breadth and diversity of the perspectives included in the participant sample [54], a limited number of respondents was selected for each country. Additionally, the dimension of the P sample is generally smaller than the Q sample [44]. However, other Q sorts from specific countries (Italy, Latvia, and Switzerland) were included for the analysis to reach a good variety of perspectives.

Consequently, the final number of Q sorts collected was 118. The detailed description of the P sample is reported in Table 2.

Table 2. Description of the P Sample (n = 118) for each country (IT: Italy, DE: Germany, LT: Latvia, NL: Netherlands, ES: Spain, CH: Switzerland, United Kingdom: UK).

Attribute	Details	IT	DE	LT	NL	ES	CH	UK	Total
Sex	Male	8	12	6	7	11	7	5	56
	Female	13	8	6	8	13	8	6	62
Age	18–45	14	10	9	6	14	11	9	73
	46–70	7	10	3	9	10	4	2	45
Type	Regular	10	11	6	8	12	8	5	60
	Occasional	11	9	6	7	12	7	6	58
Total Participants		21	20	12	15	24	15	11	118

2.6. Q Sorting Procedure

Participants were asked to rank-order each of the 48 statements into a quasi-normal distribution to generate their individual Q sorts that represent the participants' subjective perspectives [43]. The sorting distribution is described in Figure 1. Following a condition of instruction, participants arranged the statements according to their agreement, from "most disagree" ('−5') to "most agree" ('+5'). After the sorting process, post-sorting questions were collected to gather additional information from participants' choices, especially about the statements at the extremes of the Q distribution that scored '+5' and '−5'.

2.7. Factor Extraction and Interpretation

Once collected, Q sorts were cross-correlated to form a 118 × 118 matrix, which provides the similarities between each Q sort [38]. Then, this correlation matrix was subjected to factor analysis for the extraction of the most relevant factors, using the centroid method described in Brown [44]. The potential of factor analysis is that it reduces the numerous perspectives of Q sorts into a smaller number of general "*views*" or "*discourses*" concerning the topic under investigation: the factors. Each factor extracted represented a "*shared meaning or something held in common*" within the participant group [43]. Thus, each factor captures a different viewpoint shared by participants who similarly ordered the statements. There is no unique way to select the correct number of factors [39,43,44,55]. The most commonly used methods include the Scree plot, Brown's rule and Humphrey's rule [44]. The Scree plot is a line graph where eigenvalues for each factor are plotted. The point at which the line changes slope indicates the cut-off point is the number of factors to be extracted [43]. According to Brown's rule [44], the number of factors to extract are those "*that have at least two significant loadings. Factor loadings are correlation coefficients representing the degree to which a Q sort correlates with a factor . . . For a loading to be significant at the 0.01 level, it must exceed 2.58(SE_r)*", where SE is the standard error and it is given by the following expression: SE = $1/\sqrt{}$(n° of statements) [44]. For this study, the standard error of the correlation is given by $1/\sqrt{}(48)$ = 0.1443, and ±2.58 (0.1143) = ±0.3723, indicating that correlations exceeding ±0.3723 are significant (p < 0.01). Brown suggested also using Humphrey's rule for determining the number of factors: "*Humphrey's rule (Fruchter, 1954: 79–80) states that a factor is significant if the cross-product of its two highest loadings (ignoring sign) exceeds twice the standard error*" [44,56]. In this study, the factor solution was chosen according to both statistical criteria (e.g., Scree plot, Brown's rule and Humphrey's rule) and practical considerations related to the interpretability of factors [43,44].

Then, factors were rotated to maximize the explained variance between them using a combination of Varimax orthogonal rotation and judgemental rotation to better separate factors and make their interpretation clearer [55]. The judgmental rotation "*enables the investigator to follow theoretical inclinations and hunches" and "permits the observation of reality, represented by the Q sorts performed, from the theoretical vantage point of the observer*" [44].

As reported in Stephenson (1961), the main purpose is to make discoveries "*by rotating deliberately so as to bring unexpected but not unsuspected results to light*" [44,57].

3. Results

The following section reports the aggregated results of the focus group discussions and the Q study. Participants' knowledge and attitudes towards NPBTs and their relevant reasons for accepting (or not) the new breeding methods, as emerged from the discussions, are described. To preserve anonymity and privacy, from now on, any reference to the participants will contain the country code plus the participant number (e.g., "IT1"), the "Gender" code (e.g., "M" form male; "F" for female), and the short form "Reg" when referred to regular organic consumers; and "Occ" when referring to occasional (e.g., "DE2, M, Occ"). Finally, the three viewpoints identified by the Q factor analysis are described.

3.1. Focus Group Results

In all countries, most participants were slightly confused and did not know the meaning of New Plant Breeding Techniques. Participants associated very different meanings, mostly related to production methods, such as optimising production processes, using artificial fields (e.g., no need of growing outside or underground farms, vertical farming) or any other technique for protecting plants against pests and diseases. The lack of knowledge about these novel techniques also emerged from the minimal number of participants (mainly from DE, ES and IT) realising that new breeding methods embed genetic manipulation. Furthermore, participants declared themselves doubtful about the benefits and risks of these new techniques and asked for more information to form a more precise opinion.

A general rejection of using NPBTs in organic farming emerged during the discussions. Consumers appreciate organic farming because it maintains the integrity of the genetic resources, is more "natural" than the conventional sector and is "*not manipulated*". A participant clarified: "*For me, the word 'organic' is linked to nature . . . these NPBTs manipulating the DNA are shocking . . . organic farming is not associated with any genetic manipulation*" (IT1, M, Occ).

After the video illustrating the three different technologies (*gene editing, cisgenesis,* and *transgenesis*), the negative perceptions were confirmed too. The main concern was the genetic manipulation that intrinsically characterises gene-editing and cisgenesis. Additionally, most participants did not perceive differences between NPBTs and the transgenesis technique. Some of them stated: "*I did not get that and why it is different from gene manipulation*" (DE2, M, Occ), "*they are all GMOs... I don't understand why we have to use those techniques...I believe that there is no sense to genetically manipulate an apple*" (IT7, M, Reg), and another "*I do not agree with any of the three techniques, I consider that modifying a product, uh, genetically already weakens the ecological being*" (ES7, F, Occ). Only a minor group of participants showed some tolerance for cisgenesis and gene-editing, assuming that these techniques "mimic" naturally occurring processes. Some of the participants expressed a less hostile attitude. They assumed that NPBTs could benefit organic farming with economic and productivity issues (e.g., producing enough food and reducing costs).

When the organic food purchase topic was tackled, most opinions were against buying something derived from NPBTs or using genetic manipulation. Many declared that any manipulation should be forbidden in organic products. One participant affirmed: "*If I go to a store, on an organic apple and I see that the label says that is genetically manipulated, I will not buy it. Much less I would eat it!*" (ES10, M, Occ). Among the worries are some ethical and social aspects for not purchasing: "*This is dangerous . . . this ethical area . . . once you have opened Pandora's Bottle . . . how far you can close it again?*" (DE13, M, Occ), and "*Then you are going to play as God*" (NL4, F, Occ). Other consumers were more concerned about the harmful and unpredictable impacts on society and the environment than human health.

Scepticism of the economic and political rationale behind NPBTs was also brought forward. Some participants believed that lobbyists contrasting the European Court of Justice ruling that equated NPBTs to GMOs are trying to push the EU to allow their use without specific labelling. They stated: "*It's also a political and economic decision*" (DE13, M, Occ), "*The question is why? What is the benefit? . . . often there is an economic interest to sell seeds through Monsanto every year, . . . is purely economic interest*" (DE19, F, Reg), and "*This is marketing. Next, it will be given to the traders. Traders have their own rules. They will sell for much money*" (LT5, F, Occ). The use of specific labels to distinguish NPBTs-foods was requested to be mandatory by all participants, as a quest for transparency and consumer information.

3.2. Q Sorting Results

The three-factor solution was the one that provided a satisfactory explanation of the data and well-interpretable factors. The rotation results produced a matrix in which Q sorts are the rows and factors extracted are the columns. All factor loadings, indicating the relationship between each Q sort and each factor, are showed in Table 3. Q sorts are usually *flagged* (i.e., tagged as "*most representative of a given factor*") to define each factor [49,58]. Flagging allows to obtain more distinguishable viewpoints. The most representative Q sorts are those retained for the subsequent calculations, such as the calculation of factor scores, which are used for the interpretation of factors [49,58]. Factor scores indicate the correlation between each statement of the Q sample and a given factor. Those scores are calculated for each statement of the Q sample and for each of the factors, "*producing a parsimonious set of "composite Q sorts" that distil by a combination of statistical and pragmatic means the basically different viewpoints implicit in the larger concourse*" [49]. Those scores are integer approximations of z-scores, and the z-score is calculated as a weighted average of the scores given by the flagged Q sorts to that statement [58]. In other words, factor scores indicate "*indicate how a hypothetical person representing a group of similar respondents (the factor) would rank the items*" [58]. Factor scores for each statement are reported in Table 4. More specifically, distinguishing statements (i.e., "*placed in the composite Q sort in locations that are significantly different*") are particularly considered to describe factors [49]. To facilitate the communication of results and their interpretation, an informative label was assigned to each factor.

Table 3. Factor loadings for each Q sort and each Factor.

Q Sort	F1	F2	F3	Q Sort	F1	F2	F3
IT1	**0.45**	0.0033	0.4178	DE3	−0.0376	**0.6912**	−0.0847
IT2	0.2359	**0.3968**	0.221	DE4	**0.7383**	−0.3418	0.1376
IT3	**0.6037**	−0.1461	0.4501	DE5	**0.6087**	−0.3816	0.3974
IT4	**0.7284**	−0.2277	0.0917	DE6	**0.5823**	0.557	0.1601
IT5	**0.6654**	0.2965	0.039	DE7	**0.7368**	0.0167	−0.0498
IT6	**0.6072**	−0.026	0.4451	DE8	**0.7718**	−0.2606	0.0606
IT7	**0.8023**	0.0213	0.3314	DE9	−0.0053	**0.6987**	−0.0345
IT8	**0.6539**	−0.0937	0.3175	DE10	**0.6334**	−0.3029	0.2262
IT9	**0.5747**	−0.1901	0.1946	DE11	**0.7178**	0.1336	0.4236
IT10	**0.7929**	−0.117	0.1809	DE12	0.3454	0.0491	**0.4242**
IT11	**0.7344**	−0.0972	0.5084	DE13	**0.8374**	−0.0534	0.1778
IT12	**0.6014**	0.0305	0.4308	DE14	**0.5607**	−0.0716	0.4151
IT13	**0.4313**	0.0523	0.2276	DE15	**0.7417**	−0.1747	0.2796
IT14	**0.8058**	−0.061	0.1316	DE16	**0.6105**	0.2291	−0.2111
IT15	**0.7568**	−0.3297	0.1284	DE17	**0.4038**	0.2729	0.001
IT16	**0.692**	−0.0954	0.1864	DE18	**0.6772**	−0.1343	0.2306
IT17	**0.5966**	0.053	−0.0645	DE19	**0.7624**	0.0954	−0.0887
IT18	**0.5483**	0.2051	0.2571	DE20	**0.6633**	0.2205	0.1269
IT19	−0.1123	**0.4444**	0.3759	CH1	**0.7729**	0.3401	−0.0151
IT20	−0.3728	**0.7277**	0.2403	CH2	**0.8209**	−0.0906	0.2217
IT21	−0.4736	**0.496**	−0.069	CH3	**0.7872**	0.1431	0.1908
LT1	**0.5778**	0.1195	0.3369	CH4	**0.5981**	0.3245	0.5178
LT2	**0.6235**	−0.1923	0.5856	CH5	**0.8362**	−0.1265	0.2778
LT3	0.1724	**0.6975**	0.0727	CH6	**0.7584**	0.2365	−0.052
LT4	−0.2769	**0.5299**	0.2965	CH7	−0.2061	0.6062	−0.0094

Table 3. *Cont.*

Q Sort	F1	F2	F3	Q Sort	F1	F2	F3
LT5	0.0977	**0.5763**	0.0292	CH8	**0.7412**	−0.0434	−0.1197
LT6	**0.6572**	0.2718	0.1169	CH9	−0.3306	0.4077	0.0792
LT7	0.183	0.0214	0.2951	CH10	**0.6833**	−0.209	0.3441
LT8	−0.1709	**0.3849**	−0.0809	CH11	−0.235	**0.5209**	−0.3809
LT9	0.1817	0.0605	**0.6987**	CH12	**0.7175**	−0.1533	0.2505
LT10	**0.7192**	0.2453	0.2232	CH13	0.0239	0.136	0.2735
LT11	0.1099	**0.5529**	0.433	CH14	**0.6597**	−0.0433	0.2617
LT12	**0.7314**	−0.4017	0.1418	CH15	0.2865	**0.5259**	0.2221
ES1	**0.6034**	−0.2444	0.3922	UK1	0.1008	0.1999	**0.4994**
ES2	**0.7365**	−0.1807	0.2067	UK2	0.2038	−0.1951	0.1228
ES3	0.0505	0.2633	0.2406	UK3	**0.6116**	−0.1881	−0.0001
ES4	−0.489	**0.643**	−0.0918	UK4	**0.5678**	−0.1094	0.1351
ES5	−0.1767	**0.7614**	−0.1977	UK5	**0.4451**	−0.0456	0.0378
ES6	**0.7135**	−0.1855	0.3723	UK6	0.1904	**0.7126**	0.0589
ES7	**0.6163**	−0.3266	0.4492	UK7	−0.0887	0.3524	0.2967
ES8	−0.1627	0.3602	**0.4045**	UK8	**−0.5406**	0.4679	−0.274
ES9	0.3392	0.0962	0.219	UK9	0.2789	−0.152	0.2305
ES10	**0.7218**	−0.2524	0.3407	UK10	−0.18	**0.6292**	−0.0738
ES11	0.1117	−0.3293	0.2109	UK11	**0.7556**	−0.0743	0.1468
ES12	0.3167	0.1935	0.3695	NL1	**0.4759**	0.2544	0.221
ES13	−0.1579	0.216	−0.135	NL2	**0.8317**	−0.2271	0.1643
ES14	**0.6584**	−0.3735	0.4302	NL3	0.3267	0.2432	**0.4098**
ES15	−0.1476	**0.6776**	0.2251	NL4	**0.5789**	−0.1877	0.2579
ES16	**0.5056**	−0.5287	0.3814	NL5	−0.0053	**0.7029**	0.2313
ES17	**0.681**	−0.1477	0.3878	NL6	**0.6345**	−0.2263	0.2314
ES18	−0.47	**0.4875**	0.0448	NL7	0.1984	**0.3984**	0.1336
ES19	**0.4381**	−0.2638	0.214	NL8	**0.7109**	0.3528	0.2611
ES20	**0.7297**	−0.0521	0.1213	NL9	0.3463	**0.5004**	−0.168
ES21	**0.666**	−0.2409	0.2364	NL10	**0.4464**	0.2561	0.1017
ES22	0.4522	−0.3098	**0.5267**	NL11	**0.8062**	−0.2768	−0.0274
ES23	**0.5755**	−0.043	0.3291	NL12	**0.759**	−0.1588	0.0122
ES24	**0.5583**	−0.3286	0.2336	NL13	0.35	0.1005	−0.1251
DE1	−0.114	**0.5201**	−0.0713	NL14	−0.2817	0.5267	0.1033
DE2	**0.8141**	−0.057	0.0897	NL15	**0.6961**	−−0.3708	0.1284

The most representative Q sorts are reported in **bold.**

Table 4. Factor scores for each of the 48 statements.

		Factor Scores		
N	**Statements**	**F1**	**F2**	**F3**
1	I believe that NPBTs would allow to produce organic food with fewer allergens.	−1	+2	+1
2	I favour the use of NPBTs because it will make all agriculture organic and more environmentally sustainable.	−4	+1	−4
3	I believe that the use of NPBTs is necessary even in organic farming because they represent the key to reacting to climate change.	−2	**+3**	−2
4	I think that NPBTs could be used by organic farmers who want to grow crops that help restore soil health.	−1	+2	+1
5	I support gene-edited crops because of their potential to increase yields in organic farming and reduce consumer prices of organic food.	−2	+2	−2
6	I think that NPBTs may increase the nutrient content of organic food.	0	+3	+2
7	I believe that NPBTs may help obtaining seeds and plants more pest resistant and better suited to organic agriculture.	0	**+5**	+2
8	I believe in freedom, and I don't like the ban of NPBTs in organic farming.	−2	0	+1
9	In my view, NPBTs can be introduced in the organic market, since they may reduce risks for the environment and human health.	**−4**	0	0
10	Consumers will especially benefit from the use of NPBTs in organic farming.	−2	0	−3
11	I think that the NPBTs should be introduced in the organic seed market without any special authorisation.	−5	−5	−4
12	I think that NPBTs represent a useful technology for organic farmers to compete with the conventional ones.	−1	**+3**	−1

Table 4. *Cont.*

		Factor Scores		
N	**Statements**	**F1**	**F2**	**F3**
13	I think that the use of NPBTs could boost the growth of the EU organic plant breeding sector.	−1	+1	+1
14	I believe that NPBTs may help to eliminate hunger in the world.	−1	+2	**−5**
15	I believe that NPBTs may contribute to the goal of feeding the world by organic farming.	0	**+4**	**−5**
16	In my view NPBTs may guarantee healthier organic products to consumers.	**−3**	0	0
17	I think that NPBTs could have fewer undesirable health risks than GMOs.	−1	+1	+1
18	Since gene-edited crops are indistinguishable from naturally occurring crop variants, I think that NPBT should not be regulated as GMOs.	−2	−2	0
19	I'm not afraid of NPBT crops because they have been developed by public sector scientists.	**−4**	−2	0
20	I accept NPBTs because they simply accelerate modifications that could happen in nature, and therefore are compatible with organic farming principles.	−3	+2	−4
21	I believe that NPBTs' may help reduce the amount of chemicals used in organic farming.	0	**+4**	−2
22	I support the use of NPBTs because they can boost the natural defences of organic crops and contribute to the overall sustainability of organic agriculture.	−3	**+3**	−2
23	I believe that NPBTs are completely safe to be used in organic food and feed, so as plants selected by traditional breeding.	**−5**	−1	−1
24	NPBTs crops are far more 'green' and 'sustainable' than they are given credit for and should be utilised in sustainable food production systems– including organic agriculture.	**−3**	+1	−1
25	I don't support the use of NPBTs because they could favour the concentration of seeds in the hand of few multinationals.	+4	+1	+4
26	I think that the authorities should assess, case by case, the opportunity to authorise the use of NPBTs in organic agriculture.	0	+4	+3
27	I'm against the use of NPBTs because I think that these new plant breeding techniques are like GMOs and therefore must be banned in the organic farming and food.	**+3**	**−4**	−1
28	To avoid contamination of organic food and feed, I think that NPBTs must be subject to traceability and mandatory labelling in all Europe.	+4	+5	+5
29	In my view, NPBT are not the future, only traditionally-bred modern or ancient varieties can help organic farming.	+1	**−3**	+2
30	I don't think that these new techniques could ever be compatible with organic food production	+3	**−3**	+2
31	In my view, NPBT products are similar to GMOs, therefore they should be banned from the market, not just in organic farming.	1	**−5**	**−3**
32	I believe that with the release of NPBT seeds into the market, farmers will no longer be free to grow what they want and how they want.	+2	−1	+1
33	About the use of NPBTs, I think that there is not enough evidence to declare these products safe.	**+4**	0	0
34	I think that organic products obtained from NPBTs will be more expensive.	0	−1	**+4**
35	In my view, NPBTs will not help small and medium organic farmers to survive in the global market.	+1	0	**+5**
36	I think that farmers over the millennia have made progress with natural traditional breeding and there is no need of NPBTs.	+2	−2	+3
37	I'm concerned towards the use of NPBTs because I think that they are an attempt to sell GMOs to Europeans by simply changing their name.	+2	−1	0
38	I believe that NPBT-derived food can be dangerous for human health because they could be less digestible and cause new forms of allergies.	+1	**−4**	−1
39	I believe that seeds obtained from NPBTs are dangerous because they have not undergone the process of natural selection.	+2	−3	−3
40	I am scared that animals fed with NPBT-produced feed could become less fertile and more prone to disease.	+1	−2	−1
41	In my view, it must be forbidden to use feed from NPBT plants in organic animal farms.	+2	−2	0
42	NPBTs may reduce the availability of different plant varieties restricting my freedom of choice as an organic consumer.	+1	0	**+4**
43	I am afraid that NPBT plants could be crossed with plants that are not genetically manipulated and create "monsters".	0	**−4**	**−3**
44	I think NPBT crops can contaminate organic crops so that they become undistinguishable.	**+3**	0	0

Table 4. *Cont.*

N	Statements	Factor Scores F1	F2	F3
45	I don't believe that we must invest in new plant-breeding techniques because the resulting plants are not safe to grow and to eat.	0	**−3**	−2
46	I fear that NPBTs may lead to undesirable and unpredictable effects (e.g., new resistant pests and diseases) with negative implications for the environment.	**+5**	−1	+2
47	I think that we need to be cautious with NPBTs because there is the concrete risk of doing permanent damages to agricultural biodiversity, and this is morally unacceptable.	+5	+1	+3
48	I think that if NPBTs are allowed in organic farming, many consumers will be lost.	+3	−1	+3

Most distinguishing statements (±5; ±4; ±3) at 0.01 significance level are marked in **bold**. The signs preceding each factor score indicate agreement (+) or disagreement (−).

The three factors extracted accounted the 50% of the study variance. Factor 1, accounting for the largest number of defining sorts (75 Q sorts: 42 regular organic consumers and 33 occasional) and accounted for 31% of the study variance, represents the dominant viewpoint. This factor is weakly "bipolar" since one Q sort (UK8) negatively loaded into that factor [59], meaning that two symmetrical opposite viewpoints are conveyed, which each have a factor array that is the "*mirror-image*" of the other [31]. In other words, the favourable viewpoint is the mirror image of the negative viewpoint. Since only one Q sort negatively loaded into Factor 1, producing two distinct factor interpretations is not necessary, and only the positive loading will be presented [60]. A total of 26 Q sorts (9 regular and 17 occasional) defined Factor 2 and accounted for 12% of the study variance. Finally, Factor 3 accounted for six Q sorts (four regular and two occasional) and 7% of the study variance.

Table 5 reports eigenvalues, variance explained, Q sorts assigned to factors, and correlations between each factor extracted. Out of the 118 factors, 11 were not assigned to any factor since loadings were not high enough [44].

Table 5. Eigenvalues, variance explained, defining Q sorts and correlations.

	Factor 1	**Factor 2**	**Factor 3**
Eigenvalues	41.4186	12.8728	4.3641
% expl. Var.	31	12	7
Defining Q sorts	75	26	6
Factor correlations	Factor 1	Factor 2	Factor 3
Factor 1	1	−0.2216	0.5135
Factor 2	−0.2216	1	0.1369
Factor 3	0.5135	0.1369	1

3.2.1. Factor 1: The "Risk Averse"

Participants that dominate the "Risk Averse" viewpoint *a priori* reject the use of NPBTs for the *unpredictable* effects associated with their use. NPBTs are considered not to respect the integrity of both plants and animals. The post-sort interviews confirmed this position; these consumers' main concern strictly refers to the "long-term negative consequences" (LT1, F, Reg). They also believe that often, when a new technology is introduced, "the risk is much greater than the expected benefit" (CH5, M, Reg). According to this viewpoint, NPBTs are perceived as GMOs (27, +3)—in brackets from now on the first number indicates the statement, and the second number the related factor score - and incompatible with organic farming principles whose aim is to discourage any alteration of natural processes (24, −3). More than other viewpoints, this factor is characterised by a strong drive towards environmental risks. Hence, this viewpoint is highly critical and already aware of undesirable and unpredictable effects on the environment (46, +5). According to this view, biodiversity and organic crops are seriously threatened because of future potential contaminations (47, +5; 44, +3). This viewpoint also focuses on human health (9, −4), considering those breeding methods unsafe (23, −5; 33, +4; 16, −3).

3.2.2. Factor 2: The "Technological Optimists"

Compared to the first factor, the "Technological Optimists" viewpoint is markedly different and tends to focus more on positive effects and avoiding the negative ones (29, −3). Contrary to Factor 1, for this viewpoint NPBTs are neither similar to GMOs (31, −5; 27, −4) nor like "monsters" (43, −4). Thus, this group does not perceive NPBTs as unsafe or dangerous for human health (38, −4; 45, −3) but believes that those modifications produced by NPBTs already occur in nature. Most notably, this perspective considers NPBTs compatible with organic farming (30, −3). In the participant discourses, NPBTs are perceived as the science's words, "*the light at the end of the tunnel that can contribute to the sustainability of agriculture*" (LT4, F, Occ). This factor is characterised by high expectations about new breeding techniques, retaining that organic farming could only take advantage of their use. Among the potential benefits are obtaining seeds and plants more resistant to pests and diseases (7, +5) and enhancing the sustainability of overall organic agriculture (22, +3). High importance is also assigned to the role of NPBTs in helping organic farmers to compete with the conventional ones (12, +3). In addition, it is important to highlight that great importance is given to the use of new breeding methods as contributors to reducing the amount of chemicals in organic agriculture (21, +4) and facing critical threats such as climate change (3, +3) and hunger in the world (15, +4; 14, +2).

3.2.3. Factor 3: The "Socially Concerned"

This viewpoint, like Factor 1, refuses the use of NPBTs in organic farming, although social and economic aspects are much more important than environmental and health. The "Socially Concerned" viewpoint highlights the negative impacts associated with the use of new breeding methods on the freedom of choice of organic consumers, prices and the competitiveness of the whole organic sector (34, +4; 48, +3). Moreover, the use of NPBTs will also reduce the availability and variety of different organic plants (42, +4) and generate more disadvantages for small and medium farmers, concentrating power in "*too few hands*" (35, +5; 25, +4). As mentioned above, health and environmental concerns are not neglected but are considered less important (9, 0; 16, 0, 23, −1). This factor also believes that NPBTs will be far from solving world hunger or feeding the world with organic products (15, −5; 14, −5).

According to the consensus statements, all factors agreed that NPBTs should be subjected to traceability and mandatory labelling in all European countries (28, +4/+5/+5). Thus, if the organic label includes NPBTs, stricter labelling practices would be demanded by all consumers.

4. Discussion

A variety of consumers' attitudes and perspectives towards NPBTs in European countries were identified. Nevertheless, even though results cannot be generalised to the larger population, findings suggest that organic consumers across all countries investigated are negatively evaluated using NPBTs in organic farming.

In general, participants had limited knowledge about genetic engineering and a confused idea of the new plant breeding processes. Given this lack of information, they did not distinguish between new and conventional breeding methods such as transgenesis. All organic consumer groups, as in previous research [25], revealed a strong negative attitude towards both transgenesis and cisgenesis, and they did not differentiate between the techniques.

Despite the bad terms "gene" or "genetic" being initially avoided to elude bias when referring to new breeding techniques, once NPBTs (i.e., gene editing and cisgenesis; and transgenesis) were explained, the technologies were spontaneously connected to negative meanings. People associated the term NPBTs with the image of manipulating genes. Manipulation has no natural connection to the image of organic products as it appears in people's minds. Given that the meaning people attach to words is a result of social conventions [61], NPBTs in organic farming were perceived as conflicting with the 'naturalness' of production and human health [62]. This negative attitude also aligns with previous findings [9–12,14] and confirms the growing interest in eating foods without risks to human health and the environment [2,3,13,23]. Organic consumers' perception, which emerged throughout the FGs discourses, is also conveyed by two of the three factors (Factor 1: the "Risk Averse" and Factor 3: the "Socially Concerned") extracted in the Q analysis. Surprisingly, although the majority opposes the introduction of NPBTs in organic agriculture, in any of the countries, results also show the presence of a minority that embeds some degree of acceptance towards those new methods (Factor 2: the "Technological Optimists") [4–6,17,18].

Consensus across all of the participants' discourses was mainly on information requests (i.e., traceability and mandatory labelling in organic farming systems) aimed at bearing responsibility for food choices *(" . . . specific labels for the NPBTs, because each consumer should be able to choose what to buy and, above all, we should always be informed"*, IT2, F, Reg). Consumers strongly rejected NPBTs in organic farming; they believe their use threatens to reduce freedom of choice over the presence of GMO or transgenic solutions in the farming system [29,30]. Nevertheless, from the participants' discourses, NPBTs in the organic farming system is not uniformly perceived. The two opposite views (in favour of vs. against NPBTs) in the Q analysis mirror the two opposed attitudes towards genetically modified foods and organically grown food described by Dreezens and colleagues [14]. Some organic consumers who agree with the human domination over nature have higher adherence to GMOs in foods [14]. In comparison, those with better adherence to organic foods oppose the idea of influencing the natural processes, such as those loaded into Factors 1 and 3, in which the presence of regular consumers was higher compared to Factor 2 [14].

According to the FG results, the well-known aversion towards GMOs and the lack of clear information about NPBTs induced a certain degree of concern towards them. It increased the rejection of these unknown technologies [9,11]. Consumers' rejection of NPBTs was mainly associated with relevant implications for health and the environment and ethical and socio-economic aspects [2,3,9,11,12,14,23,25]. According to focus group discussions, purchasing an organic product means purchasing something "*natural*" and "*not manipulated*" [14]. Organic consumers ask that human intervention should necessarily be "*sparse and as natural as possible*". For this reason, the introduction of NPBTs in organic farming will threaten the organic label's function to be synonymous with "GMO-free" [24].

Concerning the negative views that emerged in the Q analysis, Factor 1 showed a higher risk perception towards NPBTs and had a stronger focus on environmental, health and ethical aspects than Factor 3. In accordance with focus group discourses, the first perspective (Factor 1) supports the idea that organic farming is incompatible with genetic engineering and that any human intervention should be "*as natural as possible*" (UK5, F, Occ). Moreover, Factor 1 had a strong negative perception of environmental risks connected to using GM crops, which probably would negatively influence purchasing foods from new breeding methods. Participants belonging to this factor also perceived that the use of NPBTs could produce damage to biodiversity and contaminate all other organic crops. Differently, the third perspective (Factor 3) was more specific in rejecting NPBTs, because the aversion to their use was driven by the negative effects on the economy and competitiveness of the organic sector. This socio-economic concern is also mentioned in previous literature [11]. Many consumers worry about the negative effects of GM crops on the market equilibrium and believe that only the big companies or multinationals would benefit from those innovations [11]. Despite this divergence, both factors agree that NPBTs cannot contribute to solving the climate change issue and, more in general, perceive that those technologies cannot support the organic sector growth. Finally, in contrast with Pacifico and Paris [23], who stated that new breeding methods might represent an opportunity for preserving plants' genetic diversity in organic farming, both factors only trust the traditional breeding methods.

Notably, those methods are considered more "natural" than GM techniques for a small group of participants in the focus groups. Although non-GM breeding methods remain the most preferred, results show a preference for gene-editing and cisgenesis over transgenesis, which is consistent with some previous studies [5,9,12,13,25]. Gene-editing products are assumed to "*mimic*" or basically accelerate those modifications that could happen in nature [12,17]. Some perceived improvements in productivity support this minor view (e.g., "*useful technology*") and social aspects (e.g., "*have enough food for everyone*") and reducing costs and prices. These discourses also emerged in the Q study, where Factor 2 perceived NPBTs as neither unsafe for human health nor dangerous for the environment. In this framework, this viewpoint is not far from the opinions of experts who consider NPBTs an important opportunity for the expansion of the organic sector [1–3,6,18,23]. For Factor 2, the use of NPBTs reduces environmental risks and could positively contribute to the cause of food security and climate change [2–5]. Consistently with other studies, this view highlights the importance of pesticide-free products [5,25]. This means that for some consumers, adopting NPBTs in organic farming may be accepted if it reduces pesticide use. More information about the potential technological benefits of NPBTs would increase this group's acceptance of these innovations [2,15,26,27].

5. Conclusions

The results of this study show a gap between the subjective knowledge and understanding consumers have of the new plant breeding techniques applied to organic farming and the discourse of NPBTs lobbyists and proponents. More specifically, the results identified three different viewpoints, with a prevailing negative consumer sentiment toward NPBTs in organic food and farming [9]. Factor 1 and Factor 3 were clearly negative. The relatively high number of regular organic consumers in these two factors may explain the reason for the strong rejection. Only Factor 2 is open to organic NPBTs, on the grounds of a perceived, hypothetical higher environmental and productive efficiency. Given that consumer knowledge is based not on hard facts but on subjective social constructions, Factor 2 appears based on the belief that cisgenesis and transgenesis are fundamentally different, while both consist of techniques involving the direct manipulation of genes. Besides, all factors express strong health, ethical and environmental concerns regarding the use of these (new) biotechnologies. According to these findings and given that people act according to pervasive discursive constructions, policymakers should consider establishing the equivalence of new and old genetic engineering techniques, as already sanctioned by the EU Court of Justice ruling. Freedom of choice is another relevant issue. Organic consumers want to exercise freedom. They do not like to be moulded by outside rules, and ask to be self-determined [63]. They ask for "*freedom rather than being determined by the prevailing public tastes and . . . standards*", given that they like an authentic existence [64]. Nevertheless, freedom is linked to more information. Results suggest developing different, specific labelling schemes for NPBT-derived foods, similar to those existing for GMOs [13]. Consumers ask for mandatory labelling and strict traceability rules for all these biotech products [3,15]. Policy should not try to muddy the waters but provide a safe environment for the development of organic farming as planned by the Green Deal Farm-to-Fork framework, without authorising GM plants, seeds and food, no matter if the techniques used are 'new' or 'old'.

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