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1 Does the future of meat in France depend on 2 cultured muscle cells? **Answers from different** 3 **consumer segments**

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14

15 **Highlights**

16 The French respondents to this survey are not yet convinced by “**cultured meat**”
17 produced *in vitro* especially those familiar with the meat sector.

18 Although not sufficient, the major drivers of acceptance are ethical and
19 environmental concerns while emotional resistance is a serious barrier.

20 Younger women tend to be more concerned about "conventional meat" production
21 and therefore less likely to reject this new food, unlike older consumers

22

23

24 **Abstract**

25 This research aimed to study the perception of French consumers on "cultured meat".

26 The respondents (n=5,418) are characterised by an over-representation of young
27 people, meat professional or scientists compared to the French population.

28 Approximately 40-50% of them believed that animal husbandry faced ethical and
29 environmental issues. Only 18-26% of them believed that "cultured meat" could
30 solve these difficulties, a majority thought that it would not be healthy or tasty and
31 that "cultured meat" is an "absurd and/or disgusting" idea. However, 23.9% and 16.9%

32 thought it is a "fun and/or interesting" and a "promising and/or feasible" idea and
33 91.7% were not prepared to buy "cultured meat" at a higher price than meat. The

34 respondents not familiar with "cultured meat", young people or women are more in
35 support of it due to a greater sensitivity to issues related to livestock systems. Older

36 men and meat professionals are the most reluctant. Thus, the "cultured meat" market
37 would represent at best a niche market.

38

39 1. Introduction

40

41 Despite growing concerns about environmental and ethical issues related to animal
42 production (Scollan et al., 2011), world demand for protein and more particularly
43 meat is expected to continue to increase and to reach 470 million tonnes in 2050, of
44 which 72% will be consumed in developing countries (compared to 58% today)
45 according to FAO forecasts.

46 In this particular context, meat produced *in vitro*, called "artificial meat" or "cultured
47 meat" is presented, according to its supporters and the start-ups developing it, as a
48 new biotechnology capable of addressing some of the current problems, such as
49 overcoming world hunger, limiting the environmental impacts of animal husbandry
50 while respecting current ethical values (reduction of animal slaughter and animal
51 suffering) (Choudhury et al., 2020) although these points are controversial,
52 particularly with regard to environmental impact (Chrïki and Hocquette, 2020;
53 Chrïki et al., 2020b). Furthermore, so called "artificial meat" does not currently
54 qualify as meat according to the definition of the American Meat Science Association
55 (Boler and Woerner, 2017). **Despite this**, we will refer to it as "cultured meat" in this
56 article **since this is** the most widely used wording **in the scientific literature** (Chrïki et
57 **al., 2020c). "Artificial meat" was also used indifferently to minimize any naming**
58 **effect.**

59 "Cultured meat" comes from cells initially taken by biopsy from a living animal
60 (embryonic stem cells or embryonic myoblasts). These cells are cultured and multiply
61 a very large number of times to fuse and form mainly clusters of muscle fibres with
62 sometimes other cells (such as preadipocytes to be used for adipogenesis (Mehta et
63 al., 2019), ready to be eaten in a burger for example. The cells are therefore grown in
64 a culture medium optimized for them to multiply. The culture medium used must
65 contain nutrients, hormones, growth factors, etc. (Post, 2014; Chriki and Hocquette,
66 2020).

67 Since it first appeared and gained media attention in 2013, this biotechnology has
68 generated strong scientific and media interest (Chriki et al., 2020c), and has thus
69 prompted various reactions ranging from disgust for some to fascination for others,
70 as well as simple curiosity that could encourage some consumers to try it. Opinions
71 are therefore divided, sometimes difficult to understand, and often complex to
72 interpret. Given the current craze for "cultured meat" in the press media (Chriki et al.,
73 2020c), it is therefore important to study these various opinions in order to better
74 understand and target consumer expectations on this subject (Bryant and Barnett,
75 2019; Hopkins, 2015).

76 This is why several surveys have been conducted with potential consumer groups in
77 order to explore their attitudes and assess their perception and consent to buy and
78 consume such a product. A first survey was carried out in 2015 with around 2,000
79 people worldwide (Hocquette et al., 2015). More recently, many other surveys have
80 been carried out: the first was conducted in 2016 in the USA, with 673 responses

81 (Wilks and Phillips, 2017), a Dutch study gathered only 165 responses (De Graag,
82 2020), a German study 713 responses (Weinrich et al., 2020) and an Italian study 525
83 responses (Mancini and Antonioli, 2020) as examples. These surveys led to the same
84 conclusion: despite a strong willingness to taste "cultured meat" once, the majority of
85 consumers are not yet ready to consume it regularly, although a large proportion of
86 them really do not know and may be influenced by more information.

87 However, it should be acknowledged that many of these surveys were conducted at
88 the initiative of the proponents of "cultured meat". Furthermore, providing positive
89 information to the consumer to describe the potential benefits of "cultured meat" is
90 likely to influence them in favour of "cultured meat" (Bryant and Barnett, 2020;
91 Rolland et al., 2020). One recent survey suggested that French consumers may be less
92 accepting of "cultured meat", possibly due to increasing awareness or knowledge of
93 this novel product (Bryan et al., 2020). In order to confirm this recent tendency, this
94 new study was conducted to gain a deeper understanding of consumers' perception
95 of "cultured meat" currently in France. To do this, the questionnaire included
96 increasingly precise questions which were inspired by the weaknesses and
97 limitations of previous surveys, thereby making it possible to go further in the
98 analysis. It was observed that, despite the textual description of "cultured meat"
99 production, respondents were still confused between "cultured meat" and plant-
100 based meat alternatives. This was likely to affect the accuracy of the responses to the
101 survey and this bias might exist in previous studies. Therefore, a graphic explanation
102 was used in the current survey to help respondents to immediately understand the

103 concept of "cultured meat" avoiding some bias. In addition, in the previous surveys,
104 the distinction was not always made between regular consumption and occasional
105 consumption when testing "cultured meat". This point was specifically addressed in
106 this survey by questioning French consumers about their willingness to try, eat
107 regularly and pay for "cultured meat". Besides, although not fully representative of
108 the French population, given the large number of respondents as in the present
109 survey (N> 5,000), the results will be statistically more reliable when analyzing the
110 relationships between answers. Consequently, this study will be of unprecedented
111 quality in identifying the motives and barriers to "cultured meat" acceptance as it is
112 based on 3 to 4 times more responses than other studies that may have been
113 published so far.

114 The objective of this study was therefore to study the perception of French
115 consumers with regard to "cultured meat", to determine with greater accuracy
116 whether or not, in France, in 2020, "cultured meat" could have a future in the coming
117 years on our plates.

118

119 **2. Materials and methods**

120 This study was carried out in three stages: 1) drafting the questions and formatting
121 the survey, 2) distribution via different social network platforms by different people
122 with various activities and relational networks, and finally 3) statistical analysis and
123 interpretation of the results.

124 2.1. *Questionnaire design*

125 Thirty questions were drafted, in order to carry out a neutral and objective survey,
126 but also clear and understandable to all. Neutrality is an essential criterion because
127 respondents should not be influenced by the wording of the questions. In addition,
128 this survey was inspired in certain principles by a first survey carried out in 2015
129 (Hocquette et al., 2015) in order to assess the possible evolution of consumer
130 perception five years later. Indeed, many articles on this subject have flourished,
131 particularly in the media (Chriki et al., 2020b), and consumers are therefore now
132 more aware of the subject.

133 The questions were then classified into 7 categories to clarify the reading path of the
134 survey. Thus, after a brief illustrated introductory text to present the context of the
135 survey, the questionnaire was organized around:

- 136 - Part 1: Introduction and context of the survey
- 137 - Part 2: Demographic information, with 7 personal questions to characterize the
138 respondents, including gender, age, income, sector of activity and diet,
- 139 - Part 3: Preamble of 2 questions, "Have you ever heard of "artificial meat" before? "
140 and "What are the most important criteria when you do your food shopping?"
- 141 - Part 4: Societal challenges, with 7 questions about societal issues, including two
142 starting with "To what extent do you think on-farm breeding and the meat industry
143 pose important problems" and relating to ethical or environmental problems
144 (respondents were asked to answer on a scale of 1 to 5, expressing their disagreement
145 (lower scores) or agreement (higher scores),

146 - Part 5: Characteristics of the product, with 2 questions on expected or assumed
147 characteristics of the product,
148 - Part 6: Potential interest with 4 questions
149 - Part 7: Perception
150 - and finally Part 8: Development strategies, with 2 questions on the artificial meat
151 development strategy.

152 This 30-question quiz was improved by an expert in social sciences and formatted
153 using the Google Forms app. This article presents the results of one part of the
154 questionnaire only. This research project started in March 2020 with the development
155 of the action plan and protocol, and the dissemination of the online survey began in
156 June and finished at the end of 2020 with the possibility of spontaneous sharing by
157 others.

158 The process adhered entirely to the ESOMAR (European Society for Opinion and
159 Market Research) guidelines on ethical online research (ESOMAR, 2011). This
160 includes ensuring that respondents gave their informed explicit consent to take part
161 in the survey and that their personal data was protected. Indeed, after being
162 informed of the objectives of the survey and how the information provided would be
163 used, all respondents gave their informed consent for the inclusion of their answers
164 before and after they participated in the study. Respondent details were collected in
165 an anonymous way with a “do not wish to answer” option and with no personally
166 identifiable information. Furthermore, this work is part of an international survey
167 available in different languages including Chinese as described by Liu et al., (2021).

168 This research was conducted following local guidelines based on the laws and
169 regulations of the countries in which the research was performed and this includes
170 ethical approval by ethics committees when required (such as in Brazil: CAAE
171 number: 37924620.5.0000.5404, [Chriki et al., 2021](#)).

172

173 *2.2.Data collection*

174 Subsequently, the survey was distributed as had been done for the American, Italian
175 and German surveys, for example (Mancini and Antonioli, 2020; Weinrich et al., 2020;
176 Wilks and Phillips, 2017). The first dissemination was carried out on a small scale,
177 through those close to the designers of the survey: this made it possible to have a
178 preliminary external opinion so that minor adjustments could be made.-Finally, the
179 survey was widely disseminated on social networks: various Facebook accounts with
180 over 2,000 people potentially approached simultaneously, LinkedIn to over 10,000
181 people, 2,000 on ResearchGate, Twitter to around 1,000 people and Instagram to
182 around 10,000 people. We noticed that the survey was then spontaneously shared by
183 others interested in the topic including supporters of “artificial meat”.

184 After collecting more than 5,418 responses from different channels, statistical
185 analyses were carried out. Descriptive statistics were used to explore the data, using
186 Microsoft Excel software (see Tables 1 to 5 in supplementary material).

187

188 *2.3.Statistical analysis*

189 The data were analyzed using R software (version.3.5.2) (2015) and IBM SPSS 25
190 (2017) using a variety of statistical techniques as previously done (Bryant et al., 2020;
191 Liu et al., 2021).

192 As in the previous study by Bryant et al. (2020), some, but not all of the assumptions
193 of ANOVA were, in a few cases, violated, such as normality of distributions and
194 homogeneity of variances. However, ANOVA is considered as being robust
195 (Schmider et al., 2010). Variance analysis was thus performed in SPSS as previously
196 described (Liu et al. 2021) to determine whether demographic variables affect
197 respondents' willingness to try, eat regularly and finally pay. Then the post-hoc test
198 was performed using Tukey's HSD test with the Bonferroni correction for pairwise
199 comparisons between significant groups. Differences were considered significant at a
200 Bonferroni-corrected $p < 0.05$.

201 In addition, a Principal Component Analysis (PCA) was performed with quantitative
202 data to represent and model multidimensional point cloud datasets, showing
203 whether relationships exist between variables (Destefanis et al., 2000; [Chriki et al.,](#)
204 [2021](#)). Agglomerative clustering was also performed with the Euclidean metric,
205 average linkage and with 4 clusters. This number of clusters was chosen after
206 analysis of the silhouette score. The average silhouette score over all data points for
207 this resulting clustering is 0.24. We then have discarded two clusters with an
208 insufficient number of data points (7 and 9 data points respectively). The differences
209 between the two major clusters were analyzed using the Student's t-test for
210 quantitative data and the chi square test for qualitative data.

211

212 **3. Results**

213

214 *3.1. Demographic information of respondents*

215 A total of 5,418 responses were collected via the online survey for the French-
216 speaking population (Table 1). The first part concerned personal questions in order to
217 collect demographic information. A good gender balance was observed with 52.6%
218 women and 47.4% men, which is **very close to the current gender distribution in**
219 **France: 51.6% women and 48.4% men (World data atlas, 2020)**. In terms of the age of
220 the participants in the survey, there was a majority of young people between 18 and
221 30 years of age (40.5%), slightly less between 31 and 50 years of age (36.2%) but far
222 fewer seniors over 51 years of age (only 23.3%). With regard to the level of education,
223 there was strong heterogeneity with 1.2% of respondents having primary or high
224 school education, 14.4% having a baccalaureate diploma, 25.5% having a Licence
225 (Bachelor's degree) or having studied for 2 years after the Baccalaureate, 45.9%
226 having a Master's degree and finally 11.0% having a PhD. With regard to occupation,
227 7.9% of the respondents were scientists specializing in meat, 36.8% were other
228 scientists not familiar with the meat sector, 32.8% worked in the meat sector but were
229 not scientists, and finally 22.4% had another occupation unrelated to science or the
230 meat sector. With regard to net monthly income, there was a good balance of salaries:
231 28.2% of the respondents earned less than €1,500, 17.5% between €1,500 and €2,000,

232 13.8% between €2,000 and €2,500, 9.6% between €2,500 and €3,000, 9.19% between
233 €3,000 and €4,000 and finally 8.6% earned more than €4,000 per month. As for meat
234 consumption, only a few (6.2%) had a vegetarian or vegan diet, 13.4% consumed it
235 rarely (weekly or less), the majority of respondents (54.5%) consumed meat regularly
236 (i.e. several times a week), and 13.4% consumed it daily or at every meal. Finally, the
237 survey asked the French respondents whether or not they were familiar with the
238 subject of "cultured meat", and unsurprisingly a very large majority (86.3%) of the
239 respondents had already heard of this new biotechnology.

240 To conclude, a total of 5,418 responses from different consumer segments was
241 collected to provide multiple perceptions of "cultured meat". However, the results
242 show a majority of young respondents (between 18 and 30 years of age), with a
243 Master's (MS) degree, mostly eating meat regularly (with a few vegetarians), and
244 above all almost all the respondents had prior knowledge of "cultured meat".

245

246 *3.2. Effects of demographic factors on perception, willingness to try, eat regularly or pay for*
247 *"cultured meat"*

248 *3.2.1 Global perception*

249 A key question of the survey was to ask respondents about their global perception
250 of "cultured meat" with the following wording: "What do you think of
251 artificial "meat"?" They were given the choice of only three possibilities based on the
252 major perceptions previously reported in the literature 1: It is absurd and/or
253 disgusting; 2: It is fun and/or interesting. 3: It is promising and/or feasible.

254 As shown in Figure 1, the majority of the respondents (59.2%) think that this product
255 is "absurd and/or disgusting". A smaller part of the respondents find it "fun and/or
256 interesting" (23.9%) or "promising and/or feasible" (16.9%).

257 3.2.2. Willingness to try

258 A total of 50.6% of respondents would like to try "cultured meat" (18.7% answered
259 "Definitely yes" and 31.9% "Probably yes", Table 1 in supplementary material).
260 However, willingness to try (WTT) depends on many factors. It differs the most
261 according to education level, occupation and meat consumption habits interacting
262 with each other and to a lesser extent interacting with age or gender (Table 6 in
263 supplementary material,).

264 Male respondents with a Master's degree or PhD had a higher ($P < 0.05$) WTT (Score
265 on a 1-5 scale > 3.2) than those with less education (< 2.6). The same trends were
266 observed for female respondents, except that respondents with primary or high
267 school or a Baccalaureate education had an intermediate WTT so that the WTT
268 differed ($P < 0.05$) between males (1.7 to 2.3) and females (2.6 to 2.8) for these two
269 groups. In other words, less educated males had a lower WTT than less educated
270 females but both more educated males and females had a higher WTT than the less
271 educated ones.

272 According to the results of this survey (N = 5,418 responses), females who eat meat
273 daily have a lower ($P < 0.05$) WTT (< 2.8) than females who eat less meat from never
274 to regularly (> 3.1). Similarly, males who eat meat daily or regularly have a lower ($P <$
275 0.05) WTT (< 2.9) than males who eat less meat from never to rarely (> 3.5).

276 Consequently, the WTT differs between males or females for each level of
277 consumption ($P < 0.05$).

278 Young respondents (18 to 31 years of age) familiar with the meat sector have a lower
279 ($P < 0.05$) WTT (< 2.75) than other groups of the same age (> 3.35) namely
280 respondents who do not know the meat sector or who are scientists. This trend is also
281 observed for the other age groups. More generally, for a given age group, scientists
282 have a higher WTT than other groups (Table 2A).

283 Respondents over 31 years of age who eat meat daily have a lower ($P < 0.05$) WTT ($<$
284 2.42) than respondents of the same age who eat meat rarely or never (> 3.0).

285 Respondents under 31 years of age who eat meat daily have a lower ($P < 0.05$) WTT
286 (< 3.0) than respondents of the same age who eat meat rarely (> 3.8). So, WTT is
287 negatively affected by the level of meat consumption but to a slightly different extent
288 according to age.

289 When respondents are both less educated (primary school up to two years after the
290 Baccaalaureate) and familiar with the meat sector (scientists or not), they have a lower
291 ($P < 0.05$) WTT (< 2.4) compared to more educated respondents (Baccaalaureate up to
292 PhD) either scientists (knowing the meat sector or not) or not familiar with the meat
293 sector, who have a higher WTT (> 3.1).

294 When respondents are both less educated (primary school up to two years after the
295 Baccaalaureate) and eat meat regularly or daily, they have a lower ($P < 0.05$) WTT ($<$
296 2.5) compared to more educated respondents (Baccaalaureate up to PhD) who never
297 or rarely eat meat, who have a higher WTT (> 3.35).

298 Non-scientist respondents who eat meat regularly or daily familiar with the meat
299 sector or not have a lower ($P < 0.05$) WTT (< 2.9) than scientists who do not know the
300 meat sector, (WTT > 3.2) or scientists who do know the meat sector who never eat
301 meat (WTT = 3.8) (Table 2B).

302 3.2.3. Willingness to eat

303 A total of 20.3% of respondents would like to eat "cultured meat" regularly, either at
304 home, in restaurants and/or in ready-made meals, which means that 79.7% of
305 respondents answered that they did not want to eat "cultured meat" regularly (Table
306 1 in supplementary material). However, WTE depends on many factors. It differs the
307 most according to occupation, level of meat consumption and income -interacting
308 with one another and to a less extent interacting with age or gender (Table 7 in
309 supplementary material).

310 WTE significantly differs according to gender interacting with occupation and meat
311 consumption. Indeed, WTE tends to differ according to occupation with respondents
312 familiar with the meat sector whether non-scientists or scientists having the lowest (P
313 < 0.05) WTE (1.08 to 1.15) compared to respondents not familiar with the meat sector,
314 whether non-scientist (1.25) or scientist (1.28-1.30).

315 Respondents who eat meat daily have the lowest WTE (on average 1.10) and
316 respondents who never eat meat have the highest WTE, followed by people who
317 rarely eat meat with a difference between males and females in both cases ($P < 0.05$)
318 (Table 3A). WTE is also the highest among young people not familiar with the meat
319 sector ($P < 0.05$). Being older and/or being familiar with the meat sector are both

320 factors that decrease WTE (Table 3B). WTE is also the lowest for respondents over 31
321 years of age who eat meat daily (Table 3C). WTE is the lowest (1.04) among
322 respondents familiar with the meat sector, are not scientists and eat meat daily. In
323 contrast, WTE is the highest for respondents who never eat meat (from 1.31 to 1.50).
324 For the other groups, eating meat more frequently or being familiar with the meat
325 sector are both factors that decrease WTE (Table 3D).

326 WTE is the lowest for respondents who eat meat daily (1.08 to 1.11) and the highest
327 for respondents who never eat meat, especially for those who have heard
328 of "cultured meat" (1.37). However, the difference is only significant in terms of
329 familiarity for respondents who eat meat rarely or regularly, with a higher WTE for
330 respondents who have never heard of "cultured meat" prior to the survey (Table 3E).
331 WTE also depends on income but with a different pattern according to age. Indeed,
332 for young people, WTE is the highest (1.32) for incomes below €1,500 per month. In
333 contrast, WTE is the highest (1.20) for the highest incomes above 31 years of age.

334 3.2.4. *Willingness to pay*

335 About 68.5% of the respondents would like to pay less or much less (including
336 nothing) for "cultured meat" compared to "conventional meat". In addition, 22.7% of
337 them declared they would be willing to pay the same price (Table 1 in
338 supplementary material). This means that only 8.7% of the respondents were willing
339 to pay more or much more for "cultured meat" than for "conventional meat".
340 However, this willingness to pay depends on meat consumption and education level
341 which also act interact (Table 8 in supplementary material).

342 Like WTE, WTP is the lowest among the oldest respondents eating meat daily. It is
343 the highest among the youngest respondents who never eat meat (Table 4).
344 WTP is the lowest for young people (18 to 30 years of age) in primary or high schools
345 (1.00) or for older people (over 31 years of age) with less than a master's degree level
346 of education (<1.75). On the other hand, WTP is the highest (> 2.8) for young people
347 (18 to 30 years of age) after high school and especially with a master's degree or PhD
348 (>2.3). Respondents with a PhD have the highest WTP (>1.97) but in ascending order:
349 people over 51 years of age (1.97), between 31 and 50 years of age (2.07) and between
350 18 and 31 of age (2.49). There is the same tendency for the master's degree level but
351 from 1.77 for the oldest respondents to 2.30 for the youngest.

352

353 *3.3. Drivers, motives and barriers to willingness to try, eat or pay for "cultured meat"*

354 *3.3.1. Societal challenges*

355 Another part of the survey concerned opinions on societal challenges related
356 to/concerning the meat industry. The respondents seem to be rather unsure as to the
357 ethical (such as animal suffering and slaughter) and environmental issues (such as
358 high water consumption or greenhouse gas emissions) related to livestock and the
359 meat industry. To the question "Do you think the on-farm breeding and meat
360 industry cause major ethical problems (e.g. animal suffering, slaughter, etc.)?" people
361 answered in similar proportions (between 17.8 and 23.4% from score 1 [I strongly
362 disagree] to score 5 [I strongly agree]). A similar range (between 17.5% and 23.1%)
363 was observed for the answers related to the question: "Do you think that the on-farm

364 breeding and meat industry cause major environmental problems (e.g. huge water
365 consumption, greenhouse gas emissions, etc.)?". This is also a high degree of
366 homogeneity observed concerning the possibility of reducing meat consumption to
367 address these potential problems, with 27.3% for a score of 1 and 28.8% for a score of
368 5. However, almost half (49.2% of score 1) the respondents definitively think
369 that "cultured meat" would not be more ethical than "conventional meat", i.e. able to
370 significantly improve animal welfare and reduce animal suffering. Likewise, half of
371 the respondents (50.4% of score 1) believe that "cultured meat" would definitively
372 not be more eco-friendly than "conventional meat", i.e. capable of significantly
373 reducing the environmental footprint linked to livestock (water consumption, global
374 warming, greenhouse gas emissions, etc.). Finally, a clear majority of respondents
375 believe that "cultured meat" would have negative impacts on traditional breeding
376 and the meat industry with 55.6% of score 5 (for example on jobs) and on the
377 territories and rural life with 61.8% of score 5 (for example on biodiversity, tourism,
378 landscape maintenance and the vitality of territories) (Table 2 in supplementary
379 materials)

380 3.3.2. Characteristics of the product

381 Respondents were also questioned about their opinion on the health and taste
382 characteristics of this new biotechnology. The majority of respondents thought
383 that "cultured meat" would not be healthy and safe (39.3% gave a score of 1 and 20.5%
384 a score of 2 on a scale of 5): it would not have a consistent quality and sufficient
385 nutritional quality, especially in proteins and vitamins. Likewise, according to them,

386 this product would not be as tasty as “conventional meat” either (51.9% gave a score
387 of 1 and 21.8% a score of 2 on a scale of 1 to 5): it would not be comparable to
388 conventional meat in terms of taste and flavor (Table 3 in supplementary material).
389 In summary, the French respondents to our survey seem sceptical about the safety as
390 well as the taste and flavor of “cultured meat”.

391 3.3.3 Perception and strategy

392 The majority of respondents have emotional resistance (disgust, nervousness)
393 to “cultured meat” (55.5% of scores of 4 and 5 on a scale of 5). However, 40.6% of the
394 French people who responded to the survey think that “cultured meat” could be
395 feasible in the medium term, between 6 and 15 years, and 28,0% in the short term
396 (between 1 and 5 years), only 9.3% in the long term, i.e. in 16 years or more. And
397 there are still 22.1% who think that this new biotechnology could never be marketed.
398 Nearly half of French people (46.4% who voted 1 or 2) are not convinced of the
399 private research model (by start-ups) to potentially develop research on “cultured
400 meat”, whereas about a quarter (28.5%) have no clear opinion (score 3). However,
401 they are clearly in the majority (62.8%) to think that public scientific research should
402 not invest resources and money to develop this biotechnology (Table 4 in
403 supplementary material).

404

405 3.4. Importance of potential drivers and barriers of “cultured meat” acceptance

406 To better understand the positive drivers, motives and barriers of consumer-'
407 acceptance of "cultured meat", a PCA was performed with all the quantitative
408 variables described above.

409 A first group of variables in the upper right-hand corner of the PCA plot is related to
410 a positive acceptance of "cultured meat" with positive answers to different questions
411 such as "Is artificial "meat" safe/ healthy/tasty/ethical/eco-friendly?" or "Should
412 private/public research invest in this area?". High WTT, WTE and WTP are also
413 present among these variables. Indeed, WTT and WTE are positively correlated
414 ($r=0.50$) and also positively associated with WTP ($r=0.29$) but moderately. This can be
415 explained by the fact that curiosity is the main reason for WTT (Figure 2) but less for
416 WPP and WTE artificial "meat" regularly. In addition, WTT is sensitive to more
417 demographic factors than WTE. Finally, as described above, WTE and WTP also
418 depend on the income of the respondents and WTE on previous knowledge
419 of "cultured meat" unlike WTT.

420 A second group of two variables includes strong emotional resistance to
421 eating "cultured meat" and the perception that "cultured meat" will not be
422 successful in the long term or even never. This group of variables is the opposite of
423 the first, especially emotional resistance which is negatively correlated with WTT ($r=-$
424 0.61). These two opposing groups of variables define a first axis which refers
425 to "cultured meat" acceptance.

426 A third group of three variables that are highly correlated with each other (0.69 to
427 0.80) in the lower right-hand corner of the PCA plot are related to perceived issues of

428 “conventional meat” production. These include positive answers to the following
429 questions: “Do you think the on-farm breeding and the meat industry cause major
430 ethical/environmental problems?” and “To address these potential problems, do you
431 think that reducing our meat consumption could be a good solution?”.

432 A fourth group of variables opposite to the third includes positive answers to the
433 following questions: “Do you think “artificial meat” would have negative impacts on
434 traditional livestock farming and the meat industry and on territories and rural life?”,
435 with the answers to these two questions being highly correlated ($r=0.63$). These two
436 variables are negatively correlated ($-0.48 < r < -0.31$) with the variables of the third
437 group. Altogether, these two groups of variables define a second axis related to
438 concerns about current livestock systems and meat production or consumption.
439 When people are concerned about ethics and environmental issues related to
440 livestock, they want to reduce their meat consumption. Additionally, they do not
441 believe that “cultured meat” would reduce rural life and conventional farming. In
442 contrast, people who worry about the decline of rural life and farming induced
443 by “cultured meat” are less concerned (or not at all) about the ethics and
444 environmental issues related to livestock.

445 The two axes defined above (related to “cultured meat” acceptance on one hand and
446 concerns about meat production on the other) are almost orthogonal which means
447 that they are, at least in part, independent. This can be interpreted as meaning that
448 having ethical and environmental concerns about “conventional meat” production is
449 probably not enough to have a good acceptance of “cultured meat”. Indeed, the

450 variables in the upper and lower right-hand parts of the plot are only moderately
451 correlated (around 0.3 to 0.6) indicating that concerns about current meat production
452 contribute modestly to acceptance of "cultured meat". Furthermore, concerns about
453 the negative impact on territories, rural life and local farmers are clearly barriers
454 to "cultured meat" acceptance since positive answers to these questions are
455 negatively correlated with WTT, WTE and WTP ($-0.42 < r < -0.19$). To summarise, to
456 have good acceptance of "cultured meat", consumers must not only have concerns
457 about "conventional meat" production but, in addition, be convinced that "cultured
458 meat" is ethical, eco-friendly, safe, tasty, etc. This is apparently not the case for all
459 respondents, since among those who already eat meat substitutes, a great majority of
460 them would not accept "cultured meat" as a viable alternative to "conventional meat"
461 and other meat substitutes (Figure 3).

462 All these interpretations are confirmed by two other questions in the survey. Indeed,
463 to the question "Why would you NOT be willing to try artificial "meat"?",
464 respondents answered unnaturalness (72.6%), negative impact on territories and
465 rural life (65,0%) and on local farmers (64.1%), less trust in laboratories and "cultured
466 meat" start-ups (59.2), less taste (37.2%), etc (Figure 4A). In contrast, the main
467 expectations of "cultured meat" were reduced environmental footprint (34.4%),
468 safety (33.2%), good taste (31.8%) and no animal pain/suffering (25.3%) (Figure 4B).
469 In addition, no animal pain/suffering was also the second driver of WTT (for 22.0% of
470 respondents Figure 4C). The major barrier of unnaturalness was confirmed by the
471 answers to the following question: "Which names are the most relevant to you to

472 qualify "artificial meat"? (among the names most commonly used by companies in
473 the sector)": in fact, the majority of respondents chose "artificial meat" or "synthetic
474 meat" (55.1%) which both refer to the non-natural process. **In contrast, the term**
475 **"cultured meat" was chosen by only 23% of respondents. In addition,** the term "clean
476 meat" was chosen by only by 2.3% which indicates that respondents do not perceive
477 the potential low environmental impact of **"cultured meat"** despite claims by its
478 proponents.

479

480 *3.5. Effects of demographic factors on drivers, motives and barriers to acceptance of "cultured*
481 *meat"*

482 *3.5.1. "Gender x age" interaction*

483 According to the survey (N = 5,418), the respondents the most concerned about the
484 ethical and environmental issues related to livestock are the young females (i.e.
485 under 30 years of age) and the least to be concerned are the older males (over 51
486 years of age). Similarly, the young females believe the most, and the older males the
487 least, that **"cultured meat"** would be more ethical and more eco-friendly than
488 "conventional meat" (Table 5A).

489 The respondents who are concerned the least about the potential impacts
490 of **"cultured meat"** on traditional livestock farming, the meat industry, territories and
491 rural life, are the young males and females, whereas the respondents who are the
492 most concerned are the men over 31 or 51 years of age (Table 5B).

493 To the questions “To what extent do you think that artificial “meat” is healthy, safe,
494 tasty and of high nutritional value compared to “conventional meat”?”, all the young
495 people (regardless of gender) answered more positively than the other demographic
496 groups (Table 5B).

497 3.5.2. “Gender x level of meat consumption” interaction

498 The respondents the most concerned about the ethical and environmental issues
499 related to livestock are the respondents (females and males) who never eat meat and
500 the least concerned are the males who eat meat daily. Similarly, the males who never
501 eat meat believe the most, and the males who eat meat daily the least, that “cultured
502 meat” would be more ethical and more eco-friendly than “conventional meat” (Table
503 6A).

504 The respondents who are the least concerned about the potential impacts
505 of “cultured meat” on traditional livestock farming, the meat industry, territories and
506 rural life, are the males and females who never eat meat, whereas the respondents
507 who are the most concerned are the respondents (males and females) who eat meat
508 daily (Table 6B).

509 To the questions “To what extent do you think that artificial “meat” is healthy, safe,
510 tasty and of high nutritional value compared to conventional meat?”, the males who
511 never eat meat answered the most positively and the respondents (males and females)
512 who eat meat daily the most negatively (Table 6B).

513 3.5.3. “Occupation x level of meat consumption” interaction

514 The respondents the most concerned about the ethical and environmental issues
515 related to livestock are the respondents who never eat meat, followed by the
516 respondents who eat meat rarely. The respondents the least concerned about these
517 issues are those familiar with the meat sector and who eat meat daily. Similarly, the
518 respondents who never eat meat believe the most that "cultured meat" would be
519 more ethical and more eco-friendly than "conventional meat", but to a lesser extent
520 for respondents familiar with the meat sector. Those familiar with the meat sector
521 and who eat meat daily believe the least that "cultured meat" would be more ethical
522 and more eco-friendly than conventional meat (Table 7A).

523 The Respondents who are the least concerned about the potential impacts
524 of "cultured meat" on traditional livestock farming, the meat industry, territories and
525 rural life, are the respondents who never eat meat and who are not scientists nor
526 familiar with the meat sector, whereas the respondents who are the most concerned
527 about these issues are those who eat meat daily or regularly and who know the meat
528 sector (scientists or not) (Table 7B).

529 To the questions "To what extent do you think that artificial "meat" is healthy, safe,
530 tasty and of high nutritional value compared to conventional meat?", the
531 respondents who never eat meat answered the most positively and the respondents
532 who eat meat daily and familiar with the meat sector the most negatively (Table 7B).

533 3.5.4. "Level of meat consumption x age" interaction

534 The respondents the most concerned about the ethical and environmental issues
535 related to livestock are the respondents who never eat meat, followed by the

536 respondents who eat meat rarely, regardless of age. The respondents the least
537 concerned about these issues are the respondents over 31 or 51 years of age and who
538 eat meat daily. Similarly, the respondents who never eat meat believe the most
539 that "cultured meat" would be more ethical and more eco-friendly than
540 "conventional meat", regardless of age. Those over 31 or 51 years of age and who eat
541 meat daily believe the least that "cultured meat" would be more ethical and more
542 eco-friendly than "conventional meat" (Table 8A).

543 The respondents who are the least concerned about the potential impacts
544 of "cultured meat" on traditional livestock farming, the meat industry, territories and
545 rural life, are the respondents who never eat meat regardless of age, whereas the
546 respondents who are the most concerned by these issues are those who eat meat
547 daily (Table 8B).

548 To the questions "To what extent do you think that artificial "meat" is healthy, safe,
549 tasty and of high nutritional value compared to conventional meat?", the
550 respondents who never eat meat answered the most positively and the respondents
551 who eat meat daily and over 31 or 51 years of age the most negatively (Table 8B).

552 3.5.5. "Occupation x age" interaction

553 The respondents the most concerned about the ethical and environmental issues
554 related to livestock and who believe the most that "cultured meat" would be more
555 ethical and more eco-friendly than "conventional meat" are the young respondents
556 (under 31 years of age) who do not know the meat sector. In contrast, the
557 respondents the least concerned about the issues related to livestock and who believe

558 the least that "cultured meat" would be more ethical and more eco-friendly than
559 conventional meat are the respondents over 31 or 51 years of age and familiar with
560 the meat sector (Table 9A).

561 The respondents who worry the least about the potential impacts of "cultured meat"
562 on traditional livestock farming, the meat industry, territories and rural life, are the
563 respondents who are familiar with the meat sector regardless of age or scientists
564 working on meat over 31 years of age, whereas the respondents who are the most
565 concerned by these issues are the respondents not familiar with the meat sector nor
566 scientists (Table 9B).

567 To the questions "To what extent do you think that artificial "meat" is healthy, safe,
568 tasty and of high nutritional value compared to "conventional meat"?", the young
569 scientists not working on meat answered the most positively and the older
570 respondents (above 31 or 51 years of age) familiar with the meat sector and not
571 scientist the most negatively (Table 9B).

572

573 *3.5.6. Hierarchical classifications of quantitative and qualitative variables and of respondents*

574 Hierarchical classification of all the variables confirmed the two clusters of variables
575 identified by the Principal Component Analysis: one major cluster related
576 to "cultured meat" acceptance and one cluster related to meat production issues.

577 Hierarchical classification of the respondents identified two major clusters with
578 around 2700 respondents each (Table 10). The respondents in cluster 2 are more
579 concerned about the ethical and environmental issues related to "conventional meat"

580 production (x1.8-1.9), they would agree to reducing their meat consumption (x2.10)
581 and they believe that "cultured meat" would be more ethical and eco-friendly (x2.40-
582 2.53) as well safer and tastier (x1.9-2.1). They also have less emotional resistance
583 (x0.65), higher WTT (x1.93), and higher WTE and WTP (1.36-1.45).

584

585 **4. Discussion**

586

587 *4.1. Respondents are concerned about the ethical and environmental issues related to livestock*
588 *farming but also about traditional rural life, health and nutritional quality of food products*

589 According to our results and despite the variability between the groups of
590 respondents according to their sociological characteristics, the French are very
591 concerned about the ethical and environmental problems linked to livestock farming
592 and the conventional meat industry, and therefore a large proportion of them (45.6%)
593 think that reducing our meat consumption could be a solution to the current
594 problems as previously indicated by Hocquette et al. (2015) and Bryant et al. (2020).

595 However, more than half do not think that "cultured meat" would be more ethical
596 and more eco-responsible than "conventional meat". Thus, our study confirms a
597 previous study (Hocquette et al., 2015) which indicated that a very large majority of
598 French people (of the order of 60 to 70%) would prefer to a very large majority to
599 consume less meat rather than "cultured meat" (10-15%). Similarly, the majority of

600 Brazilians said they would like to reduce their meat consumption - they are, therefore,
601 future flexitarians (Heidemann et al., 2020; [Chriki et al., 2021](#)).

602 Around three quarters of the respondents recognize the negative impacts
603 of "[cultured meat](#)" on traditional livestock and the meat industry as well as on
604 territories and rural life. Such negative impacts on conventional agriculture have also
605 been speculated by Jairath et al. (2021), but mainly for developing countries. The
606 French therefore remain attached to the current production system and are
607 concerned about the future of the territories and rural life. In comparison with the
608 same survey carried out in China, Chinese consumers seem more inclined to
609 eat "[cultured meat](#)". They are already more accustomed to eating meat substitutes,
610 and seem less concerned about the environmental issues (Liu et al., 2021). In addition,
611 French people are not yet convinced by the health and nutritional quality as well as
612 the taste of "[cultured meat](#)". This confirms a recent study indicating that meat
613 alternatives are often perceived more negatively than conventional meat (Michel et
614 al., 2021), in terms of health, taste and naturalness. "[Cultured meat](#)" arouses curiosity
615 but can create some emotional reluctance such as nervousness or disgust, for more
616 than half of the people surveyed, with a lower proportion in Croatia, Greece and
617 Spain (Francekovic et al., 2021). While the French are keen to try it, they would,
618 however, prefer to buy "[cultured meat](#)" at the same price or at a lower price than
619 conventional meat, but in the great majority, not more expensive, as confirmed by
620 other recent surveys (Francekovic et al., 2021; Michel et al., 2021).

621 According to our French respondents, "cultured meat" is likely to end up on our
622 plates within 6 to 15 years on average, which is similar to what the Chinese
623 consumers feel (Liu et al., 2021). These same respondents seem more convinced by
624 the model of private research to eventually develop "cultured meat", rather than by
625 public scientific research like the Chinese consumers (Liu et al., 2021). This is
626 probably explained by the fact that they are not generally convinced of the benefits of
627 this new biotechnology despite their concern for the ethical and environmental issues
628 associated with breeding. "Cultured meat" start-ups generally opt for different
629 strategies: Mosa Meat surfs on livestock issues to present "cultured meat" as a viable
630 alternative to "conventional meat" products. In contrast, Aleph Farm
631 presents "cultured meat" as a complementary product to the "conventional meat"
632 offer, although they also criticize the impacts of livestock.

633

634 4.2. Prior knowledge of the "cultured meat" subject may or not change consumer perception

635 In this survey, 86.3% of respondents claimed to have heard of "cultured meat", in
636 contrast with a previous survey conducted a year ago (Bryant et al., 2020), in which
637 only 22.6% of Germans and 21.6% of French people had heard of this biotechnology.
638 However, for three studies published this year, the proportions of respondents who
639 had previously heard of "cultured meat" in China (Liu et al., 2021), in Brazil (Chriki
640 et al., 2021) or in Croatia, Greece and Spain (Francekovic et al., 2021) was higher (44-
641 73%). Nevertheless, the proportion of respondents in favor of "cultured meat" does
642 not seem to be affected by this change. Indeed, in France, 16.9% of the respondents

643 believe that "cultured meat" is promising and/or feasible in our study against 20.0%
644 of respondents in France who are favorable according to the study Bryant *et al.* (2020)
645 in which the proportion of people who had heard of this biotechnology was much
646 smaller.

647 Contrary to some studies (Rolland *et al.*, 2020; Mancini and Antonioli, 2020), being
648 already aware of the "cultured meat" process does not increase "cultured meat"
649 acceptability according to our results. The differences between these observations can
650 be explained by methodological issues. The responses collected in the studies by
651 Rolland *et al.* (2020) and Mancini and Antonioli (2020) were the result of respondents
652 presented with various information, at the time of the survey, including the potential
653 benefits of "cultured meat". However, it does appear that the type of information
654 provided at the time of the survey affects the perception of respondents differently,
655 for instance, positive information (supposedly good health and nutritional qualities)
656 would increase the acceptability of the product (Bryant and Barnett, 2020;
657 Heidemann *et al.*, 2020).

658 In our study, respondents were asked about their prior knowledge of the product
659 before the survey. They had therefore constructed a more robust a priori opinion.
660 Having already heard of "cultured meat" allows consumers to have given more
661 thought to the benefits and drawbacks of this biotechnology. More particularly,
662 when consumers have access to new information that is not consistent with what
663 they know, it may induce a response in their opinion based on associations of pre-
664 existing knowledge and/or based on richer knowledge by building new associations

665 with the new information provided (Baum et al., 2021). Our questionnaire was as
666 neutral as possible to avoid the intention to influence respondents in one direction or
667 another. Indeed, we did not provide any new information, we simply asked
668 respondents if they were already aware of "cultured meat".

669 The work of Verbeke et al. (2015) highlighted three sequences of reasoning in
670 consumers when they are provided with new information about "cultured meat" (i)
671 they initially express a feeling of disgust as observed in this study, (ii) express more
672 thoughtful reactions concerning the potential advantages of "cultured meat" for
673 society (food safety, environmental protection, respect for animals) and the possible
674 disadvantages at individual level (personal health, reduced pleasure in consuming
675 meat products) or collective level (loss of traditions, less farmers and agricultural
676 activity in rural areas) and, finally, (iii) they will have more in-depth reactions which
677 ultimately induce some scepticism with a mixture of complex concerns (for example,
678 a need for knowledge and transparency). Thus, in the study by Rolland et al. (2020)
679 and Mancini and Antonioli (2020), respondents were likely to be in the first stage (or
680 for some, in stage 2) at the beginning of the survey and then progress positively into
681 stage 2 or 3 after being more informed. In contrast, in our survey, respondents were
682 likely to be already in stage 2 or 3 because the majority of them were already aware
683 of "cultured meat" before the survey and some of the answers to the relatively deep
684 questions in this survey were based on in-depth thinking from the actual participants,
685 some in the positive and others in the negative sense.

686 In addition, a more recent study has indicated that while providing information will
687 affect explicit attitudes (i.e. consumer opinions that are intentional and well
688 expressed), implicit attitudes do not change because they are less biased by external
689 factors (Baum et al., 2021). This can be explained, at least in part, by the fact that
690 implicit attitudes are, by definition, not well known, unidentified or inaccurately
691 identified, with affective factors playing a crucial role. Furthermore, willingness to
692 buy (purchase) results from a combination of explicit and implicit attitudes. This is a
693 major problem for "cultured meat" which poses a new challenge due to both its
694 unfamiliarity to consumers and the low reliance of social studies investigating
695 associations between attitudes, purchase and market development. This underlines
696 the complexity of consumer opinions and behaviors (Baum et al., 2021). This
697 complexity is likely to explain, at least in part, the above-mentioned discrepancies in
698 the literature.

699

700 *4.3. The sociological characteristics of the respondents must be taken into account when*
701 *interpreting the results*

702 There is a fairly strong generational effect, particularly with regard to ethical
703 concerns, environmental issues, meat consumption, its impact on society and the
704 environment, the overall perception of "cultured meat" and the purchase price
705 of "cultured meat". Young people have a clearer idea of the potential and limits of
706 science. The fact that older people reject "cultured meat" to a greater extent, confirms
707 the results of another survey in Germany and France (Bryant et al., 2020), and a

708 recent European survey (Grasso et al., 2019) which show that older respondents have
709 lower acceptance of "cultured meat". On the other hand, in an Australian survey on
710 Generation Z (Bogueva and Marinova, 2020), it is indicated that 72.0% of respondents
711 of this young generation (who are, by definition, under 20 years of age) are not
712 willing to accept "cultured meat" (compared to 40.5% of young people aged 18 to 30
713 in our study who find this idea absurd and/ or disgusting). The way in which the
714 questions are asked or the difference in age or maturity of the respondents may
715 explain this type of different observation.

716 Gender influences concerns about the ethical and environmental problems caused by
717 the meat industry, opinion on meat consumption and overall perception of "cultured
718 meat". Our results confirm those of Heidemann et al. (2020) who indicate that female
719 specialists in animal production are more in favor (65,0%) of "cultured meat" than
720 male. This could be related to women's sensitivity to animal welfare and the
721 environmental issues related to farming, and the fact that they are more likely to
722 adopt diversified diets including the Flexitarian diet (less meat), according to Ruby
723 and Heine (2011).

724 However, in another recent survey (Bryant et al., 2020), it was observed that women
725 are less inclined to consume "cultured meat" than men, both in Germany and
726 especially in France. This type of contradiction can be explained by an interaction
727 between age and gender since it was observed that it is the youngest women and the
728 oldest men who have the closest perceptions (Hocquette et al., 2015). However,
729 despite a significant interaction between age and gender, our study shows, on the

730 contrary, that older men are the most reluctant. The different wording of the
731 questions between the surveys could at least partly explain these contradictions.

732 Another observation of this survey is that the majority of meat professionals are
733 firmly opposed to "cultured meat" on all aspects: health, environmental, ethics, taste,
734 etc. These results confirm those of Heidemann et al. (2020) and Chriki et al. (2021)
735 who indicate that animal scientists have a lot of reservations and resistance
736 to "cultured meat", associating this biotechnology with the "unnatural" which
737 therefore has a negative connotation. They believe, moreover, that "cultured meat"
738 would be a danger to their respective jobs, if it were one day replace "conventional
739 meat". These conclusions seem to contradict the results of Bryant et al. (2020) for
740 whom working in the agricultural sector is rather a favorable factor for the
741 acceptance of "cultured meat". However, our results are consistent with other
742 previous results which have shown that the urban population (less familiar with
743 livestock) would be more willing to consume "cultured meat" (Bryant and Barnett,
744 2018; Shaw and Mac Con Iomaire, 2019).

745

746 *4.4. Opinion surveys must be interpreted with caution due to their limited representative*
747 *character*

748 The representativeness of the people surveyed in our study in relation to the French
749 population must be put into perspective. In fact, in the French population, 51.9% are
750 over 51 years old (under-represented in our sample with only 23.3%), 25.1% are
751 between 31 and 50 (over-represented in our sample with 36.2%), and 11.1% are

752 between 18 and 30 (also over-represented since they represent 40.5% of our sample).
753 With regard to the gender distribution, it is balanced in the French population with
754 49.6% women vs. 50.4% men, however women are slightly over-represented in our
755 sample (52.6%). The differences we observe reflect a greater interest in scientific news
756 among women and young people, thus inducing a greater willingness on their part
757 to answer this type of questionnaire. This type of bias in surveys has already been
758 observed, for example in the survey by Bryant et al. (2020) and Heidemann et al.
759 (2020). However, these drawbacks can be partially offset by the consequent size of
760 the sample (N = 5,418), which makes it possible to analyze each segment of the
761 population, our survey being to our knowledge the one with the largest number of
762 people among the population.

763 According to the Ministry of Higher Education, Research and Innovation, in France
764 only 1.0% of citizens have a PhD, 16.0% a master's degree, 10.0% a bachelor's degree
765 and 15.0% have completed short vocational studies. However, the respondents to our
766 survey are more graduates with 45.9% having a master's degree and 11.0% a
767 doctorate, and this is explained by the fact that the questionnaire was initially
768 distributed in scientific networks (universities, research institutes, etc.). Since people
769 with studies are more interested in science than others, one can assume that they
770 respond more easily to this kind of survey. In addition, in the French population
771 there are 3.1% scientists, compared to 44.7% in our survey, which can easily be
772 explained by the interest of scientists in innovations as well as by the essentially
773 university dissemination network. This agrees with the conclusions of Heidemann et

774 al. (2020) who indicate that biotechnology engineers would be more likely to accept
775 "cultured meat" based on their knowledge of the field as well as the professional
776 opportunities generated by this technology once it has been marketed.

777 In France, 2.5% of citizens work in the meat sector, while this sector of activity
778 represents 40.7% in our study sample. The results must therefore be corrected for this
779 type of factor. However, as noted above, our observations are in contrast to those of
780 Bryant et al. (2020) who, on the contrary, emphasize that professionals in agriculture
781 or the meat sector are open to "cultured meat". The way the questions are asked, the
782 way the subject is presented or the limited number of respondents may explain this
783 type of discrepancy.

784 The results can also be potentially affected by the diet of the respondents. In an
785 earlier study (Bryant et al., 2020), the proportion of pescatarians (who do not
786 consume meat but fish), vegetarians (who do not consume animal flesh) and vegans
787 (who do not consume any product of origin animal) were 3.2%, compared to 6.2% in
788 this survey, but the proportions of flexitarians (who limit their meat consumption,
789 without being exclusively vegetarian) are more difficult to evaluate. Given the rather
790 low figures, it is unlikely that these different proportions would have a significant
791 impact on the results. However, in the study by Heidemann et al. (2020), vegetarians
792 (7.0% of respondents) and vegans (1.1%) were the most favorable to "cultured meat".
793 Indeed, the authors indicate that those who did not consume meat were more likely
794 to respond positively than those who consumed meat daily.

795 Finally, more generally, the formulation and sequencing of the questions can modify
796 their interpretation and therefore the results (Briant and Barnett, 2020). Furthermore,
797 although the survey was conducted in the most neutral way possible, the choice of
798 questions and their order can also influence the respondents, in one direction or
799 another. Indeed, some studies are carried out by promoters of "cultured meat" with
800 the assumed objective of convincing consumers (Tomiyama et al., 2020). Lastly, due
801 to the importance of the implicit attitudes described above, a recent survey
802 illustrated the inadequacy of relying on self-reported measures when seeking to
803 capture consumer opinions on unfamiliar or unknown products such as "cultured
804 meat" (Baum et al., 2021). However, despite these limitations, comparing results
805 obtained with the same experimental design between countries (such as China as
806 published by Liu et al., 2021 and France) or between similar social groups (within the
807 same study as in this work) is likely to provide useful information.

808

809 **5. Conclusion**

810 To the best of our knowledge, this survey was conducted with the highest number of
811 respondents compared to any previous surveys conducted in France or even in the
812 world on the subject of "cultured meat". In addition, this study was conducted by a
813 group of researchers belonging to public research organizations, unrelated to private
814 companies, aiming to market this biotechnology, unlike some previous surveys.

815 This survey highlights that the French are very concerned about the ethical and
816 environmental issues related to livestock farming and meat production. This is why,
817 as shown in previous surveys, reducing the consumption of meat (known as
818 “flexitarianism”) is preferred, at the expense of “cultured meat” consumption which
819 is not perceived as more ethical, more eco-friendly, more sustainable, or even as
820 healthy and tasty as “conventional meat”. In addition, the potential negative impacts
821 of “cultured meat” on traditional livestock farming, on the meat industry as well as
822 on territories and rural life are among the concerns of respondents. Hence, for the
823 above reasons, and also because of emotional resistance and negative feelings
824 (disgust, absurdity), the majority of respondents do not support “cultured meat” as a
825 reasonable solution for the future, despite some curiosity for the product. However,
826 confirming some previous results, young people and women, more concerned about
827 ethical and environmental issues, are more likely to accept “cultured meat”.

828 Contrary to other assumptions (especially by the promoters of “cultured meat”), a
829 better understanding of the advantages, limitations and production process
830 of “cultured meat” does not necessarily favor its acceptance. On the contrary, better
831 knowledge of the livestock farming systems, their environment and the conventional
832 meat production process favors the rejection of “cultured meat”.

833 Overall, a very large majority of respondents would not be prepared to pay more
834 for “cultured meat” (if it were ever on the market) than conventional meat as
835 previously observed in other studies. Furthermore, at best, around one fifth of
836 respondents consider this alternative to conventional meat promising and/or feasible.

837 An equivalent proportion of respondents believe that "cultured meat" has no future
838 in France. Between these two extremes, a large proportion of unsure respondents can
839 be influenced. It is therefore important to objectively inform consumers of the
840 advantages/disadvantages of this new technology. Thus, even if "cultured meat" is
841 one day marketed, its societal or environmental impacts would be very weak to
842 moderate due to a low to moderate market share, and due to the fact that the
843 production of conventional meat is not completely replaced by the production
844 of "cultured meat".

845

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854

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969

970 **Figure captions:**

971 Figure 1: General opinion of respondents on "cultured meat" also called "artificial
972 meat" (N = 5,418 responses).

973 Figure 2: Principal component analysis showing relationships between the studied
974 variables corresponding to the main questions with potential answers from 1 to 5.

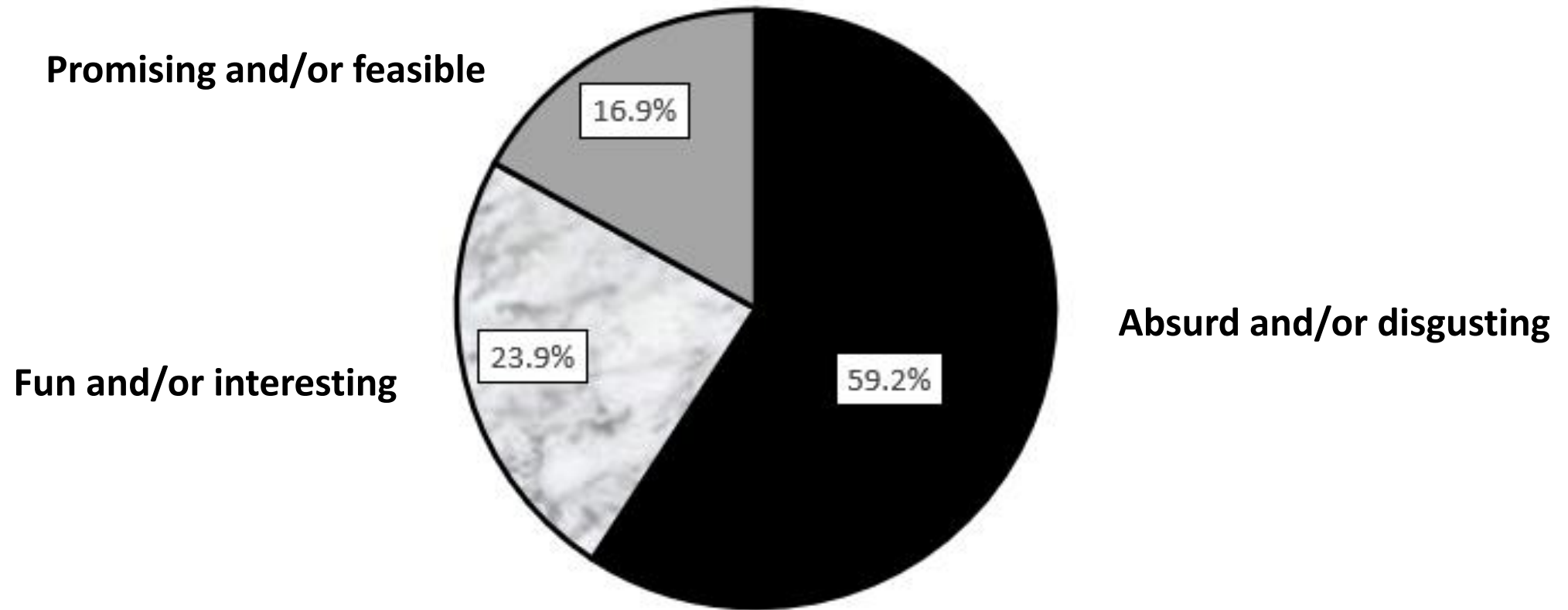
975 AM: Artificial Meat. WTT: Willingness to try. WTE: Willingness to eat. WTP:
976 Willingness to pay.

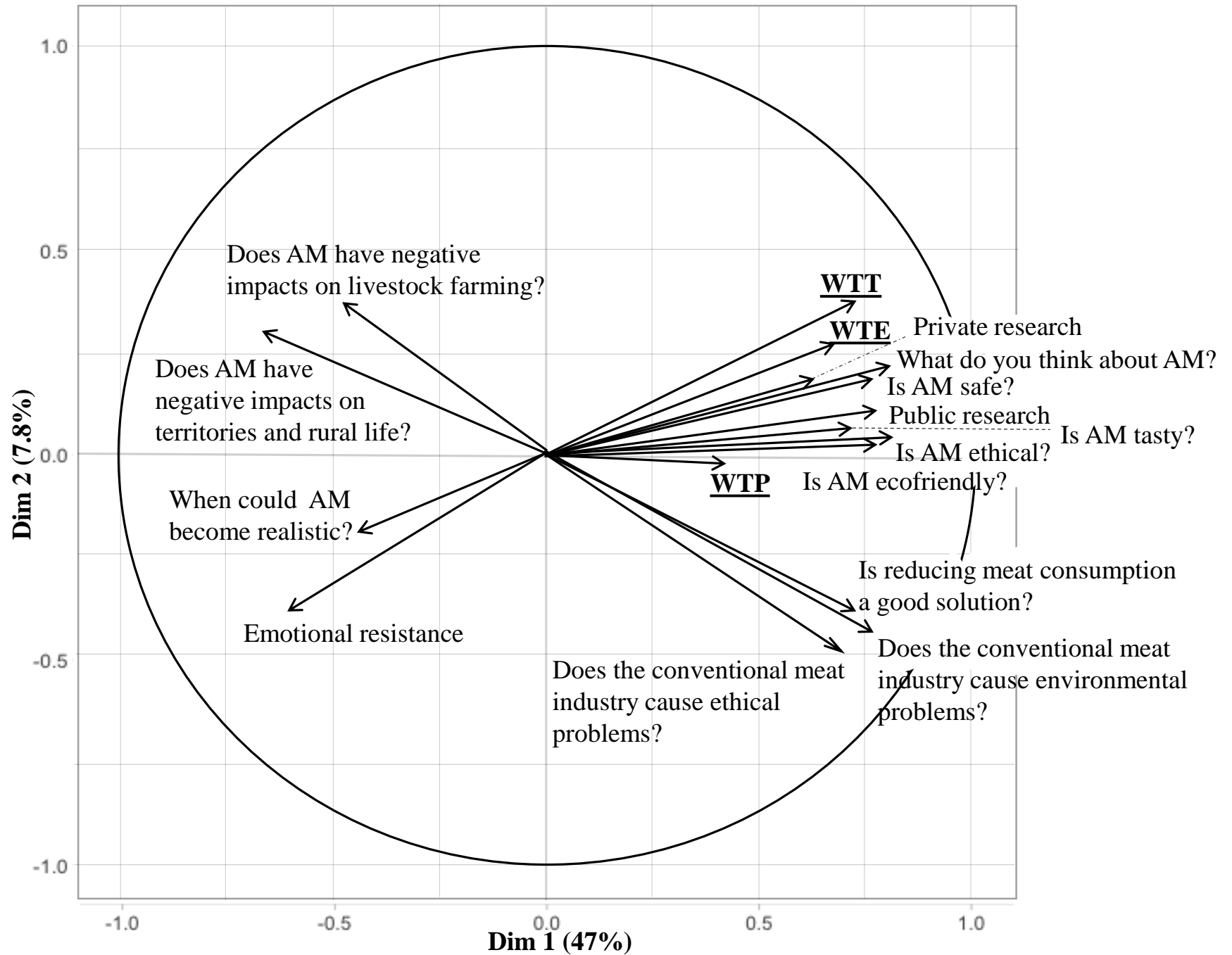
977 Figure 3: Potential acceptance of "cultured meat" also called "artificial meat"
978 compared to other solutions and other meat substitutes.

979 Figure 4: Reasons not to try "cultured meat" also called "artificial meat" (A),
980 expectations (B) and reasons to try "cultured meat" (C). Results are expressed as a
981 percentage of answers (N = 5,418 responses). As these are multiple choices questions,
982 the sum of the percentages is greater than 100.

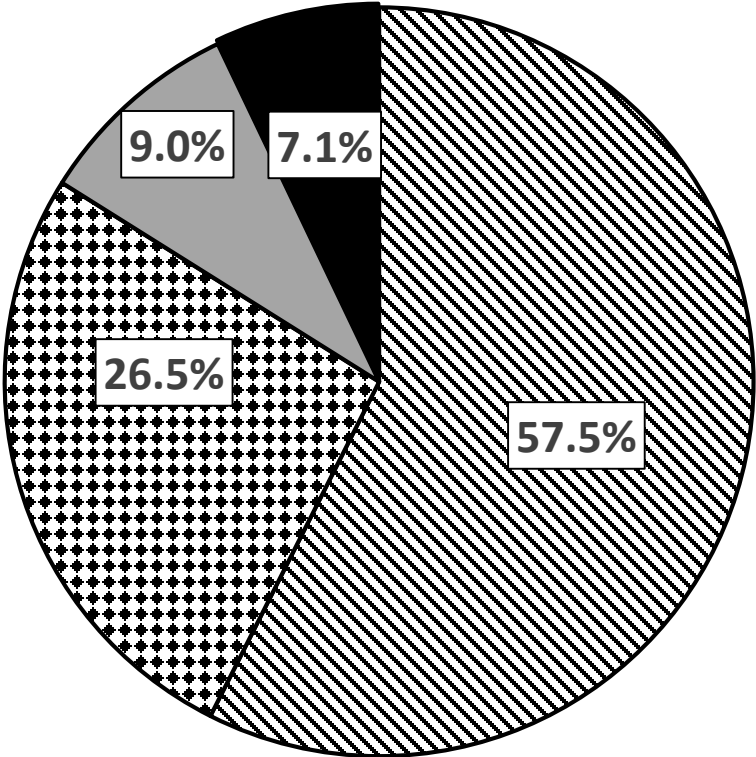
983

What do you think of artificial meat?





Would you accept artificial "meat" as a viable alternative to "conventional meat" in the future, compared to other meat substitutes (such as soy protein) or other solutions (such as reducing food waste or developing our farming practices)?



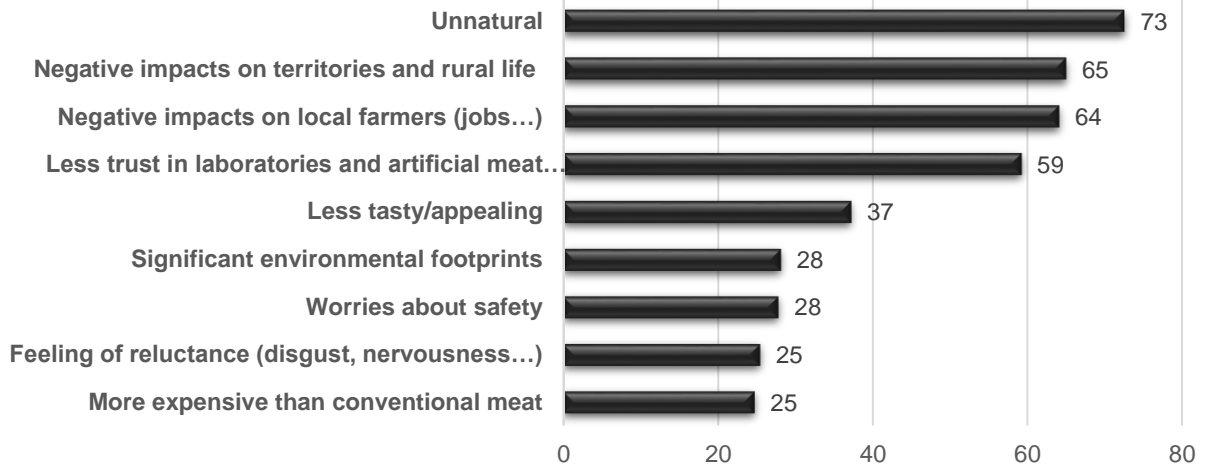
☒ No and I don't eat meat substitutes/alternatives

☒ No but I already eat meat substitutes/alternatives

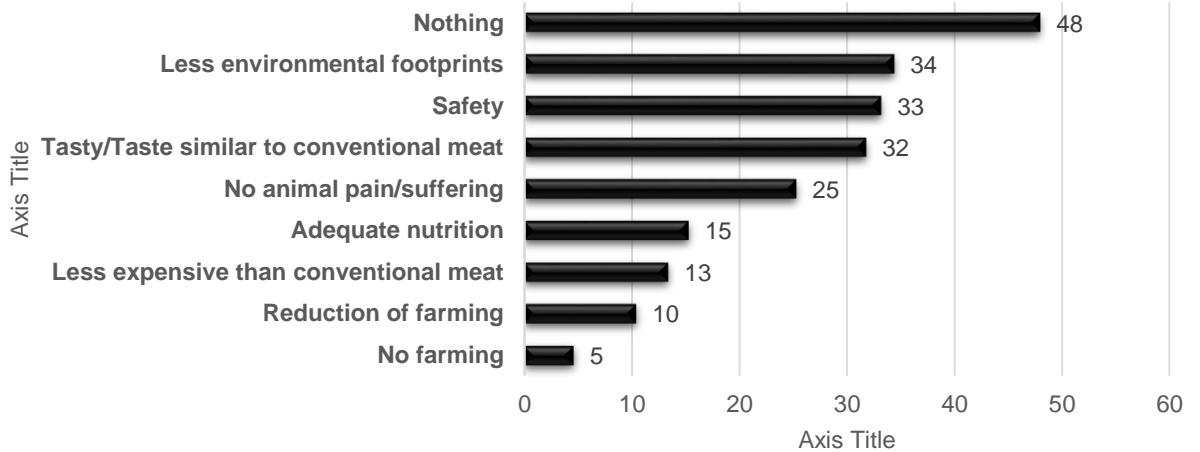
☒ Yes but I don't eat meat substitutes/alternatives

☒ Yes and I already eat meat substitutes/alternatives

A. Why would you NOT be willing to try artificial meat?



B. What would you expect from artificial meat?



C. What could be the reasons for you to try artificial meat?

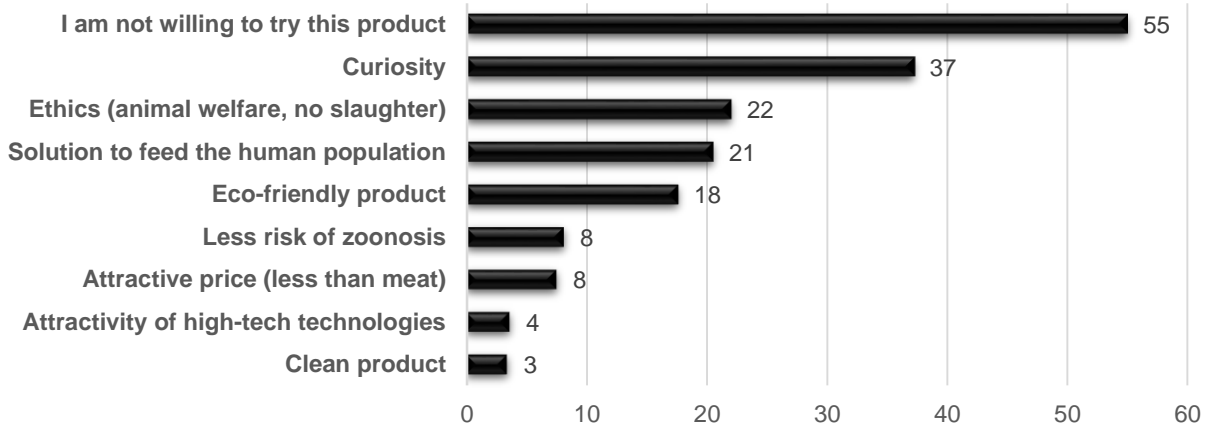


Table 1**Demographic information of the French survey respondents (N = 5,418 responses)**

Questions	Response options	Number of responses	Percentage of responses
Gender	Female	2852	52.6
	Male	2566	47.4
Age	18-30 years of age	2194	40.5
	31-50 years of age	1959	36.2
	>51 years of age	1265	23.3
Education	Primary or high school	67	1.2
	Baccalaureate	782	14.4
	Two years of education after the Baccalaureate	249	4.6
	Licence (Bachelor's degree)	1131	20.9
	Master's degree	2489	45.9
	PhD	596	11.0
	Do not wish to answer	104	1.9
Business area	Meat scientist	429	7.9
	Other scientist	1996	36.8
	Familiar with the meat sector	1778	32.8
	Other	1215	22.4
Net monthly income*	€0-1500	1528	28.2
	€1500-2000	948	17.5
	€2000-2500	747	13.8
	€2500-3000	521	9.6
	€3000-4000	498	9.2
	€4000 and more	467	8.6
	Do not wish to answer	709	13.1
Meat consumption habits	Never: vegetarian or vegan diet	334	6.2
	Rarely: weekly or less	726	13.4
	Regularly: several times a week	2954	54.5
	Daily or at every meal	726	13.4
Familiarity with the topic of artificial "meat"	Yes	4678	86.3
	No	740	16.7

**€1 corresponds to approximately \$1.21*

Table 2**Pairwise comparisons for willingness to try between demographic groups for occupation interacting with age or level of meat consumption (N = 5,418 responses)**

A	Familiar with the meat sector and not scientist	Scientist working on meat	Scientist not working on meat	Not scientist not familiar with the meat sector
18-30 yrs old	2.75 ^c	3.54 ^{ef}	3.75 ^f	3.36 ^e
31-50 yrs old	2.32 ^a	3.12 ^{de}	3.31 ^e	2.76 ^c
> 51 years old	2.34 ^{ab}	3.20 ^{de}	2.87 ^{cd}	2.62 ^{bc}
B	Familiar with the meat sector and not scientist	Scientist working on meat	Scientist not working on meat	Not scientist not familiar with the meat sector
Daily	2.16 ^a	3.14 ^{bc}	3.42 ^{cd}	2.57 ^a
Regularly	2.52 ^a	3.37 ^c	3.45 ^{cd}	2.87 ^{ab}
Rarely	3.40 ^{cd}	3.32 ^c	3.73 ^d	3.20 ^c
Never	3.73 ^{cd}	3.80 ^d	3.20 ^c	3.18 ^{bc}

WTT is expressed on a 1-5 scale with only one possible answer to the question "Would you be willing to try artificial "meat"?": 1: Definitely not, 2: Probably not, 3: Unsure, 4: Probably yes, 5: Definitely yes. The means with different superscript letters within the same sub-table differ significantly at $P > 0.05$

Table 3

Pairwise comparisons for willingness to regularly eat artificial “meat” between demographic groups for different interactions between selected factors (level of meat consumption, gender, age groups, occupation and familiarity with artificial “meat”, N = 5,418 responses)

A: level of meat consumption x gender	Never	Rarely	Regularly	Daily
Females	1.32 ^d	1.26 ^{cd}	1.24 ^{bc}	1.09 ^a
Males	1.39 ^e	1.44 ^e	1.18 ^b	1.11 ^a
B: occupation x age	Familiar with the meat sector and not scientist	Scientist working on meat	Scientist not working on meat	Not scientist not familiar with the meat sector
18-30 yrs old	1.13 ^{bc}	1.20 ^{cd}	1.37 ^e	1.39 ^e
31-50 yrs old	1.06 ^a	1.10 ^{ab}	1.20 ^{cd}	1.22 ^d
> 51 years old	1.08 ^{ab}	1.11 ^{abc}	1.14 ^{bc}	1.19 ^{cd}
C: level of meat consumption x age	Never	Rarely	Regularly	Daily
18-30 yrs old	1.32 ^{de}	1.34 ^{de}	1.35 ^e	1.19 ^c
31-50 yrs old	1.44 ^e	1.21 ^c	1.15 ^{bc}	1.06 ^a
> 51 years old	1.33 ^{de}	1.24 ^{cd}	1.13 ^b	1.06 ^a
D: level of meat consumption x occupation	Never	Rarely	Regularly	Daily
Familiar with the meat sector and not scientist	1.38 ^{fg}	1.21 ^{bcd}	1.09 ^b	1.04 ^a
Scientist working on meat	1.50 ^g	1.24 ^{cde}	1.14 ^{bcd}	1.08 ^{ab}
Scientist not working on meat	1.31 ^{efg}	1.30 ^{efg}	1.31 ^{efg}	1.22 ^{cde}
Not scientist not familiar with the meat sector	1.40 ^g	1.31 ^{efg}	1.31 ^{efg}	1.17 ^{bcd}
E: familiarity with artificial “meat” x level meat consumption x gender	Never	Rarely	Regularly	Daily
Familiarity: No	1.21 ^{cde}	1.36 ^e	1.28 ^{de}	1.08 ^{ac}
Familiarity: Yes	1.37 ^e	1.27 ^d	1.20 ^b	1.11 ^a

WTE: 1- I don't want to eat regularly, 2 - home/restaurant/ready-made meal. The means with different superscript letters within the same sub-table differ significantly at P > 0.05

Table 4

Pairwise comparisons for willingness to pay between demographic groups for level of meat consumption interacting with age (N = 5,418 responses)

	Never	Rarely	Regularly	Daily
18-30 years old	2.85 ^f	2.51 ^e	2.22 ^{de}	1.86 ^{abc}
31-50 years old	2.78 ^f	2.10 ^{cde}	1.88 ^{abc}	1.77 ^{ab}
> 51 years old	2.59 ^{ef}	2.24 ^{de}	1.78 ^{ab}	1.69 ^a

The means with different superscript letters within the same sub-table differ significantly at $P > 0.05$.

1: Definitely not, 2: Probably not, 3: Unsure, 4: Probably yes, 5: Definitely yes.

Table 5**Effects of “gender x age” interaction on drivers, motives and barriers of acceptance of fake “meat”**

A. Mean answers to four questions: Does meat production cause ethical (Answer 1) or environmental problems (Answer 2)? Is Artificial Meat ethics (Answer 3) or eco-friendly (Answer 4)?

		Answer 1	Answer 2	Answer 3	Answer 4
18-30 years of age	Men	2.88 ^c	3.17 ^b	2.48 ^c	2.29 ^c
18-30 years of age	Women	3.51 ^d	3.65 ^c	2.79 ^d	2.47 ^d
31-50 years of age	Men	2.35 ^a	2.48 ^a	1.81 ^a	1.70 ^a
31-50 years of age	Women	3.02 ^c	3.00 ^b	2.07 ^b	1.91 ^b
More than 51 years of age	Men	2.44 ^b	2.54 ^a	1.73 ^a	1.66 ^a
More than 51 years of age	Women	3.20 ^c	3.21 ^b	2.27 ^{bc}	2.14 ^c

Respondents had to answer on a scale of 1 to 5, expressing their disagreement (lower scores) or their agreement (with higher scores) to the indicated question.

B. Mean answers to four questions: Has artificial meat negative impacts on livestock (Answer 1) or rural life (Answer 2)? Is Artificial Meat safe (Answer 3) or tasty (Answer 4)?

		Answer 1	Answer 2	Answer 3	Answer 4
18-30 years of age	Men	4.18 ^{ab}	3.99 ^a	2.52 ^d	2.09 ^d
18-30 years of age	Women	4.20 ^{ab}	4.00 ^a	2.60 ^d	2.20 ^d
31-50 years of age	Men	4.26 ^b	4.20 ^b	2.02 ^a	1.66 ^{ab}
31-50 years of age	Women	4.37 ^c	4.30 ^b	2.19 ^{bc}	1.74 ^{bc}
More than 51 years of age	Men	4.11 ^a	4.43 ^c	2.09 ^{ab}	1.57 ^a
More than 51 years of age	Women	4.31 ^{bc}	4.50 ^c	2.29 ^c	1.83 ^c

Respondents had to answer on a scale of 1 to 5, expressing their disagreement (lower scores) or their agreement (with higher scores) to the indicated question.

Table 6**Effects of “gender x meat consumption level” interaction on drivers, motives and barriers of acceptance of fake “meat”**

A. Mean answers to four questions: Does meat production cause ethical (Answer 1) or environmental problems (Answer 2)? Is Artificial Meat ethics (Answer 3) or eco-friendly (Answer 4)?

Meat consumption level	Gender	Answer 1	Answer 2	Answer 3	Answer 4
Never	Women	4.74 ^e	4.76 ^f	3.46 ^e	3.11 ^e
	Men	4.83 ^e	4.77 ^f	3.90 ^f	3.49 ^f
Rarely	Women	4.07 ^d	4.20 ^e	2.89 ^d	2.57 ^d
	Men	3.82 ^d	4.14 ^e	2.92 ^d	2.52 ^d
Regularly	Women	3.13 ^c	3.22 ^d	2.37 ^c	2.17 ^c
	Men	2.54 ^b	2.72 ^c	1.94 ^b	1.83 ^b
Daily	Women	2.42 ^b	2.40 ^b	1.86 ^b	1.72 ^{ab}
	Men	1.97 ^a	2.11 ^a	1.62 ^a	1.55 ^a

Respondents had to answer on a scale of 1 to 5, expressing their disagreement (lower scores) or their agreement (with higher scores) on the indicated question.

B. Mean answers to four questions: Has artificial meat negative impacts on livestock (Answer 1) or rural life (Answer 2)? Is Artificial Meat safe (Answer 3) or tasty (Answer 4)?

Meat consumption level	Gender	Answer 1	Answer 2	Answer 3	Answer 4
Never	Women	3.50 ^a	2.81 ^b	3.47 ^e	3.28 ^f
	Men	3.55 ^{ab}	2.06 ^f	4.06 ^f	3.66 ^g
Rarely	Women	3.95 ^c	3.84 ^d	2.72 ^d	2.33 ^d
	Men	3.71 ^b	3.62 ^c	2.83 ^d	2.50 ^e
Regularly	Women	4.26 ^d	4.28 ^e	2.35 ^c	1.85 ^c
	Men	4.32 ^d	4.40 ^f	2.20 ^b	1.71 ^b
Daily	Women	4.54 ^e	4.56 ^f	1.85 ^a	1.50 ^a
	Men	4.49 ^e	4.60 ^f	1.80 ^a	1.46 ^a

Respondents had to answer on a scale of 1 to 5, expressing their disagreement (lower scores) or their agreement (with higher scores) on the indicated question.

Table 7
Effects of “occupation x level of meat consumption” interaction on drivers, motives and barriers of acceptance of fake “meat”

A. Mean answers to four questions: Does meat production cause ethical (Answer 1) or environmental problems (Answer 2)? Is Artificial Meat ethics (Answer 3) or eco-friendly (Answer 4)?

Occupation	Level of meat consumption	Answer 1	Answer 2	Answer 3	Answer 4
Familiar with the meat sector and non-scientist	Never	4.49 ^h	4.45 ^{gh}	3.15 ^f	2.85 ^{fg}
	Rarely	3.62 ^g	3.69 ^{ef}	2.32 ^{de}	2.16 ^d
	Regularly	2.27 ^b	2.31 ^b	1.60 ^b	1.53 ^b
	Daily	1.80 ^a	1.83 ^a	1.30 ^a	1.28 ^a
Scientist working on meat	Never	5.00 ^h	4.80 ^h	3.60 ^g	3.4 ^h
	Rarely	3.87 ^g	4.03 ^{fg}	2.70 ^e	2.41 ^{ef}
	Regularly	2.53 ^{cd}	2.66 ^c	1.95 ^c	1.75 ^c
	Daily	2.16 ^b	2.22 ^b	1.80 ^{bc}	1.72 ^{bc}
Scientist not working on meat	Never	4.73 ^h	4.75 ^h	3.60 ^g	3.11 ^{gh}
	Rarely	4.07 ^g	4.35 ^g	3.14 ^f	2.63 ^f
	Regularly	3.25 ^f	3.50 ^e	2.64 ^e	2.36 ^e
	Daily	2.73 ^d	2.94 ^d	2.47 ^e	2.15 ^d
Non-scientist not familiar with the meat sector	Never	4.94 ^h	4.96 ^h	3.75 ^g	3.55 ^h
	Rarely	4.08 ^g	4.13 ^g	2.74 ^{ef}	2.62 ^f
	Regularly	3.08 ^e	3.14 ^d	2.22 ^d	2.18 ^d
	Daily	2.37 ^{bc}	2.40 ^{bc}	1.86 ^c	1.78 ^c

Respondents had to answer on a scale of 1 to 5, expressing their disagreement (lower scores) or their agreement (with higher scores) to the indicated question.

B. Mean answers to four questions: Has artificial meat negative impacts on livestock (Answer 1) or rural life (Answer 2)? Is Artificial Meat safe (Answer 3) or tasty (Answer 4)?

Occupation	Level of meat consumption	Answer 1	Answer 2	Answer 3	Answer 4
Familiar with the meat sector and non-scientist	Never	3.79 ^a	2.79 ^b	3.26 ^{fg}	3.02 ^f
	Rarely	4.13 ^b	4.20 ^{de}	2.59 ^{de}	2.16 ^{de}
	Regularly	4.54 ^{bc}	4.68 ^f	1.83 ^b	1.48 ^b
	Daily	4.64 ^a	4.78 ^f	1.47 ^a	1.29 ^a
Scientist working on meat	Never	3.00 ^{ef}	2.50 ^{ab}	3.80 ^g	3.50 ^{fg}
	Rarely	4.11 ^{fg}	4.11 ^{de}	2.97 ^f	2.51 ^e
	Regularly	4.45 ^g	4.68 ^f	2.57 ^{de}	1.78 ^c
	Daily	4.52 ^{efg}	4.70 ^f	2.23 ^{cd}	1.61 ^{bc}
Scientist not working on meat	Never	3.64 ^{cd}	2.84 ^b	3.65 ^g	3.29 ^f
	Rarely	3.88 ^{de}	3.77 ^c	2.96 ^f	2.40 ^e
	Regularly	4.13 ^{de}	4.12 ^{de}	2.66 ^e	2.00 ^d
	Daily	4.35 ^d	4.32 ^e	2.47 ^d	1.80 ^c
Non-scientist not familiar with the meat sector	Never	3.18 ^{bc}	2.14 ^a	3.75 ^g	3.71 ^g
	Rarely	3.75 ^{cd}	3.56 ^c	2.42 ^f	2.40 ^e
	Regularly	4.14 ^{cd}	4.09 ^d	2.16 ^c	1.83 ^c
	Daily	4.36 ^{bc}	4.32 ^{de}	1.74 ^b	1.50 ^{bc}

Respondents had to answer on a scale of 1 to 5, expressing their disagreement (lower scores) or their agreement (with higher scores) to the indicated question.

Table 8**Effects of “level of meat consumption x Age” interaction on drivers, motives and barriers of acceptance of artificial meat**

A. Mean answers to four questions: Does meat production cause ethical (Answer 1) or environmental problems (Answer 2)? Is Artificial Meat ethics (Answer 3) or eco-friendly (Answer 4)?

Level of meat consumption	Age	Answer 1	Answer 2	Answer 3	Answer 4
Never	18-30 years of age	4.70 ^f	4.74 ^g	3.46 ^{de}	3.08 ^e
	31-50 years of age	4.89 ^f	4.81 ^g	3.74 ^e	3.39 ^{ef}
	More than 51 years of age	4.90 ^f	4.81 ^g	3.97 ^e	3.68 ^f
Rarely	18-30 years of age	4.05 ^e	4.32 ^f	3.21 ^d	2.76 ^d
	31-50 years of age	3.94 ^e	3.99 ^e	2.43 ^c	2.23 ^c
	More than 51 years of age	3.94 ^e	3.99 ^e	2.50 ^c	2.32 ^c
Regularly	18-30 years of age	3.17 ^d	3.39 ^d	2.63 ^c	2.38 ^c
	31-50 years of age	2.65 ^c	2.75 ^c	1.93 ^b	1.80 ^b
	More than 51 years of age	2.69 ^c	2.77 ^c	1.89 ^b	1.81 ^b
Daily	18-30 years of age	2.39 ^b	2.53 ^b	1.98 ^b	1.89 ^b
	31-50 years of age	1.99 ^a	2.01 ^a	1.53 ^a	1.43 ^a
	More than 51 years of age	2.03 ^a	2.09 ^a	1.59 ^a	1.49 ^a

Respondents had to answer on a scale of 1 to 5, expressing their disagreement (lower scores) or their agreement (with higher scores) to the indicated question.

B. Mean answers to four questions: Has artificial meat negative impacts on livestock (Answer 1) or rural life (Answer 2)? Is Artificial Meat safe (Answer 3) or tasty (Answer 4)?

Level of meat consumption	Age	Answer 1	Answer 2	Answer 3	Answer 4
Never	18-30 years of age	3.58 ^a	2.82 ^b	3.52 ^f	3.28 ^e
	31-50 years of age	3.43 ^a	2.15 ^a	3.88 ^f	3.56 ^e
	More than 51 years of age	3.23 ^a	2.36 ^{ab}	3.68 ^f	3.61 ^e
Rarely	18-30 years of age	3.90 ^b	3.69 ^c	2.96 ^e	2.58 ^d
	31-50 years of age	3.94 ^b	3.94 ^{de}	2.36 ^{cd}	2.02 ^c
	More than 51 years of age	3.77 ^b	3.86 ^{cd}	2.60 ^d	2.19 ^c
Regularly	18-30 years of age	4.27 ^c	4.15 ^e	2.54 ^d	2.05 ^c
	31-50 years of age	4.33 ^{cd}	4.44 ^f	2.13 ^c	1.66 ^b
	More than 51 years of age	4.27 ^c	4.44 ^f	2.16 ^c	1.61 ^b
Daily	18-30 years of age	4.50 ^e	4.43 ^f	1.95 ^b	1.61 ^b
	31-50 years of age	4.54 ^e	4.68 ^g	1.71 ^a	1.41 ^a
	More than 51 years of age	4.45 ^{de}	4.68 ^g	1.80 ^{ab}	1.37 ^a

Respondents had to answer on a scale of 1 to 5, expressing their disagreement (lower scores) or their agreement (with higher scores) to the indicated question.

Table 9**Effects of “Occupation x age” interaction on drivers, motives and barriers of acceptance of artificial meat**

A. Mean answers to four questions: Does meat production cause ethical (Answer 1) or environmental problems (Answer 2)? Is Artificial Meat ethics (Answer 3) or eco-friendly (Answer 4)?

Occupation	Age	Answer 1	Answer 2	Answer 3	Answer 4
Familiar with the meat sector and non-scientist	18-30 years of age	2.53 ^c	2.55 ^c	1.79 ^b	1.71 ^c
	31-50 years of age	2.05 ^a	2.08 ^a	1.45 ^a	1.38 ^a
	More than 51 years of age	2.15 ^{ab}	2.22 ^{ab}	1.48 ^a	1.47 ^{ab}
Scientist working on meat	18-30 years of age	2.88 ^d	3.09 ^d	2.28 ^c	2.07 ^d
	31-50 years of age	2.41 ^{bc}	2.44 ^{bc}	1.83 ^b	1.67 ^{bc}
	More than 51 years of age	2.38 ^{bc}	2.42 ^{bc}	1.83 ^b	1.73 ^c
Scientist not working on meat	18-30 years of age	3.68 ^e	3.96 ^f	3.12 ^e	2.73 ^e
	31-50 years of age	3.18 ^d	3.35 ^d	2.39 ^c	2.10 ^d
	More than 51 years of age	3.14 ^d	3.27 ^d	2.31 ^c	2.03 ^d
Non-scientist not familiar with the meat sector	18-30 years of age	3.56 ^e	3.70 ^e	2.79 ^d	2.64 ^e
	31-50 years of age	3.12 ^d	3.15 ^d	2.21 ^c	2.14 ^d
	More than 51 years of age	3.14 ^d	3.13 ^d	2.15 ^c	2.15 ^d

Respondents had to answer on a scale of 1 to 5, expressing their disagreement (lower scores) or their agreement (with higher scores) to the indicated question.

B. Mean answers to four questions: Has artificial meat negative impacts on livestock (Answer 1) or rural life (Answer 2)? Is Artificial Meat safe (Answer 3) or tasty (Answer 4)?

Occupation	Age	Answer 1	Answer 2	Answer 3	Answer 4
Familiar with the meat sector and non-scientist	18-30 years of age	4.57 ^c	4.55 ^f	1.91 ^b	1.60 ^{bc}
	31-50 years of age	4.57 ^c	4.70 ^f	1.66 ^a	1.42 ^a
	More than 51 years of age	4.44 ^c	4.63 ^f	1.78 ^{ab}	1.48 ^{ab}
Scientist working on meat	18-30 years of age	4.35 ^{bc}	4.46 ^{ef}	2.64 ^e	2.14 ^f
	31-50 years of age	4.49 ^c	4.69 ^f	2.47 ^{de}	1.65 ^{bcd}
	More than 51 years of age	4.39 ^{bc}	4.64 ^f	2.40 ^{cde}	1.61 ^{bcd}
Scientist not working on meat	18-30 years of age	4.05 ^a	3.78 ^b	2.95 ^f	2.42 ^g
	31-50 years of age	4.09 ^a	4.19 ^d	2.56 ^e	1.87 ^{de}
	More than 51 years of age	4.12 ^{ab}	4.28 ^{de}	2.53 ^e	1.75 ^{cd}
Non-scientist not familiar with the meat sector	18-30 years of age	3.92 ^a	3.54 ^a	2.41 ^{cde}	2.28 ^{fg}
	31-50 years of age	4.13 ^{ab}	3.97 ^c	2.15 ^c	1.94 ^{ef}
	More than 51 years of age	4.03 ^a	4.10 ^d	2.21 ^{cd}	1.84 ^{cde}

Respondents had to answer on a scale of 1 to 5, expressing their disagreement (lower scores) or their agreement (with higher scores) to the indicated question.

Table 10**Differences in answers to the different questions in the survey by respondents from the two major clusters**

	Cluster 1	Cluster 2	Ratio
Number of respondents	2688	2713	
Does meat production cause ethical problems?	2.12	3.75	1.77***
Does meat production cause environmental problems?	2.10	3.99	1.90***
Is reducing meat consumption the solution?	1.97	4.15	2.10***
Is artificial meat ethical?	1.26	3.19	2.53***
Is artificial meat eco-friendly?	1.20	2.89	2.40***
Does artificial meat have negative impacts on livestock?	4.58	3.92	0.86***
Does artificial meat have negative impacts on rural life?	4.77	3.69	0.77***
Is artificial meat safe?	1.49	3.11	2.08***
Is artificial meat tasty?	1.29	2.46	1.90***
What do you think of artificial meat?	1.10	2.04	1.85***
Do you express emotional resistance?	4.20	2.72	0.65***
Willingness to try	2.04	3.94	1.93***
Willingness to eat regularly	1.02	1.39	1.36***
Willingness to pay	1.65	2.39	1.45***
When will artificial meat appear?	2.65	1.87	0.71***
Is private research needed?	1.88	3.21	1.71***
Is public research needed?	1.31	1.87	1.77***

The differences between the two clusters are all highly significant at $P < 0.001$