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Research Article

Cultured Meat: A Mind Genomics Cartography of a Technology in its Infancy

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Abstract

Respondents evaluated combinations of messages about the emerging technology of cultured meat, these messages created to be meaningful to a non-technical person, and dealing with the sensory, technical, and sociological aspects of cultured meat. The data suggest that the respondent does not understand what cultured meat 'means', and may agree with statement which directly negate each other. There are three poorly-defined mind-sets underlying the Mind-Set-Focus on ingredients and on product form; Mind-Set 2-Focus on sustainability and ingredients; Mind-Set 3-Focus on ethical and social issues as well as on product form. These three mind-sets are intertwined within the population, and cannot be separated by conventional geo-demographics. These data present a unique opportunity to understand the formation of one understands about a new technology in food design, cultured meat.

Keywords: *In vitro*, Cultured meat, Ecology and Engineering techniques.
Abbreviations: LCA-Life Cycle Assessment and OLS-Ordinary Least-Squares.

Introduction

The one need only read the food technology releases, whether from academics publishing in the literature to the 'news' releases from the food industry to newsletters from the world of investment, to realize that there is an ongoing revolution in the world of meat. Cultured meat forms part of the emerging field of cellular agriculture [1]. Growing muscle tissue in culture from animal stem cells to produce meat theoretically eliminates the need to sacrifice animals, so-called "cultured" or "synthetic" or "*in vitro*" meat could in theory be constructed with different characteristics and be produced faster and more efficiently than traditional meat [2]. The acceptance of plant-based meats is increasing, along with their commercial successes. The flavors are more nearly approximating those of the conventional meats that they are slowly supplanting. Consumers are attracted to these plant-based meats because of a variety of alterative features, ranging from health of oneself, sustainability of the planet, and simply the novelty of a new fad which is taking root and becoming permanent.

In this world of new 'meat' is another type of product, cultured meat. Cultured meat is meat grown through cells, from original animal cells. Cultured meat is far less known, and straddles the middle zone between conventional meats to which people are accustomed, and the new plant-based meats which attempt to be meat, but made from plants, and are thus acceptable to vegans and others required to, or wanting to reduce their meat intake.

The topic of cultured meat is complex, combining different aspects of science, ecology, food, and emotions. In contrast to plant-based meats which are vegan and can invoke all the positives from sustainability of the planet to health benefits, cultured meat emerges from test tubes, from meat, bringing with it a lot of emotional baggage. Cultured meat has evolved from an idea and concept into a reality with the August 2013 cultured hamburger tasting in London [3]. As have analyzed on the research paper, the first *in vitro* meat burger is made in 2013, that was the first step that have changed the philosophy and the development of *in vitro* meat, by using the method of growing the beef by using stem cells from cow's shoulder [5].

As Ford on his study in 2010, cited that "*in vitro*" meat production appears to be a novel and contemporary concept, the idea of cultured meat for human consumption was conceived long back by Frederick Edwin Smith, a writer, who predicted, "It will no longer be necessary to go to the extravagant length of rearing a bullock in order to eat its steak. From one 'parent' steak of choice tenderness it will be possible to grow as large and as juicy a steak as can be desired" [4]. Cultured meat (i.e., meat produced *in vitro* using tissue engineering techniques) is being developed as a potentially healthier and more efficient alternative to conventional meat, and a Life Cycle Assessment (LCA) research method was used for assessing environmental impacts of cultured meat production [7].

Cultured meat or *in vitro* meat offers a safe and disease-free way forward to meet increasing meat requirement without involving animal sacrifices and at the same time, reducing greenhouse emissions, as compared to conventional meat [8].

The issues involved in cultured meat emerge from technology and communication. According to Kadim the technology underlying cultured meat is still in its early stages. The technical issues are to produce sufficient amounts of the product, with the *in vitro* or synthetic meat constructed to possess the different characteristics of meat products, the latter being the business issue going hand in hand with the technology. The reality is that for cultured meat to be a success it must be incorporated into many products, not just one. The technical issue is to create a number of different products, for the different kinds of meats that people purchase and consume. The generation of bio-artificial muscles from satellite cells has been ongoing for about 15 years, but has never been used for generation of meat, while it already is a great source of animal protein and for that in order to serve as a credible alternative to livestock meat, lab or factory grown meat should be efficiently produced and should mimic meat in all of its physical sensations, such as visual appearance, smell, texture and of course, taste [9]. Besides reducing the animal suffering significantly, it will also ensure sustainable production of designer, chemically safe and disease free meat with flavor nutritional profile as the conditions in an *in vitro* meat production system are controlled and manipulated [10].

Consumer acceptance of cultured meat is expected to depend on a wide diversity of determinants ranging from technology-related perceptions to product-specific expectations, and including wider contextual factors like media coverage, public involvement, and trust in science, policy and society [11]. United States and the European Union commonly discuss cultured meat in terms of benefits, history, process, time, livestock production problems, and skepticism [12]. Willingness to purchase plant-based and cultured meat burgers is linked to age, sex, views of other food technologies, and attitudes towards the environment and agriculture [13].

Consumer acceptance of cultured meat is expected to depend on a wide diversity of determinants ranging from technology-related perceptions to product-specific expectations, and including wider contextual factors like media coverage, public involvement, and trust in science, policy and society [11]. Cultured meat or *in vitro* meat offers a safe and disease-free way forward to meet increasing meat requirement without involving animal sacrifices and at the same time, reducing greenhouse emissions, as compared to conventional meat [8]. From study ingredients and production, cultured meat production systems also provide control over meat composition and quality by modifying flavor, fatty acid composition, fat content, and especially, the ratio of saturated to unsaturated fatty acids [4].

Today's reality is that *in vitro* cultured meat production is still in its infancy. That infancy is both technological (methods), and consumer knowledge and acceptance. The first "*In vitro* Meat Symposium" in 2008, held in Norway suggested that it would take 5-10 years to produce *in vitro* meat products that would be price-competitive with European beef [12]. That prediction has come true, but not for cultured meat, but rather for plant-based meat, and a number of successful entries in the market, such as Impossible Foods, Inc. In contrast, there does not appear to be a successful or at least widely known success in the world of cultured meat. Furthermore, even the term 'cultured meat' is not clear, whereas plant-based meat is more descriptive and positive to those who believe that plant-based diets are good one's health. This paper explores the reaction of consumers to different concepts about cultured meat. The objective is to determine whether it is possible to form a coherent 'picture' of the concept of cultured meat, by presenting respondents with different combinations of phrases pertaining to cultured meat, and measuring which phrases drive 'agreement.' In these types of studies with well-defined topics, both food and beyond food, respondents have little problem generating coherent data which provides the picture of the concept. This study is among the first, if not the first, to work with a concept that is not well understood by the population because the concept refers to the production of a familiar but 'general' item (meat) by a technology with which most people are totally unfamiliar (*in vitro* culturing).

Method

The approach used is known as mind genomics [14]. Simply explained, mind genomics is the experimental analysis of the everyday. Rather than isolating one variable and studying it thoroughly in the manner of today's science, mind genomics looks at combinations of events or combinations of messages, the more typical situation presenting itself to the person. The objective is to discover how the typical person 'weighs' the different aspects of a compound situation to arrive at a decision [14]. Thus, Mind Genomics is really a study of how people interpret and judge the world around them. Mind Genomics is appropriate to understand the nature of the cultured meat 'concept.'

Mind Genomics works in a 'Socratic' fashion, beginning with a topic, moving to four questions which tell a story about the topic, and then on to four answers for each question, the answers being structured as stand-alone phrases. The four questions may not be correct, and the four answers may not all be relevant. Mind Genomics is a fast (hour or two), inexpensive, iterative system which presents combinations (vignette) of thee answers (also known as elements), to a respondent, obtains the rating of each vignette on a simple, anchored scale, and deconstructs the rating into the contribution of the component elements. The objective is to formulate ideas about a topic, test them quickly in combination, so that the respondent cannot intellectualize the answer and thus game the experiment.

Table 1 presents the four questions and the four answers to each question. A single question can have different answers, including answers which contradict each other. In the actual creation of the vignettes, each respondent evaluates a unique set of 24 vignettes, comprising 2-4 elements or answers from the four questions, with at most one answer from a question in a vignette. Thus, no vignette could ever simultaneously feature both A1 (Cultured meat is sustainable) and A2 (Cultured meat is less sustainable).

Question A: What is the sustainability?	
A1	Cultured meat is sustainable
A2	Cultured meat is less sustainable
A3	Cultured meat is safe
A4	Cultured meat reduces animal cruelty
Question B: What are the ingredients?	
B1	Suspicious of ingredients
B2	Artificial and full of chemicals
B3	Healthier ingredients than real meat
B4	Produced using latest advanced technology
Question C: What are the sensory characteristics?	
C1	It should have the same taste as regular meat
C2	No problem if it tastes a bit differently
C3	Will never taste as premium meat
C4	Won't be able to differentiate from traditional meat
Question D: What are the possible products?	
D1	Should be added to sauces, ground
D2	Should be formed as meat slices, hamburger patty
D3	Should be added to soups, bigger pieces
D4	Should be built up on bones, drumsticks

Table 1: The four questions about *in-vitro* 'cultured' meat and the four answers to each question.

Virtually all approaches in conjoint measuring which feature 'profiles,' viz., the aforementioned vignettes, present the same set of vignettes to many respondents, and by so doing obtain a better estimate of the mean, viz., the central tendency. The underlying thinking is to average out the random variability by increasing the base size. Mind Genomics operates in a different way, creating a unique set of vignettes or profiles for each respondent. The 24 vignettes for each respondent conform to a basic, underlying experimental design. All that differs is the nature of the combinations, which differ from respondent to respondent. This is called a permuted design [15].

The analysis reveals the underlying patterns more clearly because across the set of respondents there is many more combination tested from the set of possible combinations (so-called space filling). Metaphorically, Mind Genomics can be liked to an 'MRI of the mind.' Just as the MRI takes many pictures of tissue from different angles and recombines these pictures into a three-dimensional representation, so Mind Genomics takes many pictures of a concept, using the different vignettes and different respondents to generate the different views.

Analysis

The first step in the analysis reduces the scale to a binary scale, to capture either Agree/Not Agree, or Disagree/Not Disagree. The transformations below show the rules. The transformation to a binary scale makes the explanation of the results easier. In research it may be easy to use Likert Scale or category scales, but it is difficult to interpret the results. Managers and others using the data want to be able to look at the data and form a quick impression of the results to help understand the topic. In this spirit, the binary transformation works well.
Agree: Rating 7-9 transformed to 100 to show AGREE. Ratings 1-6 transformed to 0, to show NOT AGREE.
Disagree: Ratings 1-3 transformed to 100 to show DISAGREE. Ratings 4-9 transformed to 0 to show NOT DISAGREE.

The second step in the analysis used regression to estimate the contribution of each of the 16 elements to the binary transformed rating, either at the level of the individual respondent (for mind-set segmentation), or at the level of the total group (Example: Total, age, gender, mind-set).

The key to Mind Genomics results emerges from OLS (Ordinary Least-Squares) regression. The independent variables are the 16 different elements or answers, coded 0 when absent from a vignette, and coded 1 when present in a vignette. The dependent variable is either the binary Agree/Not Agree Scale (also called TOP3, from the highest three boxes or scale points (7-9), a colloquial use adopted from consumer research), or BOT3, for the Disagree/Not Disagree scale, from the lowest three boxes or scale points (1-3).

The equation is expressed as a simple linear function, without an additive constant. The choice to use an additive constant is left to the researcher. We will forego the use of the constant in order to compare the TOP3 and BOT3 results, viz., and the coefficients from the OLS regression model. The equation is written as: TOP3 (or BOT3) = k_1A1 + k_2 A2 …. k_{16}D4.

The Mind Genomics program also measured the Response Time, defined as the number of seconds (to the nearest tenth of second) elapsing between the presentation of the vignette on the respondent's screen and the rating. The Response Time became the third dependent variable, which was related to the presence/absence of the elements in the vignettes. The ultimate aim of the analysis was to determine how the different elements contribute to agreement to disagreement and to the response time (or engagement time).

Results-Total panel

Our first analysis loos at the strongest scoring elements from the total panel of 100 respondents, each of whom evaluated a unique set of 24 vignettes. The models for the Total Panel thus are based on 2400 observations or cases, 24 cases from each of 100 respondents. The coefficients in **Table 2** show the additive percent of respondents who:
Rate the vignette 7-9 when the element is introduced (TOP3)-Agree
Rate the vignette 1-3 when the element is introduced (BOT3)-Disagree

Table 2 also shows the response time or consideration time, viz., the estimated number of seconds required by the respondent to read the particular element in the vignette.

One of the first observations to emerge from the study is that opposite elements emerge as being believed, generating agreement (TOP3). These contradictory results appear in the column labelled TOP3 (ratings of 7-9, viz., Agree, converted to 100; ratings of 1-6, viz., Do Not Agree or undecided converted to 0). An example of this mutual contradiction yet agreed to comes from the pair B2 (Artificial and full of chemicals), and B3 (Healthier ingredients than real meat). These are opposite, yet strongly agreed to by respondents. The same equal performance of opposites occurs in elements A1 and A2, dealing with sustainability.

In the many dozens of other studies run with Mind Genomics, the strong performance of opposing elements virtually never emerges. Thus, the question is what is happening in this study to allow agreement to opposing elements, with the opposing elements never appearing with each other, however. That result simply does not occur in other studies. The most reasonable explanation is that the concept of 'cultured meat' is simply amorphous. The respondents are being presented with combinations of messages about a product or concept of which they have little idea. They cannot remember what they rated for other vignettes, but they do recognize the terms chemical, ingredient, and sustainability, respectively. And so, perhaps, they simply respond.

When we look at the second column BOT3 (Do Not Agree), we see fewer results that we would call mutually contradictory in a dramatic fashion, but there are still mutual contradictions. The two pairs of mutually contradictory statements are still close in their disagreement. B2 and B3 (Artificial and full of chemicals; Healthier ingredients that real meat) show similar disagreements (BOT3=9 for B2, 11 for B3). The bigger difference is in sustainability, A1 and A2 (Cultured meat is sustainable, BOT3=6, Cultured meat is less sustainable, BOT3=11). There is a sense here that although the respondent may not know about cultured meat, there is probably something which makes it sustainable for the environment.

The final column shows the response time in seconds. Although the respondents cannot tell us how much time they spend reading each element, the underlying experimental design enables us to estimate the number of seconds spent. The response times for all the elements except one (B1 Suspicious of ingredients) are all less than 1.0 seconds. In similar studies with foods and non-foods, the response times, or more correctly the coefficients from the response time models) range from 0.3 to 1.8 or even 2.0 seconds. The response times for these elements are remarkably similar (0.6 to 1.1), and suggest that none of the elements capture the attention of the respondent and engage the respondent.

It may well be that the respondents read the information, but do not have a mental model or image of what cultured meat actually is. Thus, the respondents may read the vignettes in a mechanical way, without engagement.

Total Panel		TOP3	BOT3	RT
B2	Artificial and full of chemicals	**16**	9	0.8
B4	Produced using latest advanced technology	**16**	7	0.9
B3	Healthier ingredients than real meat	**15**	11	0.9
B1	Suspicious of ingredients	14	8	1.1
C1	It should have the same taste as regular meat	13	9	0.8
D3	Should be added to soups, bigger pieces	12	3	0.6
D1	Should be added to sauces, ground	11	5	0.8
D4	Should be built up on bones, drumsticks	11	7	0.9
A3	Cultured meat is safe	11	8	0.6
C3	Will never taste as premium meat	11	10	0.7
C4	Won't be able to differentiate from traditional meat	10	7	0.7
A1	Cultured meat is sustainable	10	6	0.8
A2	Cultured meat is less sustainable	10	11	0.6
C2	No problem if it tastes a bit differently	10	8	0.7
D2	Should be formed as meat slices, hamburger patty	9	5	0.7
A4	Cultured meat reduces animal cruelty	8	10	0.9

Table 2: Coefficients for the three equations relating the presence/absence of the 16 elements to TOP3 (Agree), BOT3 (Disagree), and RT (response time). Data from the Total Panel. The equations are estimated without an additive constant. The coefficients are sorted in descending or by TOP3.

We get a better sense of the lack of a concept about cultured mean by computing the difference between coefficients for A1 and A2 (cultured meat is sustainable vs. cultured meat is not sustainable), and computing the difference for B2 and B3 (Artificial and full of chemicals vs. Healthier ingredients than real meat). Recall that each respondent generated a single model (without an additive coefficient) relating the presence/absence of the element to the TOP3 rating. We create two new variables (Coefficient A1-Coefficient A2; Coefficient B2-Coefficient B3).

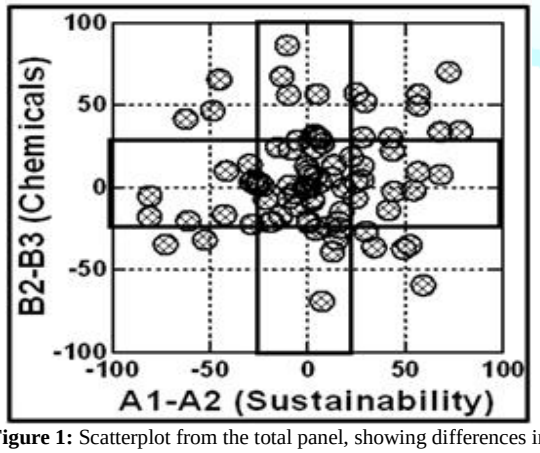

Figure 1: Scatterplot from the total panel, showing differences in the values of the coefficients for mutually contradictory elements. Each circle corresponds to a respondent. Individuals close to the 0 coordinate, whether X, Y or both, are individuals who do not have a clear concept of cultured meat.

We have 100 of these pairs, one pair for each respondent. **Figure 1** shows a scatterplot of the differences, with the abscissa corresponding to (Coefficient A1-Coefficient A2), and the ordinary corresponding to (Coefficient B2-Coefficient B3). Each circle corresponds to one respondent. Differences around 0 suggest lack of a concept about cultured meat, either for ingredient (abscissa) or sustainability (ordinate).

Figure 1 shows many respondents clustering around the center, where both A1 and A2 are similar, and/or B2 and B3 are similar. The location of the individual respondents around 0 in one or both axes suggest that the individual respondents agree with mutually contradictory phrases, and thus do not understand the concept of cultured meat, at least in a way which leads them to form an opinion of what it is, and what it is not

Emergent Mind-Sets

A major contribution of Mind Genomics is its ability to reveal new to the world groups of people who think alike, so-called mind-sets. Mind-sets are defined by similar patterns of coefficients in the models relating the presence/absence of elements to the key response, in this study TOP3, agree. The creation of mind-sets is done using clustering programs with the clustering algorithm assigning each respondent, in turn, to one of a small number of clusters or groups, based upon an 'objective' statistical criterion [16].

The criterion for this study is the minimization of the quantity 'D' defined as D= (1-Pearson Correlation). The Pearson correlation, R, measures the strength of a linear relation between two individuals or objects, based upon a set of measures. A perfect linear relation generates a Pearson R of 1, so that D, the distance between two people, is 0 (1-1=0). A perfect inverse relation between two people generates a Pearson R of -1, so the distance between two people is 2.

One of the benefits of uncovering mind-sets is its ability to unpack 'flat data' from the total panel; coefficients which are fairly low for the total panel, but which show dramatically different values by mind-set. In most mind genomics studies, the mind-sets reveal dramatically different groups of respondents. The interpretation of the mind-sets is simple. For cultured meat, however, the mind-sets are less clear, indeed quite fuzzy, with each mind-set comprising messages of two different types. This again is a good indication that the clarity of the cultured meat concept is modest, at best **(Table 3)**.

Mind-Set 1: Focus on ingredients and on product form. They agree with the two aspects of chemicals and ingredients, viz., being healthier, and yet being artificial and suspicious of that artificiality. We again see evidence that respondents in Mind-Set 1 they are confused about what cultured meat really is, but they know it involves chemicals.

Mind-Set 2: Focus on sustainability and ingredients. They again do not know what cultured meat really is, agree with both sustainability and non-sustainability, as well as healthier ingredients versus suspicious of ingredients, respectively. Again, we see a group of respondents who do not know what cultured meat really is, at least based on their ratings.

Mind-Set 3: Focus on ethical/social issues, and on product form. They agree with the mutually contradictory statements of sustainability and non-sustainability.

We again see the lack of understanding by plotting the differences between A1 and A2, and between B2 and B3. The scatterplots for the three mind-sets appear in **(Figure 2)**. The two intersecting rectangles, forming a cross, encompass the region where the respondent generates approximately the same coefficients for A1 and A2 and or B2 and B3. The cross encompasses many of the respondents, who generate the same coefficients for mutually contradictory elements, either for sustainability (A1-A2) or

chemicals (B2-B3), respectively. Mind-Set 3 (Focus on ethical/social issues, and on product form) shows the highest proportion of those who show similar coefficients, and thus have the poorest mental conception of what cultured meat really is.

TOP3=Agree		MS1	MS2	MS
Mind-Set 1: Focus on ingredients and on product form				
B2	Artificial and full of chemicals	**24**	**17**	2
B3	Healthier ingredients than real meat	**22**	**16**	3
B1	Suspicious of ingredients	**21**	**15**	0
B4	Produced using latest advanced technology	**20**	**21**	-1
D3	Should be added to soups, bigger pieces	**18**	3	**20**
D4	Should be built up on bones, drumsticks	**18**	2	**16**
D1	Should be added to sauces, ground	**16**	1	**22**
D2	Should be formed as meat slices, hamburger patty	**15**	-5	**22**
Mind-Set 2: Focus on sustainability and ingredients				
B4	Produced using latest advanced technology	**20**	**21**	-1
B2	Artificial and full of chemicals	**24**	**17**	2
A3	Cultured meat is safe	0	**16**	**19**
A2	Cultured meat is less sustainable	-6	**16**	**26**
B3	Healthier ingredients than real meat	**22**	**16**	3
A1	Cultured meat is sustainable	-5	**15**	**26**
B1	Suspicious of ingredients	**21**	**15**	0
Mind-Set 3: Focus on ethical/social issues, and on product form				
A2	Cultured meat is less sustainable	-6	**16**	**26**
A1	Cultured meat is sustainable	-5	**15**	**26**
C1	It should have the same taste as regular meat	10	11	**24**
A4	Cultured meat reduces animal cruelty	-6	11	**22**
D1	Should be added to sauces, ground	**16**	1	**22**
D2	Should be formed as meat slices, hamburger patty	**15**	-5	**22**
D3	Should be added to soups, bigger pieces	**18**	3	**20**
A3	Cultured meat is safe	0	**16**	**19**
C4	Won't be able to differentiate from traditional meat	5	11	**18**
D4	Should be built up on bones, drumsticks	**18**	2	**16**
Elements which do not drive strong agreement for any mind-set				
C3	Will never taste as premium meat	6	14	11
C2	No problem if it tastes a bit differently	11	10	9

Table 3: Coefficients for the mind-sets relating the presence/absence of the 16 elements to TOP3 (Agree) the equations are estimated without an additive constant. The coefficients are sorted in descending order by mind-set, and show the lack of clarity about the concept of cultured meat.

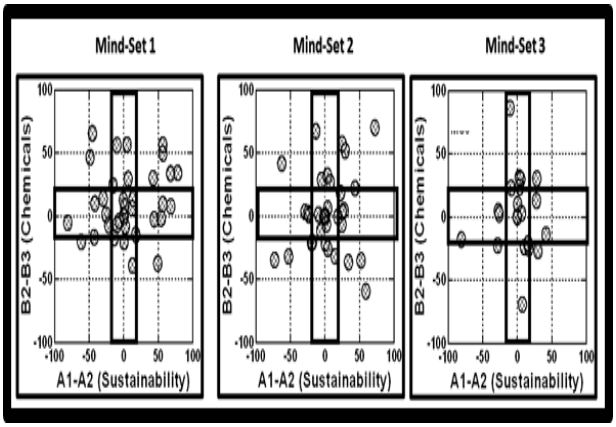

Figure 2: Scatterplots from the three mind-sets, showing differences in the values of the coefficients for mutually contradictory elements. Each circle corresponds to a respondent. Individuals close to the 0 coordinate, whether X, Y or both, are individuals who do not have a clear concept of the nature of cultured meat.

When the metric is the coefficient for disagree with the statement (BOT3), the same issues arise, but not as clearly **(see Table 4)**. The models with 1-3 recoded as 100, and 4-9 recoded as 0, again confirm a lack of understanding of the concept on the part of the three mind-sets when it comes to chemicals (B2 and B3 achieving similar coefficients, B2. We will relax the criteria for importance, and thus include coefficients of +10 or higher for 'disagree', rather than the value +15 or higher for 'agree' in that was highlighted in Table 3, above.

Mind-Set 1: Focus on ingredients and on product form-shows a variety of statements with which the respondents disagree, but there is clearly no pattern.
Mind-Set 2: Focus on sustainability and ingredients: Disagree equally with both statements about chemicals (B2 and B3)-also shows a variety of statements which seems to be almost random, with no clear pattern.
Mind-Set 3: Focus on ethical/social issues, and on product form: Disagree equally with both statements about chemicals (B2 and B3)-disagrees with statements about ingredients, but no clear pattern.

Distribution of Mind-Sets in the Population

Table 6 shows the distribution of respondents in the three mind-sets by total, state, gender, age, respectively. At the surface level there is no clear association between who a person IS and the mind-set of the person **(Table 6)**. When researchers work with different groups of people, the best practices prescribe that the respondent population be described by who the person IS, by what the person does, and by what the person believes, at least in a macro sense. Except in the unusual of circumstances it is difficult to pigeonhole a person into a mind-set by the first two, is and does. Simply knowing a person's general geo-demographic characteristics does not predict the mind of the person. Nor, in fact does behavior predict the mind. We may all do the same thing, albeit for different reasons. Finally, how a person thinks about general topics (Example- nutrition, sustainability, cruelty to animals) does not suffice to predict how a person will respond to granular, more specific information. A person may want to sustain the earth but shudder at the thought of cultured meat from a test tube.

Discussion and Conclusions

Previous studies with Mind Genomics going back up to two decades suggest that it is straightforward to uncover the way people make decisions about many topics, ranging from food to politics to ethics and the law, medicine, and so forth [14]. The results from mixing

BOT3=Disagree		MS1	MS2	MS3
Mind-Set 1: Focus on ingredients and on product form				
A2	Cultured meat is less sustainable	**19**	7	7
C3	Will never taste as premium meat	**13**	**10**	7
A4	Cultured meat reduces animal cruelty	**12**	**10**	6
C1	It should have the same taste as regular meat	**10**	**15**	-1
A3	Cultured meat is safe	**10**	**11**	2
Mind-Set 2: Focus on sustainability and ingredients				
C1	It should have the same taste as regular meat	**10**	**15**	-1
B3	Healthier ingredients than real meat	7	**12**	**16**
C2	No problem if it tastes a bit differently	7	**12**	3
B2	Artificial and full of chemicals	5	**11**	**13**
A3	Cultured meat is safe	**10**	**11**	2
D1	Should be added to sauces, ground	4	**10**	0
C3	Will never taste as premium meat	**13**	**10**	7
A4	Cultured meat reduces animal cruelty	**12**	**10**	6
Mind-Set 3: Focus on ethical/social issues, and on product form				
B3	Healthier ingredients than real meat	7	**12**	**16**
B4	Produced using latest advanced technology	7	3	**14**
B2	Artificial and full of chemicals	5	**11**	**13**
B1	Suspicious of ingredients	5	9	**13**
Elements which do not drive strong agreement for any mind-set				
D4	Should be built up on bones, drumsticks	5	6	9
D3	Should be added to soups, bigger pieces	1	4	4
A1	Cultured meat is sustainable	9	6	3
D2	Should be formed as meat slices, hamburger patty	4	8	0
C4	Won't be able to differentiate from traditional meat	9	8	0

Table 4: Coefficients for the mind-sets relating the presence/absence of the 16 elements to BOT3 (Disagree) the equations are estimated without an additive constant. The shaded cells with bold numbers are those elements driving a modest to strong disagreement, as shown by the coefficient for BOT3. The coefficients are sorted in descending order by mind-set, and show the lack of clarity about the concept of cultured meat.

together ideas by experimental design, presenting these to respondents, and deconstructing the ratings into the part-worth contributions of the different elements, the different components, are generally consistent and enlightening.

In the light of the extensive, almost three-decade period of use of mind genomics in both scientific and business applications, one would assume that the approach would work when the topic is a new technology, cultured meat. There is, after all, a parallel world called plant-based meat, instantiated by companies such as Impossible Foods, Inc., and beyond meat, Inc.

These plant-based meats have achieved an increasing degree of success over the past several years, and used by consumers who buy the product frozen to prepare at home, or who have hamburgers at quick serve restaurants.

The reason for the failure of mind genomics to map out the concept of cultured meat may well be traced to the fact that although the scientific notion of *in vitro* cultivation is known widely in the scientific community, the term 'cultured meat' does not resonate

Response Time (Seconds)		MS1	MS2	MS3
Mind-Set 1: Focus on ingredients and on product form				
B4	Produced using latest advanced technology	**1.0**	0.6	0.9
Mind-Set 2: Focus on sustainability and ingredients				
D4	Should be built up on bones, drumsticks	0.7	**1.5**	0.4
B1	Suspicious of ingredients	0.9	**1.3**	0.9
D1	Should be added to sauces, ground	0.5	**1.3**	0.5
A4	Cultured meat reduces animal cruelty	0.8	**1.1**	0.6
B3	Healthier ingredients than real meat	0.6	**1**	0.9
A1	Cultured meat is sustainable	0.7	**1.0**	0.6
Mind-Set 3: Focus ethical/ social issues, and product form				
C1	It should have the same taste as regular meat	0.5	0.9	**1.1**
C2	No problem if it tastes a bit differently	0.6	0.7	**1.1**
Elements which do not show long response times (1.0 seconds or longer)				
C3	Will never taste as premium meat	0.5	0.8	0.8
C4	Won't be able to differentiate from traditional meat	0.6	0.8	0.7
B2	Artificial and full of chemicals	0.9	0.8	0.7
D2	Should be formed as meat slices, hamburger patty	0.8	0.8	0.5
A2	Cultured meat is less sustainable	0.5	0.8	0.4
A3	Cultured meat is safe	0.6	0.7	0.4
D3	Should be added to soups, bigger pieces	0.7	0.8	0.2

Table 5: Coefficients for the mind-sets relating the presence/absence of the 16 elements to Response Time (RT). The equations are estimated without an additive constant. The shaded cells with bold numbers are those elements driving longer engagement with the message, as inferred by a longer response time. The coefficients are sorted in descending order by mind-set, and show the lack of clarity about what types of messages about cultured meat engage the respondent.

Total		Mind-Set 1: Focus on ingredients and on product form	Mind-Set 2: Focus on sustainability and ingredients	Mind-Set 3: Focus ethical/ social issues and product form
Total	100	37	40	23
California	50	20	20	10
New York	50	17	20	13
Male	49	18	21	10
Female	51	19	19	13
Age 17-29	51	20	18	13
Age 30-59	49	17	22	10

Table 6: Distribution of the mind-sets in the population of 100 respondents.

with consumers. It may be that they associated it with other food items that have the word 'cultured' in their names, such as 'cultured' milk, used for buttermilk or kefir, milk whose composition is changed by bacterial cultures. The problem may thus be traceable to the unfortunate use of a scientific term, cultured, associated with probiotics, rather than some other name. Certainly, the notion of 'cultured' meat is not easy to explain, and nowhere as evocative as the apparently less-used but more realistic name 'test-tube meat.'

This is a first, exploratory study of the topic of cultured meat. It may be instructive to repeat this study once a year over the next decade to map out the change, and possible the emerge of the concept of cultured meat as the technology matures, and as products created by culturing meat cells *in vitro* enter the market and achieve commercial success.

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