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*Published in:*
Public Understanding of Science

*DOI:*
10.1177/09636625221114608

*Publication date:*
2022

*Licence:*
Other

*Document Version*
Peer reviewed version

# Heterogeneous Attitudinal Profiles Towards Gene Editing: Evidence From Latent Class Analysis

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**Author-accepted manuscript of the final paper accepted in**

**PUBLIC UNDERSTANDING OF SCIENCE**

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## Abstract

Advances in gene editing technology have important implications for the treatment and prevention of disease. Accordingly, it is important to understand public perceptions towards gene editing, as the public's willingness to endorse gene editing may be as important as technological breakthroughs themselves. Previous research has almost exclusively examined attitudes towards gene editing on specific issues, but hasn't addressed how attitudes towards gene editing across a range of issues coalesce in individuals: i.e. the degree to which discrete, heterogeneous attitudinal profiles exist vs a simple support/oppose continuum. Here we addressed this issue using latent class analysis on data from The Pew Research Center (N = 4726; US residents) across a wide range of gene editing topics. We found that attitudes towards gene editing cohere into 10 distinct latent classes that showed some evidence of a support/oppose continuum, but also for clear qualitative differences between each class, even with support or oppose classes, on a number of issues. The most opposed classes significantly differed from the supporter classes in age, sex, political ideology, and self-rated knowledge. These findings provide evidence that attitudes towards gene editing are heterogeneous and public discourse, as well as policy making need to consider a range of arguments when evaluating this technology.

## Introduction

Advances in molecular biology in recent years have meant that DNA can be sequenced at low cost and precise changes to a given DNA sequence can be performed (Feng et al., 2018; Gilles and Averof, 2014; Oude Blenke et al., 2016). For example, gene-editing techniques, such as CRISPR-Cas9, allow silencing of particular genes or introducing new genes. Such technologies have shown important benefits – not least the capability of treating a variety of genetic disorders and diseases (Gilles and Averof, 2014).

However, the use of this novel technology is met with a range of ethical and philosophical concerns well-documented in academic discourse (de Araujo, 2017; Howell et al., 2020; Vogel and Ouagrham-Gormley, 2018), it remains under-researched which attitudes toward this technology are held by the public and how they may influence public discourse and policy. Research on gene editing attitudes has noted several themes. Firstly, gene editing is often seen as immoral, unnatural, or humans 'playing god' (Robillard et al., 2014; Xiang et al., 2015). People also often show trepidation about the use of gene editing in babies (compared to adults) (Delhove et al., 2020; Uchiyama et al., 2018). There is also concern surrounding whether gene editing will be used for medical purposes (e.g. curing or preventing disease) or for enhancement purposes (e.g. giving a person greater intelligence or strength) (Critchley et al., 2019; Delhove et al., 2020; McCaughey et al., 2016; Scheufele et al., 2017). Finally, people are often worried regarding the impact gene editing will have on society, such as creating inequality or access to such technologies being limited to the wealthy (Robillard et al., 2014; Xiang et al., 2015). Building from these observations, recent work has indicated that gene editing attitudes – at least across themes such as enhancement of physical and cognitive abilities, the treatment of physical and cognitive illnesses, and whether the target of gene editing is a baby or adult– can be described fairly well by two (moderately correlated) latent factors representing ‘treatment’ and ‘enhancement’ (Halstead & Lewis, 2020).

While a representation of attitudes towards gene editing on two dimensions allows for a relative and quantitative comparison across individuals (i.e. whether attitudes are held more or less strongly), it does not speak to the question of how attitudes towards a range of gene editing topics cohere within individuals. For example, there may be people who are opposed to gene editing across the board. But people could also be opposed in general terms, but while not feeling that gene editing is morally unacceptable or 'playing God', they could instead be concerned specifically about the impacts on social equality. Qualitatively discrete classes of attitudes have been seen across a range of socio-political attitudes research (e.g. Feldman & Johnston, 2014; Lewis & de-Wit, 2019). Understanding how gene editing attitudes cohere as well as what predicts membership of these classes (e.g. gender, education, religiosity) provides an important window into the structure of these attitudes not revealed by more traditional, variable-centred approaches such as factor analysis (Halstead and Lewis, 2020) or the investigation of associations with individual topics (Critchley et al., 2019).

This implies that attitudes towards gene editing are unlikely to be comprehensively assessable through single questions or topics. An attitude is an evaluative tendency toward an entity and this tendency is composed of one’s beliefs about the entity (e.g., gene editing is something), one's affect associated with the entity (e.g., feelings associated gene editing), and recollections of past behaviours or interactions with the entity (in this case it is more likely past discussions about and portrayals of this entity, as personal experience is less likely) (Richardson et al., 2020). When investigating attitudes towards "gene editing", which comprises many techniques, and may be applied in a range of contexts and for a range of reasons, it seems relevant to cover a range of topics covering varied areas of attitude formation as well as options to indicate beliefs and feelings.

Here we exploited the opportunity offered by the American Trends Panel Survey that in its 15th wave covered a broad range of aspects around the topic of gene editing, such as its

moral acceptability, consequences for society, and affective response to the technology. We use latent class analysis (LCA), which allows one to formally examine whether specific subsets of attitudes coalesce within groups of individuals. As such, one is able to discern if attitude coherence on a given topic reflect discrete 'types', or classes. The use of LCA also allows an examination of whether membership of these discrete latent classes differ on candidate predictor socio-demographic variables. For example, political conservatism and religiosity have been shown to predict opposition towards gene editing (Weisberg et al., 2017; Critchley et al., 2019; Delhove et al., 2020). And those who self-report higher levels of gene editing knowledge are more likely to support the use of such technology (Cebesoy and Öztekin, 2016; Črne-Hladnik et al., 2012). But it remains unknown whether these candidate predictors show links to gene editing attitudes across attitudes all/most latent classes of opposers vs supporters, or only to specific latent classes.

## Methods

### Participants

The data used in the current study was collected by The Pew Research Center as part of Wave 15 (between the 2nd and 28th of March, 2016) of the American Trends Panel, using a combination of online and mail questionnaires with US residents. The full panel consists of 8,314 respondents of which 4,726 took part in Wave 15 (4,243 in web-based interviews and 483 in mail-based interviews). Of the sample, 49.4% identified as male and 80% as White (8.7% Black, 2.5% Asian, 3.5% Mixed race and the rest identifying as Other or Don't Know). The modal age category was 50-64 years old (31.5%; Pew provided data on age bucketed into 4 categories; see details below). This data set is available to download from the Pew Research Centre (https://www.pewresearch.org/science/datasets/).

## Measures

Participants were given the following passage of information before responding to the gene editing questions: *New developments in genetics and gene-editing techniques are making it possible to treat some diseases and conditions by modifying a person's genes. In the future, gene-editing techniques could be used for any newborn, by changing the DNA of the embryo before it is born, and giving that baby a much reduced risk of serious diseases and conditions over his or her lifetime. Any changes to a baby's genetic make-up could be passed on to future generations if they later have children, and over the long term this could change the genetic characteristics of the population*.

### *Subjective gene editing knowledge*

Subjective gene editing knowledge was measured using the following question: *How much have you heard or read about this idea before today?* The response options ranged from: 1 = *A lot*, 2 = *A little*, 3 = *Not at all*. These responses were recoded so that a higher score represented a greater level of self-rated gene editing knowledge.

### *Gene editing attitude selection*

This dataset contained a range of gene editing variables. Given our specific focus here on gene editing attitudes (i.e. an evaluative tendency toward an entity: (Richardson et al., 2020) we selected a sub-set of these items for the current analysis. These items are detailed in full in Table 1. Our question selections reflected the following themes: 1) Levels of excitement about gene editing; 2) Levels of worry about gene editing; 3) Beliefs regarding gene editing crossing a natural boundary; 4) Concerns about the consequences if gene editing was adopted; 5) Whether using gene editing to give babies a reduced risk of disease is morally wrong; 6) Whether the use of gene editing to give a person average/above average health is an appropriate use of technology.

***Demographics***

*Age*

Age was measured using the following question: *What is your age?* followed by a free-text response, which was then recoded (by Pew) into 4 categories – 1 = *18-29*, 2 = *30-49*, 3 = *50-64*, 4 = *65+*.

*Education*

Education was measured using the following question: *What is the highest degree or level of school that you have COMPLETED?* The response options ranged from: *No schooling completed* to *Doctorate degree*, which was then recoded into 3 categories: 1= *High school or less*, 2= *Associates degree or equivalent*, 3= *College graduate or higher*.

*Income*

Income was measured using the following question: *Last year, that is in 2015, what was your total family income from all sources, before taxes?* The response options ranged from: 1= *Less than $10,000*, 2= *$10,000 to less than $20,000*, 3= *$20,000 to less than $30,000*, 4= *$30,000 to less than $40,000*, 5= *$40,000 to less than $50,000*, 6= *$50,000 to less than $75,000*, 7= *$75,000 to less than $100,000*, 8= *$100,000 to less than $150,000*, 9= *$150,000 or more*.

*Race*

Race was measured using the following question: *Which of the following describes your race?* The response options ranged from 1= *White*, 2= *Black or African American*, 3= *Asian or Asian American*, 4= *Mixed Race*, 5= *Or some other race*, and 6= *Don't know/Refuse to answer*.

*Religiosity*

Religiosity was measured using the following question: *Aside from weddings and funerals, how often do you attend religious services?* The response options ranged from 1 = *More than once a week* to 6= *Never*. These responses were reverse coded so that a higher score represented a higher level of religiosity.

*Political ideology*

Political ideology was measured using the following question: *In general, would you describe your political views as…* The response options ranged from 1= *Very Conservative* to 5 = *Very Liberal*. A higher score represented a higher level of political liberalism. Participants were also asked *In politics today, do you consider yourself a…* The response options ranged from 1 = *Republican*, 2 = *Democrat*, 3 = *Independent*, 4 = *Something else*, and 5 = *Refuse to answer*.

**Table 1.** Questions selected for analysis.

| Prompt | Question | Response options | Valid percent (N) |
|---|---|---|---|
| Thinking about the possibility of this gene-editing giving HEALTHY babies a much reduced risk of serious diseases and conditions… | How ENTHUSIASTIC are you, if at all, about this possibility for society as a whole? | ▪ Very enthusiastic | 14.3 (677) |
| | | ▪ Somewhat enthusiastic | 36.9 (1746) |
| | | ▪ Not too enthusiastic | 30.6 (1445) |
| | | ▪ Not at all enthusiastic | 17 (803) |
| | | ▪ Don't know/Refuse to answer | 1.2 (55) |
| | How WORRIED are you, if at all, about this possibility for society as a whole? | ▪ Very worried | 20.3 (960) |
| | | ▪ Somewhat worried | 48.9 (2313) |
| | | ▪ Not too worried | 23.6 (1117) |
| | | ▪ Not at all worried | 5.9 (280) |
| | | ▪ Don't know/Refuse to answer | 1.2 (56) |
| | Which of these statements comes closer to your view, even if neither is exactly right? | ▪ As humans, we are always trying to better ourselves and this idea is no different. | 53.8 (2543) |
| | | ▪ This idea is meddling with nature and crosses a line we should not cross. | 44.3 (2093) |
| | | ▪ Don't know/Refuse to answer | 1.9 (90) |
| If this gene-editing become available, giving HEALTHY babies a much reduced risk of serious diseases and conditions, do you think the following are likely or not likely to happen as a result? | People who have this gene-editing will be more productive at their jobs | ▪ Yes, likely | 32.5 (1538) |
| | | ▪ No, not likely | 64.5 (3047) |
| | | ▪ Don't know/Refuse to answer | 3 (141) |
| | People who have this gene-editing will feel superior to people who do not | ▪ Yes, likely | 55.8 (2638) |
| | | ▪ No, not likely | 41.6 (1964) |
| | | ▪ Don't know/Refuse to answer | 2.6 (124) |
| | People who have this gene-editing will feel more confident and better about themselves | ▪ Yes, likely | 54.6 (2580) |
| | | ▪ No, not likely | 42.6 (2012) |
| | | ▪ Don't know/Refuse to answer | 2.8 (134) |
| | Widespread use of this option will lead to new innovation and problem-solving in society | ▪ Yes, likely | 45.7 (2161) |
| | | ▪ No, not likely | 51.5 (2435) |
| | | ▪ Don't know/Refuse to answer | 2.8 (130) |
| | Do you think using this gene-editing giving HEALTHY babies a much reduced risk of serious diseases and conditions is… | ▪ Morally acceptable | 32.6 (1543) |
| | | ▪ Morally UNacceptable | 29.4 (1389) |
| | | ▪ Not sure | 36.8 (1738) |
| | | ▪ Don't know/Refuse to answer | 1.2 (56) |
| Would you say this is an appropriate use of technology or taking technology too far if the effects were such that those who had this gene-editing were… | Always EQUALLY HEALTHY as the average person today | ▪ An appropriate use of technology | 58.4 (2759) |
| | | ▪ Taking technology too far | 38.8 (1836) |
| | | ▪ Don't know/Refuse to answer | 2.8 (131) |
| | MUCH HEALTHIER than the average person today | ▪ An appropriate use of technology | 53.7 (2536) |
| | | ▪ Taking technology too far | 43.1 (2035) |
| | | ▪ Don't know/Refuse to answer | 3.3 (155) |

## Analysis

*Latent class analysis*

The latent class analysis was carried out using R (R Core Team, 2016) and the poLCA package (Linzer and Lewis, 2011). Our criteria for model selection was based upon the Bayesian Information Criteria (Nylund et al., 2007), the entropy values for each class, and the interpretability of each class extraction (Marsh et al., 2009; Meeus et al., 2011; Schreiber, 2017). LCA was seen as particularly suited to investigate the overarching structure of an "attitude towards gene editing". LCA assumes a categorical trait that causally determines the responses to the attitude items. But in contrast to other available methods, it does not assume that the indicators themselves are interval-scaled, nor does it assume that the latent trait is a single underlying quantitative dimension (or set of dimensions) on which quantitative differences are characterised. Nevertheless, the resulting classes can be ordered (hinting at quantitative inter-class differences) or they can be heterogeneous patterns including ambivalent attitudes towards the gene editing. Therefore, the model matches our theoretical intention of measuring a latent variable through a set of manifest indicators, while offering flexibility in indicator scaling and shape of the results.

*Multinomial logistic regression*

We first assigned participants a class based on their highest membership probability. Next, the multinomial logistic regression was conducted (*nnet* package; Venables et al., 2002), using class membership as the dependent variable (in line with Bakk & Kuha, 2021), using Class 8 as the reference class as it was the class most opposed to gene editing. This was done to examine if there were significant differences in the demographic variables of each of the classes, and whether these differences predicted an increased level of support for gene editing.

## Results

Summary statistics are presented in Table 2. Our sample was predominantly older, politically liberal leaning, with relatively low levels of education. They had low levels of religiosity and had "a little" pre-existing self-rated knowledge about gene editing.

**Table 2.** Descriptive statistics for the complete sample.

| Variable | Response options | Valid percent (N) |
|---|---|---|
| Age | 18-29 | 12.9 (608) |
| | 30-49 | 28 (1322) |
| | 50-64 | 31.6 (1492) |
| | 65+ | 27.5 (1300) |
| | Missing | 0.1 (4) |
| Education | Highschool or less | 18.3 (865) |
| | Associates degree or equivalent | 32.1 (1518) |
| | College graduate or higher | 49.6 (2343) |
| | Missing | 0 (0) |
| Political party | Republican | 27.6 (1285) |
| | Democrat | 36.1 (1682) |
| | Independent | 26.9 (1253) |
| | Something else | 8.5 (396) |
| | Refuse to answer | 1.0 (46) |
| | Missing | 1.4 (64) |
| Income | <$10 | 7.1 (328) |
| | $10-20 | 8.6 (397) |
| | $20-30 | 9.2 (428) |
| | $30-40 | 9.8 (454) |
| | $40-50 | 9.1 (420) |
| | $50-75 | 16.8 (779) |
| | $75-100 | 14.1 (655) |
| | $100-150 | 14.5 (671) |
| | $150> | 10.9 (508) |
| | Missing | 1.8 (86) |
| Religiosity (as measured by church attendance) | More than once a week | 19.8 (937) |
| | Once a week | 21.8 (1030) |
| | Once or twice a month | 15.7 (744) |
| | A few times a year | 9.4 (445) |
| | Seldom | 21.6 (1022) |
| | Never | 11.6 (547) |
| | Missing | 0.0 (1) |

| | | |
|---|---|---|
| Knowledge | A lot | 35.1 (524) |
| | A little | 53.7 (2511) |
| | Not at all | 11.2 (1644) |
| | Missing | 1.0 (47) |
| Political ideology | Mean (SD) | 1.1 (3) |
| | Missing | 0.3 (16) |

Note. Income reported in 1000's of USD. A higher score in political ideology represents a more liberal political ideology.

**Class discussion (organised from most supportive to least supportive)**

Table 4 presents the conditional response probabilities for the 10 latent classes, which were chosen as the optimal solution. In the following discussion we organise the classes as a rough continuum, from most supportive to least supportive, and highlight the notable differences in configuration of each class.

***Classes supportive towards gene editing***

Those in Class 1 are consistently supportive of gene editing. They are very likely to respond in a positive manner to most of the items, apart from whether gene editing will lead to people feeling superior, which they are divided on. We describe this class as 'Committed Futurists'.

Class 2 is similar to Class 1 across the bulk of the items; however, they are differentiated from Class 1 by virtue of being 'somewhat worried' of the technology (despite their enthusiasm) and being unsure of whether gene editing babies to increase their disease resistance is morally acceptable. We describe this class as 'Anxious Futurists'.

Class 3, again, is generally supportive, being very likely to respond positively to the majority of items. However, compared to classes 1 and 2, individuals in this class do not tend to think there will be societal implications with regards to productivity, superiority, confidence and innovation. We describe this class as 'Doubtful supporters'.

***Classes opposed to gene editing***

Class 4 is the first class to show a likelihood for responding with lower levels of enthusiasm as well as higher levels of worry. Nevertheless, they tend to not think that gene editing will have societal implications. And they think that the technology is appropriate for bettering ourselves. However, they tend to be unsure whether it is moral to use this technology on babies. We describe this class as 'Cautious Pragmatists'.

Class 5 is similar to Class 4 insomuch that the members show a likelihood for responding with lower levels of enthusiasm and higher levels of worry. In contrast, the members of this class tend to think gene editing is unnatural and using it to better ourselves is not appropriate. But they feel that societal implications - i.e. increases in productivity, perceptions of superiority, confidence, and innovation - are likely. And like Class 4 they also tend to be unsure whether it is moral to use this technology on babies. We describe this class as 'Cautious Moralists'.

Class 6 is the first class where we see a high likelihood of negative sentiment across the items. Members of this class are likely to be unenthusiastic and worried about the use of gene editing, to think that it is taking technology too far, and to not feel it will have societal implications. We describe this class as 'Moderate Opposers', due to their more muted opposition compared to the following 2 classes.

Class 7 is a near-mirror of Class 6, except members of this class show a likelihood to report that there will be societal implications with respect to people who have had gene editing feeling superior and more confident. We describe this class as 'Social Justice Opposers'.

Class 8 is the mirror opposite of Class 1, being opposed/negative to all of the items. We describe this class as 'Outright opposers', as they believe all negative consequences of gene editing are likely, and they have the strongest negative affect towards the technology.

**Don't know/Unsure classes**

Class 9 expressed a lack of enthusiasm and a degree of worry regarding gene editing, as well as a belief that gene editing was meddling with nature and its use was taking technology too far. Other than these responses, they were generally unsure or did not know how to respond. We describe this class as 'Cautiously Uncertain'.

Class 10 consistently either refused to answer, or indicated they did not know how to respond. Whether this was from genuinely not knowing about the topic, or not wanting to complete these questions is unclear. Due to this ambiguity, caution should be exhibited in making inferences based on this class's response patterns. We describe this class as 'Ambiguously Uncertain'.

**Table 3. Descriptions of the 10 latent classes.**

| Class | Description |
|---|---|
| **1 – Committed Futurists** | **Positive sentiments expressed across all items.** |
| **2 – Anxious Futurists** | **Generally positive sentiments, but a degree of worry regarding gene editing and an uncertainty of its appropriateness for use in babies.** |
| **3 – Doubtful Supporters** | **Generally positive sentiments, but are doubtful of the positive societal consequences of the technology.** |
| **4 – Cautious Pragmatists** | **Higher levels of worry than enthusiasm, doubtful of societal consequences, and unsure of the morality of gene editing babies.** |
| **5 – Cautious Moralists** | **Higher levels of worry than enthusiasm, combined with a belief that gene editing is unnatural and using it to better ourselves is not appropriate.** |
| **6 – Moderate Opposers** | **High levels of negative sentiment across all items, but less pronounced than Classes 7 and 8.** |
| **7 – Social Justice Opposers** | **High levels of negative sentiment across all items, but also believe that gene editing will lead to those who use it feeling more confident, and superior to those that do not.** |
| **8 – Outright opposers** | **The polar opposite of Class 1, they express strongly negative sentiments across all items.** |
| **9 - Cautiously Uncertain** | **Moderate levels of worry regarding gene editing. However, they were most likely to indicate they were unsure or did not know across most items.** |

**10 - Ambiguously Uncertain** **They consistently chose to respond with don't know, or refused to answer.**

**Table 4.** Conditional probabilities for each class.

| | Class | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 - Committed Futurists | 2- Anxious Futurists | 3- Doubtful Supporters | 4- Cautious Pragmatists | 5- Cautious Moralists | 6- Moderate Opposers | 7- Social Justice Opposers | 8- Outright opposers | 9- Cautiously Uncertain | 10- Ambiguously Uncertain |
| Class Share | 8.4 | 17.9 | 14.3 | 8.7 | 15.7 | 10.8 | 11.4 | 9.2 | 2.6 | 0.8 |
| Average probability of class membership | 8.8 | 17.0 | 14.1 | 9.7 | 15.7 | 10.8 | 11.6 | 8.6 | 2.7 | 0.8 |
| How ENTHUSIASTIC are you, if at all, about this possibility for society as a whole? | | | | | | | | | | |
| Very enthusiastic | 0.82 | 0.12 | 0.25 | 0.03 | 0.06 | 0.02 | 0 | 0.01 | 0.04 | 0.03 |
| Somewhat enthusiastic | 0.15 | 0.77 | 0.64 | 0.42 | 0.38 | 0.16 | 0.05 | 0 | 0.27 | 0.05 |
| Not too enthusiastic | 0.01 | 0.1 | 0.1 | 0.5 | 0.43 | 0.77 | 0.42 | 0.11 | 0.42 | 0 |
| Not at all enthusiastic | 0.01 | 0 | 0 | 0.06 | 0.13 | 0.04 | 0.53 | 0.88 | 0.18 | 0.07 |
| Don't know/Refuse to answer | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0.09 | 0.85 |
| How WORRIED are you, if at all, about this possibility for society as a whole? | | | | | | | | | | |
| Very worried | 0.07 | 0.06 | 0.03 | 0.14 | 0.2 | 0.1 | 0.62 | 0.62 | 0.15 | 0 |
| Somewhat worried | 0.22 | 0.62 | 0.39 | 0.69 | 0.65 | 0.67 | 0.34 | 0.12 | 0.51 | 0.04 |
| Not too worried | 0.45 | 0.31 | 0.51 | 0.15 | 0.09 | 0.22 | 0.03 | 0.07 | 0.2 | 0 |
| Not at all worried | 0.26 | 0 | 0.07 | 0.02 | 0.04 | 0 | 0.01 | 0.19 | 0.05 | 0.09 |
| Don't know/Refuse to answer | 0 | 0 | 0 | 0 | 0.01 | 0 | 0 | 0 | 0.09 | 0.88 |
| Which of these statements comes closer to your view, even if neither is exactly right? | | | | | | | | | | |
| As humans, we are always trying to better ourselves and this idea is no different. | 0.99 | 0.94 | 0.99 | 0.55 | 0.31 | 0.17 | 0.02 | 0.07 | 0.26 | 0.04 |
| This idea is meddling with nature and crosses a line we should not cross. | 0.01 | 0.05 | 0 | 0.44 | 0.69 | 0.83 | 0.97 | 0.92 | 0.56 | 0.08 |
| Don't know/Refuse to answer | 0.01 | 0.01 | 0 | 0.01 | 0 | 0 | 0.01 | 0.01 | 0.18 | 0.88 |
| People who have this gene-editing will be more productive at their jobs | | | | | | | | | | |
| Yes, likely | 0.8 | 0.69 | 0.18 | 0.11 | 0.66 | 0.04 | 0.19 | 0.02 | 0.09 | 0 |
| No, not likely | 0.19 | 0.29 | 0.82 | 0.89 | 0.33 | 0.96 | 0.81 | 0.97 | 0.37 | 0 |
| Don't know/Refuse to answer | 0.01 | 0.02 | 0 | 0 | 0.01 | 0 | 0 | 0.01 | 0.54 | 1 |
| People who have this gene-editing will feel superior to people who do not | | | | | | | | | | |
| Yes, likely | 0.56 | 0.81 | 0.13 | 0.52 | 0.89 | 0.37 | 0.95 | 0.31 | 0.3 | 0.03 |
| No, not likely | 0.43 | 0.18 | 0.87 | 0.48 | 0.1 | 0.62 | 0.05 | 0.68 | 0.25 | 0 |
| Don't know/Refuse to answer | 0.01 | 0.01 | 0 | 0 | 0.01 | 0.01 | 0 | 0.01 | 0.46 | 0.97 |
| People who have this gene-editing will feel more confident and better about themselves | | | | | | | | | | |
| Yes, likely | 0.9 | 0.97 | 0.25 | 0.39 | 0.93 | 0.19 | 0.77 | 0 | 0.18 | 0 |
| No, not likely | 0.1 | 0.02 | 0.75 | 0.6 | 0.07 | 0.81 | 0.23 | 0.98 | 0.25 | 0 |
| Don't know/Refuse to answer | 0 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0.02 | 0.57 | 1 |
| Widespread use of this option will lead to new innovation and problem-solving in society | | | | | | | | | | |
| Yes, likely | 0.94 | 0.8 | 0.49 | 0.36 | 0.71 | 0.12 | 0.17 | 0.06 | 0.24 | 0 |
| No, not likely | 0.05 | 0.19 | 0.51 | 0.64 | 0.28 | 0.88 | 0.82 | 0.93 | 0.3 | 0 |
| Don't know/Refuse to answer | 0.01 | 0.01 | 0 | 0.01 | 0.01 | 0 | 0.01 | 0.02 | 0.46 | 1 |
| Do you think using this gene-editing giving HEALTHY babies a much reduced risk of serious diseases and conditions is… | | | | | | | | | | |
| Morally acceptable | 0.93 | 0.59 | 0.72 | 0.15 | 0.08 | 0.02 | 0.01 | 0.03 | 0.11 | 0 |
| Morally UNacceptable | 0.01 | 0.03 | 0.01 | 0.17 | 0.37 | 0.5 | 0.89 | 0.72 | 0.19 | 0.03 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Not sure | 0.06 | 0.38 | 0.27 | 0.68 | 0.55 | 0.47 | 0.1 | 0.24 | 0.57 | 0.09 |
| Don't know/Refuse to answer | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.12 | 0.88 |
| | | | | | | | | | | |
| Always EQUALLY HEALTHY as the average person today | | | | | | | | | | |
| An appropriate use of technology | 0.95 | 0.93 | 0.93 | 0.86 | 0.39 | 0.09 | 0.14 | 0.04 | 0.24 | 0 |
| Taking technology too far | 0.05 | 0.06 | 0.06 | 0.14 | 0.6 | 0.9 | 0.86 | 0.93 | 0.31 | 0.12 |
| Don't know/Refuse to answer | 0 | 0.01 | 0.01 | 0 | 0.01 | 0.01 | 0 | 0.02 | 0.44 | 0.88 |
| | | | | | | | | | | |
| MUCH HEALTHIER than the average person today | | | | | | | | | | |
| An appropriate use of technology | 0.96 | 0.92 | 0.9 | 0.76 | 0.3 | 0.03 | 0.07 | 0.03 | 0.23 | 0 |
| Taking technology too far | 0.03 | 0.07 | 0.09 | 0.23 | 0.68 | 0.97 | 0.93 | 0.94 | 0.26 | 0.1 |
| Don't know/Refuse to answer | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0 | 0.03 | 0.51 | 0.9 |

*Multinomial regression*

The multinomial regression analysis revealed several noteworthy differences when comparing our reference class (Class 8) to the rest of the classes. Firstly, being younger is significantly associated with being strongly opposed to gene editing (consistent across all classes, save Class 9). There was also a significant association between sex and class membership, with females being more likely to be in the strongly opposed classes compared to four more positive classes (Classes 1-3, 6). Higher levels of education were associated with being less opposed (Classes 2, 3, 5). Regarding political ideology, being more conservative was significantly associated with being in the strongly opposed classes. Higher self-rated knowledge and lower income were significantly associated with being in the most opposed class. Higher levels of religiosity were associated with being less likely to be a member of any of the more positive classes (1-5). Classes 9 and 10 were non-significantly different from the reference class across all demographic measures, barring Class 10 being significantly older and less knowledgeable regarding gene editing. For full details of the multinomial logistic regression, see Table 5.

**Table 5.** Multinomial regression with class 8 ('outright opposers') as the reference class (coefficients reported as odds ratios).

| | Classes | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 - Committed Futurists | | 2- Anxious Futurists | | 3- Doubtful Supporters | | 4- Cautious Pragmatists | | 5- Cautious Moralists | | 6- Moderate Opposers | | 7- Social Justice Opposers | | 9- Cautiously Uncertain | | 10- Ambiguously Uncertain | |
| **Variable** | **OR** | **95% CI** | **OR** | **95% CI** | **OR** | **95% CI** | **OR** | **95% CI** | **OR** | **95% CI** | **OR** | **95% CI** | **OR** | **95% CI** | **OR** | **95% CI** | **OR** | **95% CI** |
| **Age** | **1.64** | **1.42, 1.90** | **1.64** | **1.44, 1.85** | **1.37** | **1.20, 1.56** | **1.35** | **1.17, 1.56** | **1.13** | **1.00, 1.28** | **1.15** | **1.01, 1.32** | **1.2** | **1.05, 1.37** | 1.26 | 0.70, 2.25 | **1.99** | **1.58, 2.49** |
| **Sex** | **0.46** | **0.34, 0.62** | **0.55** | **0.43, 0.71** | **0.57** | **0.43, 0.74** | 1.17 | 0.87, 1.56 | 0.81 | 0.63, 1.05 | **0.73** | **0.56, 0.96** | 1.06 | 0.81, 1.38 | 1.77 | 0.46, 6.82 | 1.16 | 0.75, 1.79 |
| **Education** | 1.21 | 0.98, 1.51 | **1.21** | **1.01, 1.45** | **1.43** | **1.17, 1.74** | 0.97 | 0.79, 1.19 | **1.25** | **1.04, 1.50** | 1.04 | 0.86, 1.26 | 1.12 | 0.92, 1.35 | 0.62 | 0.26, 1.50 | 0.99 | 0.73, 1.35 |
| **Income** | 1.04 | 0.97, 1.11 | **1.07** | **1.01, 1.14** | **1.12** | **1.06, 1.19** | 0.99 | 0.93, 1.06 | **1.06** | **1.00, 1.13** | 1.05 | 0.99, 1.11 | **1.09** | **1.03, 1.16** | 0.85 | 0.63, 1.13 | 1.02 | 0.92, 1.13 |
| **Political ideology** | **1.71** | **1.48, 1.98** | **1.55** | **1.37, 1.76** | **1.57** | **1.37, 1.79** | **1.26** | **1.09, 1.45** | **1.36** | **1.20, 1.55** | **1.16** | **1.01, 1.32** | 0.97 | 0.85, 1.11 | 1 | 0.56, 1.78 | 1.23 | 1.00, 1.52 |
| **Knowledge** | **0.37** | **0.29, 0.47** | **0.47** | **0.38, 0.57** | **0.46** | **0.37, 0.57** | **0.65** | **0.51, 0.82** | **0.61** | **0.50, 0.76** | 0.86 | 0.69, 1.08 | **0.68** | **0.54, 0.85** | 0.84 | 0.31, 2.27 | **0.67** | **0.47, 0.95** |
| **Religiosity** | **0.73** | **0.67, 0.80** | **0.77** | **0.71, 0.83** | **0.72** | **0.67, 0.79** | **0.89** | **0.81, 0.97** | **0.88** | **0.81, 0.95** | 0.93 | 0.85, 1.01 | 0.96 | 0.88, 1.04 | 0.88 | 0.62, 1.25 | 0.88 | 0.78, 1.00 |

Note. Significant variables are in bold. All variance inflation factors below 2. Number of observations used for analysis = 4640.

## Discussion

The current study sought to understand the structure of attitudes toward gene editing. In particular, we focused on how sentiment on a range of gene editing issues coalesce *within* groups of individuals (i.e. latent classes), and to test some potential predictors of membership of these classes. We observed evidence for 10 latent classes. Broadly, these classes consist of three classes supportive of and five opposed to gene editing (with two additional small-sized classes that reflected a strong propensity to report majority 'don't know' responses). But importantly, we noted clear qualitative distinctions between classes on specific items, where the classes were otherwise highly similar. While the analysis with the available indicators clearly identifies a group of respondents that is largely in favour and cannot see drawbacks (Class 1, 9%) and three classes that are opposed under all circumstances (Classes 6 – 8, together 32%), the majority of respondents shows more mixed attitudes towards gene editing. The items about enthusiasm and worry mirror a wide range of between-class variability, while "As humans, we are always trying to better ourselves and this idea is no different", "equally healthy", and "much healthier" on the other hand lead to very clear distinctions, but conclusions based on these items alone would ignore the variability in classes 1-3 and 6-8.

For example, one of the opposing classes (Class 7) stood out from other opposer classes by virtue of a specific profile of belief that gene editing would lead to people feeling superior and more confident (but not that society would become more productive or innovative). We interpreted this as a class of people who are opposed to gene editing for social justice reasons: i.e. they view the technology as likely to create division/antipathy between those who can afford and those who can't. And while we saw two classes (Classes 4 & 5) with very similar profiles on enthusiasm and worry about the use of gene editing (both were moderately unenthusiastic and worried), Class 4 felt gene editing was just humanity bettering itself and not a moral issue, whereas Class 5 had clear moral concerns about the technology.

This finding of qualitatively distinct profiles of attitudes even *within* classes of supporters or opposers has implications for communication strategies to the public with regard to the introduction of gene editing. For example, one take home message is that moral concerns are not monolithic across opposers and supporters: some such individuals clearly opposed gene editing because of more instrumental concerns (Class 6). Conversely, some supporters expressed a degree of uncertainty regarding the morality of gene editing (Class 4). In turn, communicating to those who oppose or support may still be advised to address moral issues (e.g. via religious leaders, or scientists respectively, as has been the case with abortion and contraception); but for some opposers and supporters, other factors clearly play a more pronounced role.

We also saw interesting links between a range of socio-demographic variables and membership of gene editing classes. Those with higher self-rated genetics knowledge were more likely to be members of the oppositional groups, which is contrary to previous research that found self-rated knowledge was positively related to support for gene editing (Cebesoy and Öztekin, 2016; Črne-Hladnik et al., 2012). Conservatives, and those higher in religiosity were more likely to be members of oppositional groups, in line with previous findings (Critchley et al., 2019; Delhove et al., 2020; Hendriks et al., 2018; Scheufele et al., 2017). We also observed that women are more likely to be members of oppositional classes, a finding that aligns with several previous studies (Critchley et al., 2019; Delhove et al., 2020; Gaskell et al., 2017; Jedwab et al., 2020).

Given the rapid advances in gene editing technology in recent years, its broad number of applications, and potential reach in society, it is important to ensure that the public are able to form informed attitudes towards the technology. In the absence of information that addresses the concerns of the public from reliable sources, there is the possibility of misinformation shaping the adoption of a potentially life-saving technology (Jayaseelan et al., 2020; Patev and

Hood, 2021; Scheufele and Krause, 2019). The present study provides an insight into the current concerns of the general public, which allows educators to provide more relevant information and reduce the possibility of misinformation.

Divisions of opinion and groups of individuals that hold different configurations of attitudes towards gene editing may also have important consequences for future medical practice, for example in precision medicine applications (DuBois et al., 2021) and genetic counselling. Discussions of best practice in genetic counselling have highlighted the need for evidence based practices (Bowles Biesecker and Marteau, 1999) and how practice needs to change in response to the growing number of gene-based healthcare tools (Schupmann et al., 2020). Genetic counselling also makes use of a non-directive approach (i.e. providing information but not seeking to influence patients) (Arribas-Ayllon and Sarangi, 2014; Costal Tirado et al., 2017; Elwyn, 2000) and genetic counselling services should work with a people-centred philosophy (e.g., Costal Tirado et al., 2017). Studies such as ours are valuable since they explore concerns and attitudes towards the broader topic area (DuBois et al., 2021) and the methodology could be adopted to focus on practice-specific concerns..

Given that two of the key sources of division in opinion were the moral aspects of gene editing, and its consequences for society, these issues need to be discussed in literature intended to inform the public of gene editing technology. This would serve to better inform potential users of the technology on issues important to them, so they are better equipped to make an informed decision on whether they would want to use or support it. (Jasanoff et al., 2015; Ormond et al., 2019). The demographic information for each class also suggests ways to improve the way potential users are informed. For example, political ideology and religiosity appear to differentiate the supporter and oppositional classes. This suggests that sources of information need to be provided by representatives from across the political spectrum, as well as both secular and religious groups. This will ensure that potential users are able to trust the

information they receive, which is a significant factor in the evaluation of a technology (Braun and Meacham, 2019; Guttinger, 2018; Siegrist, 2000).

Some limitations of the current study are as follows. Firstly, the items used in our analyses refer to adults and babies interchangeably, which means we could not establish if the latent class structure was further differentiated across that important issue (Delhove et al., 2020). Secondly, whether gene editing constituted a treatment, or an enhancement was not specified in the item wordings, leaving participants to use their own interpretation (as discussed in Howell et al., 2020; So et al., 2017). Thirdly, given the high number of classes, it may be difficult to replicate the same class solution in other samples. Finally, these data were collected in 2016, and attitudes may have changed in the intervening time period in light of increasing knowledge and understanding (or misunderstanding) of gene editing technologies.

***Conclusion***

Our findings show that while attitudes towards gene editing can be organised roughly on a support/oppose continuum, there exist attitudinal coherence within both supporter and opposer classes such that it is clear that the reasons for supporting (or opposing) often reflect different combinations of beliefs. In addition, several demographic predictors, such as sex, political ideology, self-rated gene editing knowledge, and religiosity significantly differed between strongly opposed and supportive groups. Overall, these results help to deepen our understanding of the ways in which people support or oppose gene editing technology, and the factors that may shape these attitudes.

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**Heterogeneous Attitudinal Profiles Towards Gene Editing: Evidence From Latent Class Analysis**

**Isaac N. Halstead, Jan R. Boehnke, and Gary J. Lewis**

## Supplemental materials

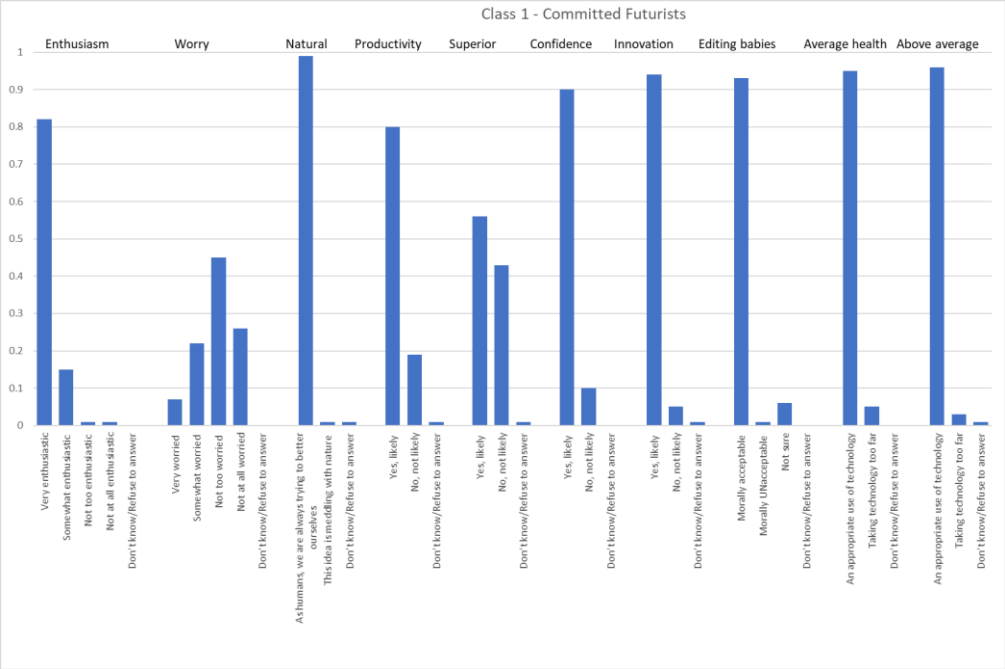
# Contents

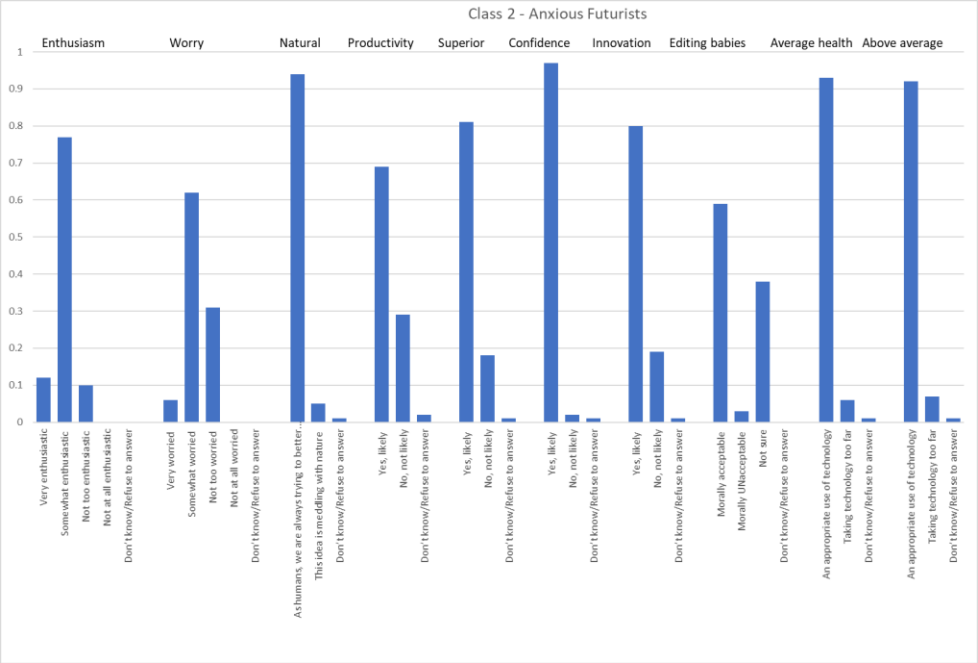
***Fit statistics for latent class model solutions.***

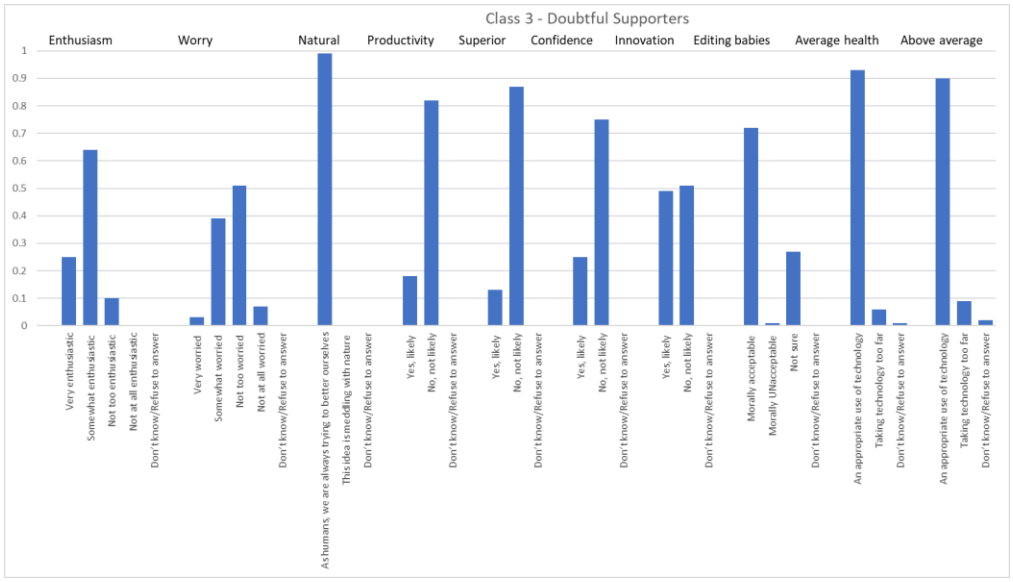
| Model | Log likelihood | Residual df | BIC | aBIC | cAIC | Likelihood ratio | Entropy |
|---|---|---|---|---|---|---|---|
| 1 | -43637.4 | 4701 | 87486.39 | 87406.95 | 87511.39 | 26218.03 | - |
| 2 | -37869.1 | 4675 | 76169.75 | 76007.69 | 76220.75 | 14681.41 | 0.89 |
| 3 | -36298.1 | 4649 | 73247.73 | 73003.06 | 73324.73 | 11539.42 | 0.901 |
| 4 | -35612 | 4623 | 72095.4 | 71768.1 | 72198.4 | 10167.1 | 0.805 |
| 5 | -35024.1 | 4597 | 71139.71 | 70729.8 | 71268.71 | 8991.431 | 0.795 |
| 6 | -34690.8 | 4571 | 70693.1 | 70200.57 | 70848.1 | 8324.839 | 0.778 |
| 7 | -34479.9 | 4545 | 70491.28 | 69916.13 | 70672.28 | 7903.036 | 0.777 |
| 8 | -34305.2 | 4519 | 70361.78 | 69704.01 | 70568.78 | 7553.55 | 0.779 |
| 9 | -34155.8 | 4493 | 70282.92 | 69542.53 | 70515.92 | 7254.713 | 0.775 |
| **10** | **-34020.9** | **4467** | **70233.15** | **69410.14** | **70492.15** | **6984.958** | **0.759** |
| 11 | -33918.4 | 4441 | 70248.17 | 69342.55 | 70533.17 | 6779.998 | 0.763 |

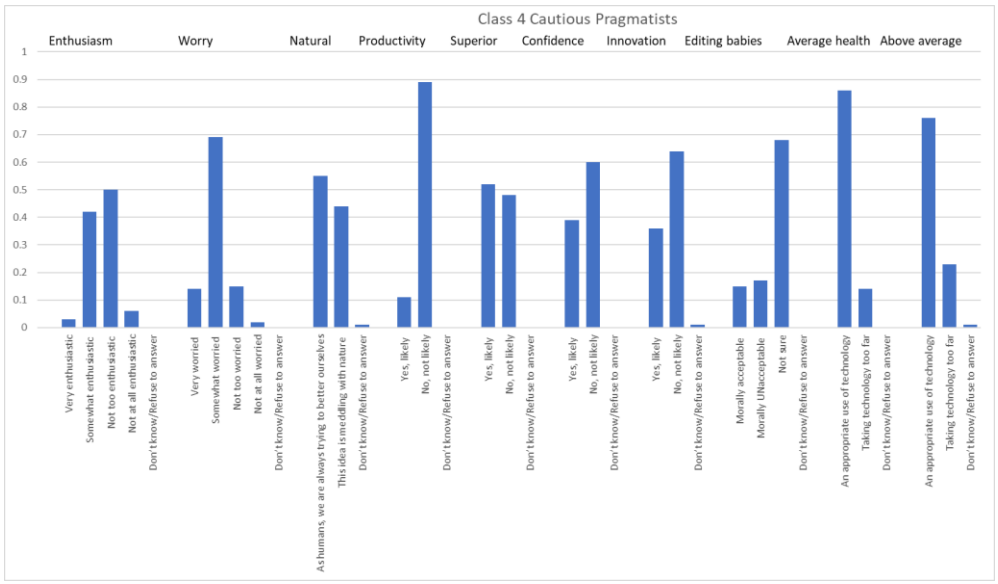
Note. Bolded indicates retained model. Underscores indicate lowest observed information criterion.

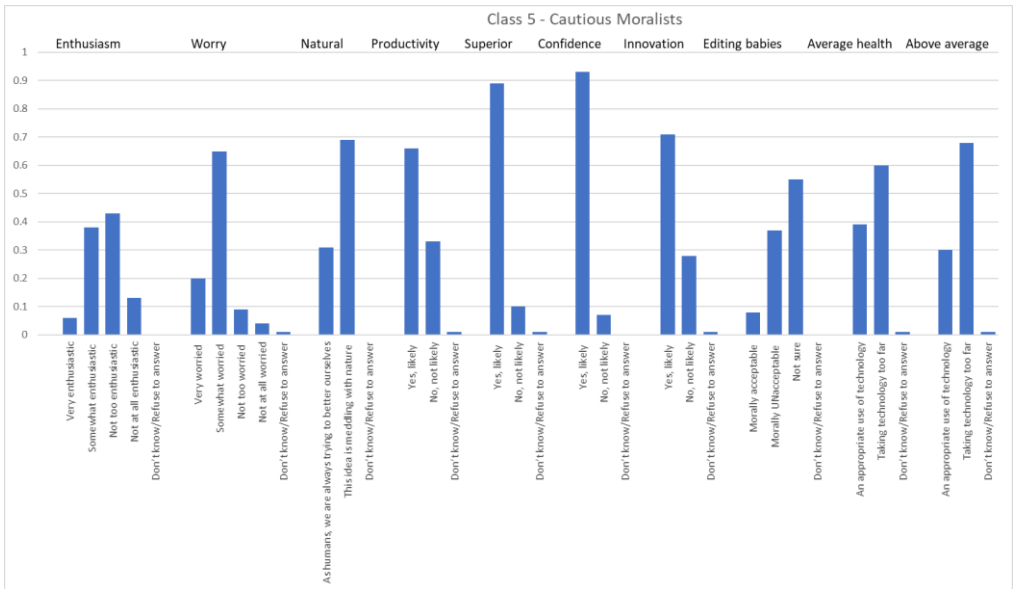
## *Conditional response probabilities*

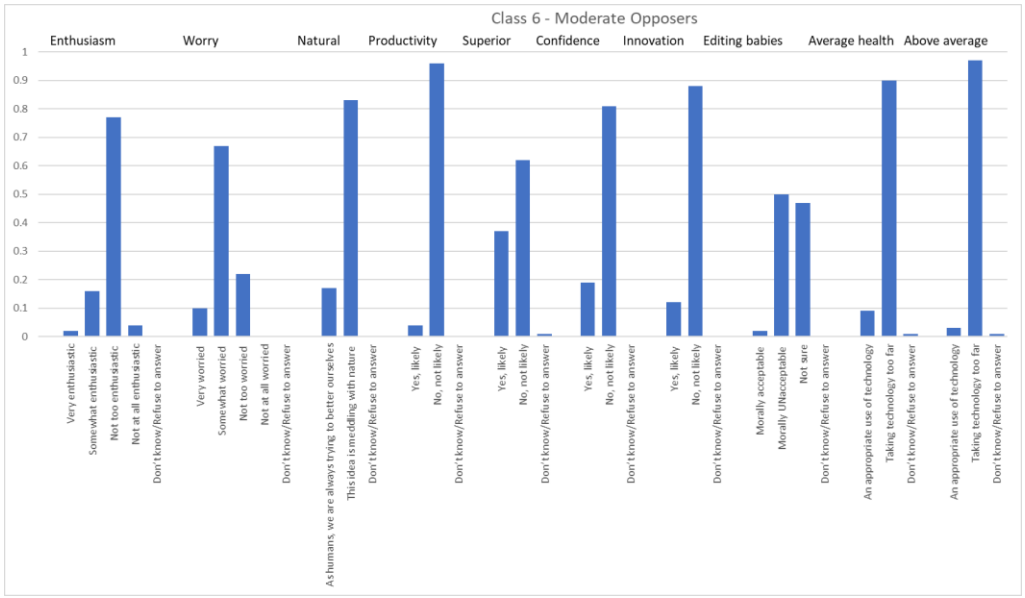



Class 3 - Doubtful Supporters
Enthusiasm
Worry
Natural
Productivity
Superior
Confidence
Innovation
Editing babies
Average health
Above average
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Very enthusiastic
Somewhat enthusiastic
Not too enthusiastic
Not at all enthusiastic
Don't know/Refuse to answer
Very worried
Somewhat worried
Not too worried
Not at all worried
Don't know/Refuse to answer
As humans, we are always trying to better ourselves
This idea is meddling with nature
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Morally acceptable
Morally UNacceptable
Not sure
Don't know/Refuse to answer
An appropriate use of technology
Taking technology too far
Don't know/Refuse to answer
An appropriate use of technology
Taking technology too far
Don't know/Refuse to answer


Class 4 Cautious Pragmatists
Enthusiasm
Worry
Natural
Productivity
Superior
Confidence
Innovation
Editing babies
Average health
Above average
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Very enthusiastic
Somewhat enthusiastic
Not too enthusiastic
Not at all enthusiastic
Don't know/Refuse to answer
Very worried
Somewhat worried
Not too worried
Not at all worried
Don't know/Refuse to answer
As humans, we are always trying to better ourselves
This idea is meddling with nature
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Morally acceptable
Morally UNacceptable
Not sure
Don't know/Refuse to answer
An appropriate use of technology
Taking technology too far
Don't know/Refuse to answer
An appropriate use of technology
Taking technology too far
Don't know/Refuse to answer


Class 5 - Cautious Moralists
Enthusiasm
Worry
Natural
Productivity
Superior
Confidence
Innovation
Editing babies
Average health
Above average
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Very enthusiastic
Somewhat enthusiastic
Not too enthusiastic
Not at all enthusiastic
Don't know/Refuse to answer
Very worried
Somewhat worried
Not too worried
Not at all worried
Don't know/Refuse to answer
As humans, we are always trying to better ourselves
This idea is meddling with nature
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Morally acceptable
Morally UNacceptable
Not sure
Don't know/Refuse to answer
An appropriate use of technology
Taking technology too far
Don't know/Refuse to answer
An appropriate use of technology
Taking technology too far
Don't know/Refuse to answer


Class 6 - Moderate Opposers
Enthusiasm
Worry
Natural
Productivity
Superior
Confidence
Innovation
Editing babies
Average health
Above average
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Very enthusiastic
Somewhat enthusiastic
Not too enthusiastic
Not at all enthusiastic
Don't know/Refuse to answer
Very worried
Somewhat worried
Not too worried
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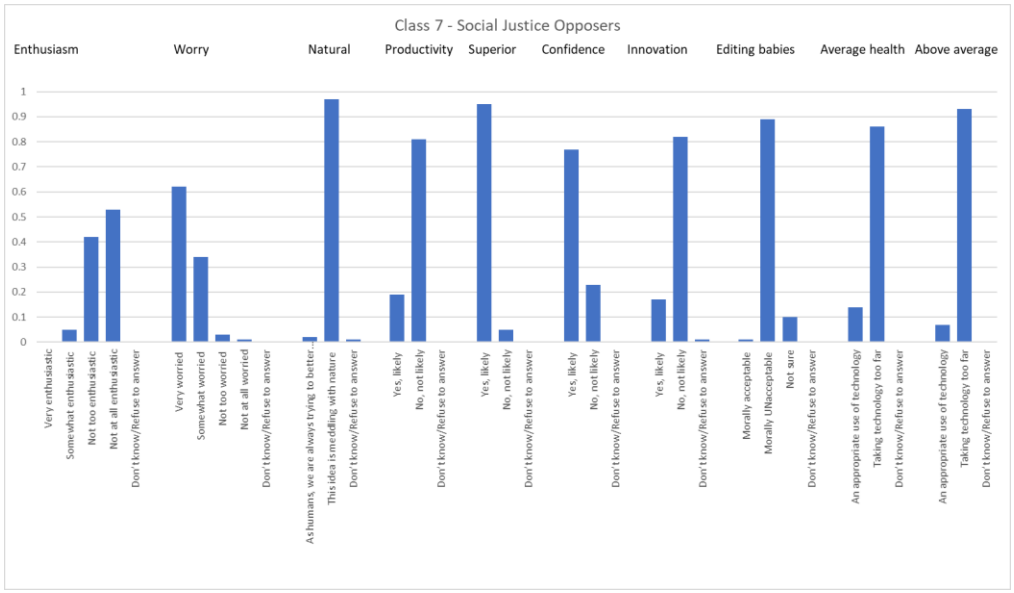
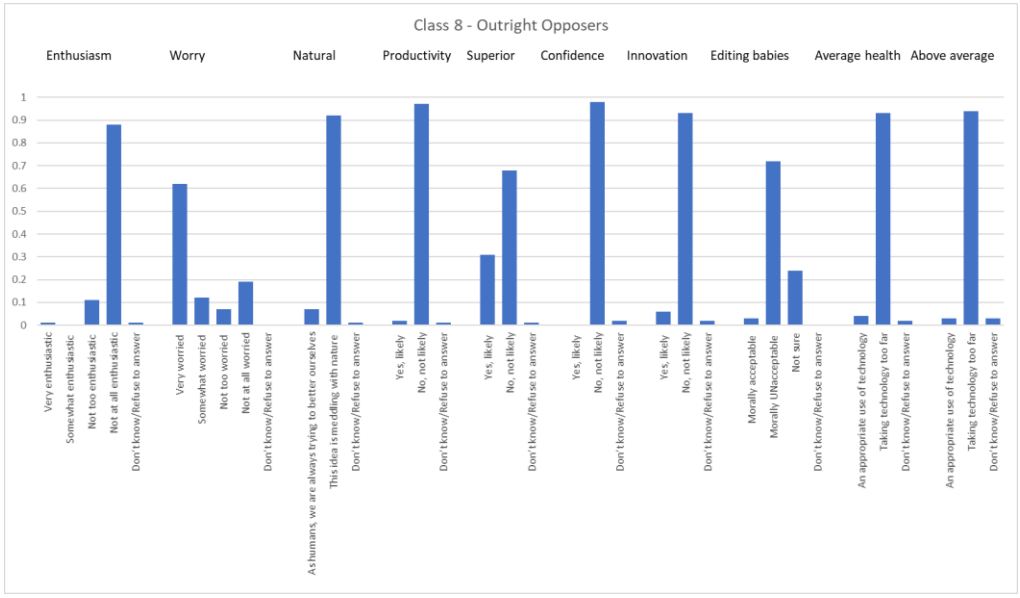
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Morally acceptable
Morally UNacceptable
Not sure
Don't know/Refuse to answer
An appropriate use of technology
Taking technology too far
Don't know/Refuse to answer
An appropriate use of technology
Taking technology too far
Don't know/Refuse to answer


Class 7 - Social Justice Opposers
Enthusiasm
Worry
Natural
Productivity
Superior
Confidence
Innovation
Editing babies
Average health
Above average
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Very enthusiastic
Somewhat enthusiastic
Not too enthusiastic
Not at all enthusiastic
Don't know/Refuse to answer
Very worried
Somewhat worried
Not too worried
Not at all worried
Don't know/Refuse to answer
As humans, we are always trying to better...
This idea is meddling with nature
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Morally acceptable
Morally UNacceptable
Not sure
Don't know/Refuse to answer
An appropriate use of technology
Taking technology too far
Don't know/Refuse to answer
An appropriate use of technology
Taking technology too far
Don't know/Refuse to answer


Class 8 - Outright Opposers
Enthusiasm
Worry
Natural
Productivity
Superior
Confidence
Innovation
Editing babies
Average health
Above average
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Very enthusiastic
Somewhat enthusiastic
Not too enthusiastic
Not at all enthusiastic
Don't know/Refuse to answer
Very worried
Somewhat worried
Not too worried
Not at all worried
Don't know/Refuse to answer
As humans, we are always trying to better ourselves
This idea is meddling with nature
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Yes, likely
No, not likely
Don't know/Refuse to answer
Morally acceptable
Morally UNacceptable
Not sure
Don't know/Refuse to answer
An appropriate use of technology
Taking technology too far
Don't know/Refuse to answer
An appropriate use of technology
Taking technology too far
Don't know/Refuse to answer

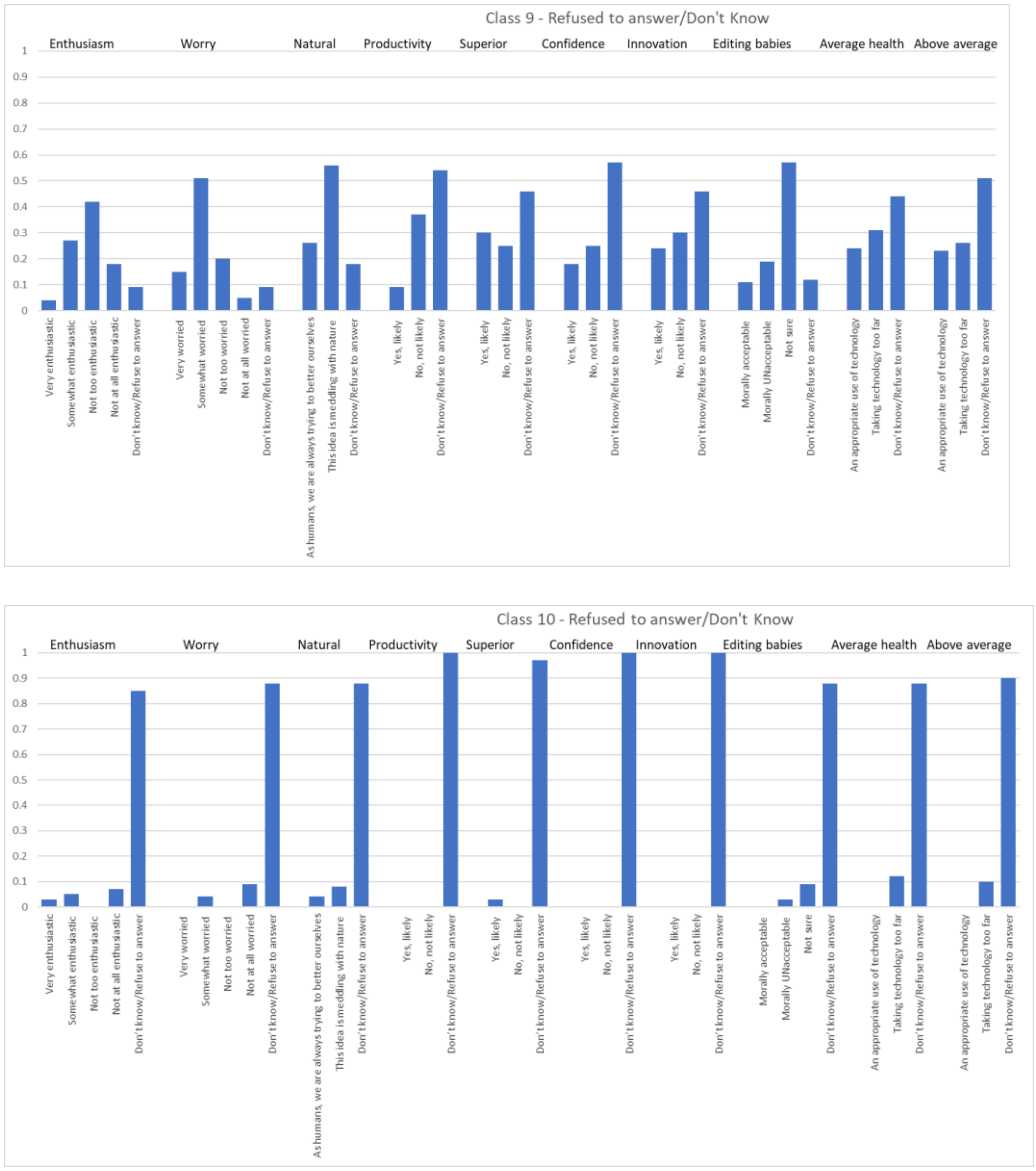
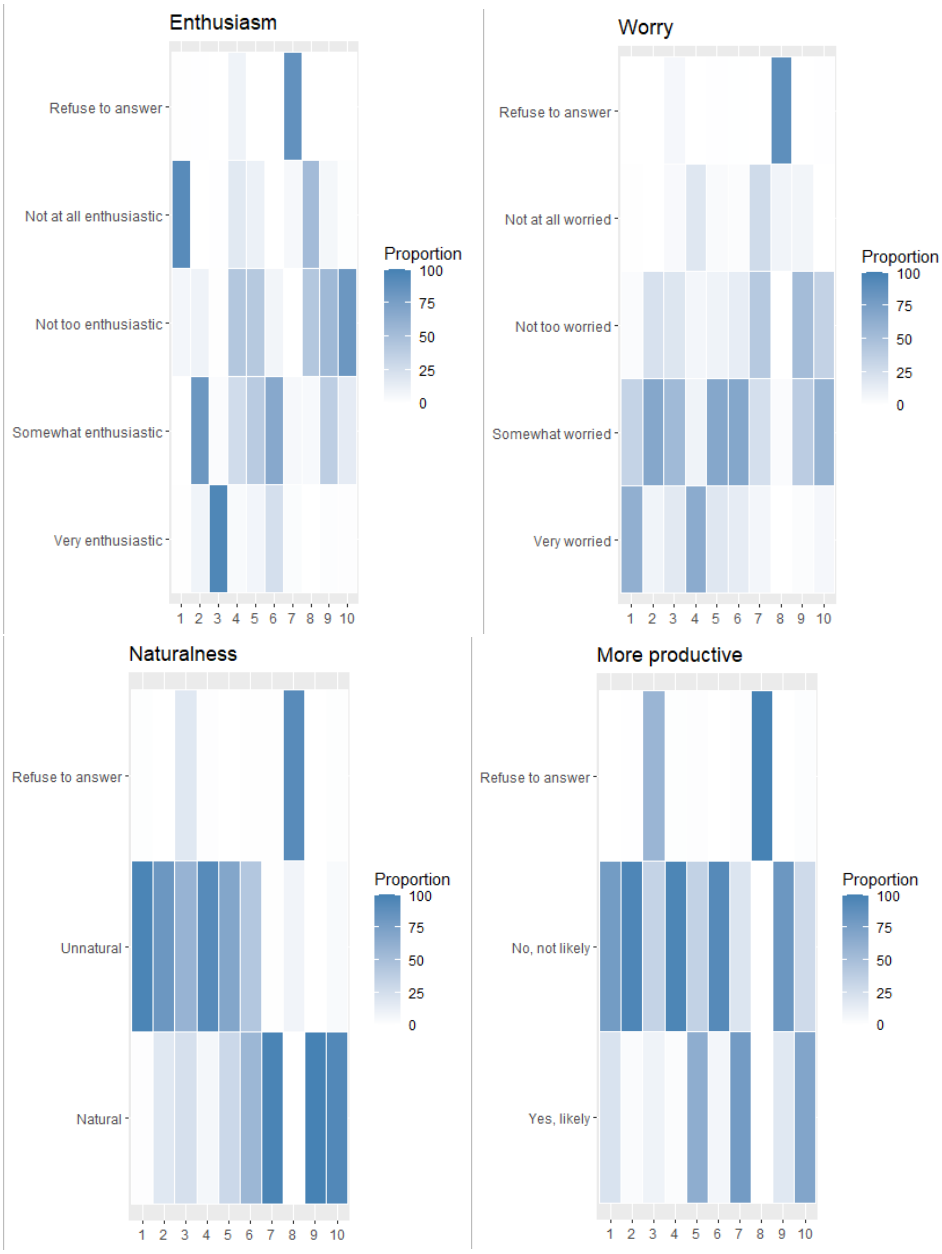


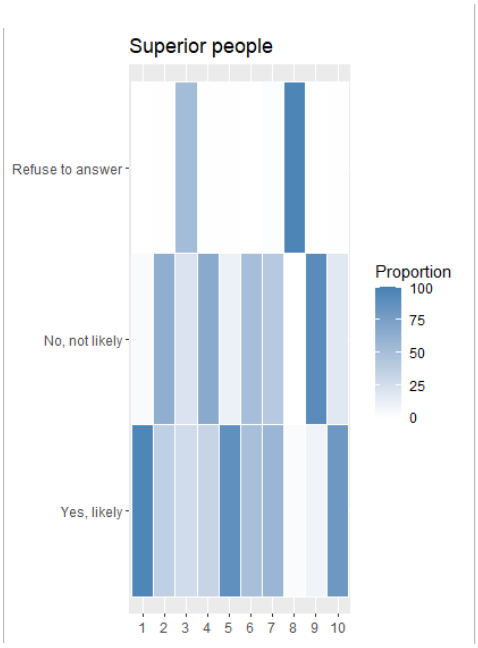


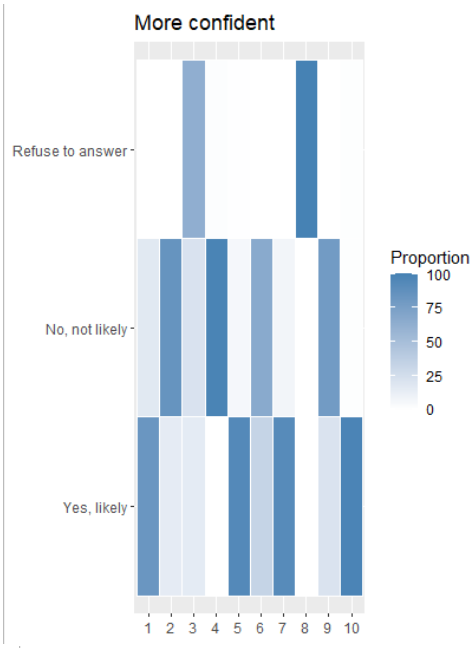


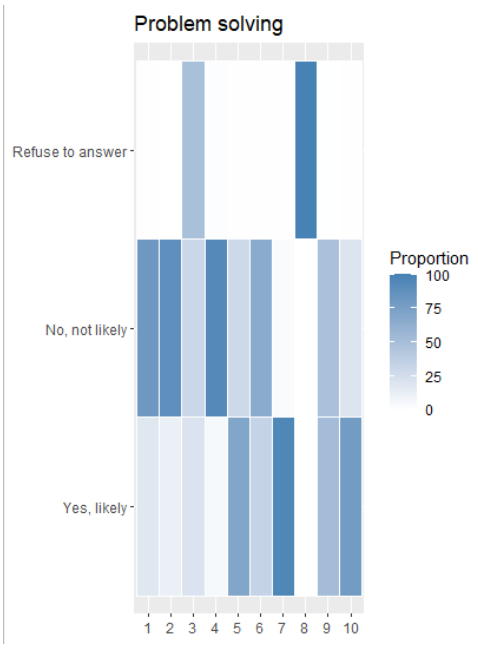
**Figure 1.** The panels present the conditional response probabilities (y-axis) for each of the items (x-axis) used in the latent class analyses by class.

## *Heatmap of conditional response probabilities*




Superior people
Refuse to answer
No, not likely
Yes, likely
1 2 3 4 5 6 7 8 9 10
Proportion
100
75
50
25
0


More confident
Refuse to answer
No, not likely
Yes, likely
1 2 3 4 5 6 7 8 9 10
Proportion
100
75
50
25
0


Problem solving
Refuse to answer
No, not likely
Yes, likely
1 2 3 4 5 6 7 8 9 10
Proportion
100
75
50
25
0

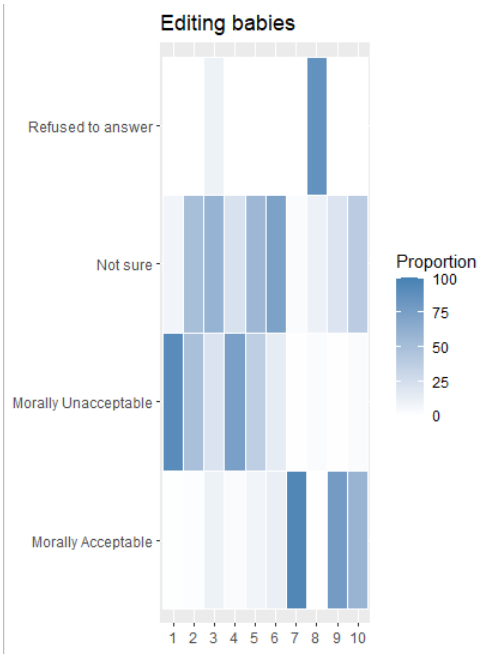

Editing babies
Refused to answer
Not sure
Morally Unacceptable
Morally Acceptable
1 2 3 4 5 6 7 8 9 10
Proportion
100
75
50
25
0


**Figure 2.** Heatmaps of the conditional response probabilities for the individual categories of the items used in the latent class analysis (y-axis) per class (x-axis); each panel presents one of the questions.

***Descriptive statistics by class***

Table 6 presents summary statistics to describe the distribution of the attributes within the ten classes. The more positive classes (Classes 1-3) were generally older, and more likely to be democrats, male, liberal leaning, better educated, rate their levels of gene editing knowledge to be lower, and possess lower levels of religiosity than the opposer classes. As we move from the supporter classes to the moderate (4, 5, 6) and strong opposition classes (7 and 8), the classes get progressively younger, more republican, female, and conservative leaning. The classes also progressively decrease in their education levels, rate their gene editing knowledge to be higher and sharply increase in their levels of religiosity.

**Table 6**. Descriptive statistics by class membership.

| | | Classes | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | Valid percentages | | | | | | | | | |
| **Sex** | | | | | | | | | | | |
| | Male | 60.96 | 56.37 | 57.10 | 37.05 | 46.97 | 47.84 | 42.22 | 39.22 | 37.90 | 41.03 |
| | Female | 39.04 | 43.63 | 42.90 | 62.95 | 53.03 | 52.16 | 57.78 | 60.78 | 62.10 | 58.97 |
| **Age** | | | | | | | | | | | |
| | 18-29 | 16.12 | 10.50 | 14.07 | 12.59 | 16.98 | 11.98 | 9.63 | 13.33 | 4.84 | 12.82 |
| | 30-49 | 21.16 | 23.70 | 26.81 | 27.36 | 28.84 | 32.22 | 32.22 | 35.63 | 18.55 | 33.33 |
| | 50-64 | 23.43 | 31.49 | 31.70 | 31.23 | 32.88 | 32.81 | 33.89 | 32.87 | 35.48 | 20.51 |
| | 65+ | 39.29 | 34.32 | 27.41 | 28.81 | 21.29 | 22.99 | 24.26 | 18.16 | 41.13 | 33.33 |
| **Education** | | | | | | | | | | | |
| | Highschool or less | 14.36 | 15.45 | 10.21 | 26.63 | 15.61 | 24.12 | 17.59 | 25.92 | 29.03 | 38.46 |
| | Associates degree or equivalent | 30.48 | 29.60 | 28.11 | 34.14 | 32.30 | 32.16 | 36.67 | 36.93 | 31.45 | 33.33 |
| | College graduate or higher | 55.16 | 54.95 | 61.69 | 39.23 | 52.09 | 43.73 | 45.74 | 37.16 | 39.52 | 28.21 |
| **Political party** | | | | | | | | | | | |
| | Republican | 20.72 | 21.92 | 19.52 | 23.65 | 25.17 | 37.62 | 37.64 | 40.09 | 27.64 | 34.21 |
| | Democrat | 45.27 | 42.40 | 43.09 | 39.16 | 39.59 | 27.13 | 22.66 | 25.17 | 30.08 | 28.95 |
| | Independent | 26.34 | 27.07 | 30.33 | 28.33 | 25.03 | 26.14 | 28.28 | 21.91 | 30.89 | 21.05 |
| | Something else | 7.67 | 7.43 | 6.46 | 7.88 | 8.84 | 8.71 | 10.49 | 11.42 | 8.94 | 10.53 |
| | Refuse to answer | .00 | 1.20 | .60 | .99 | 1.36 | .40 | .94 | 1.40 | 2.44 | 5.26 |
| **Knowledge** | | | | | | | | | | | |
| | Not at all | 24.18 | 13.40 | 15.09 | 8.29 | 9.18 | 5.29 | 8.36 | 6.70 | 7.56 | 8.33 |
| | A little | 50.38 | 60.97 | 61.09 | 50.00 | 56.55 | 49.02 | 51.12 | 39.49 | 50.42 | 33.33 |
| | A lot | 25.44 | 25.62 | 23.82 | 41.71 | 34.28 | 45.69 | 40.52 | 53.81 | 42.02 | 58.33 |
| **Political ideology** | Mean (SD) | 3.31 (1.13) | 3.16 (1.06) | 3.25 (1.04) | 2.99 (1.08) | 2.84 (1.07) | 2.73 (1.05) | 2.55 (1.08) | 2.57 (1.07) | 2.61 (1.20) | 2.74 (1.17) |
| **Religiosity** | Median | 1 | 2 | 1 | 2 | 5 | 5 | 5 | 5 | 5 | 5 |

Note. Mode and median reported where appropriate. Income is in $1,000's of USD. Higher scores in political ideology and religiosity reflect greater levels of liberalism and religiosity. Highest N = 4726, lowest N = 4640.