Consumer perception of food products involving genetic modification: Results from a qualitative study in four Nordic countries

Working paper no 72

July 2000

Consumer perception of food products involving genetic modification: Results from a qualitative study in four Nordic countries

Klaus G. Grunert
The MAPP Centre, Aarhus
Liisa Lähteenmäki
VTT, Helsinki
Niels Asger Nielsen
The MAPP Centre, Aarhus
Jacob B. Poulsen
The MAPP Centre, Aarhus
Oydis Ueland
Matforsk, Oslo
Annika Åström
SIK The Swedish Institute for Food and Biotechnology, Gothenburg

EXECUTIVE SUMMARY

1. The present study addresses consumer acceptance of food products involving the use of different applications of genetic modification in four Nordic countries. Three food products were used as examples: hard cheese, hard candy, and salmon. Three types of applications of genetic modification were investigated: modification of the raw material, use of genetic modification in enzyme production, and direct use of genetically modified microorganisms. In addition, three levels of presence of the genetically modified material in the final product were investigated: not present, present, and present and living/able to function.

2. The results from consumer samples in Denmark, Finland, Norway and Sweden are remarkably similar, showing a strong stability in consumer reactions to the use of genetic modification in food production in these four countries.

3. Consumer perception is characterised by a basic dichotomy of GM and non-GM products. Being non-GM is regarded as a major benefit in itself. When a product involves genetic modification, this elicits numerous negative assocations, of which the strongest ones are 'unhealthy' and 'uncertainty.'

4. The level of presence of the genetically modified material in the final product has a clear impact on consumer acceptance. When the GM material is present and viable/able to function, acceptance is lowest.

5. The type of application of genetic modification has an impact on consumer acceptance as well, but it differs across products. Still, there is a clear tendency that acceptance of salmon products where the salmon itself was genetically modified was lowest among all products tested.

6. The consumer benefits which the application of GM brings about (e.g., improved taste, functional benefits, environmental benefits) are largely perceived, but cannot overcompensate for the negative associations to GM. In some cases, a supposed benefit (e.g., faster growth of salmon, leading to reduced energy costs) was actually perceived as a disadvantage. Benefits combining personal tangible benefits with societal relevance (e.g., a low calorie candy which can be consumed by people suffering from diabetes) may have most positive impact on consumer acceptance.

ACKNOWLEDGEMENT

Research reported in this paper is part of "Consumer and Biotechnology" – project (P98098) and was partly supported by the Nordic Industrial Fond, which is an official institution under the Nordic Ministry Council. (This project is co-ordinated by Liisa Lähteenmäki, VTT.)

INTRODUCTION

Genetic modification (GM) is a much-debated topic in the food sector these years. Many scientists and many decision-makers in the food industry see enormous potential in the application of genetic modification in food technology. Among the advantages mentioned are lower production costs, environmental benefits, and possibilities for product development with regard to sensory, convenience, and health properties. At the same time, European consumers have been very sceptical towards the new technology. They seem to associate considerable risk with the new technology (Bredahl, Grunert & Frewer, 1998; European Commission, 1997; Frewer & Shepherd, 1995), even though most experts dismiss the possibility of serious risks arising from the application of genetic modification (Scholderer, Balderjahn & Will, 1998). Other critical aspects raised in the public debate are ethical issues, the right to choose, and general issues about the industrialisation of food production.

Resistance to the application of genetic modification is not universal, however. There is evidence that consumer attitudes towards the technology depend both on the area of application and on the type of modification (European Commission, 1997; Frewer, Hedderley et al. 1997). Modification of plants and microorganisms appears to be more acceptable than modification of animals, and applications in the medical area are more acceptable than applications in the food area.

Evidence is, however, much more limited on possible variations in acceptability within the food area. Bredahl (1999) analysed consumers' cognitive structures with regard to a yoghurt produced using a genetically modified starter culture and a beer brewed using genetically modified yeast. While both applications involve the modification of microorganisms, they differ in that the yoghurt still contains the genetically modified organism, whereas it is filtered out of the beer. This difference did not seem to affect consumer perceptions, though, which were characterised by sweeping but diffuse fears of undesirable consequences of using GM. Bredahl's results also showed that product benefits resulting from the use of GM were perceived by consumers, but could in most cases not compensate for negative associations.

Our study builds on this work and aims at understanding how consumers' perception of food products involving an application of genetic modification depends on key dimensions characterising the use of this technology. More specifically, the aim is to investigate how consumer perceptions are affected by a) what is genetically modified, and b) whether the genetically modified material is present in the final food product or not, and, if it is indeed present, whether it is living (able to reproduce). An additional aim of the study was to shed more light on the way in which product benefits resulting from the use of genetic modification affect consumers' perceptions and acceptability of these products.

THEORETICAL AND METHODOLOGICAL APPROACH

In this study, we want to look at the beliefs that consumers form about a range of food products employing genetic modification. Beliefs are organised in consumers' cognitive structure. A popular way of modelling cognitive structure in consumer research has been the means-end approach (Gutman, 1982; Olson,

1989; Peter, Olson & Grunert, 1999). The means-end approach assumes that consumption-relevant cognitive structure is organised in terms of chains, which link the perception of concrete product attributes to self-relevant consequences and ultimately to the attainment of life values. The means-end chain approach thus attempts to show how perception of objects in the environment (products) are related to basic motivators (life values), and in this way to shed light on the question of what motivates consumers to favour some purchase options over others (Pieters, Baumgartner & Allen, 1995; Walker & Olson, 1991).

The means-end approach has previously been shown to be useful in analysing consumer behaviour in the food domain (Bredahl, 1999; Grunert, Sørensen et al., 1995; Nielsen, Bech-Larsen & Grunert, 1998; ter Hofstede, Steenkamp & Wedel, 1999). It should be noted, however, that the means-end approach allows insight into consumer perception of products, but that currently no formal theory linking these perceptions to consumer food choice exist.

In most studies employing the means-end approach, consumers' perceptions of products and their links to self-relevant consequences and life values have been measured by the laddering method (Grunert & Grunert 1995; Reynolds & Gutman 1984; 1988). Laddering is a qualitative interview method, which consists of two steps: generating salient attributes of products, and then inferring the way these attributes are linked to self-relevant consequences and life values in the mind of the consumer. This basic approach will also be used in this study.

MATERIALS AND METHODS

As mentioned in the introduction, the current study aims at analysing consumer perceptions and acceptance of food products along the following dimenions:

1. what is genetically modified

- plant or animal material used as raw material in food production
- use of genetic modification in enzyme production
- use of genetically modified microorganisms

2. distance of the genetically modified material from the consumer

- use as an aid in processing, not present in the final product
- present in the final product
- present and living in the final product

3. risks and benefits experienced by the consumer

In order to develop stimulus material covering these dimensions, a group of 16 experts from the food industry, all well informed about issues on genetic modification in the context of food production, were asked to generate product examples, which were to be described along the three dimensions above. Products could be existing or hypothetical ones. This resulted in a list of 48 product descriptions, ranging from ice cream over gravy thickener and meat to coffee.

With 30 of these products, which represented satisfactory variation across the three dimensions named above, a pretest employing a variation of the laddering method was conducted. Product descriptions with both benefits and possible risks of the product were typed on cards in a language accessible to consumers (25-60 words per product). Nine respondents were asked to sort 15 product descriptions into meaningful piles according to perceived risks. The piles were labelled and used as the starting point for a laddering procedure. The procedure was then repeated for benefits. The respondents were then given a second set of 15 product descriptions to be sorted according to their acceptability (no acceptance, some acceptance, acceptance). Again, the sorting was to be used as a point of departure for a laddering procedure.

The pretest showed considerable problems with a procedure covering a wide range of products. Respondents found it difficult to concentrate on risks or benefits only and hence had problems in labelling the piles. Several of the respondents in the pretest were so strongly against genetic modification that they refused to believe in any of the benefits mentioned in the product descriptions. Trying to 'force' respondents to assume that the benefits were real, led to nonsensical results. In the acceptability sorting task, several respondents sorted all product descriptions into one pile (not acceptable).

Based on the experience with the pretest, the design was modified. It was decided to concentrate on only three products, which were to be varied so as to cover the three dimensions named above. The products selected were hard cheese, salmon, and hard candy. These products were chosen because together they could cover the range of GM applications spanned by the first two dimensions listed above.

Table 1 shows the overall design adopted, and appendix 1 shows the product descriptions generated for the three products. For each product, a conventional variety was added as a benchmark for the perception of the genetically modified products. The construction of product descriptions was based on examples from the panel of industry experts mentioned above. In order to simplify the product descriptions it was decided to describe enzymes as genetically modified, although the industry experts stated that there is no such thing as a genetically modified enzyme and that the strictly correct term would be 'enzymes produced by genetically modified mircoorganisms.' While there was no problem in generating benefits of the products, the industry experts had problems in pointing out actual risks, noting that risks were basically minimal. In order to construct stimulus material which resembles the type of information to which consumers are exposed in their daily lives as closely as possible, formulations of the type "some people think that..." were adopted for the risks. All products were characterised as 'approved by the Ministry of Health' or 'approved by the authorities' in order to simulate the fact that no products will be marketed which have not passed the standard controls by the relevant authorities.

For each cell entry in the matrix in table 1, a product description card was produced. The card consisted of a picture of the product in question (this was the same across all variants of the product) and the information given in appendix 1. The procedure adopted was to give respondents the set of five cards and ask them to rank them in terms of acceptability. This procedure has earlier been shown to provide the best elicitation as starting point for a

laddering interview in terms of closeness to criteria relevant in a real choice situation (Bech-Larsen & Nielsen, 1999). Respondents are then asked to give reasons for their rank ordering. Usually, such reasons are formulated at the attribute level, and can serve as a starting point for a laddering procedure. When reasons are formulated at the consequence level, reverse laddering is used to generate the corresponding attributes.

Table 1. Overall design og stimulus material

	What is modified		
Distance	raw material	enzyme production	microorganisms
not present	a1 candy salmon	b1 candy	c1 salmon
present, not living	a2 salmon	b2 cheese	c2 cheese
living able to function	a3 salmon	b3 candy cheese	c3 cheese
conventional	conventional candy cheese salmon		

DATA COLLECTION

A total of 285 respondents participated in the study. Four countries participated in the study: Denmark, Finland, Norway and Sweden. In Denmark, Finland and Sweden, 25 respondents were interviewed per product category. In Norway, 20 respondents were interviewed per product category. All respondents were females with main responsibility for grocery shopping in her household, all were aged 25-60 years, and all were frequent buyers of the traditional variant of the product in question. Age groups 25-45 and 46-60 were equally represented.

All interviews were carried out by staff that had been trained in conducting laddering interviews. First the respondents were asked to rank the five product descriptions according to preference, ie buying intention. Next they were asked to give reasons for their ranking, ie what attributes were decisive for the ranking. After the ranking, laddering was applied with the decisive attributes as point of departure. The data were collected in the Spring/Summer of 1999.

DATA ANALYSIS

For the rank-order task, mean rankings were computed for the various product variants.

After completing the field work, the Danish laddering data were categorised into attributes, consequences and values, and by thorough meaning-based interpretation of all individually mentioned concepts the data were coded into broader categories. The procedure was carried out separately for the three products.

The resulting lists of categories were translated into English and used by bilingual researchers as a basis for categorising and coding the Finnish, Norwegian and Swedish data. Additional categories were added at this stage when necessary. To ensure that the coding of all data sets was based on the same conceptual understanding and to check for linguistic errors, all allocated codes were finally checked and harmonized across countries by one single researcher. In this way the laddering data from the interviews about cheese were coded into 48 broader categories, those from candy into 42 categories, and those from salmon into 44 categories. All categories are listed in appendix 2.

The coded data were then analysed and interpreted at the aggregate level by means of hierarchical value maps (HVMs), which is the standard format in which laddering data are made amenable to interpretation (Grunert & Grunert, 1995; Reynolds & Gutman, 1988). A major force of hierarchical value maps is that they provide the researcher with a convenient overview of the collected data, and across homogeneous groups of respondents' hierarchical value maps may be viewed as representations of cognitive structures. While ideally all cognitive categories and their mentioned interlinks should be shown in a hierarchical value map, clearly this conflicts with the basic reason for creating the map and the map would probably be uninterpretable. For the sake of simplicity, associations between categories are therefore usually only presented in hierarchical value maps if some minimum number of respondents mentioned them, directly or indirectly. Since most links between concepts are either not mentioned at all or mentioned by a relatively high number of respondents, this principle makes it possible to create interpretable and still highly informative hierarchical value maps.

Separate value maps were produced for each product and country in order to take possible cross-national differences into account. In addition, separate country maps were produced for each product variant, since it is the different perceptions of the various product variants which are in the focus of interest here. Each hierarchical value map was produced with cut-off levels ranging from three to ten, depending on the number of ladders in the data set, before a final solution was chosen by inspecting the interpretability of the produced maps. The hierarchical value maps presented here may therefore have different cut-off levels, which should be taken into account when interpreting and evaluating the complexity of the results. Derivation of the maps was done using the LadderMap software (Reynolds & Gengler, 1987).

This procedure resulted in a total of 72 hierarchical value maps: 3 products x 5 product variants x 4 countries=60 maps plus 3 products x 4 countries=12

maps, altogether 72 maps. These maps are reproduced in appendix 3. In interpreting these maps, the major concern was to find explanations for the rankings obtained from the respondents. To this end, special attention was paid to whether links from attributes to consequences and values were positive (ie, an attribute helps attaining a value) or negative (ie, an attribute inhibits attaining a value). Chains which reached the value level were interpreted as more important for consumer preference formation than those stopping at the consequence level, and chains which were interlinked in networks were likewise regarded as having more impact than those which remain isolated.

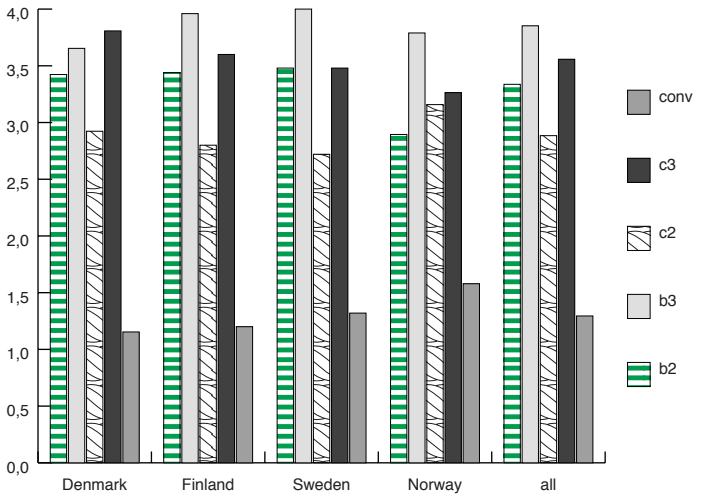
In order to achieve further data reduction and make interpretation easier, the pooled frequency data for mentioning attributes and consequences in connection to the three products were subjected to multiple correspondence analysis, which can provide a joint display of attributes/consequences and product variants on the same dimensionality. It was decided to use the CGS scaling technique, which has been developed as a way of presenting results of correspondence analysis in maps in which categories can be analysed by their proximities not only within but also across rows and columns (Carroll, Green & Schaffer, 1986). Only attributes/consequences that were mentioned by at least 10 respondents with regard to a particular product were included in the analysis. The solutions were varimax-rotated.

RESULTS

Results for cheese

The mean rankings for the five cheeses are shown in figure 1. The pattern in the four countries is remarkably similar. The traditional product has the lowest mean rank score, ie, is preferred most by consumers. Product variants b2 and c2, in which the GM material is present in the final product, but not active, is ranked medium. Product variants b3 and c3, in which the GM material is both present and active, is ranked last. It appears that the 'distance' dimension in table 1 has a clear impact on consumer preferences, whereas the impact of what is genetically modified – microorganisms or enzyme production – is less discernible.

Figure 1. Mean rankings for cheese variants



Starting with the Danish data, the overall HVM for cheese in appendix 3-1 shows that consumer perceptions were dominated by considerations of health, uncertainty, and environment. This is unusual for a food HVM, in which health considerations usually appear next to considerations of enjoyment. The framing of the stimulus material in terms of various applications of GM seems to have resulted in an overweight of health considerations, even though a rich flavour was actually mentioned as a product benefit for both b2 and b3. The HVM also shows a clear polarisation into a network of negative associations purely related to GM and a network of positive associations related to both the traditional product and some of the GM products. This impression is supported by the product variant-specific maps in A3-2 to A3-6. The conventional product carries only positive associations, and health is the most central concept in the whole network. The maps for the four GM variants show association both to the risks and the benefits of these products, documenting that consumers in fact did process the information also on the benefits and were able to attach meaning to them. Also, in all maps the benefits reach the value level, which is usually regarded as an indicator that these benefits are highly relevant to consumers. But the risks are likewise taken seriously and are related to at times rather sweeping, general consequences, like a lack of personal freedom. It should also be noted that in all maps, in addition to associations to the various risks and benefits mentioned in the product descriptions, consumers also have associations to the pure fact that the product was employed using GM, irrespective of the risks and benefits. The most prominent of these associations is that to uncertainty, one does not know what GM is, which in turn is related to health risks. Given that the conventional product did not have any negative associations, it is not hard to explain why it was ranked first by most of the respondents. The fact that b3 and c3 received poorer ranking than b2 and c2 can be related to the former two products being associated to the risks of allergy and pathogenic bacteria, respectively.

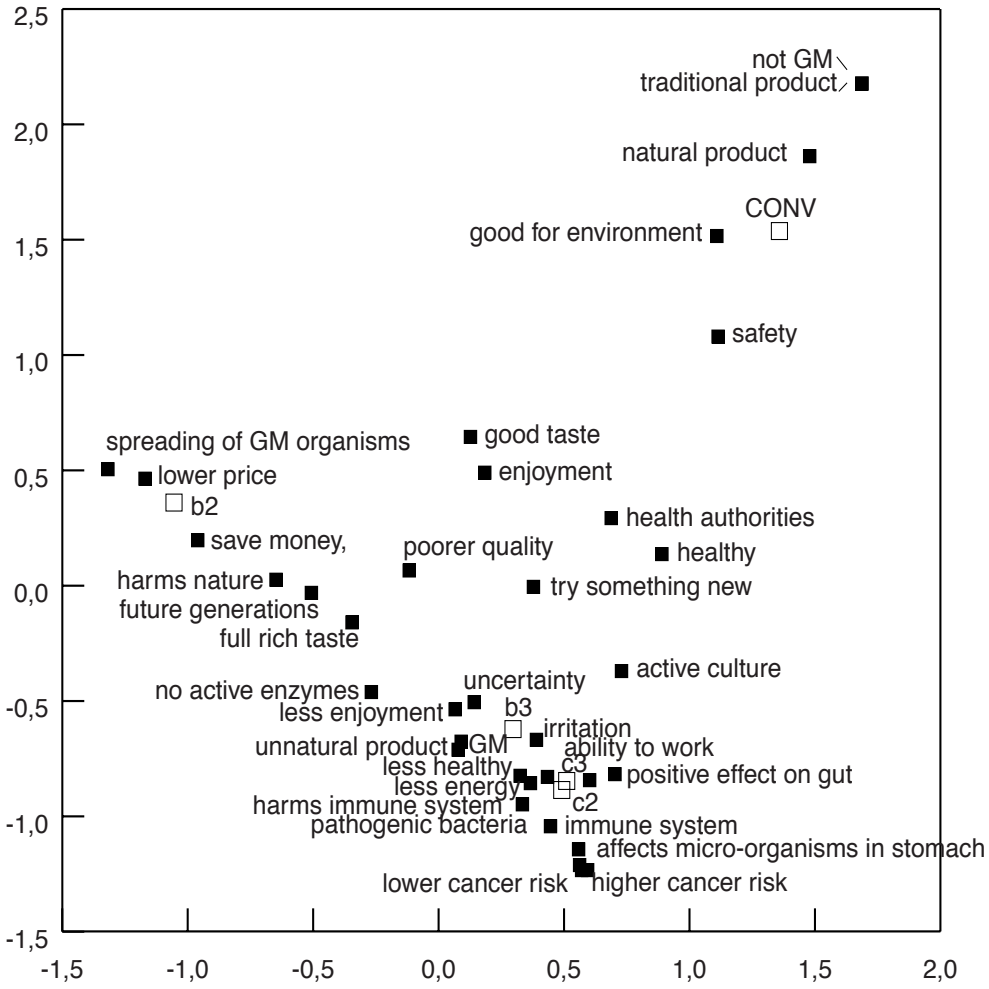
The Finnish overall cheese HVM in A3-7 is completely dominated by associations to the use of GM in production. It is different from the Danish one, though, in that GM carries both positive and negative associations. However, the negative associations reach the value level more often than the positive ones, which suggests that the negative associations will have a stronger impact on purchase behaviour. Otherwise, the maps resemble the Danish ones: the benefits are perceived and do reach the value level, indicating their relevance. They are offset by the risks and by the association of uncertainty to the use of GM in producing cheese. Also the differentiation of b2/c2 on the one hand and b3/c3 on the other hand is similar.

The Swedish overall cheese HVM in A3-13 shows a clear polarisation into GM/ unnatural/uncertainty on the one side and not GM/natural/safety on the other side. Both safety and uncertainty reach the value level via perceived consequences for health. This strong emphasis on safety is clearly seen in the map for the conventional product (A3-14), in which safety is the only concept linking attributes to the value level. The maps for the GM-product variants are largely dominated by the perception of risks (with the exception of c3); the benefits seem to have been perceived and processed by the respondents to a lesser extent than in the Danish and Finnish samples. With regard to the least preferred products b3 and c3, the fact that the GM material is active, is evidenced in the map.

Finally, the Norwegian overall cheese HVM in A3-19 again shows a strong emphasis on health and safety/uncertainty and a polarisation into GM/not GM. However, it also shows a direct positive association from GM to healthy/avoid illness. The product variant HVMs again show, as in the Danish and Finnish samples, perceptions of both risks and benefits, with the exception of b3, where the 'rich flavour' benefit does not seem to be perceived by the respondents.

Figure 2 shows the configuration resulting from the correspondence analysis of the attribute and consequence frequencies pooled across the four national samples. The conventional product stands apart in the upper right part of the diagram, while three out of four GM variants are in the lower part of the diagram. Some key attributes and consequences, like good taste, enjoyment, and healthy, are located in the middle of the diagram, indicating that they are relevant associations to all five products. Numerous negative associations cluster around the GM product variants, but also the product-specific benefits can clearly be distinguished: lower price for b2, full rich taste for both b2 and b3, and a number of positive health effects for both c2 and c3. It should be noted, however, how positive and negative associations lie close to each other, indicating that the specific benefits advocated for the product may be – in the consumer's mind – offset by negative effects inferred from the use of GM: high/low cancer risk, positive/negative effects on gut and microorganisms in stomach, positive/ negative effects on the immune system etc.

Figure 2. Correspondence analysis, cheese data

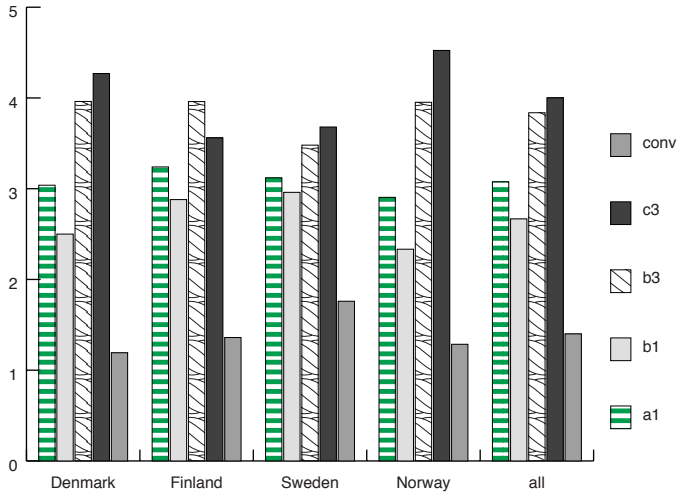


Overall, the results for the cheese product variants show three interesting properties. Firstly, it becomes clear that in the minds of the respondents, perceptions of the five product variants were clearly framed as a non GM/GM dichotomy. Secondly, it was evident that the benefits of the GM product variants, to the extent that they were perceived and regarded as relevant, were overcompensated by the perception of risks and by the negative associations to GM in general. Finally, the data clearly showed the importance of the distance dimension: the more distant the GM application from the consumer, the higher the acceptability.

Results for candy

Figure 3 shows the mean rankings for the five product variants of candy. Again, it is remarkable how much the patterns of rankings in the four countries resemble each other. The conventional product receives the best rankings throughout. Product b1, involving GM enzyme production, but in which the enzymes are not present in the product, comes next. Third ranking is obtained in all four countries by product a1, which is produced using genetically modified sugarbeet. The two products involving present and active GM material, b3 and c3, receive the least preferred ranking; which of these actually is least preferred differs between the countries. As a result we see, as in the cheese data, that the distance dimension seems to have a clear impact on consumer preference: the more distant the GM application from the consumer, the more acceptable the product. However, here we also find a consistent effect of the other dimension, namely that a modified raw material (a1) is less acceptable than a modified production aid, ie, enzymes (a1 versus b1).

Figure 3. Mean rankings of candy variants



The Danish overall candy HVM in A3-25 shows, as with the cheese data, that consumer perceptions mainly centre around health issues and uncertainty about the nature of GM. Likewise, most of the map consists of two interlinked parts, in which GM products are seen to inhibit the same consequences and values which the non-GM product helps attain, namely healthiness and ultimately quality of life. Of the benefits which were 'built into' the GM product descriptions, those relating to taste are not mentioned, whereas those relating to less calories, environmental effects, and use by diabetics are mentioned, but form isolated chains in the HVM, indicating less relevance for consumers' preference formation. This HVM clearly demonstrates why the conventional product received the best rankings, even though it had none of the specific benefits which the GM products boasted.

The HVM for the conventional product, A3-26, shows that its main advantage is perceived as being not GM, related to safety and good health. HVM A3-28 for product b1 aids in understanding why this product was on average rated second. The advantage that diabetics can consume the product is highly relevant, and the fact that the GM material is not present in the candy is positive. The uncertainty about GM in general detracts from the positive beliefs, but the positive beliefs dominate in the map. HVM A3-27, for product a1, which was on average ranked third, shows a picture in which the positive and the negative chains are more or less balanced, both being related to the same life value. The picture changes when we come to the maps for products b3 and c3 in A3-29 and A3-30. The soft, creamy filling, the benefit of product b3, is mentioned in the map, but is completely dominated by the negative associations to GM in general, the specific risk of GM organisms spreading in nature, and the fact that the GM material is present in the candy. As for c3, the intended benefit of the product, namely the functional effect of the filling, is actually perceived as a disadvantage, since such a functional candy is perceived as unnatural and suspicious. With no positive associations, the map shows why this product received the last average rank in the Danish sample.

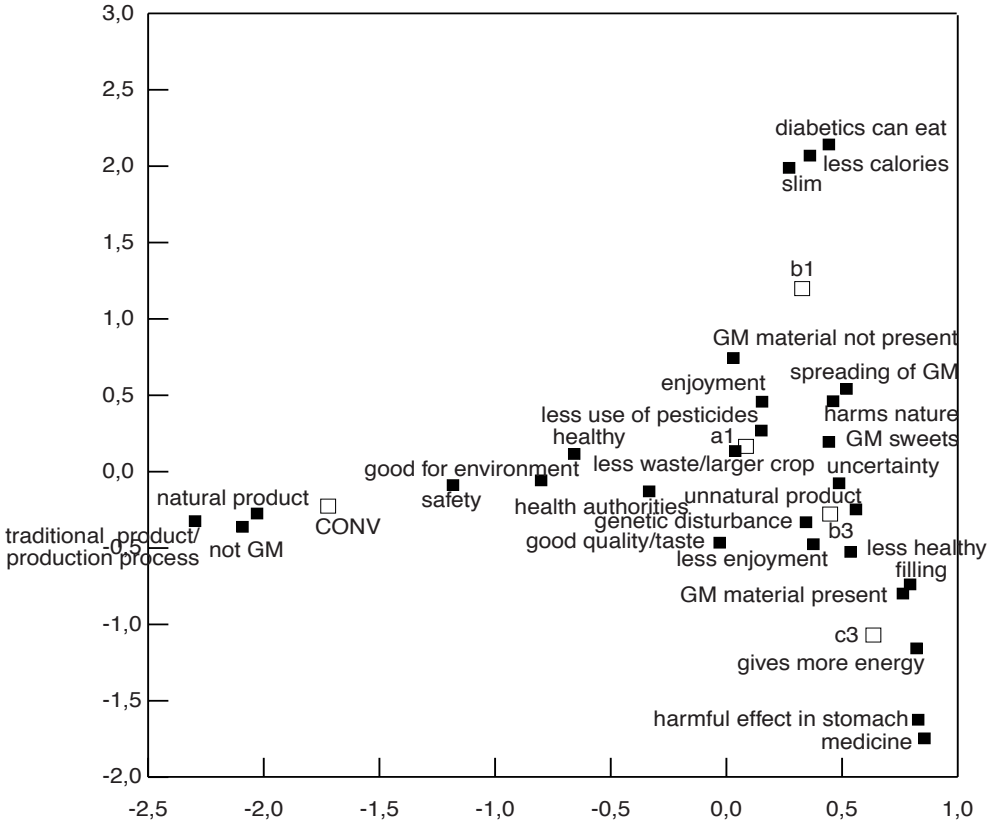
The Finnish overall candy HVM in A3-31 is quite close to the Danish one, in that it mostly shows the opposing associations to GM versus conventional products. Again the major benefits are mentioned, and they all reach the value level in the Finnish map. The map for the conventional product (A3-32) mainly shows that this product is perceived as safe and healthy, with no negative associations. Also the maps for a1 and b2 (A3-33/34) resemble the Danish ones, in that b1 is mostly positive with clear positive associations to the benefits of less calories and use by diabetics, and a1 is more balanced with both positive and negative associations, weighing up the positive environmental benefits against the uncertainty about GM. The maps for b3 and c3 are mostly characterised by negative associations, even though the Finnish respondents differed from the Danish ones in that they believed in the positive effects of the functional filling of product c3 (which is also mirrored in the fact that the Finnish respondents, as the only group, ranked c3 third and not last).

The Swedish HVMs in A3-37 to A3-42 show the same overall pattern as the Danish and Finnish data, although the differences between the four GM product variants are less pronounced. While b1 is clearly the relatively most positive among the GM variants, the three others are dominated by negative associations.

Also the Norwegian data (A3-43 to 48) show the same overall pattern. While the conventional product is the only one with entirely positive associations, the maps for a1 and b1 are fairly balanced, and the maps for b3 and c3 are predominantly (in the case of b3 exclusively) negative.

With so much congruence in the rankings and in the HVMs, one should expect a fairly clear structure in the correspondence analysis as well. The resulting configuration is shown in figure 4. The horizontal dimension separates the conventional product from the four GM products. The vertical dimension separates the GM products according to the rankings which they have received, with the (relatively) most preferred b1 at the top and the least preferred c3 at the bottom. The middle right part of the configuration contains those associations which are common to the GM products, like harms nature, uncertainty, unnatural product. In the upper right part are those products in which the GM material is not present, whereas in the lower part are those in which the GM material is present. The extreme products b1 and c3 have unique associations which follow from their specific risk and benefits.

Figure 4. Correspondence analysis, candy data



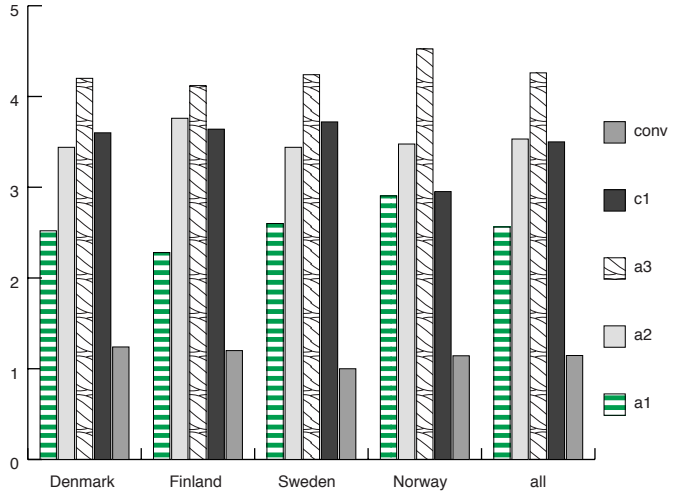
The candy data provide an interesting case, and the fact that the results are so similar in the four countries makes it an especially strong case. Firstly, the conventional product wins over the GM products by its sole virtue that it is not GM, ie, all benefits of the GM products cannot compensate for the disadvantages associated to the term GM. Secondly, within the GM product variants there is a clear structure of perceptions and preferences. As we also saw in the cheese data, the distance of the GM application from the consumer

has a major impact. Within products where the GM application is distant, a product in which the raw material itself was subjected to GM is less acceptable than when the GM is associated to a processing aid. Thirdly, the benefits seem to carry a quite different weight in compensating for the perceived disadvantages of GM. A functional benefit (c3) is regarded at least by some as suspicious, and a purely sensory benefit does not seem to be important enough. Environmental benefits are perceived as relevant, but the benefit which seemed to have most effect was the fact that a product was low in calories and could be consumed by diabetics, which combines an ego-centred benefit with a societally relevant benefit.

Results for salmon

Figure 5 shows the mean rankings for the five salmon product variants. As for the other products, the conventionally produced product gets the best average rank. The three products involving GM raw material, a1, a2 and a3, receive mean ranks corresponding to the distance of the GM material from the consumer, ie, a1 receives the best and a3 the poorest ranking. As for product c1, involving GM microorganisms, it receives about the same average rank as a2. Thus, the salmon results deviate from the results for the two other products, where the distance dimension always seemed to have precedence over the 'what is modified' dimension in affecting the rankings. Again we find a remarkable similarity of the mean rankings across the four country samples.

Figure 5. Mean ranking of salmon variants



The overall HVM for salmon based on the Danish respondents in A3-49 shows a clear dominance of negative perceptions of the various GM applications, as opposed to the natural, non-GM product. The only benefit which comes up in the map refers to less use of fodder, and it is in an isolated chain which does not reach the value level. The map for the conventional product (A3-50) reiterates that the conventional product is regarded as safe and healthy, which explains why it receives the best rank.

The four maps for the GM product variants (A3-51 to 54) show a picture which differs somewhat from what we saw for cheese and candy: The maps almost exclusively contain negative association to GM. The use of less fodder appears as a short isolated chain in the maps for a2 and a3, but cannot be expected to have strong impact on consumers' preferences. The only 'benefit' perceived for a1 and c1 is that the GM material is not present in the fish.

Explanations for the relative rankings of the four GM product variants have therefore to be found not in the benefits of the products, but in the type of GM application and in the type of risks perceived. As already indicated, the presence of GM material in the fish, noted for a3, detracts considerably from preference. In addition, the risk that the GM salmon may disturb wild salmon production, noted for a2 and a3, seems to be of greater concern than the risk which was attached to the production of GM soybeans in a1 – in the map for a1, the specific risk actually does not even appear, and the negative associations are restricted to the general reservations about unhealthiness and uncertainty.

Concerning the result that c1 was clearly less preferred than a1, this can be related to the risk of spreading GM organism in nature, which was mentioned for c1 and appears in the map for c1 (otherwise the maps for a1 and c1 are almost identical). It seems that a1 gets a relatively better evaluation because the risk mentioned in connection with a1, the reduction of biodiversity in the area where the soybeans are grown, was not understood by the respondents, leaving only the more general concerns.

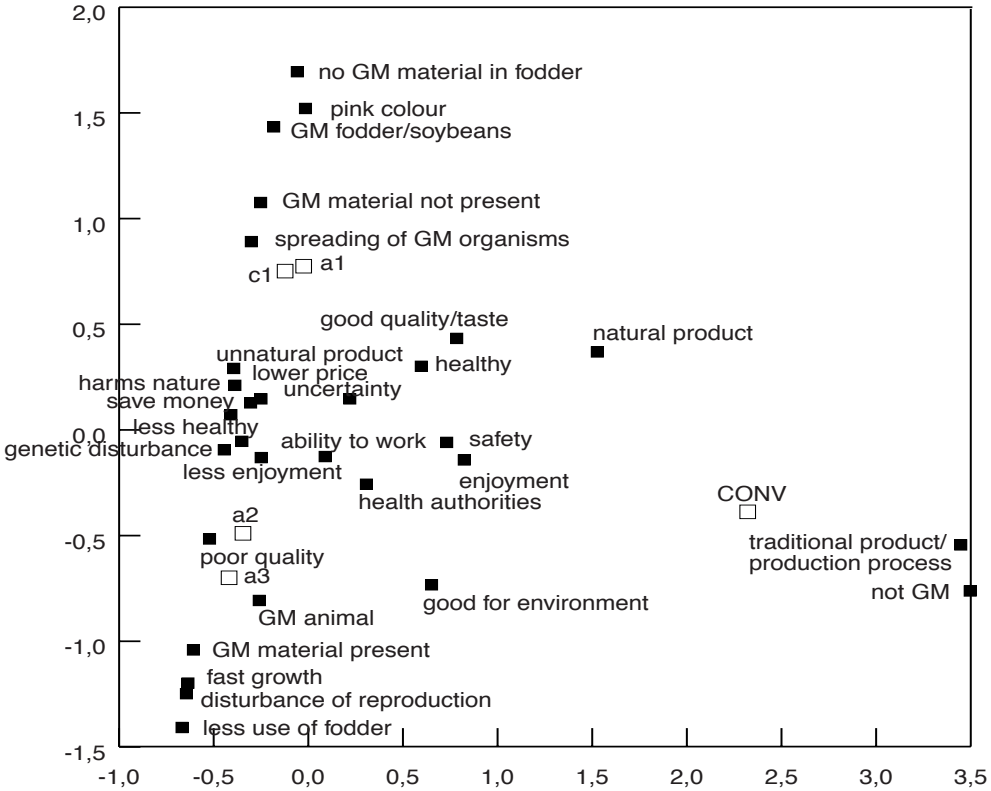
The overall Finnish map in A3-55 contains less negative associations on the GM aspects and more positive associations about the conventional product than the Danish HVM; also, the benefit of a lower price is mentioned. The positive associations to the conventional product in A3-56 are in line with the ranking also received by the conventional product in the Finnish sample. In the maps for the GM product variants (A3-57 to 60), the benefits are mentioned, but are overcompensated by the negative associations to GM, especially the presence of GM material in the fish and the disturbance of wild salmon production in a2 and a3.

The overall Swedish salmon map in A3-61 shows a central position of all the risks mentioned in the GM product descriptions; in addition, the faster growth achieved by GM, supposedly a benefit, is actually perceived as harming nature and the environment. Again, the positive map for the conventional product illustrates why the conventional product received the best rank. The maps for the three products a1, a2 and a3 (A3-63 to 65) almost exclusively contain negative associations, most notably the fast growth achieved by GM in products a2 and a3 is linked to a whole host of negative associations. a1 has the 'benefit' that the GM material is not present in the fish, and the GM soybeans do not carry as many negative associations as the GM fish, which can explain why among the GM product variants a1 received the best rank. a3 has most negative associations, relating to both fast growth, GM material present in the fish, and disturbance of wild salmon production. As for c1, the same interpretation as for the Danish data seems to apply, namely that it is mainly the risk of GM organisms spreading in nature which is responsible for the lower ranking of this product than a1.

Finally, the Norwegian overall salmon map (A3-67) shows the usual polarisation into GM products and conventional products, and shows almost no benefits of the GM product variants, and lists fast growth as linked to uncertainty. All four maps for the GM product variants (A3-69 to 72) show only negative associations (with the exception of low price in a2), so that again the explanation for the rankings has to be found in the type of risk and disadvantages perceived. The interpretation is basically the same as in the other countries, namely that it is a combination of the distance dimension, the risk of disturbance of wild salmon production, and the risk of spreading of GM organisms in c1 which can explain the rankings obtained.

The configuration resulting from the correspondence analysis, shown in figure 6, shows a similar structure as the one obtained for the candy data. The conventional product is on the right alone, and on the left the GM product variants are ordered in a way consistent with their average rankings, with a1 at the top and a3 lowest. Associations common to all GM variants are left in the middle, namely uncertainty, unnatural product, less healthy, harms nature. The upper left part has all the associations relating to the fodder and the absence of GM material in the product, whereas the lower part has the associations related to the presence of GM material, fast growth, and the effects of using less fodder.

Figure 6. Correspondence analysis, salmon data



The salmon case provides additional insight compared to the cheese and candy cases in that the perceptions of the GM product variants here were mainly characterised by risks, the benefits played only a minor role. The rankings of the GM product variants a1, a2 and a3 can again be related to the distance dimension, and here especially to the risks perceived.

DISCUSSION

We presented descriptions of cheese, candy and salmon products to small samples of respondents in four Nordic countries. The descriptions represented various applications of GM, varied along a 'distance' dimension and a 'what is modified' dimension, and were presented along with a conventionally produced product. Respondents ranked the products according to preference, and their perceptions were ascertained by the laddering method.

The similarity of the results across the four samples in the four countries is striking. In almost all cases the pattern of mean rankings is the same in the four countries, showing that here very stable mechanisms are at work in determining consumer preference. Also the results from the laddering interviews, as presented in HVMs, are remarkably similar. This is the more interesting as there were, in fact, quite large differences in the mean number of ladders generated per respondent (13.8 in Finland, 5.6 in Norway, 5.0 in Sweden, 12.9 in Denmark). To which extent these differences in the number of ladders produced mirror culturally dependent different response styles or differences in the way the interviews were conducted, is difficult to say.

Some conclusions are the same for the three products, in other respects the results for the three products complement each other.

For all three products, it was clear that the major distinction respondents make is between GM and non-GM products. The conventional product received the best average rank consistently, even though it was the only product variant in which the product description did not mention explicit benefits. The major benefits of the conventional product as perceived by the respondents was that it was conventionally produced. This is associated mainly with safety and good health, whereas any kind of GM application is associated to uncertainty and less health, along with a host of other, more specific negative associations.

Within the GM product variants, the 'distance' dimension turned out to be a powerful determinant of consumer reactions. In almost all cases where the average ranks in complete consistence with the distance dimension, with products where the GM material is absent in the final product, ranked best and those where the material is present and active got the poorest ranking.

The other dimension investigated, namely whether the GM application referred to a raw material, enzyme production, or microorganisms, was not quite as clear-cut. In the cheese case, whether the GM application referred to enzyme production or to microorganisms did not seem to be important to consumers. In the candy case, modifying processing aids (enzyme production/microorganisms) was more acceptable than modifying the raw material sugarbeet. In the salmon case, modifying soybeans to be used as feed was more acceptable than feed containing modified microorganisms – ie, the reverse effect as the one found for candy – but this result is probably due to the specific risks perceived with these two salmon products.

The three products also showed different effects of the risks and benefits used to describe the product variants. In none of the cases the benefits were able to compensate for the negative associations to GM in general and the more specific risks. However, the degree to which the benefits figured in respondents'

perception varied. In both the cheese and candy cases, benefits were actually perceived, and were – in many cases – also regarded as relevant to consumers. As especially the candy case showed, both relatively remote societal benefits (like benefits to the environment) and personal hedonic benefits (like a smooth taste) do not seem to be good promoters of GM acceptance, whereas a benefit combining societal relevance and personal tangible benefits (can be consumed by diabetics) seems to do best relatively in compensating partly for the risks and negative associations. The salmon case stood out in that most of the benefits were not perceived or not regarded as relevant in most of the cases, so that consumer preferences in this case were mostly determined by the risks perceived and by the distance dimension.

REFERENCES

Bech-Larsen, T. & Nielsen, N. A. (1999). A comparison of five elicitation techniques for elicitation of attributes of low involvement products. *Journal of Economic Psychology 20,* 315-341.

Bredahl, L. (1999). Consumers' cognitions with regard to genetically modified foods – results of a qualitative study in four countries. *Appetite 33*(3), 343-360.

Bredahl, L., Grunert, K. G. & Frewer, L. (1998). Consumer attitudes and decision-making with regard to genetically engineered food products – a review of the literature and a presentation of models for future research. *Journal of Consumer Policy 21,* 251-277.

Carroll, J. D., Green, P. E. & Schaffer, C. M. (1986). Interpoint distance comparisons in correspondence analysis. *Journal of Marketing Research 23,* 271-280.

European Commission (1997). *The Europeans and modern biotechnology – Eurobarometer 46.1.* Luxembourg: Office for Official Publications of the European Communities.

Frewer, L. & Shepherd, R. (1995). Ethical concerns and risk perceptions associated with different applications of genetic engineering: Interrelationships with the perceived need for regulation of the technology. *Agriculture and Human Values 12*, 48-57.

Frewer, L. J., Hedderley, D. et al. (1997). 'Objection' mapping in determining group and individual concerns regarding genetic engineering. A*griculture and Human Values 14,* 67-79.

Grunert, K. G. & Grunert, S. C. (1995). Measuring subjective meaning structures by the laddering method: Theoretical considerations and methodological problems. *International Journal of Research in Marketing 12*, 209-225.

Grunert, K. G., Sørensen,E. & Nielsen, N. A. (1995). Analysing food choice from a means-end perspective. In: F. Hansen (Ed.), *European advances in consumer research, vol 2*, pp. 366-371 Provo, UT: Association for Consumer Research.

Gutman, J. (1982). A means-end chain model based on consumer categorization processes. *Journal of Marketing 46*(2) 60-72.

Nielsen, N. A., Bech-Larsen, T. & Grunert, K. G. (1998). Consumer purchase motives and product perceptions: A laddering study on vegetable oil in three countries. *Food Quality & Preference 9,* 455-466.

Olson, J. C. (1989). Theoretical foundations of means-end chains. *Werbeforschung & Praxis*(5), 174-178.

Peter, J. P., Olson, J. C. & Grunert, K. G. (1999). *Consumer behaviour and marketing strategy – European edition*. Maidenhead: McGraw-Hill.

Pieters, R., Baumgartner, H. & Allen, D. (1995). A means-end chain approach to consumer goal structures. *International Journal of Research in Marketing 12*, 227-244.

Reynolds, T. J. & Gengler, C. E. (1987). *Laddermap*. Dallas, University of Texas and Clarkson University, Potsdam.

Reynolds, T. J. & Gutman, J. (1984). Laddering: Extending the repertory grid methodology to construct attribute-consequence-value hierarchies. In: R. E. Pitts & A. G. Woodside (Eds.), *Personal values and consumer psychology*. Lexington, MA: Lexington Books.

Reynolds, T. J. & Gutman, J. (1988). Laddering theory, methods, analysis, and interpretation. *Journal of Advertising Research 18(*1), 11-31.

Scholderer, J., Balderjahn, I. & Will, S. (1998). *Communicating the risks and benefits of genetically engineered food products to the public: the view of experts from four European countrie*s. Aarhus: The Aarhus School of Business. MAPP working paper no 57.

ter Hofstede, F., Steenkamp, J.-B. E. M & Wedel, M. (1999). International market segmentation based on consumer-product relations. *Journal of Marketing Research 36*, 1-17.

Walker, B. A. & Olson, J. C. (1991). Means-end chains: Connecting products with self. *Journal of Business Research 22*, 111-119.

Appendix 1: Product descriptions

PRODUCT DESCRIPTIONS: CHEESE

	What is modified		
DISTANCE	RAW MATERIAL	ENZYME PRODUCTION	MICRO-ORGANISMS
NOT PRESENT	**a1**	**b1**	**c1**
PRESENT, NOT LIVING	**a2**	**b2** • produced by genetically modified enzymes • the enzymes give richer flavour and lower price • the enzymes are present but not active in the cheese • approved by the Ministry of Health • some people think that there is a risk of the genetically modfied micro-organisms spreading in nature	**c2** • containing a genetically modified culture • the culture reduces the risk of cancer in the gut • the culture is present but not active in the cheese • approved by the Ministry of Health • some people think that there is a risk of the genetically modfied culture will take over space from other micro-organisms resulting in an unbalanced gut microflora
LIVING/ ABLE TO FUNCTION	**a3**	**b3** • containing a genetically modified enzymes • the enzymes give richer flavour • the enzymes are present and active in the cheese • approved by the Ministry of Health • some people think that there is a risk of the genetically modfied enzymes being more allergenic than ordinary enzymes	**c3** • containing a genetically modified culture • the culture reduces the risk of cancer in the gut • the culture is present but not active in the cheese • approved by the Ministry of Health • some people think that there is a risk of the genetically modfied culture will take over space from other micro-organisms resulting in an unbalanced gut microflora
CONVENTIONAL	**conv** • produced by conventional enzymes and micro-organisms • traditional flavour • culture is present and active in the product • approved by the Ministry of Health • does not contain any genetically modified material		

PRODUCT DESCRIPTIONS: HARD CANDY

	What is modified		
DISTANCE	RAW MATERIAL	ENZYME PRODUCTION	MICRO-ORGANISMS
NOT PRESENT	**a1** • raw material derived from genetically modified sugarbeets • the sugarbeet is resistant to weed-killers meaning less spraying • gives higher yield and less waste • the genetically modified is not present in the hard candy • approved by the Ministry of Health • some people think that there is a risk of spreading resistance to other plants	**b1** • produced by genetically modifed enzymes • low in calories • can be consumed by diabetics • the enzymes are not present in the candy • approved by the Ministry of Health • some people think that ther e is a risk of unintentional outlet of active genetically modified micro-organisms in nature	**c1**
PRESENT, NOT LIVING	**a2**	**b2**	**c2**
LIVING/ ABLE TO FUNCTION	**a3**	**b3** • contains a soft inner filling produced by genetically modified enzymes • gives an exceptionally smooth/creamy filling • can only be made by use of modified enzymes • enzymes are present and active in the candy • approved by the Ministry of Health • some people think that there is a risk of un-intentional outlet of active genetically modi-fied mciro-organisms in nature	**c3** • with a soft filling containing genetically modified micro-organisms • with the micro-organisms the candy can prevent diarrhea and constipation • the micro-organisms are present and active in the candy • approved by the Ministry of Health • some people think that there is a risk of the genetically modfied micro-organisms colonizing the gut and, as a result, other micro-organisms will suffer
CONVENTIONAL	**conv** • produced by conventional enzymes from ordinary sugarbeets • do not contain any genetically modified material • culture is present and active in the product • approved by the Ministry of Health		

PRODUCT DESCRIPTIONS: SALMON

	What is modified		
DISTANCE	RAW MATERIAL	ENZYME PRODUCTION	MICRO-ORGANISMS
NOT PRESENT	**a1** • have ingested feed containing oil from genetically modified soybeans • gene modification makes the production process cheaper • the fodder contains no genetically modified material and therefore it is not present in the salmon • approved by the Ministry of Health • some people think that there is a risk of reducing the biodiversity in the areas where the soybeans are grown	**b1**	**c1** • to gain the pink colour the salmon is fed fodder containing genetically modified micro-organisms • use of the genetically modified micro-organisms results in lower production costs and lower consumer prices • the genetically modified micro-organisms are not present inthe salmon • approved by the Ministry of Health • some people think that ther e is a risk of unintentional outlet of active genetically modified micro-organisms in nature
PRESENT, NOT LIVING	**a2** • have been genetically modified for faster growth • less fodder is needed which saves natural resources • lower consumer prices • the genetically modified material is present but not active in the salmon • approved by the Ministry of Health • some people think that there is a risk of escaped genetically modified salmon might disturb spawning of wild salmon	**b2**	**c2**
LIVING/ ABLE TO FUNCTION	**a3** • have been genetically modified for faster growth • less fodder is needed which saves natural resources • lower consumer prices • the genetically modified material is present and active in the salmon • approved by the Ministry of Health • some people think that there is a risk of escaped genetically modified salmon might disturb spawning of wild salmon	**b3**	**c3**
CONVENTIONAL	**conv** • bred by traditional methods • fodder does not contain any genetically modified material • approved by the Ministry of Health		

APPENDIX 2: CATEGORIES

Cheese

Attributes

Natural product, pure raw materials
Not genetically modified
Genetically modified
No active enzymes
Approved by health authorities
Lower price
Poorer quality
Good taste
Not natural/artificial product
Traditional product/taste
Full, rich taste
Good quality
Active culture/enzymes

Consequences

Healthy, avoid illness
Less energy, fatigue, feel unwell
Less healthiness, disease, abnormities
Irritation/trouble
Uncertainty, do not know what it is
Influences ability to work
Increases immune system
Affects other micro organisms in stomach, unbalanced gut microflora
Harms nature/environment, plants, animals disappear
Harms future generations
Spreading of genetically modified organisms in nature
Safety, know what you get
Less enjoyment
Become a problem for society
Enjoyment
Save money, better economy, buy something else
Lower cancer risk
Positive effect on gut and intestines
Swop of genes results in pathogenic bacteria
Give more energy
Harms immune system/natural balance
Good for the environment/nature
Allergy risk
Native, brand loyalty
Try somehting new, surprises, choices
Higher cancer risk
No allergy risk

Values

Happiness, well-being, quality of life
Freedom, independence, personal development
Care for others, the family and good social relations
Security
Self-esteem
Activity, energy
Good health and long life
Respect for nature/environment/follwoing generations

Candy

Attributes

Natural product, pure raw materials
Not genetically modified
Genetically modified candy/sugarbeets
Approved by health authorities
Lower price
Poor quality
Good quality/taste
Unnatural/artificial product
Traditional normal product/production process
Genetically modified material present in candy
Genetically modified material not present in candy
Less calories
Soft/creamy filling

Consequences

Healthy, avoid illness
Less energy, fatigue, feel unwell
Less healthy, disease, deformities
Uncertainty, do not know what it is, uncontrolled
Influences ability to work
Harms nature/environment, plants, animals disappear
Harms future generations, genetic disturbance
Spreading of genetically modified organisms in nature
Safety, know what you get
Less enjoyment
Enjoyment
Save money, better economy, buy something else
Gives more energy
Good for the environment/nature, natural balance maintained
Less waste/bigger crop
Less use of pesticides
Risk of harmful effects in stomach
Good for stomach – medicine
Stay/become slim
Diabetics can eat
Beautiful body

Values

Happiness, well-being, quality of life
Freedom, independence, personal development
Care for others, the family and good social relations
Security
Self-esteem
Activity, energy
Good health and long life

Salmon

Attributes

Natural product, pure raw materials
Not genetically modified
Genetically modified animal
Approved by health authorities
Lower price
Poor quality
Good quality/taste
Unnatural/artificial product
Traditional normal product/production process
Genetically modified material present in fish
Genetically modified fodder/soybeans
Genetically modified material not present in fish
No genetically modified material in fodder
Fed genetically modified fodder to gain pink colour

Consequences

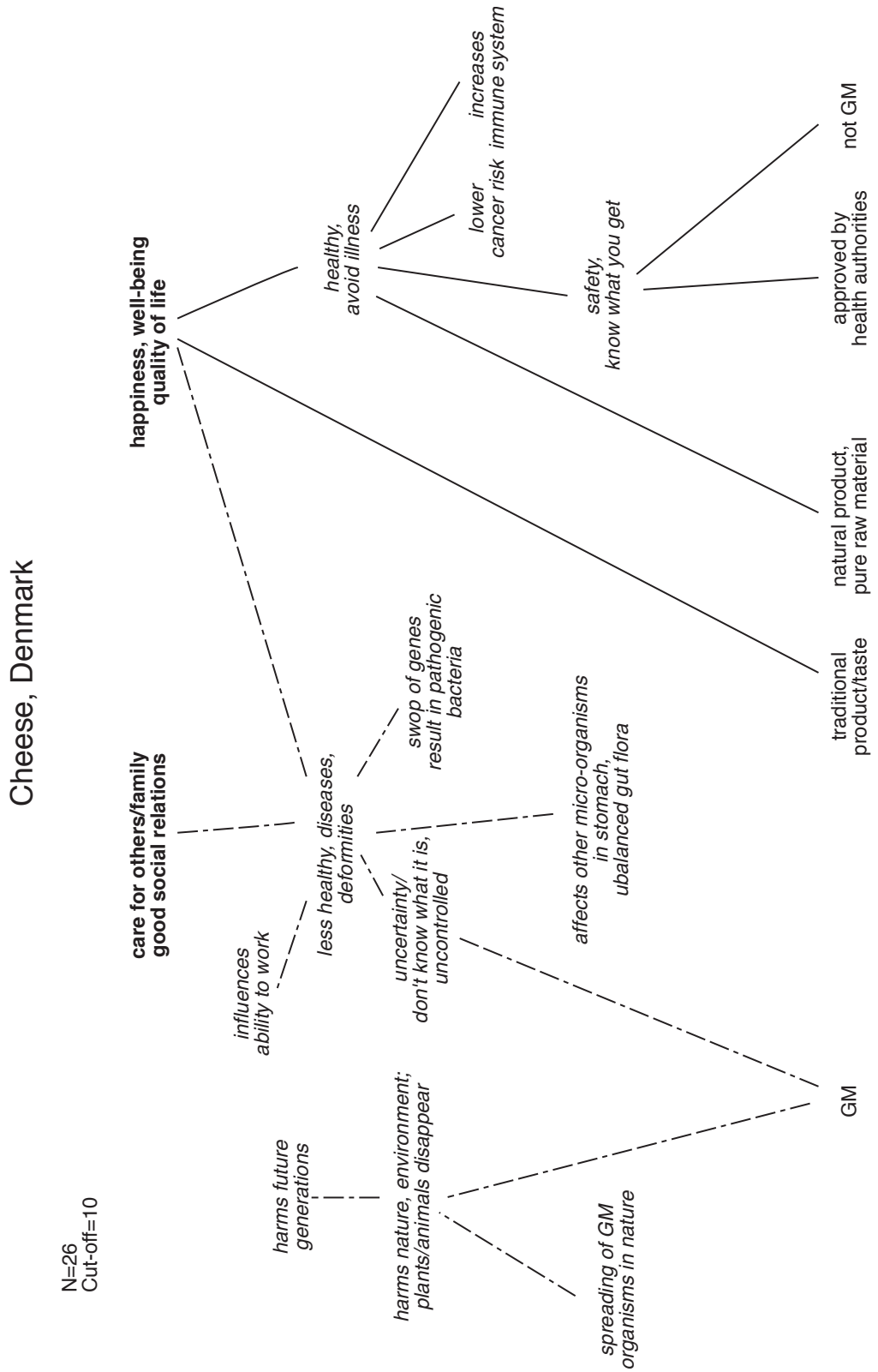
Healthy, avoid illness
Less energy, fatigue, feel unwell
Less healthy, disease, deformities
Uncertainty, do not know what it is
Influences ability to work
Harms nature/environment, plants, animals disappear
Harms future generations, genetic disturbance
Spreading of genetically modified organisms in nature
Safety, know what you get
Less enjoyment
Enjoyment
Save money, better economy, buy something else
Gives more energy
Good for the environment/nature, natural balance maintained
Fast growth
Disturbance of wild salmon reproduction
Less use of fodder
I want more information
I want something new
Unnecessary
Refuse consumption
Positive for consumer and consumption

Values

Happiness, well-being, quality of life
Freedom, independence, personal development
Care for others, the family and good social relations
Security
Self-esteem
Activity, energy
Good health and long life

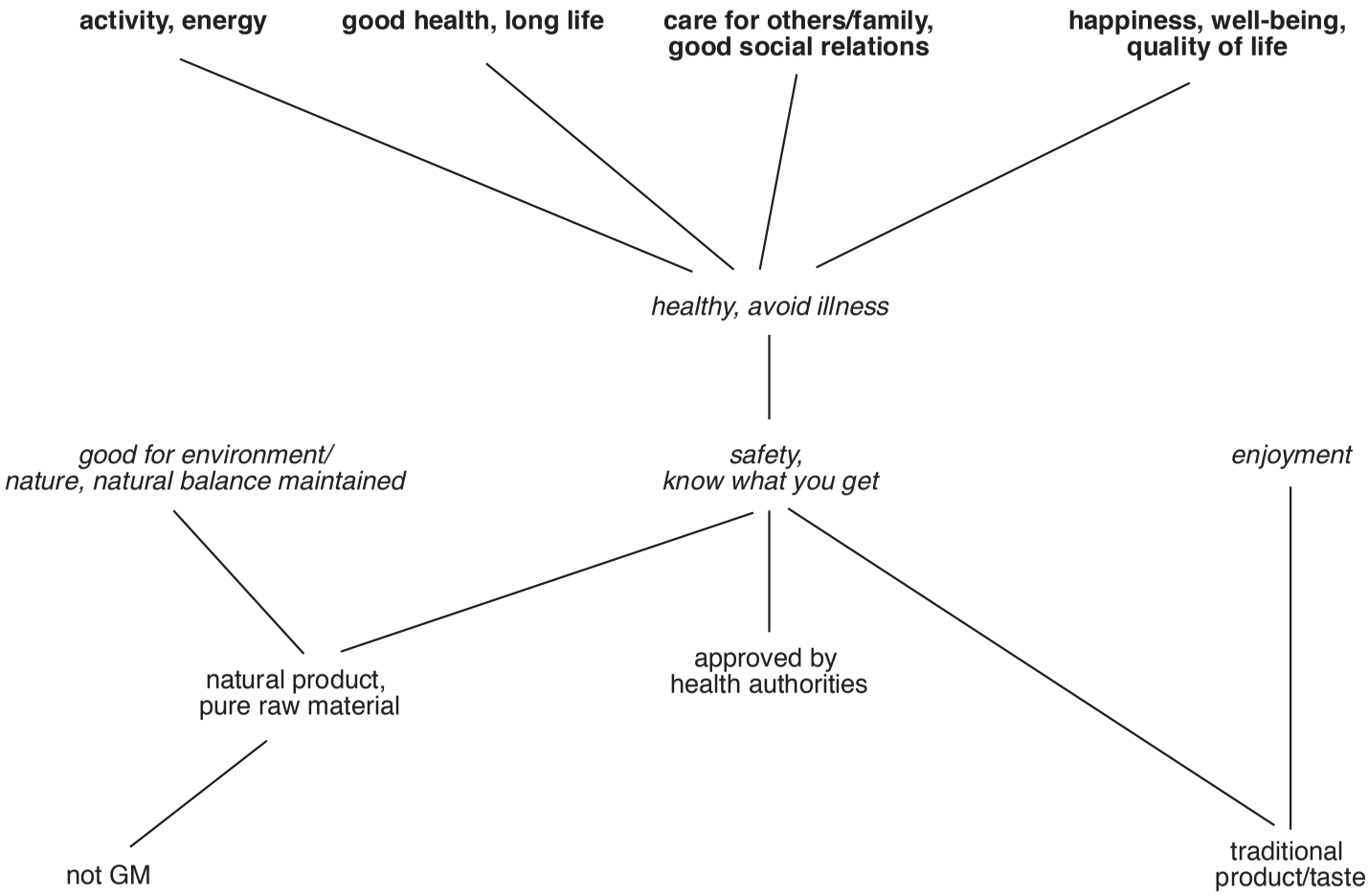
APPENDIX 3: HIERARCHICAL VALUE MAPS

A solid line means "leads to"
A dotted line means "prevents"



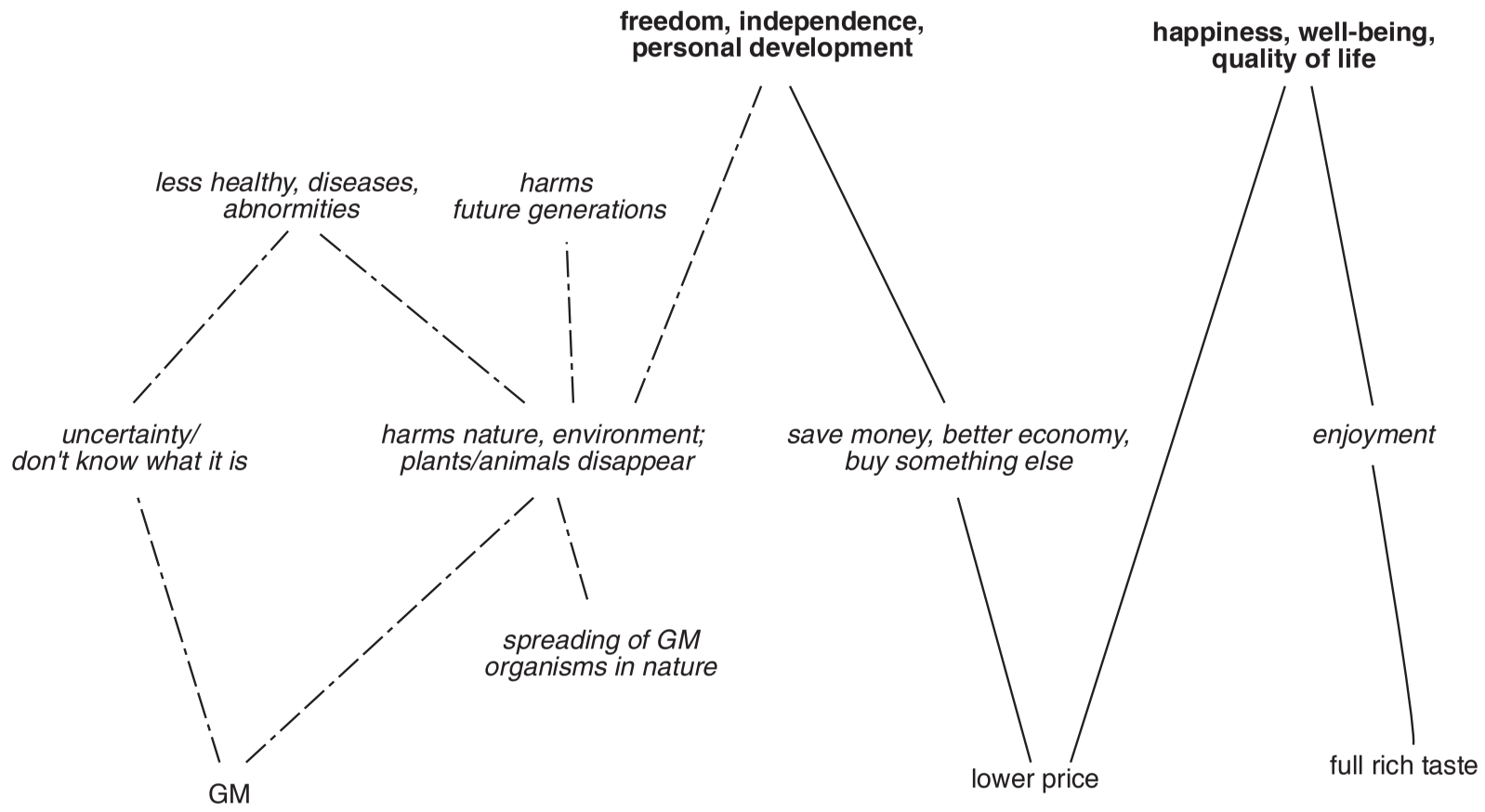
Cheese conventional, Denmark

N=26
Cut-off=4



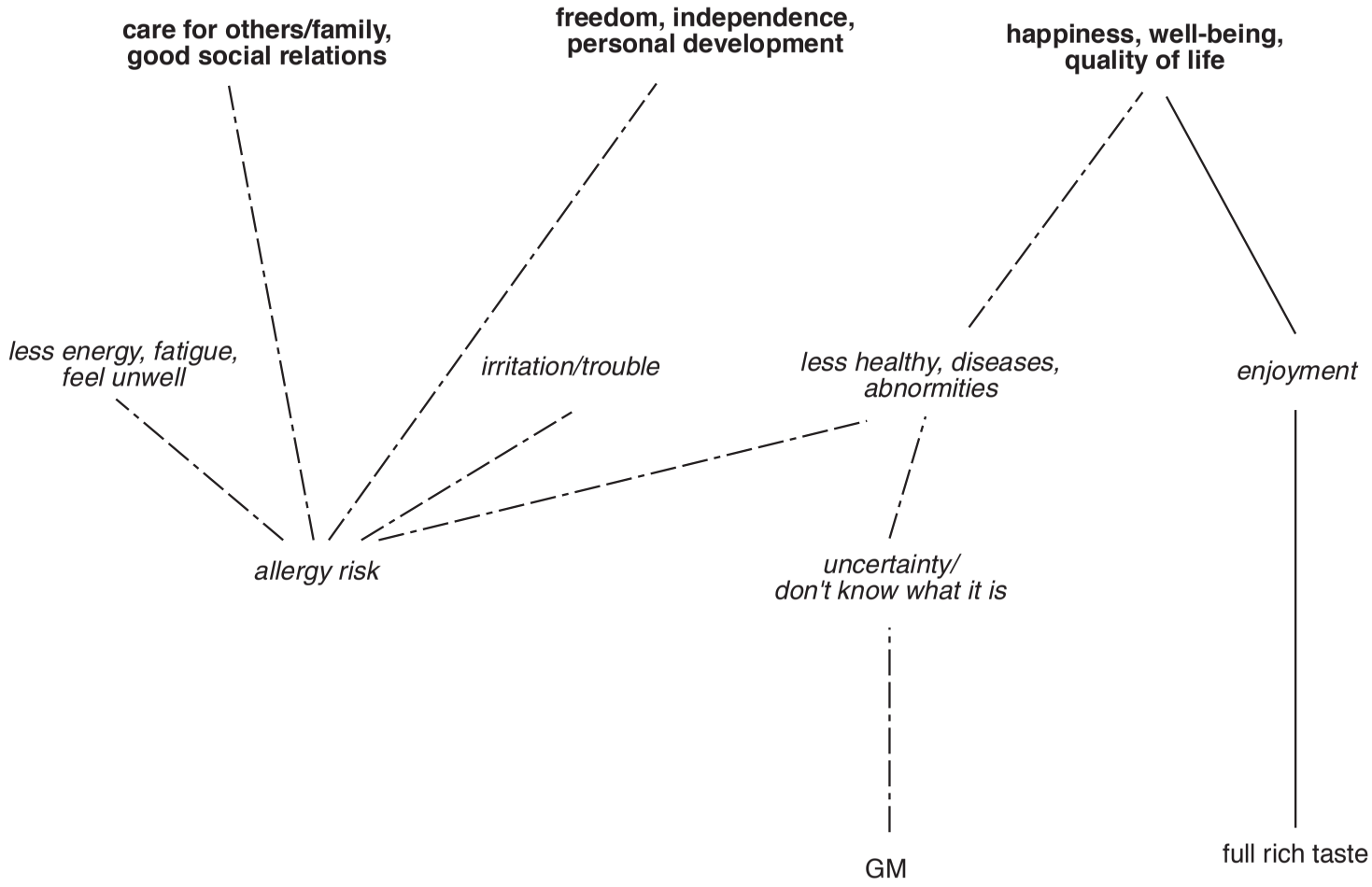
Cheese b2, Denmark

N=26
Cut-off=4

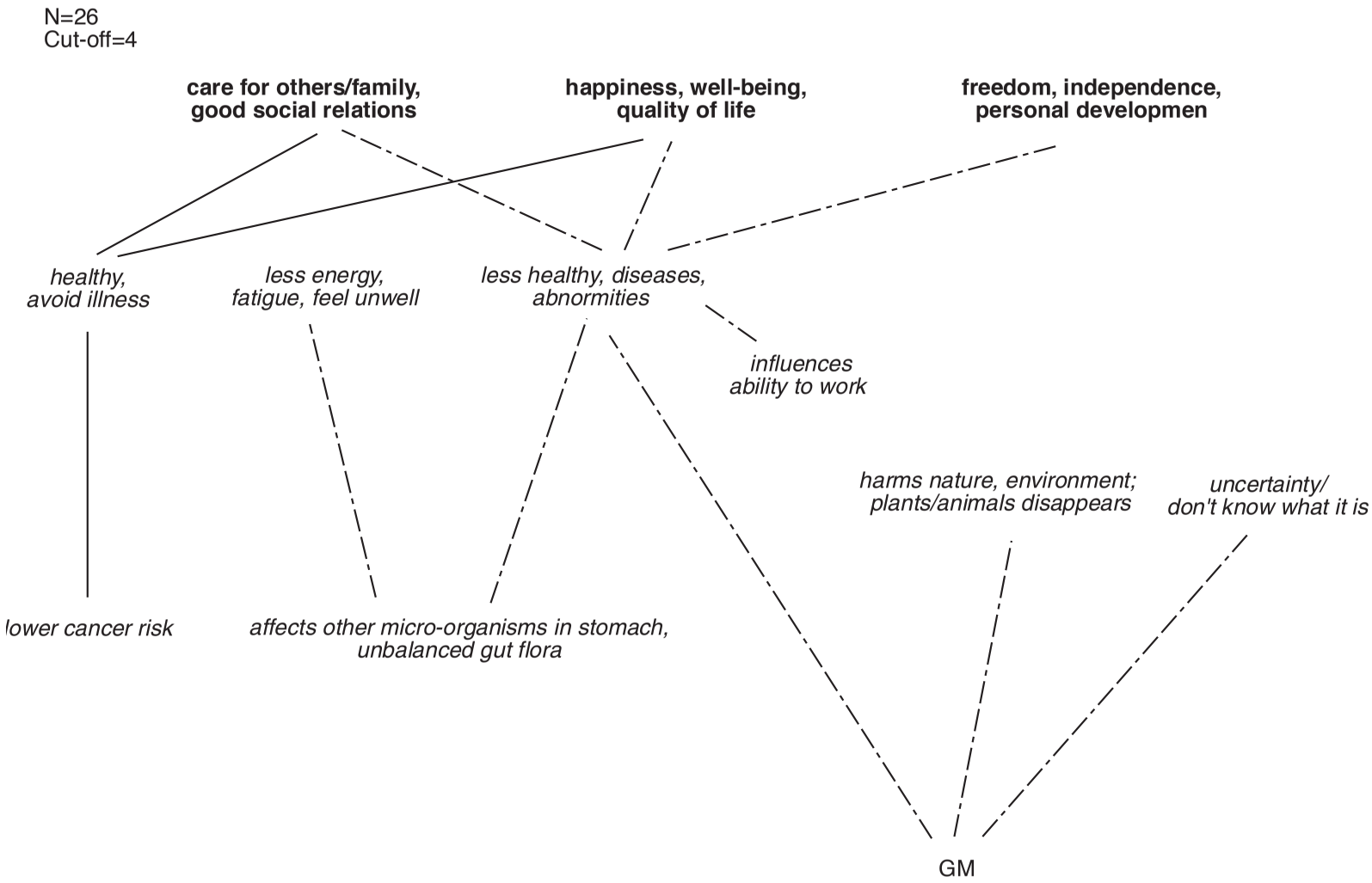


Cheese b3, Denmark

N=26
Cut-off=4

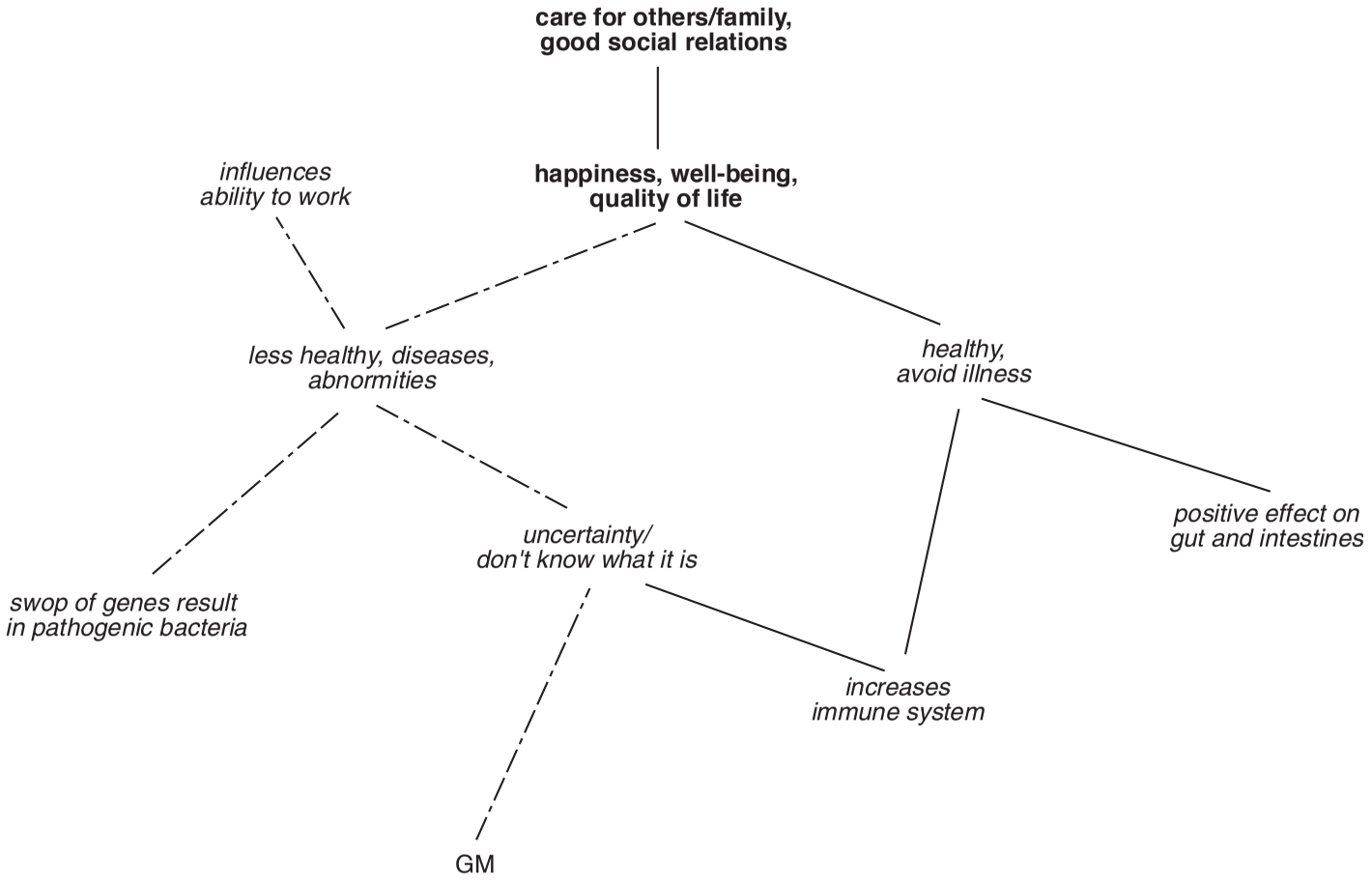


Cheese c2, Denmark

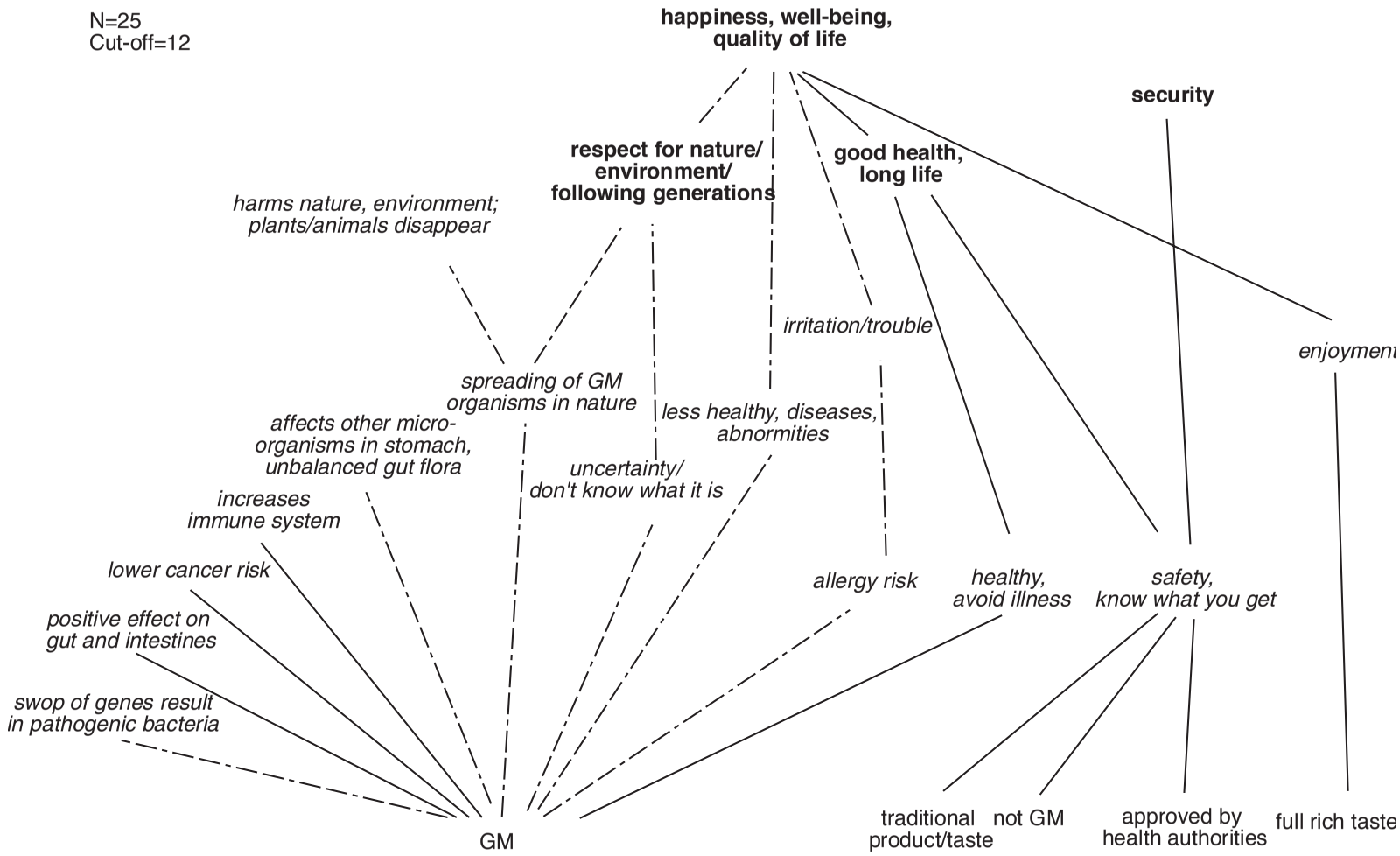


Cheese c3, Denmark

N=26
Cut-off=4

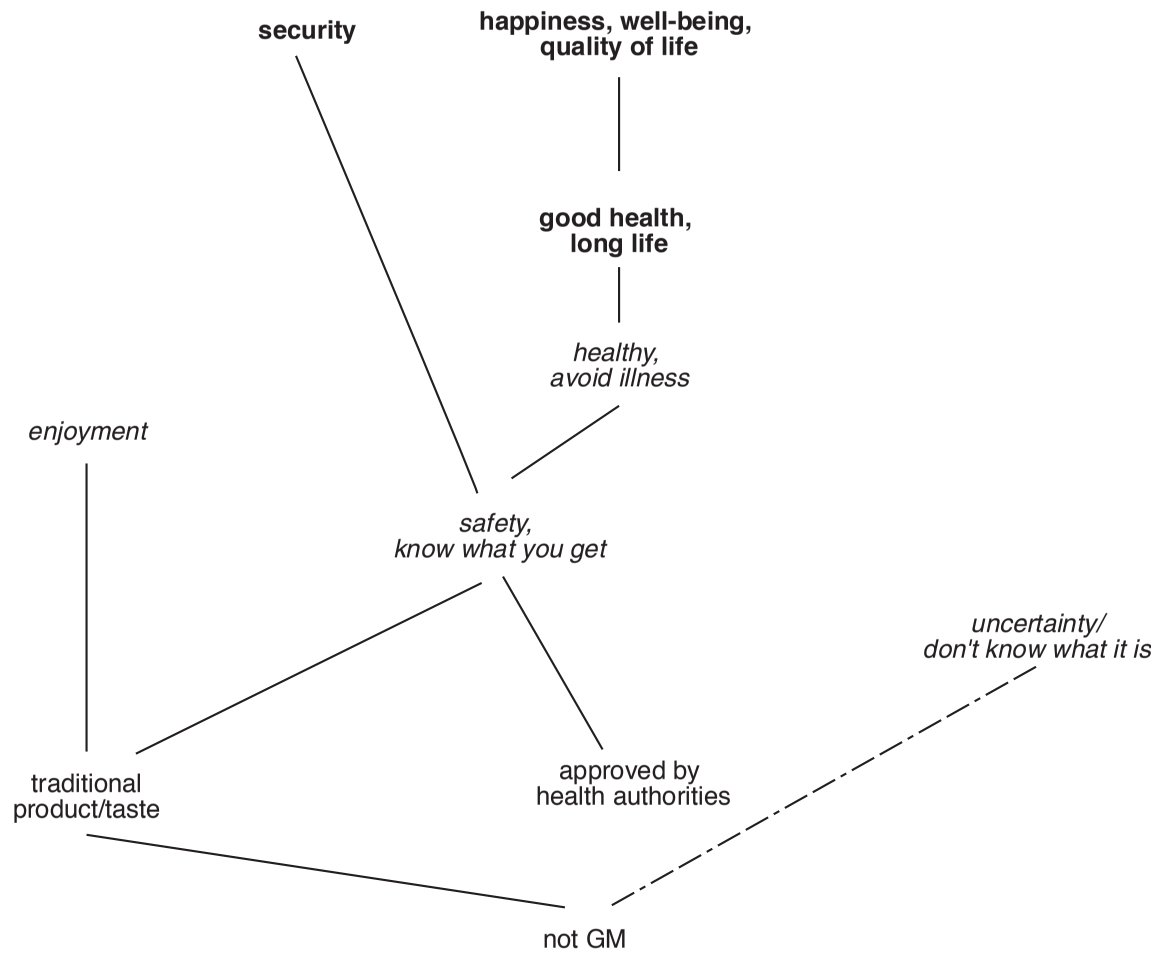


Cheese, Finland



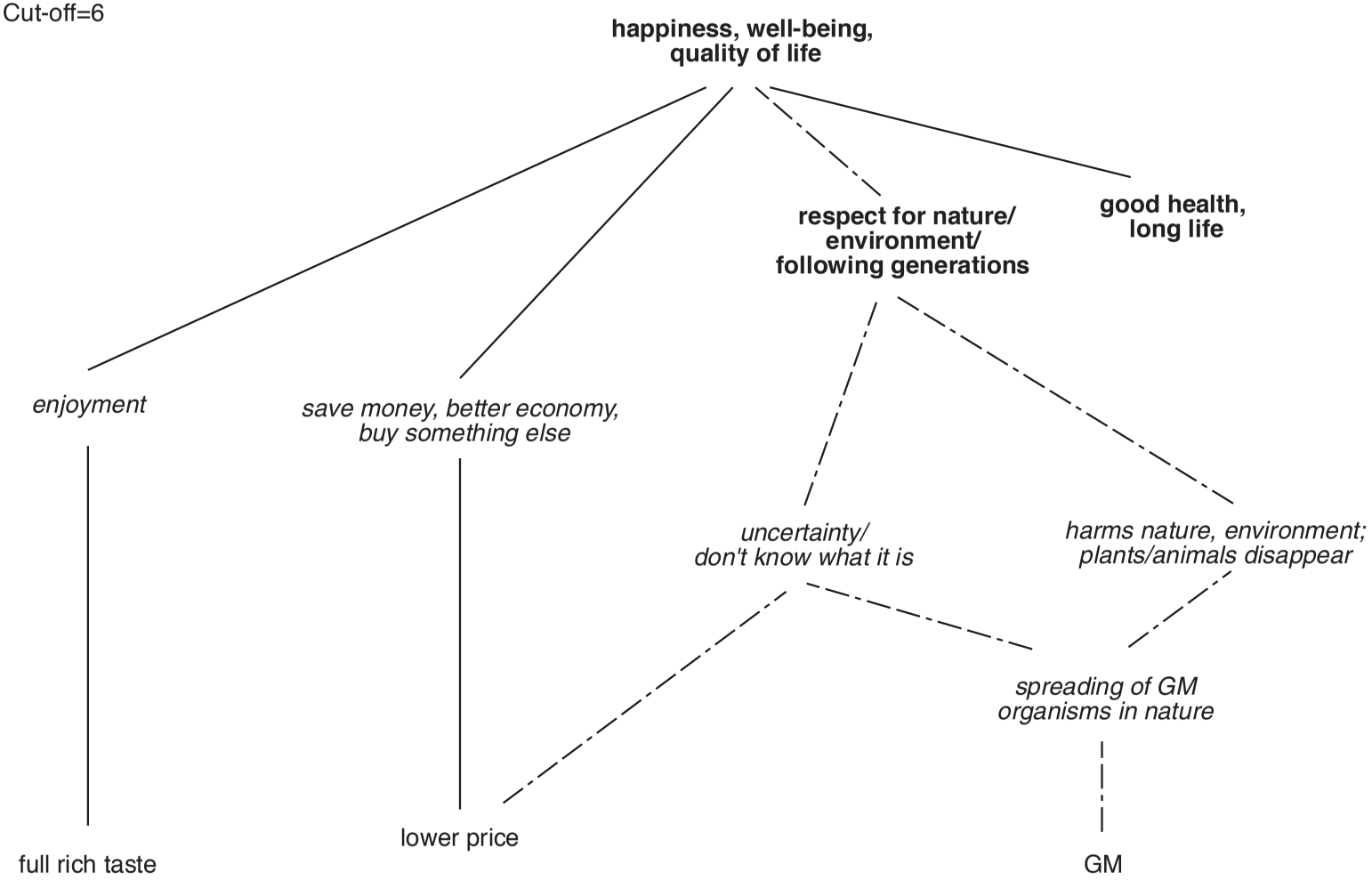
Cheese conventional, Finland

N=25
Cut-off=6



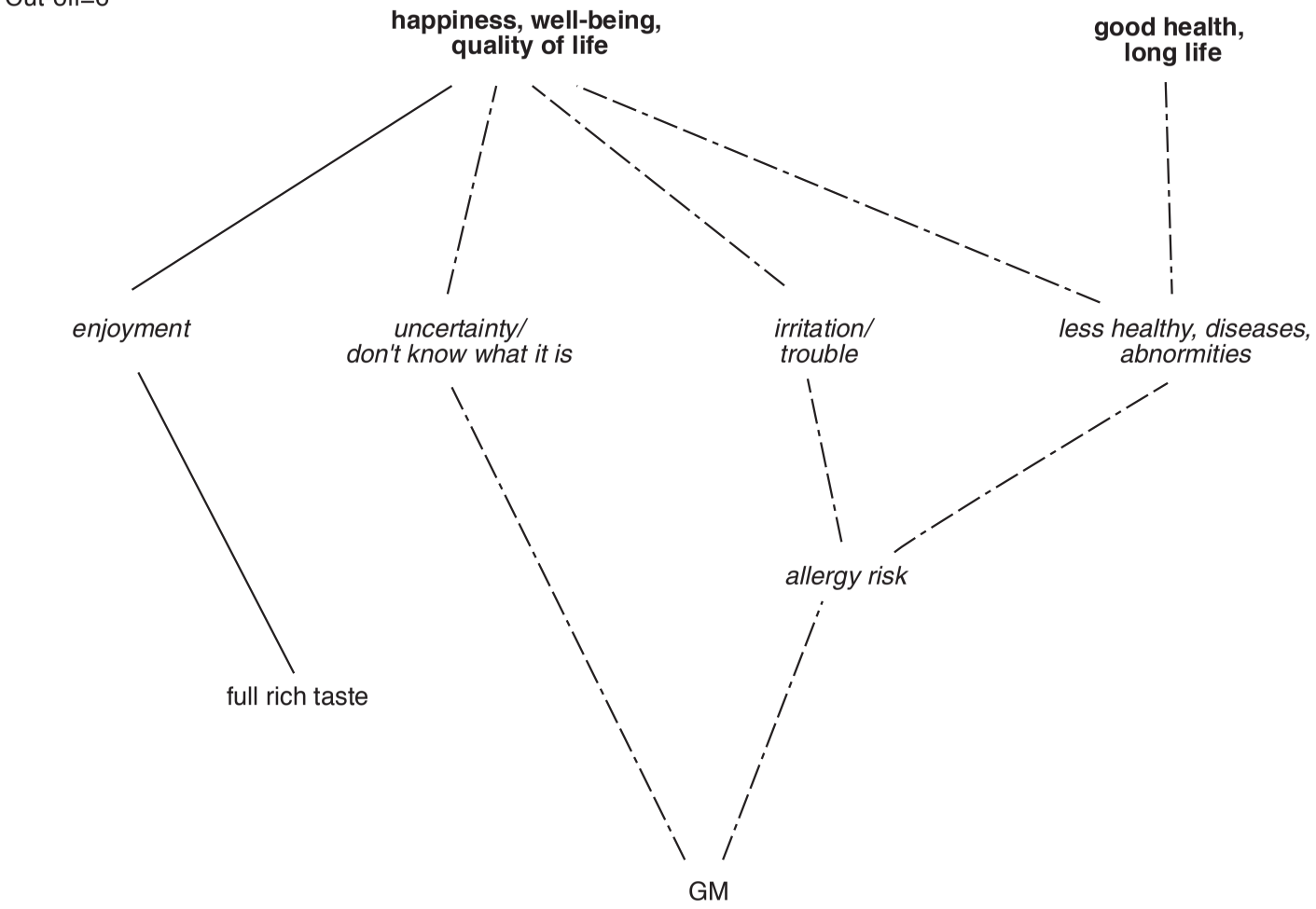
Cheese b2, Finland

N=25
Cut-off=6



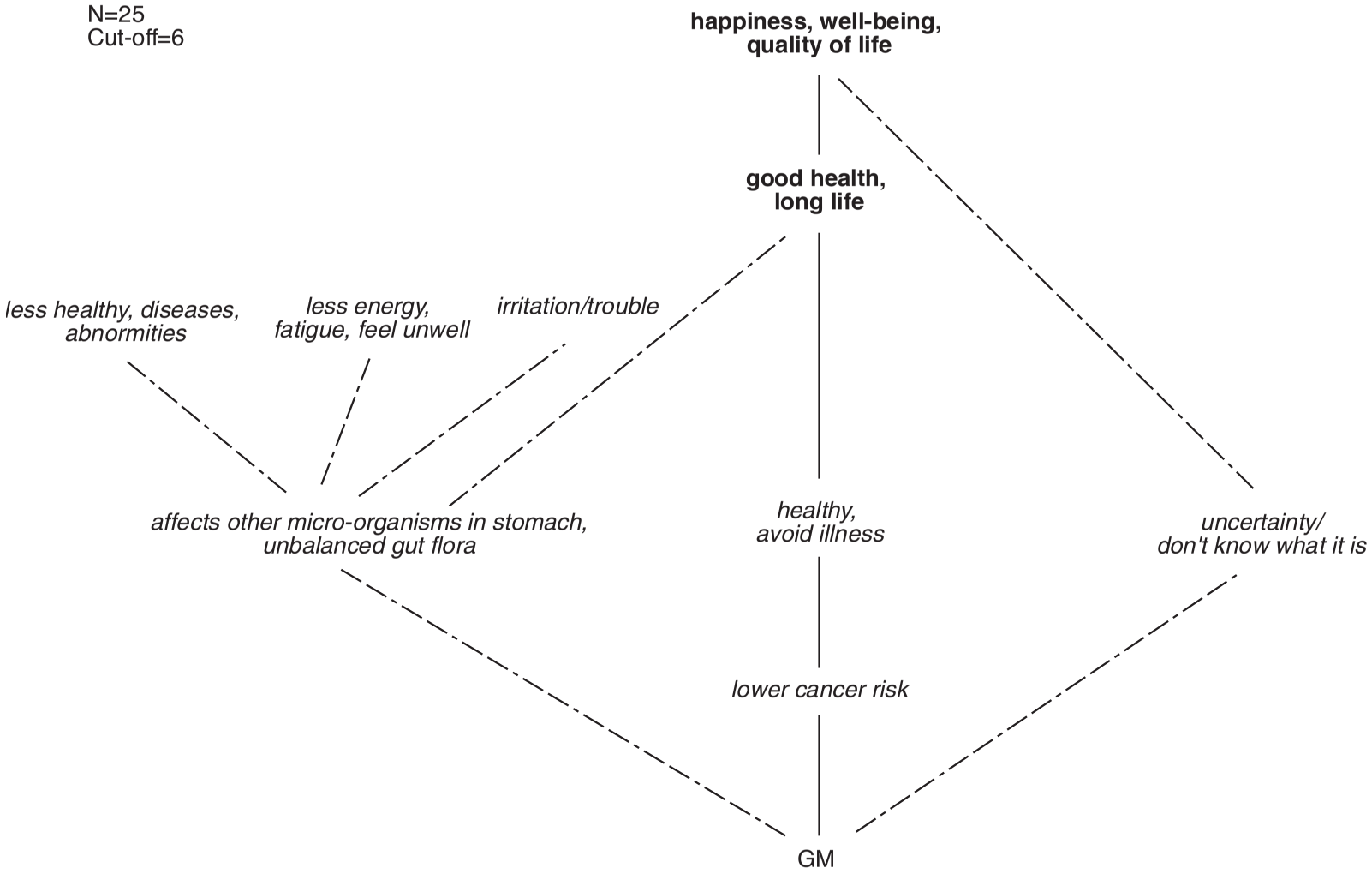
Cheese b3, Finland

N=25
Cut-off=6



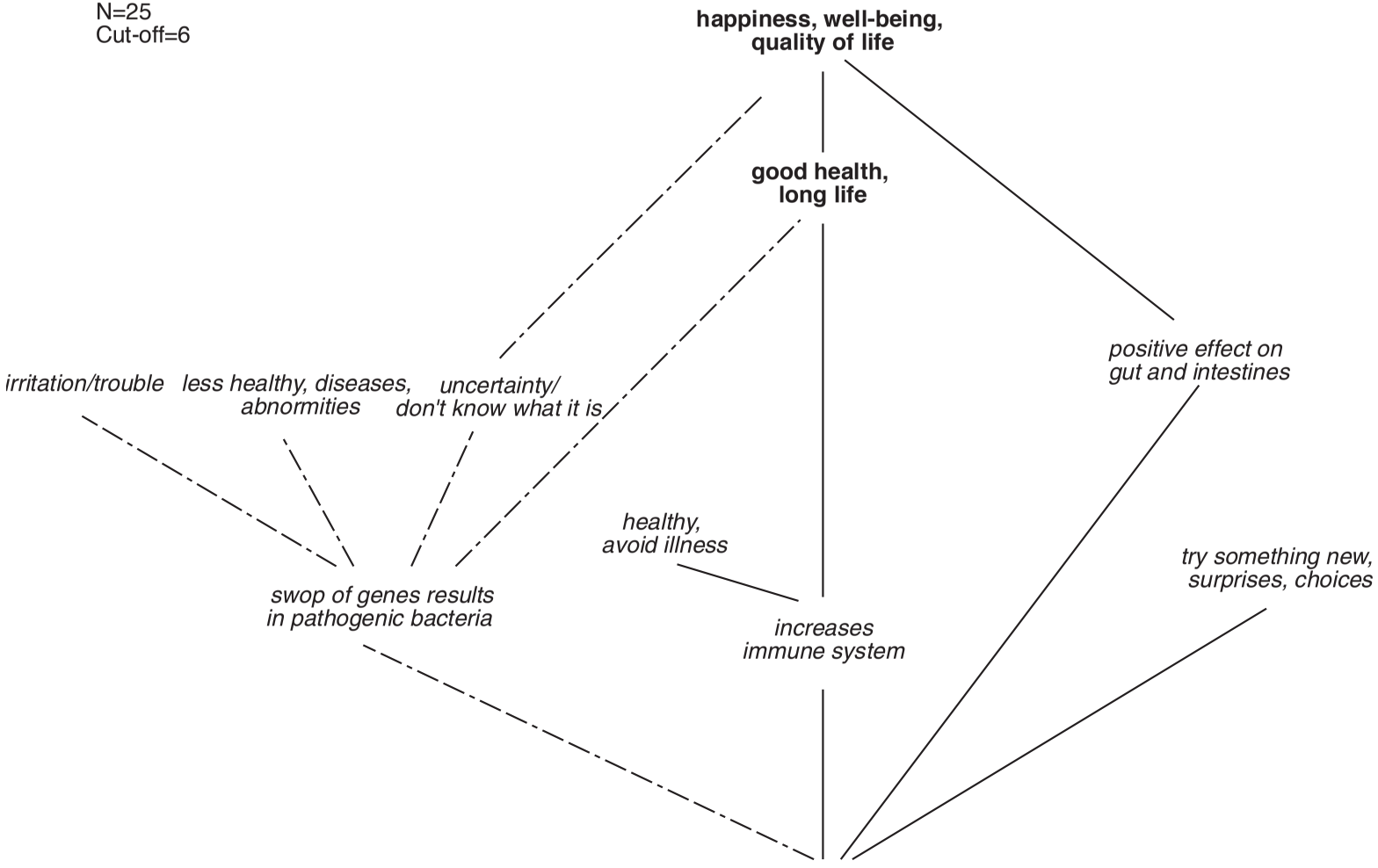
Cheese c2, Finland

N=25
Cut-off=6



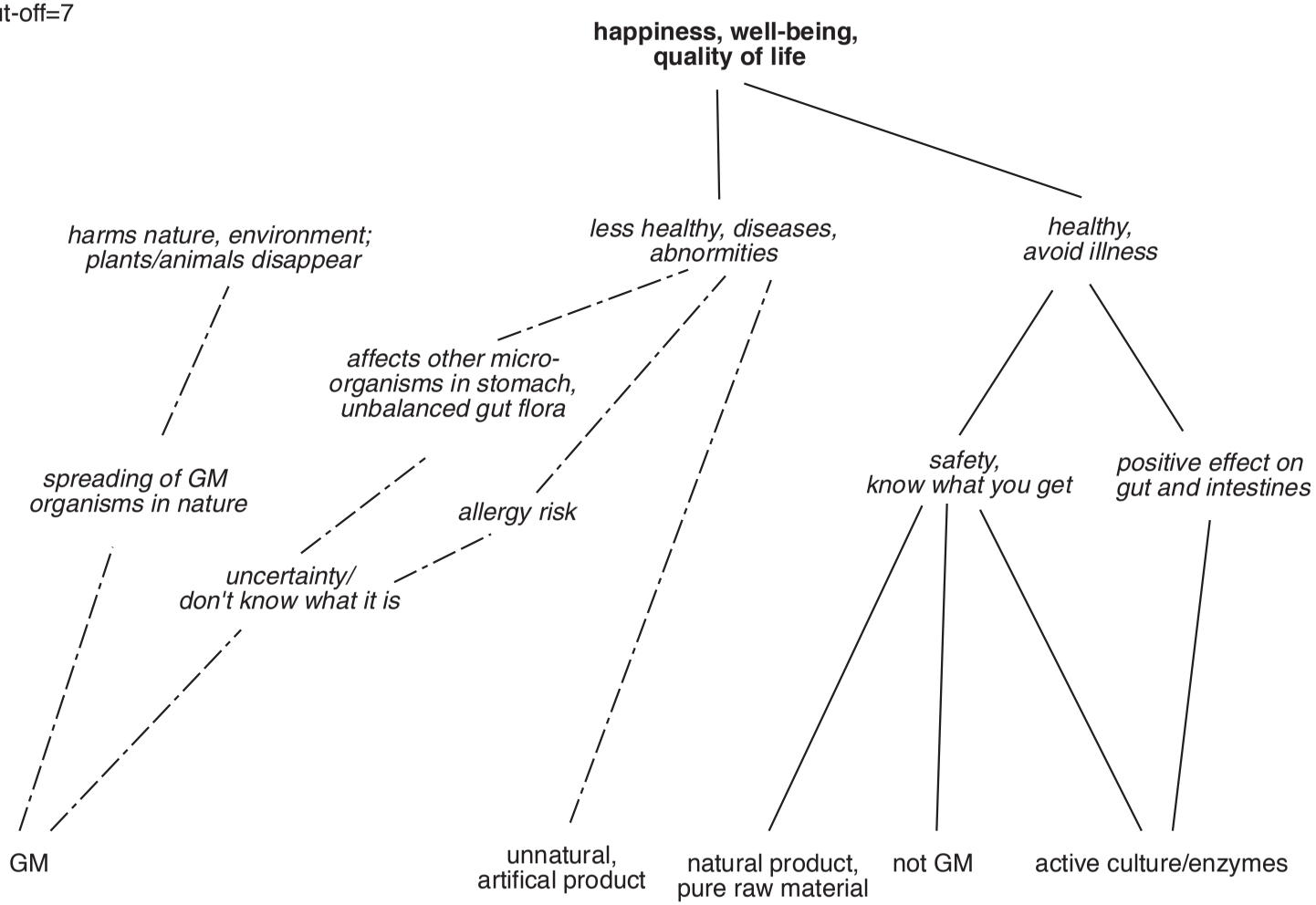
Cheese c3, Finland

N=25
Cut-off=6



Cheese, Sweden

N=25
Cut-off=7

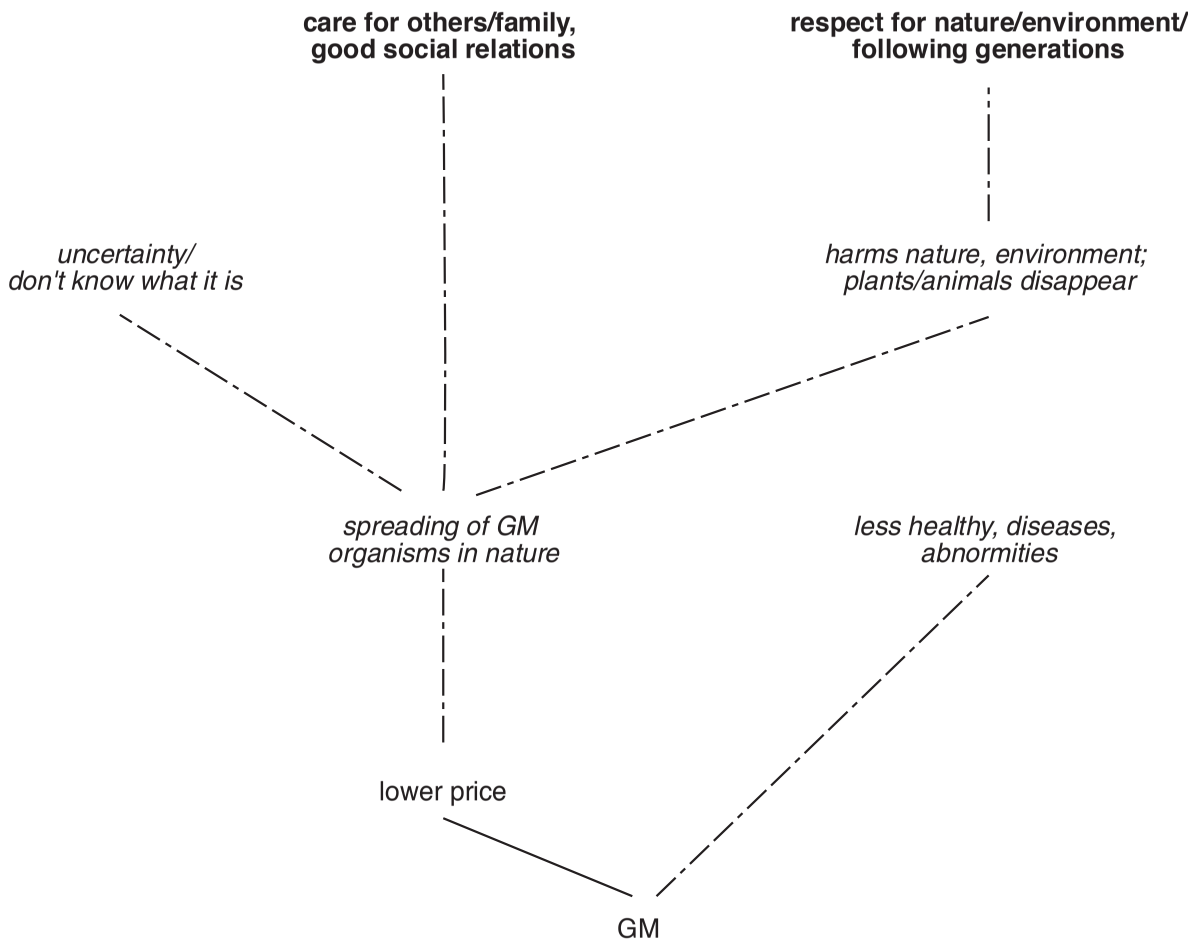


Cheese conventional, Sweden

N=25
Cut-off=4

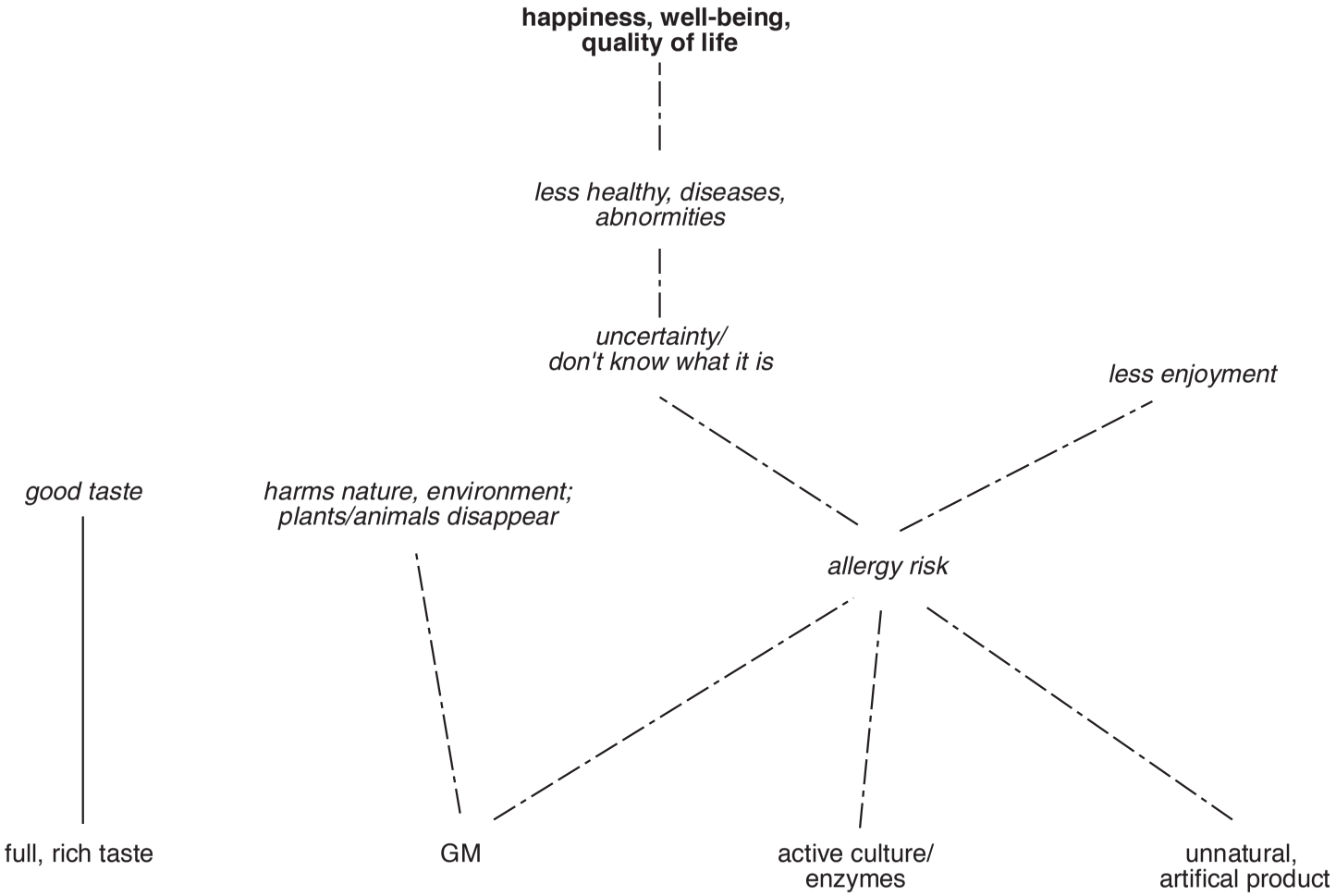
Cheese b2, Sweden

N=25
Cut-off=4



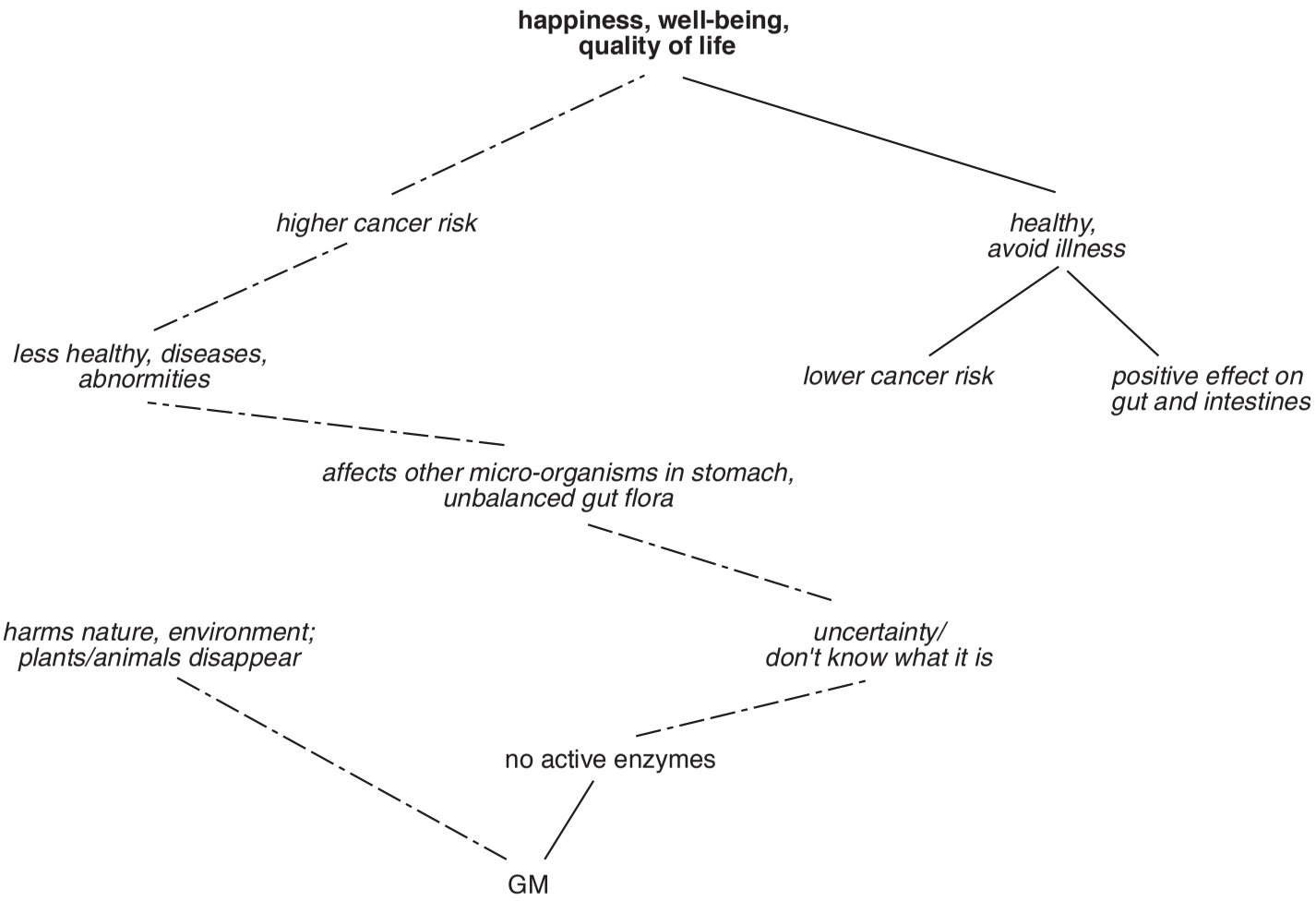
Cheese b3, Sweden

N=25
Cut-off=4



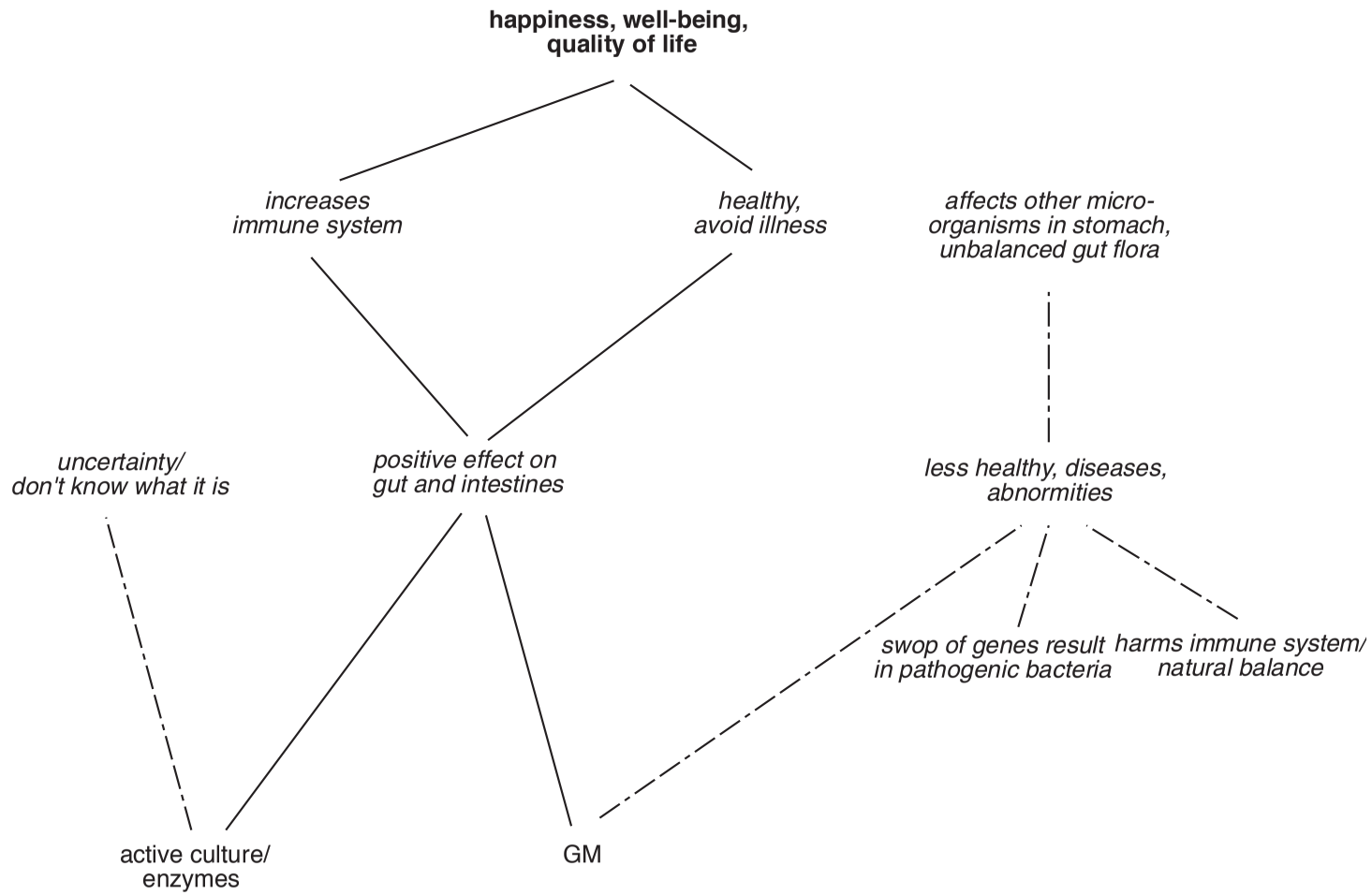
Cheese c2, Sweden

N=25
Cut-off=4



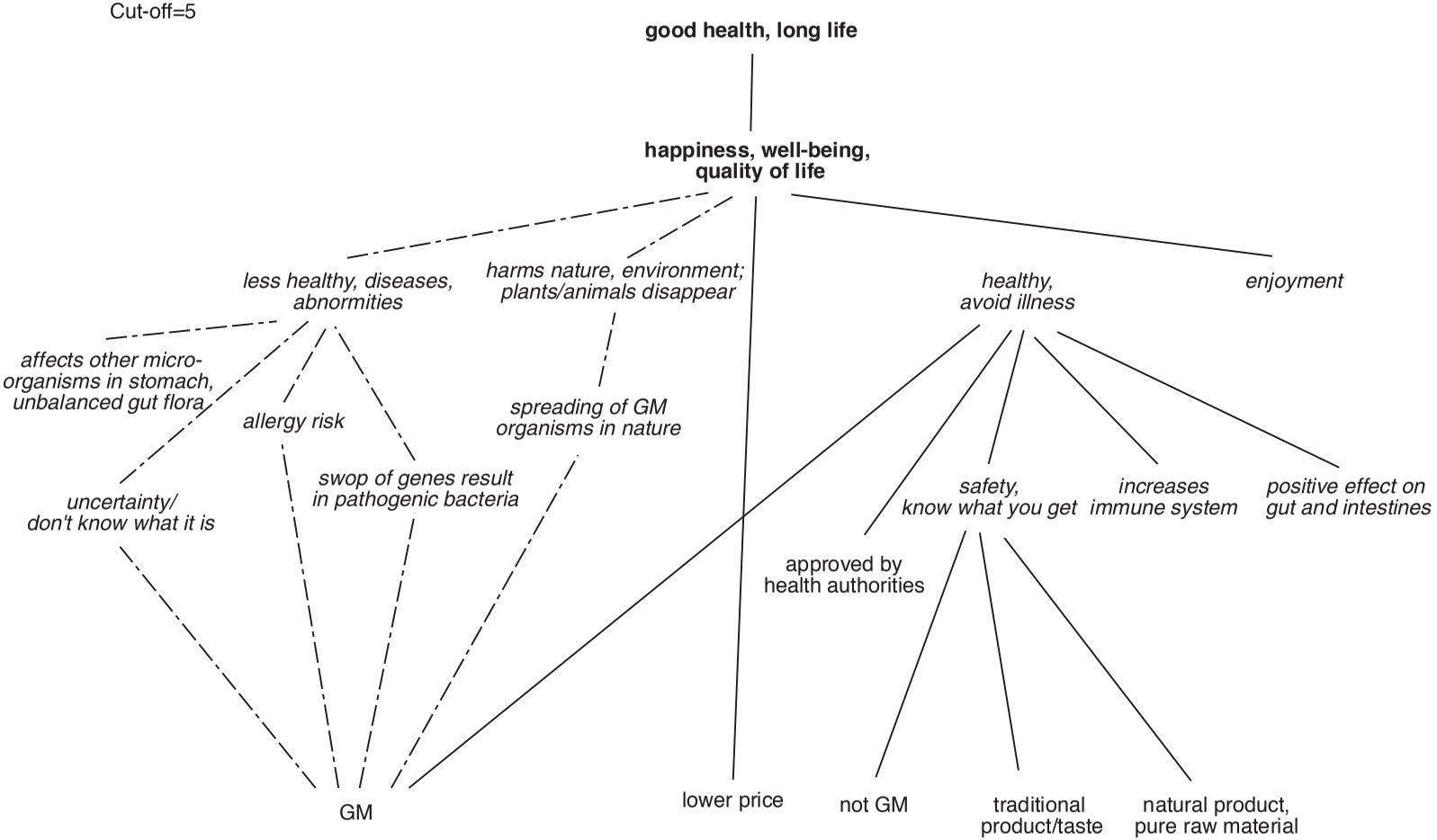
Cheese c3, Sweden

N=25
Cut-off=4



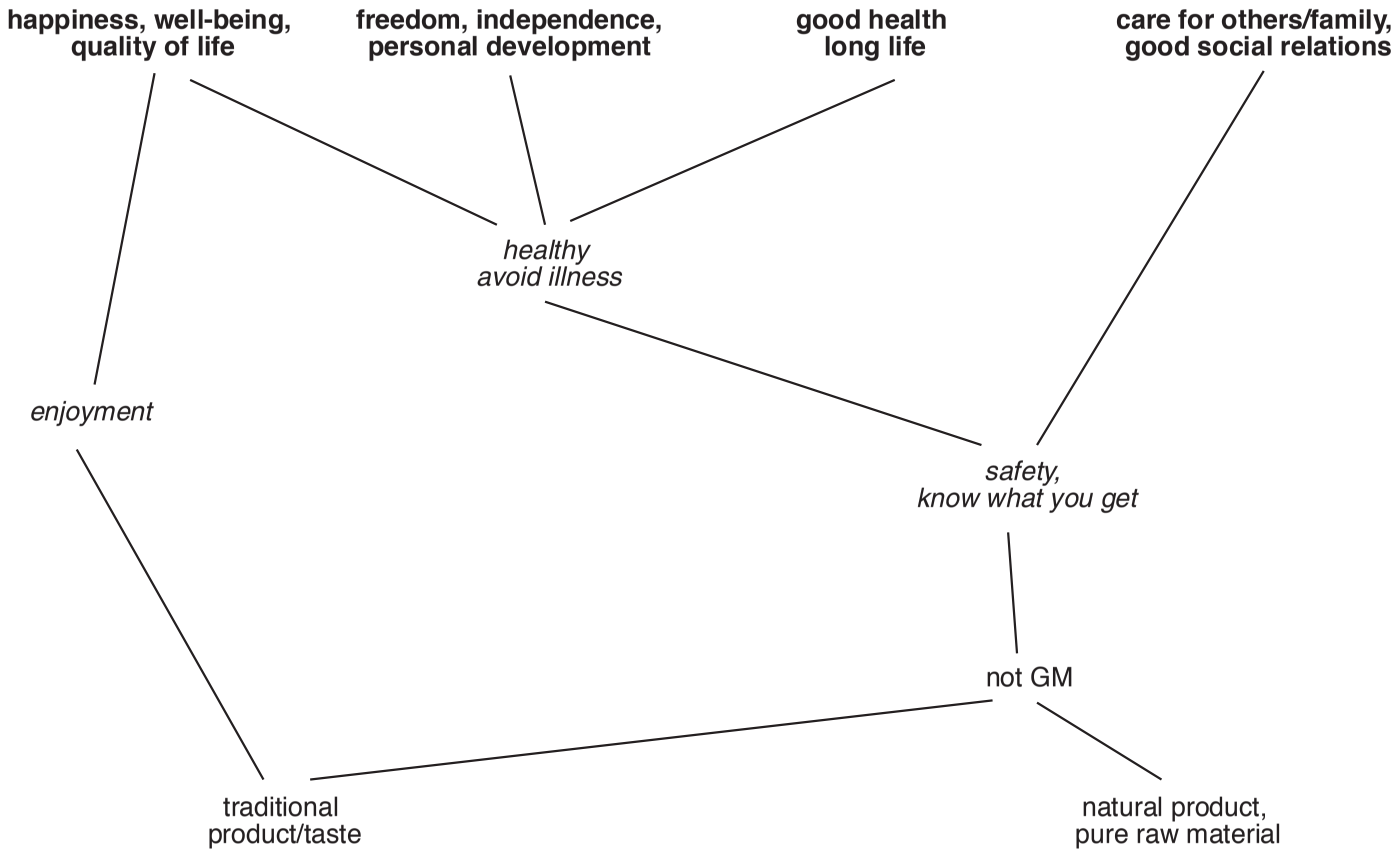
Cheese, Norway

N=19
Cut-off=5



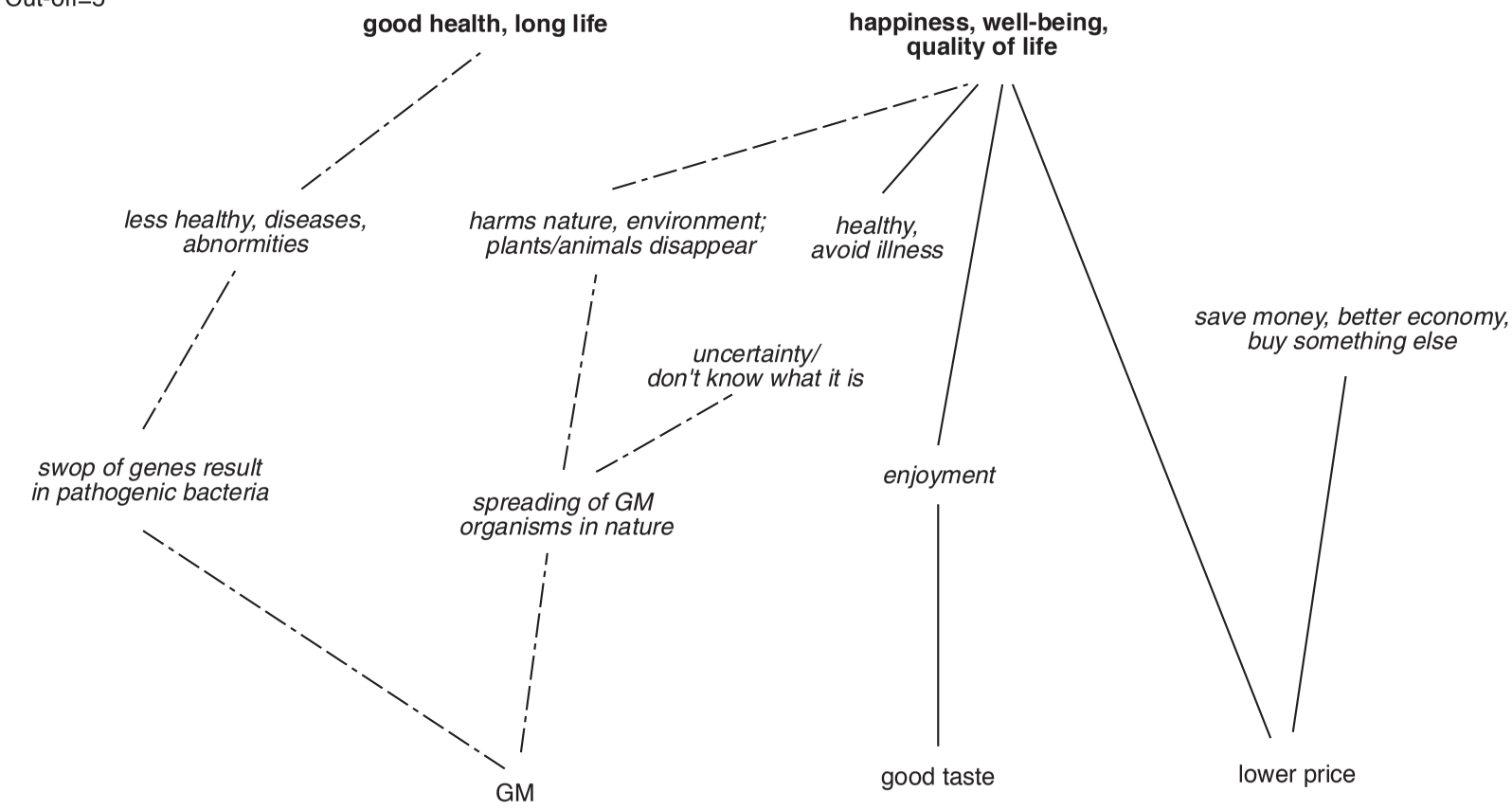
Cheese conventional, Norway

N=19
Cut-off=3



Cheese b2, Norway

N=19
Cut-off=5

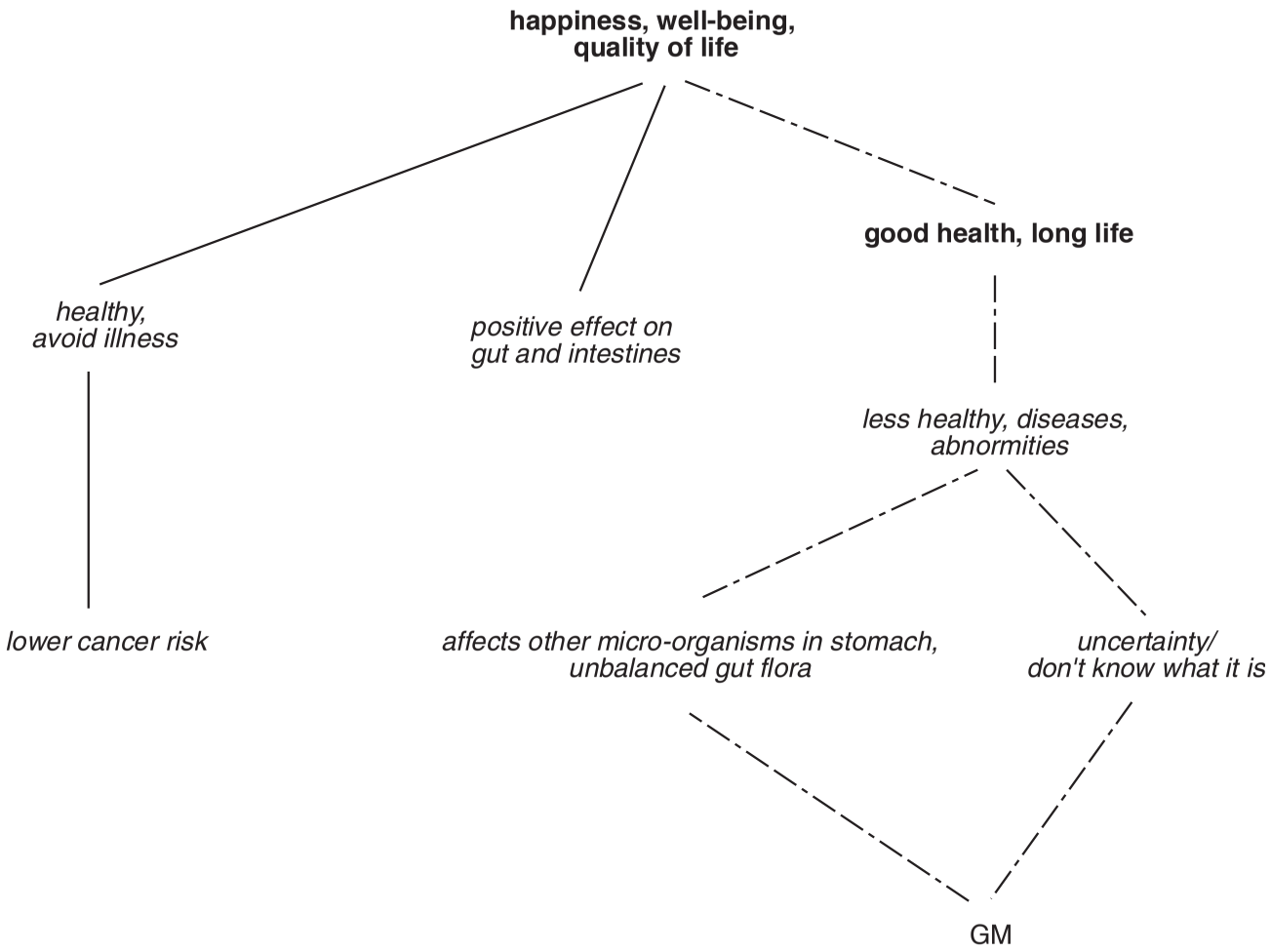


Cheese b3, Norway

N=19
Cut-off=3

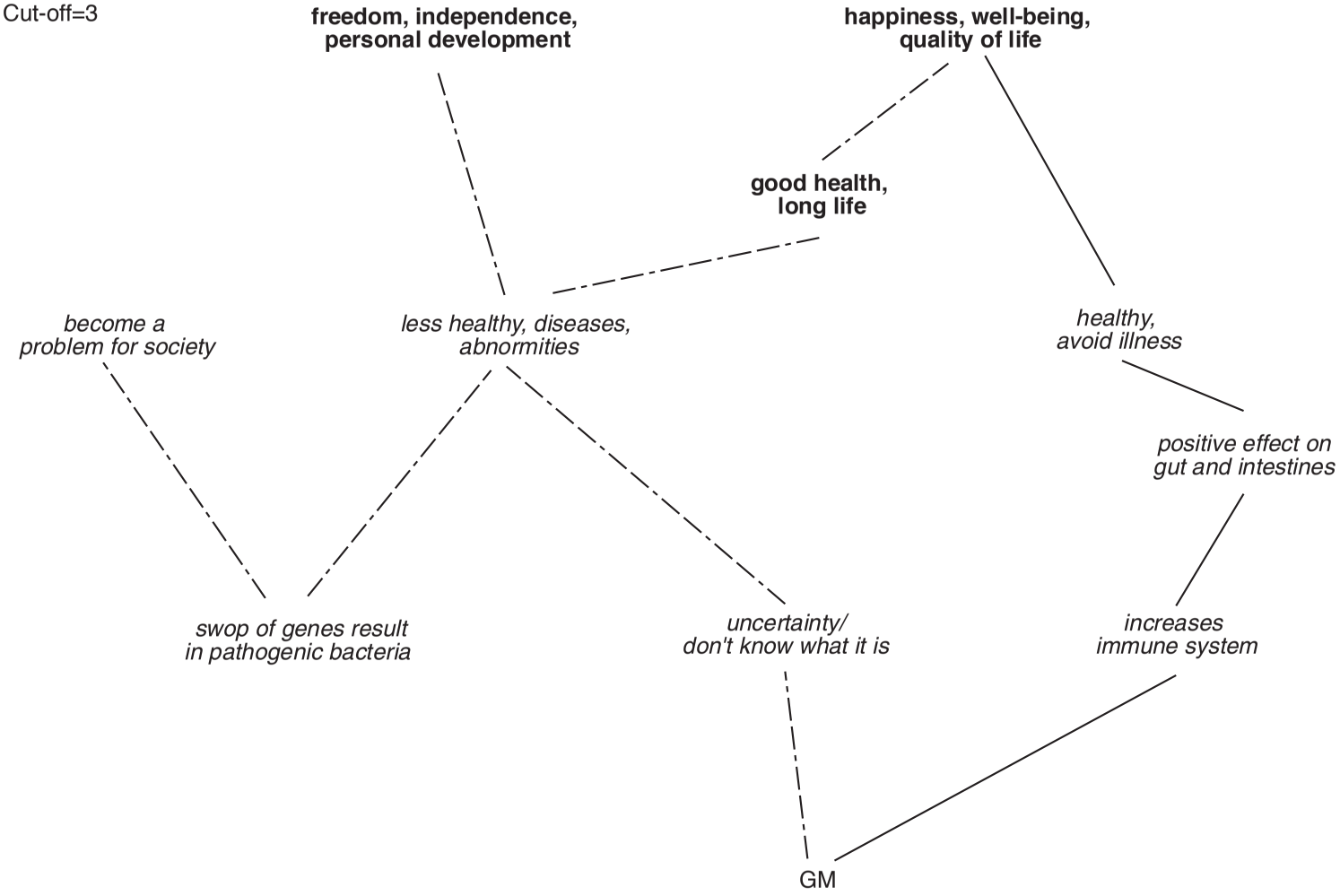
Cheese c2, Norway

N=19
Cut-off=3

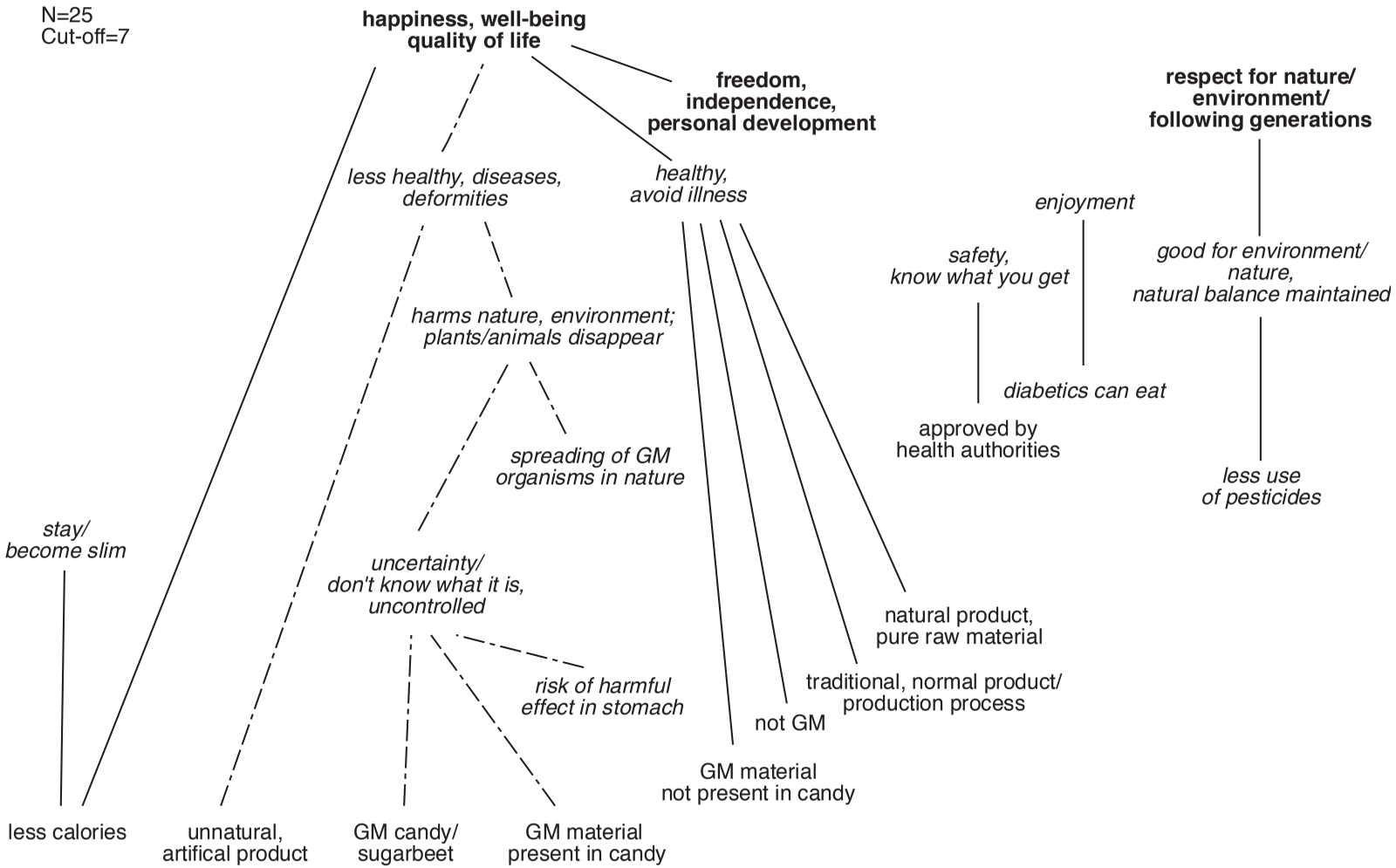


Cheese c3, Norway

N=19
Cut-off=3

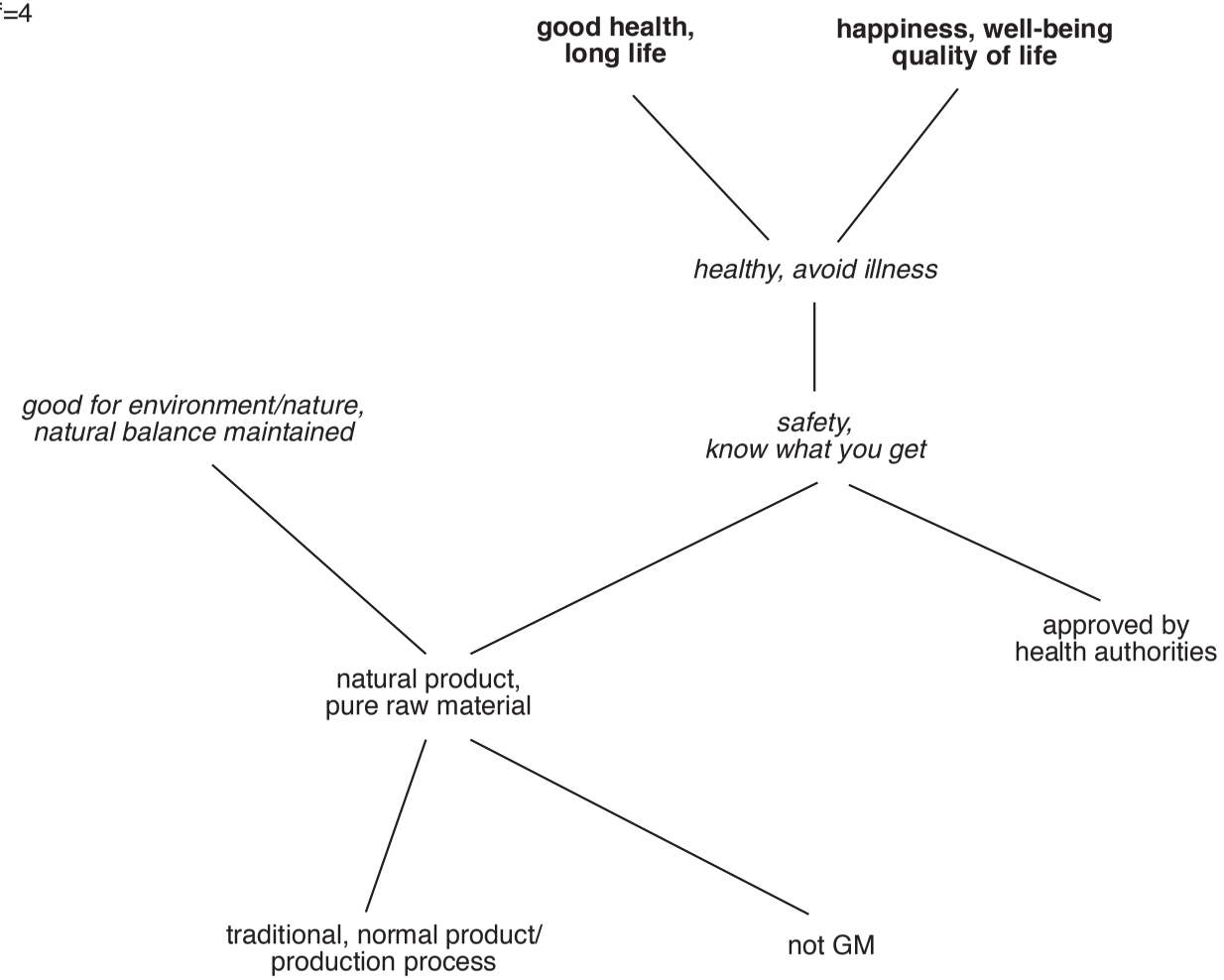


Candy, Denmark

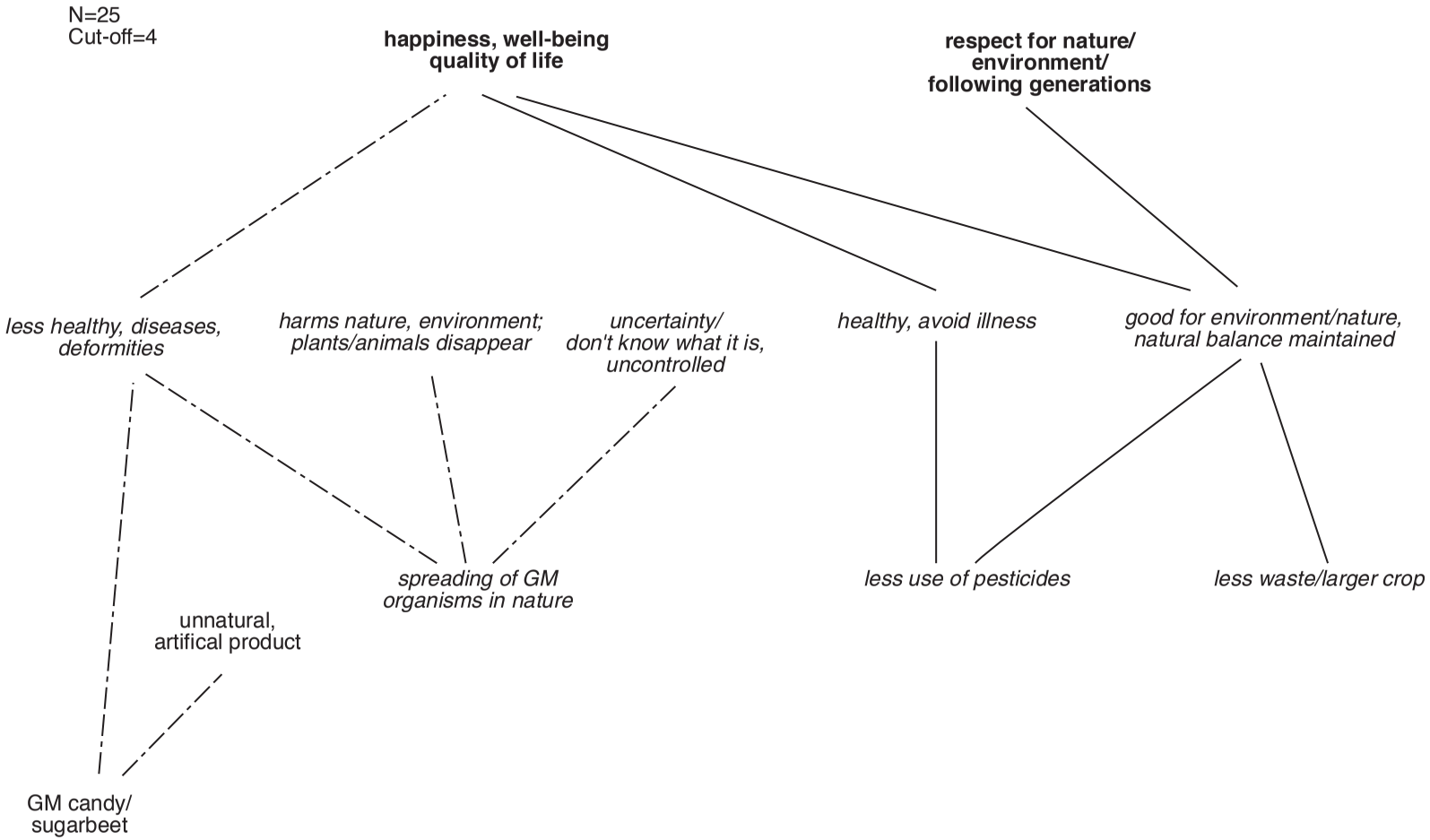


Candy conventional, Denmark

N=25
Cut-off=4



Candy a1, Denmark



Candy b1, Denmark

N=25
Cut-off=4

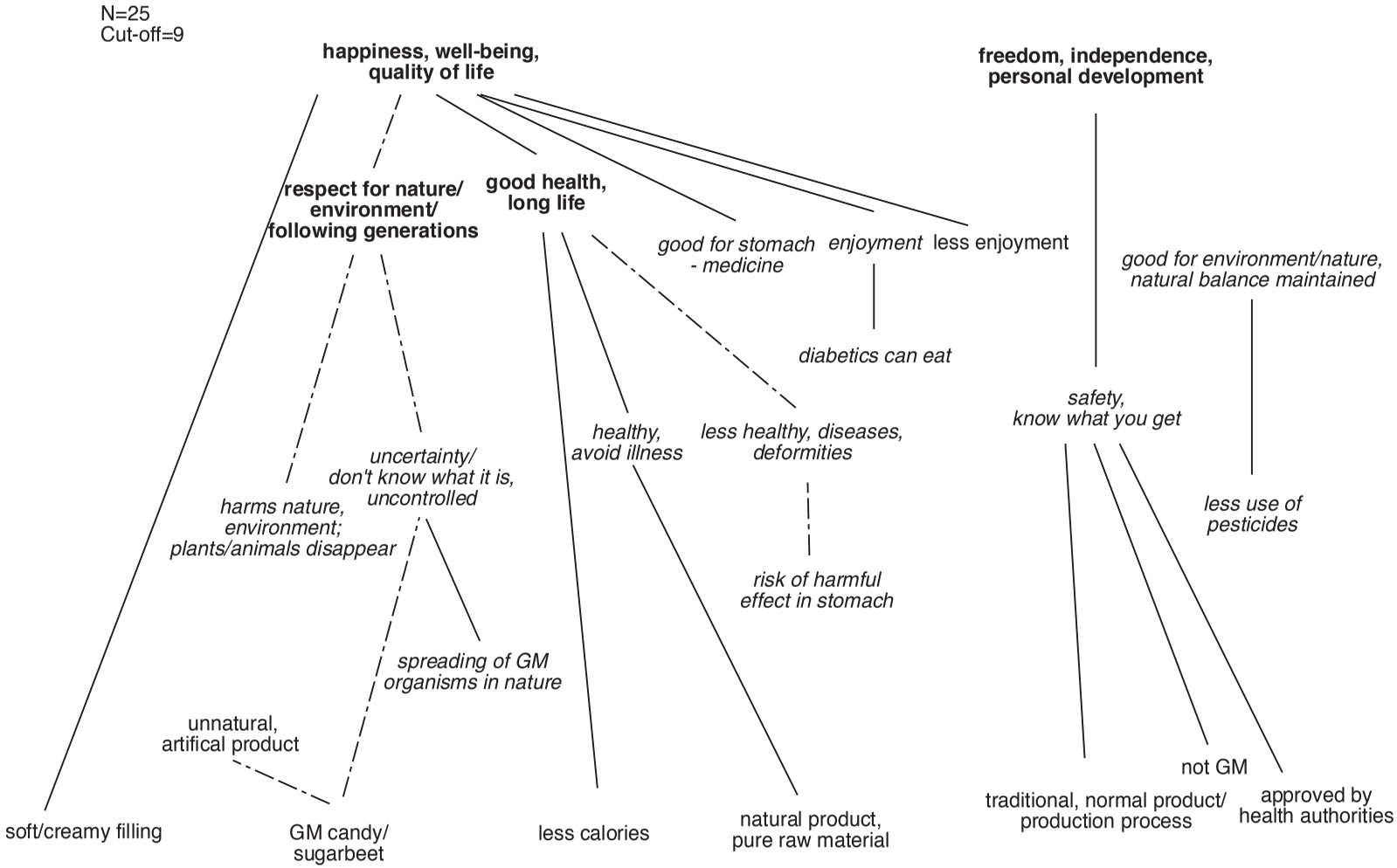
Candy b3, Denmark

N=25
Cut-off=4

Candyc3, Denmark

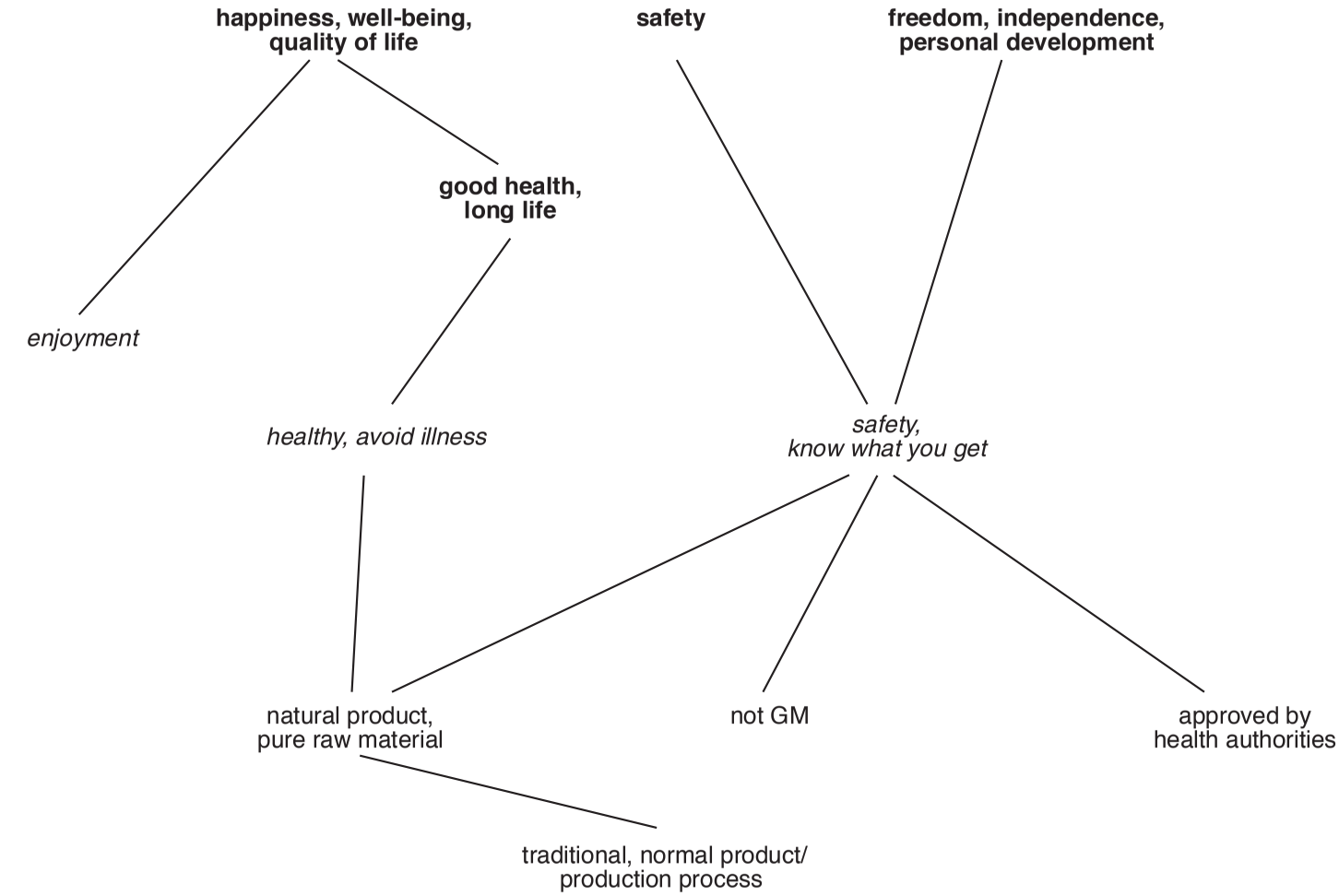
N=25
Cut-off=4

Candy, Finland



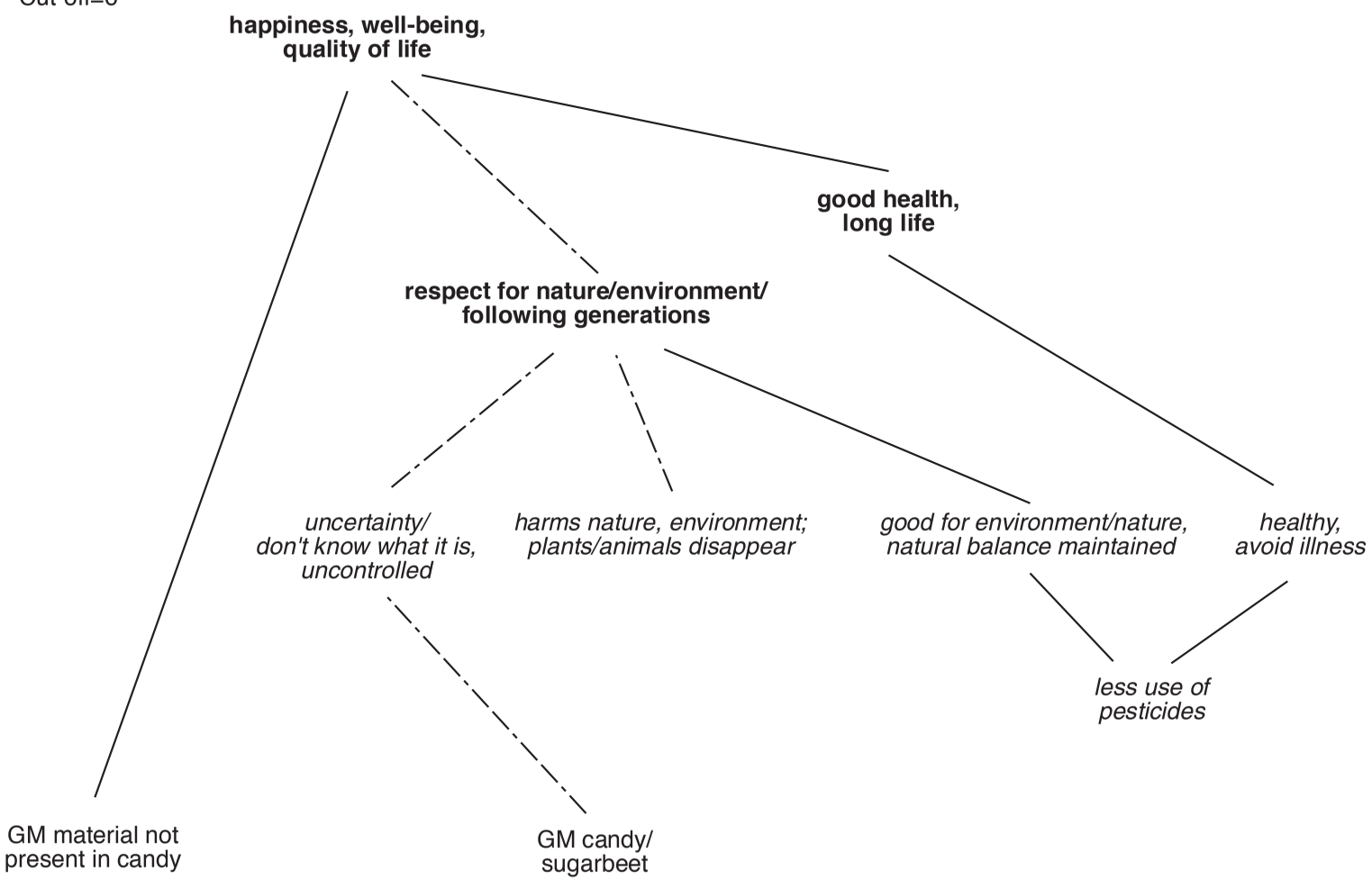
Candy conventional, Finland

N=25
Cut-off=6



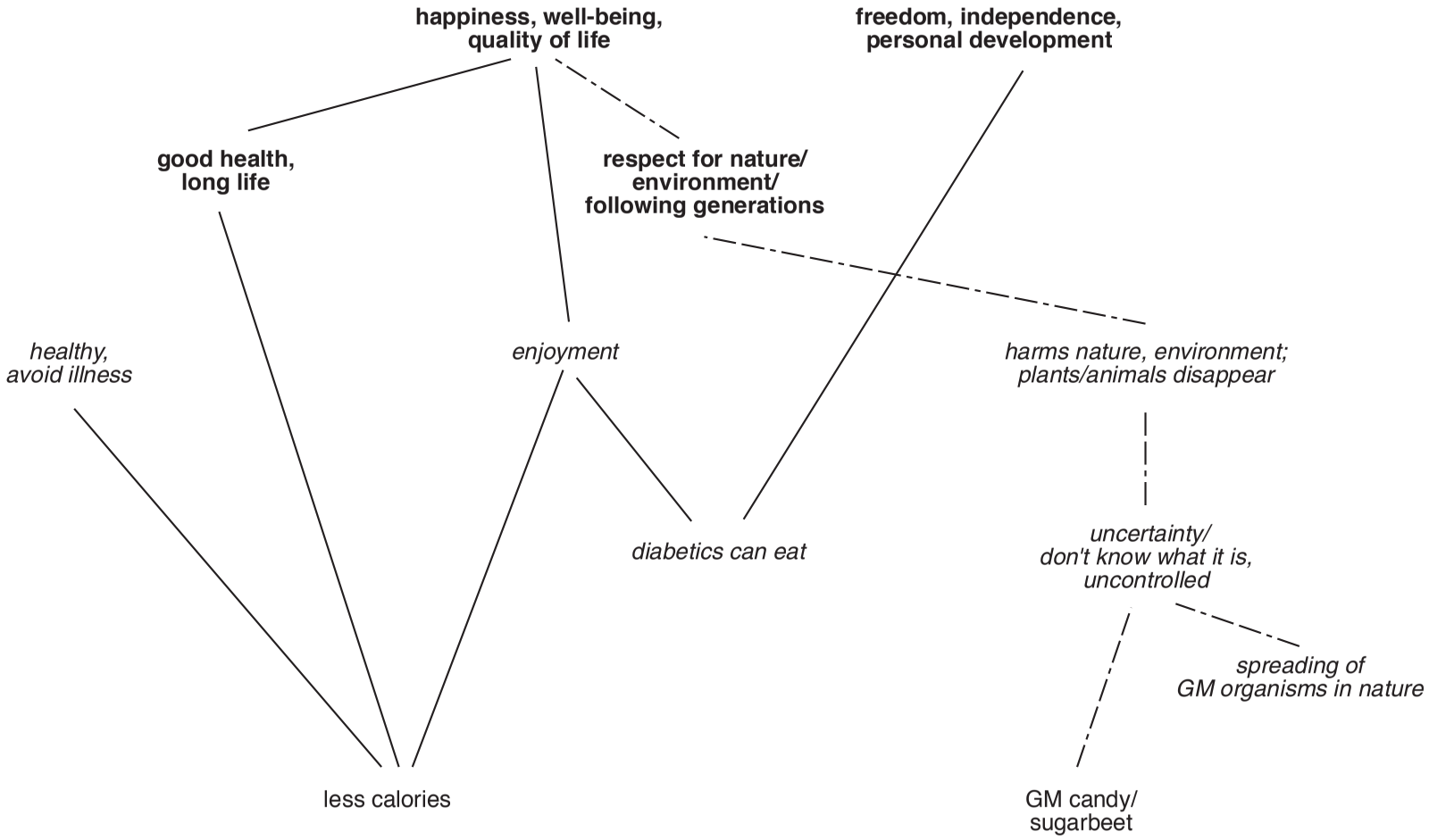
Candy a1, Finland

N=25
Cut-off=6



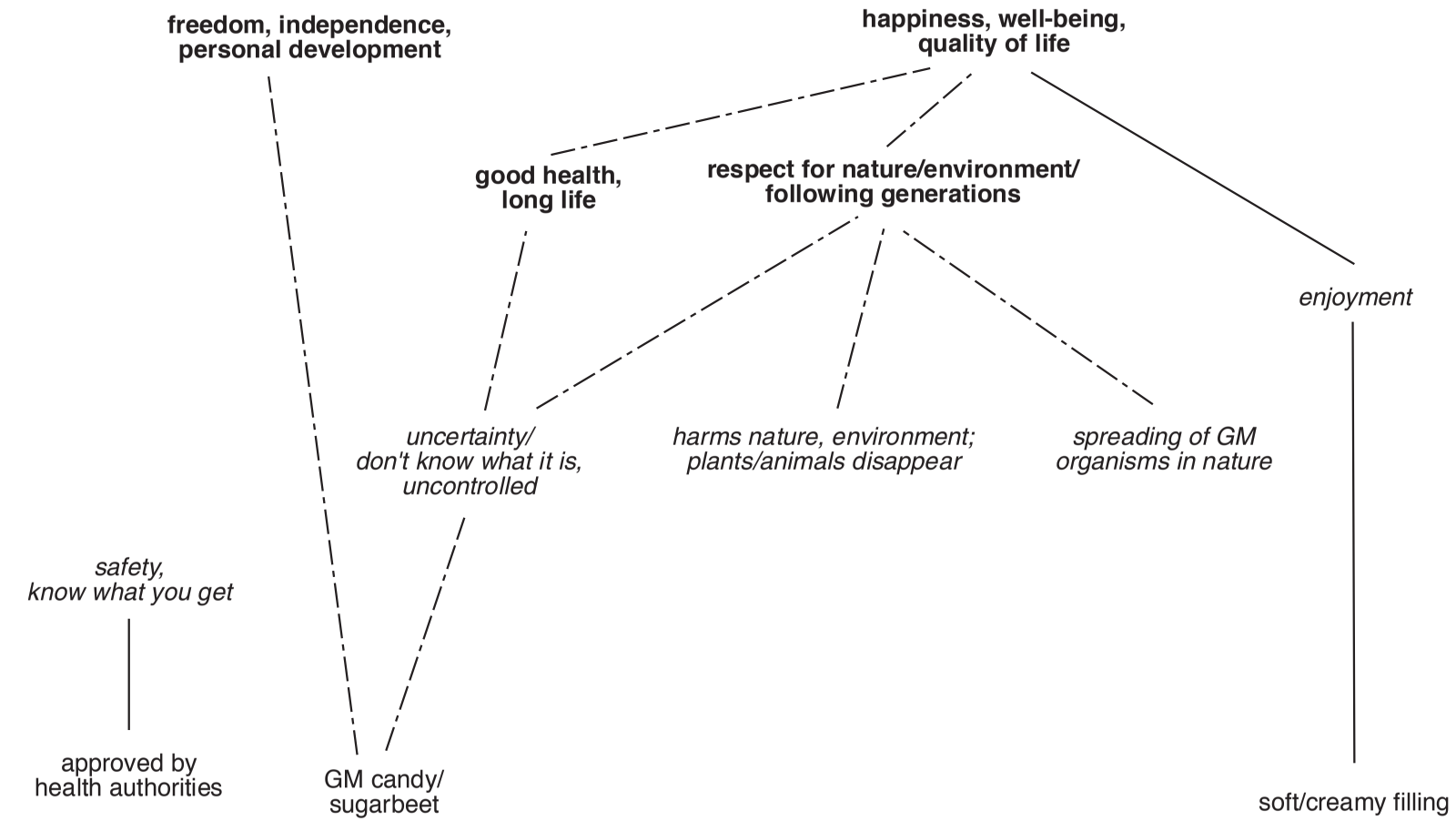
Candy b1, Finland

N=25
Cut-off=6



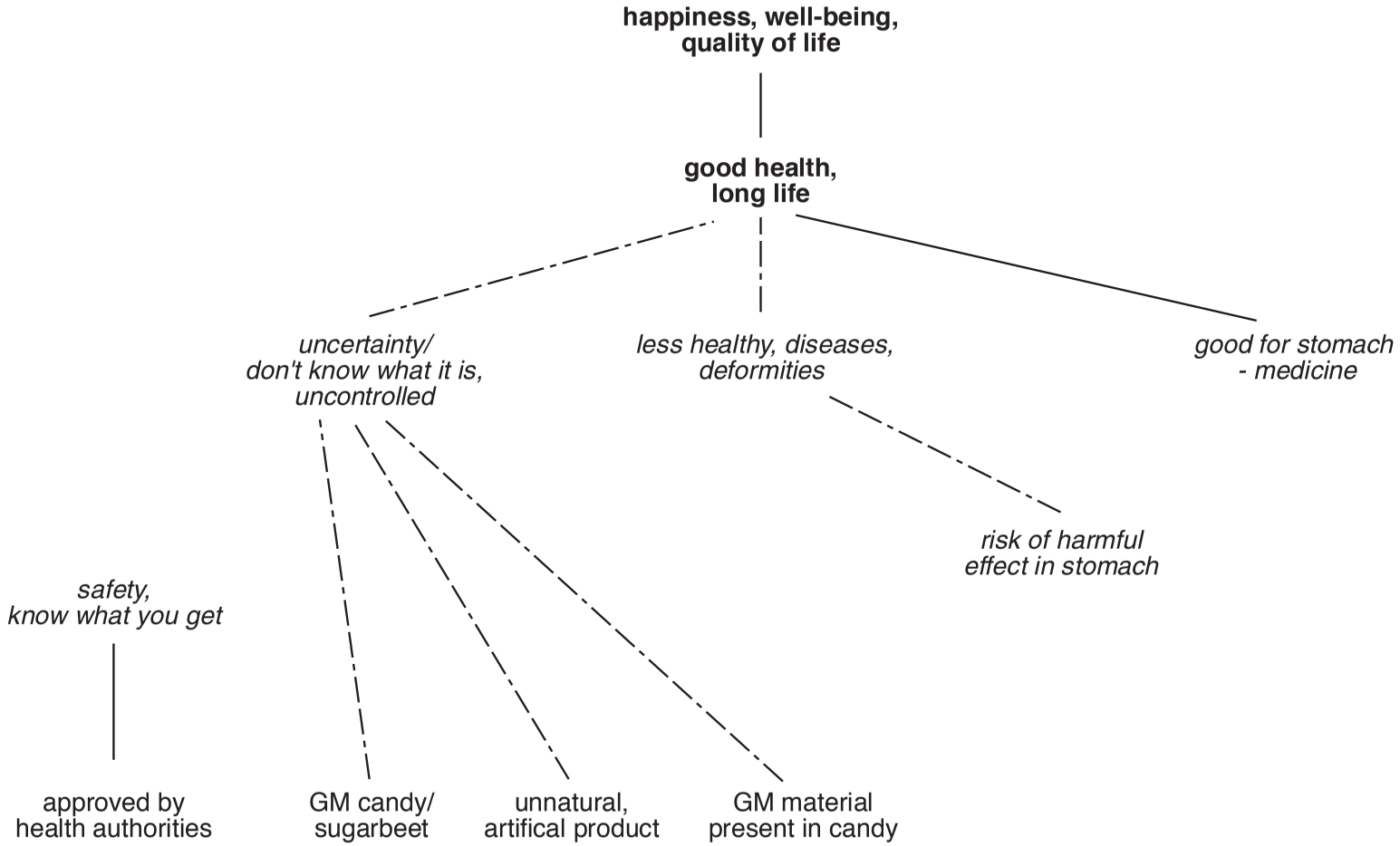
Candy b3, Finland

N=25
Cut-off=6

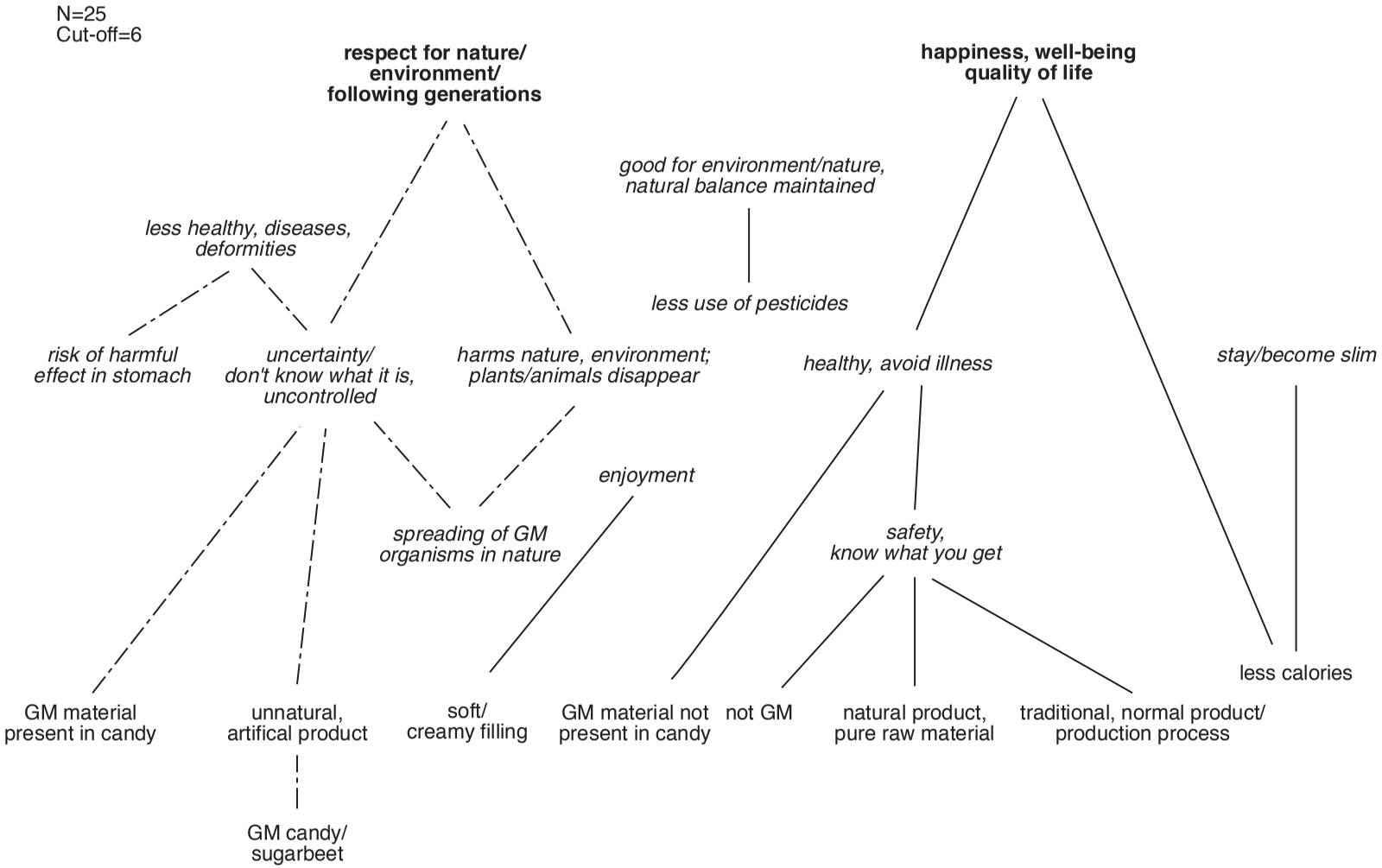


Candy c3, Finland

N=25
Cut-off=5



Candy, Sweden

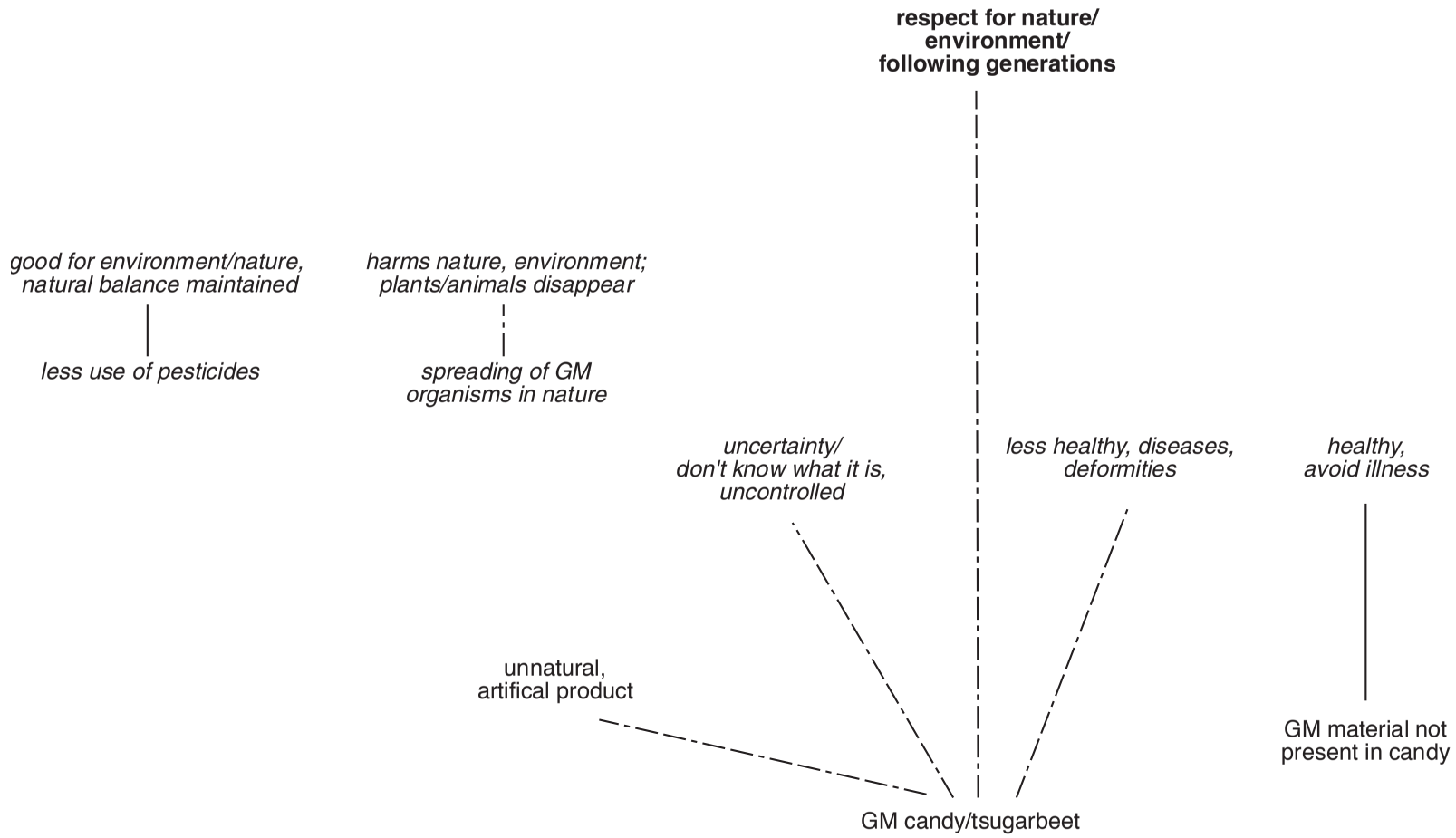


Candy conventional, Sweden

N=25
Cut-off=4

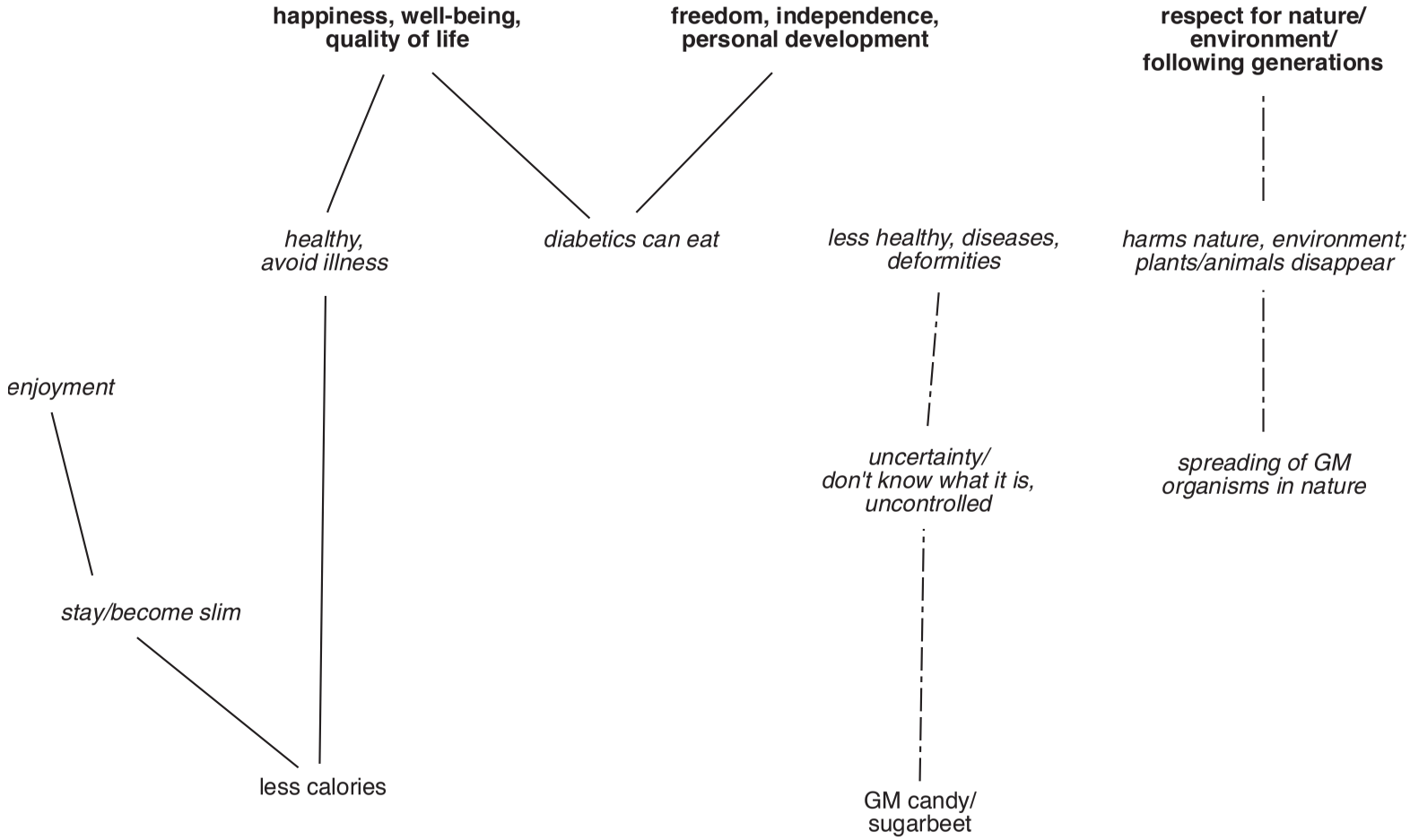
Candy a1, Sweden

N=25
Cut-off=4



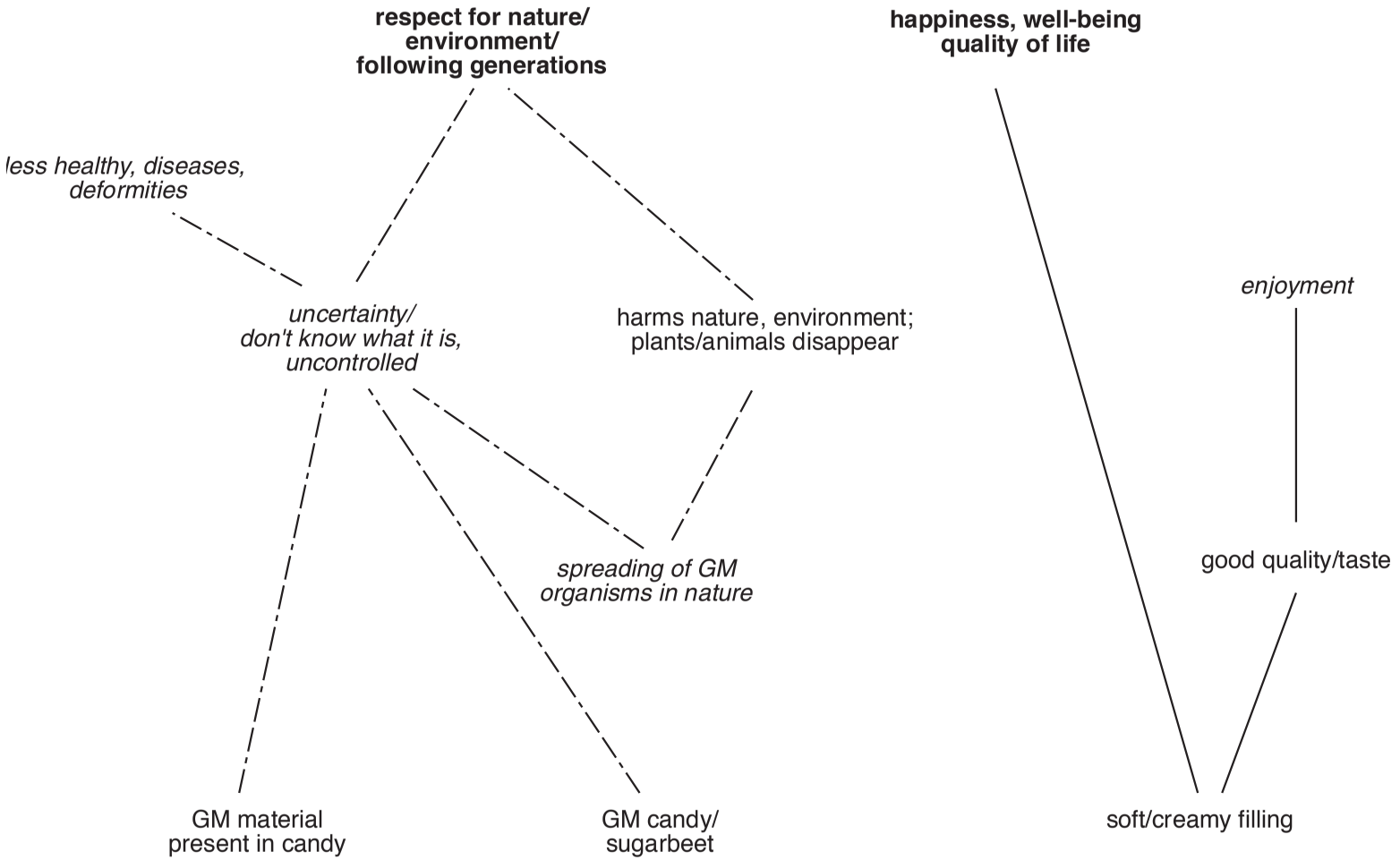
Candy b1, Sweden

N=25
Cut-off=4



Candy b3, Sweden

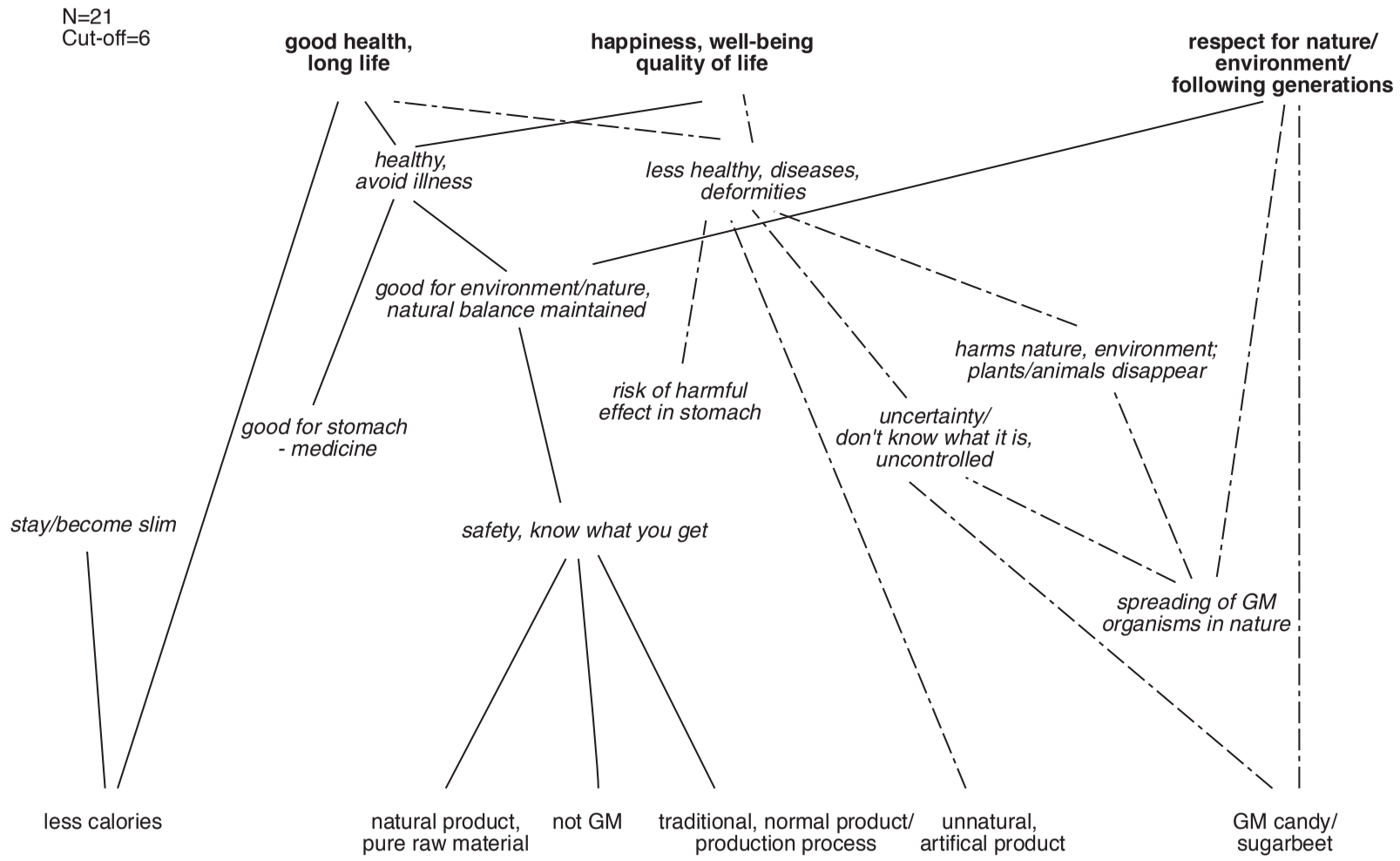
N=25
Cut-off=4



Candy c3, Sweden

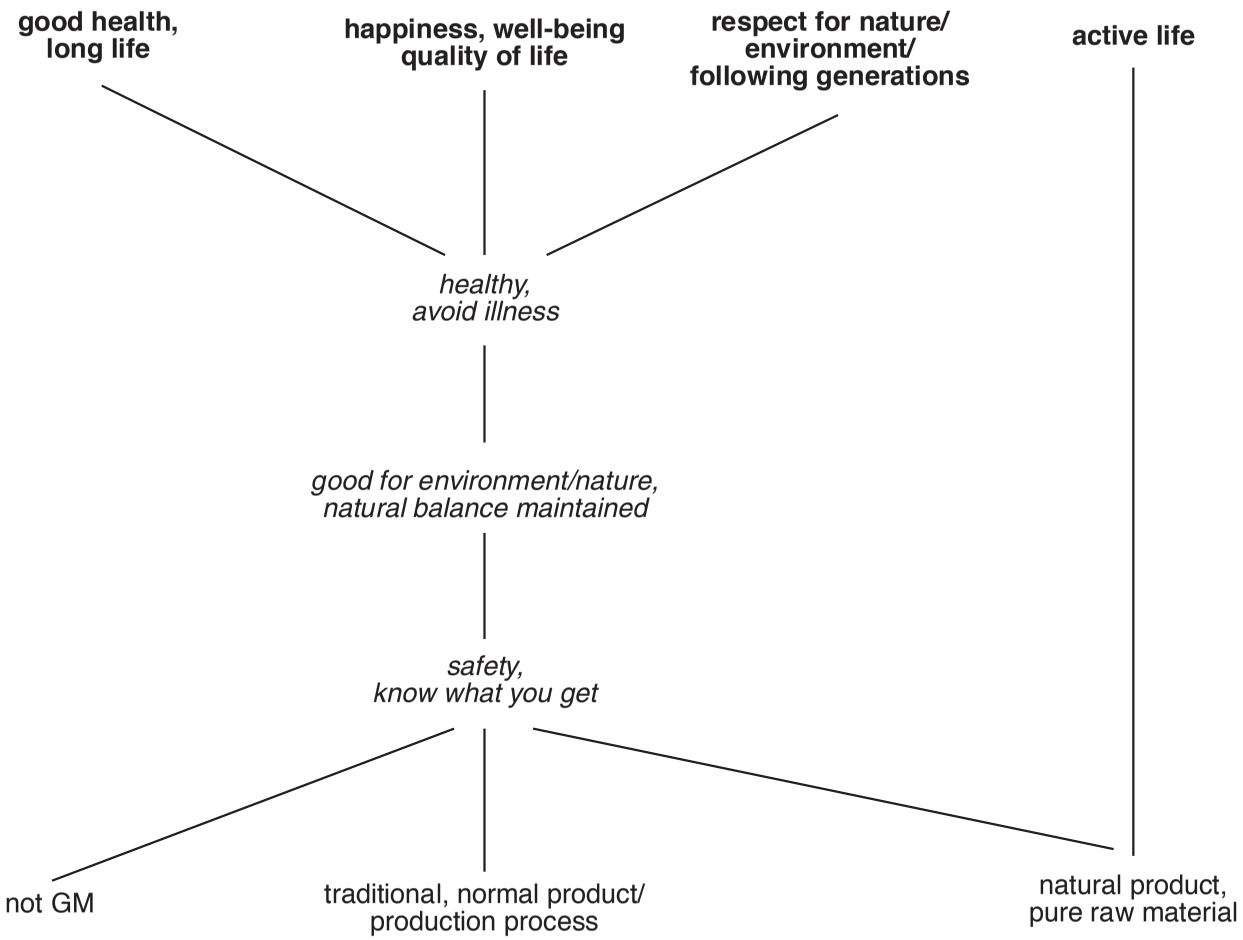
N=25
Cut-off=3

Candy, Norway



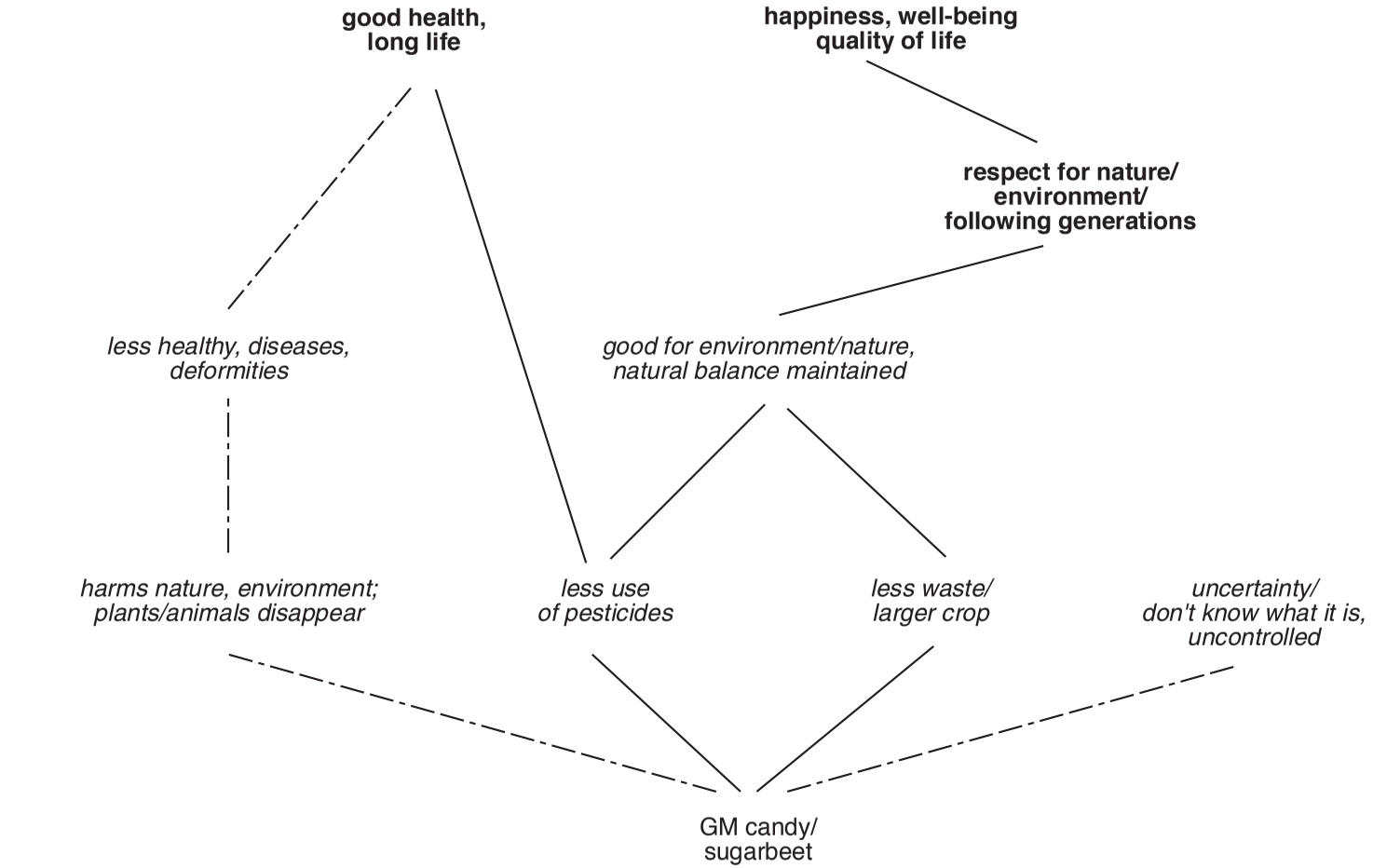
Candy conventional, Norway

N=21
Cut-off=3



Candy a1, Norway

N=21
Cut-off=3

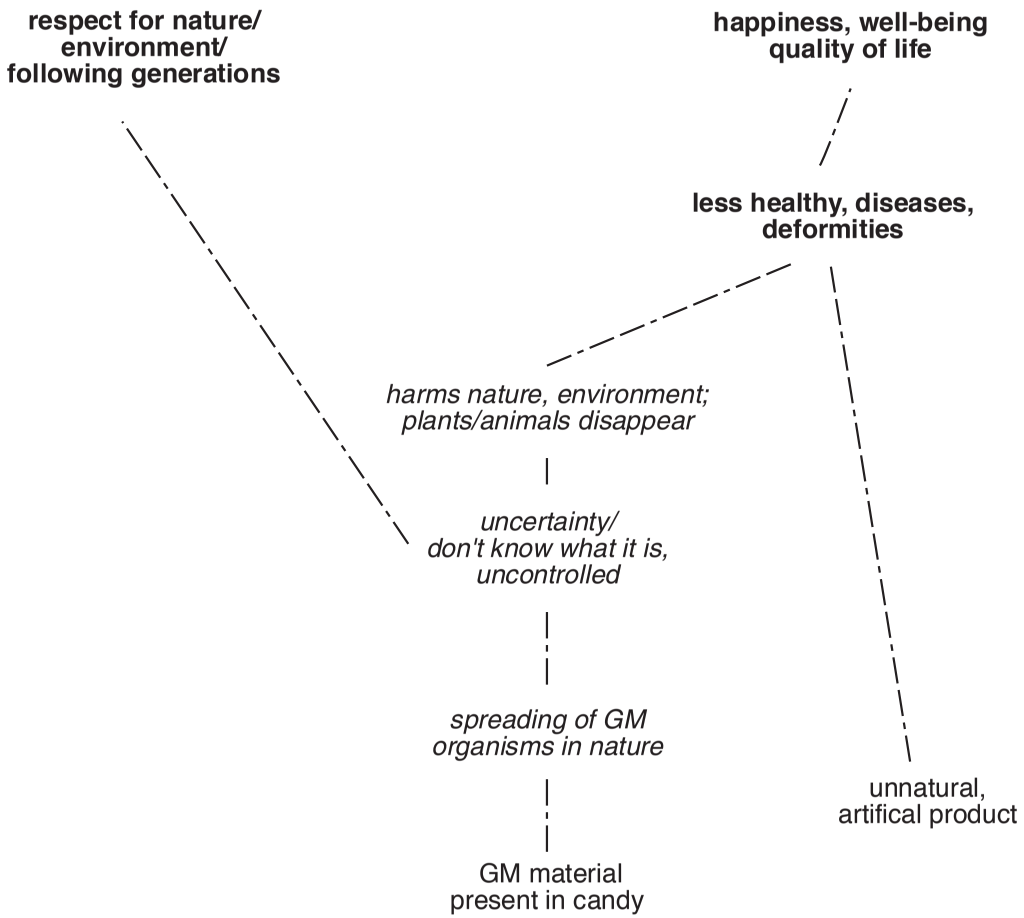


Candy b1, Norway

N=21
Cut-off=3

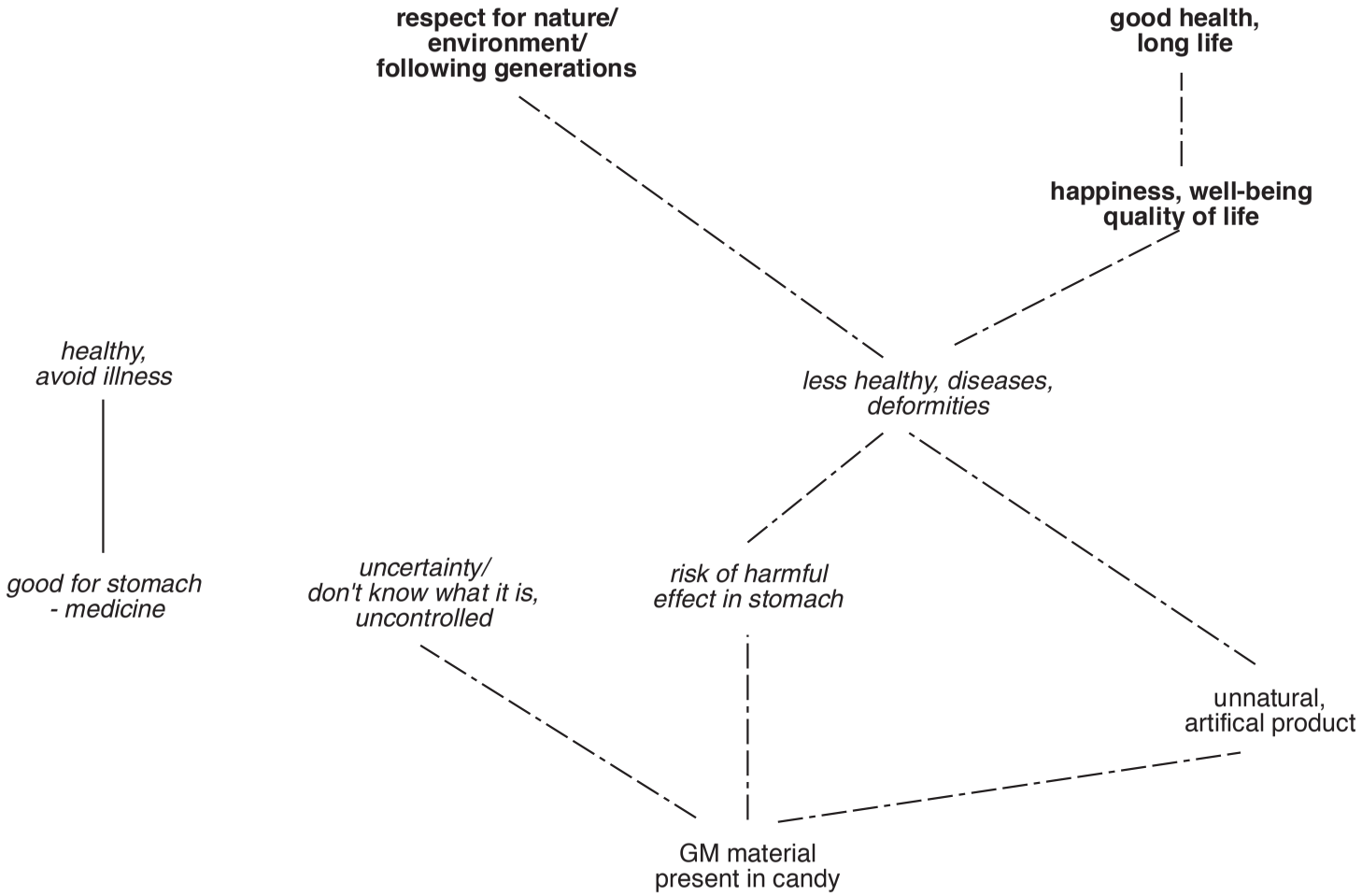
Candy b3, Norway

N=21
Cut-off=3



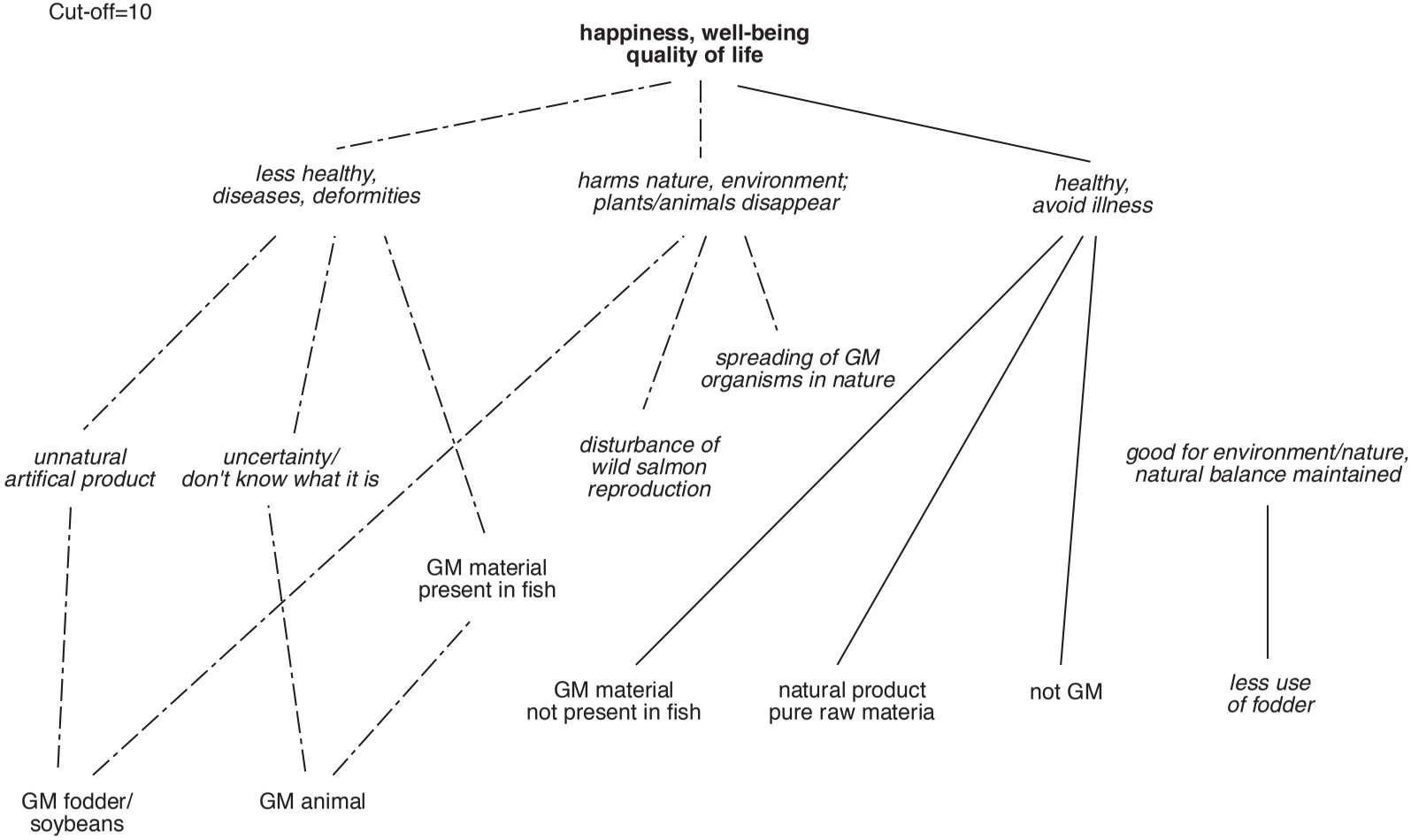
Candy c3, Norway

N=21
Cut-off=3



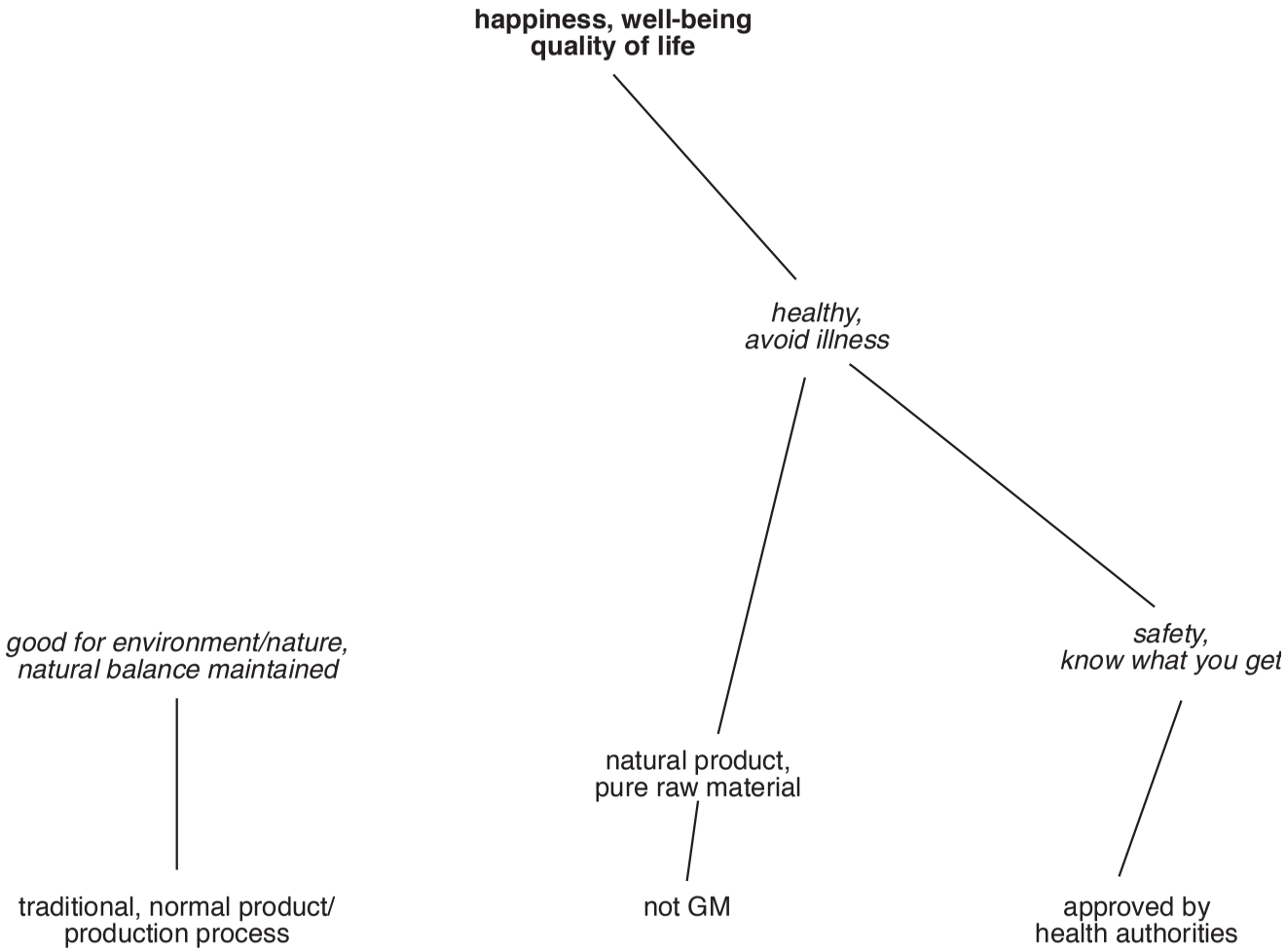
Salmon, Denmark

N=25
Cut-off=10



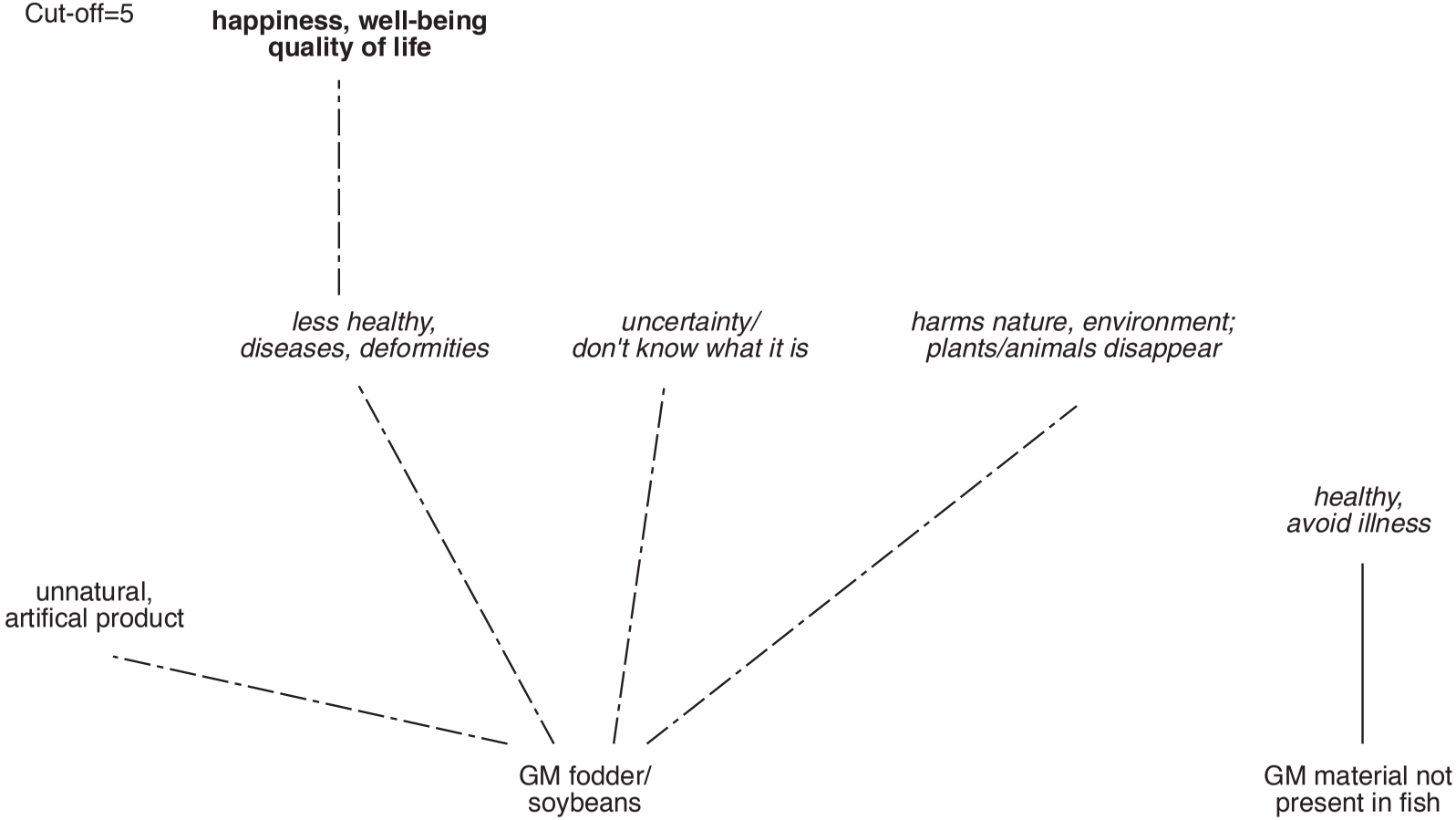
Salmon conventional, Denmark

N=25
Cut-off=5



Salmon a1, Denmark

N=25
Cut-off=5

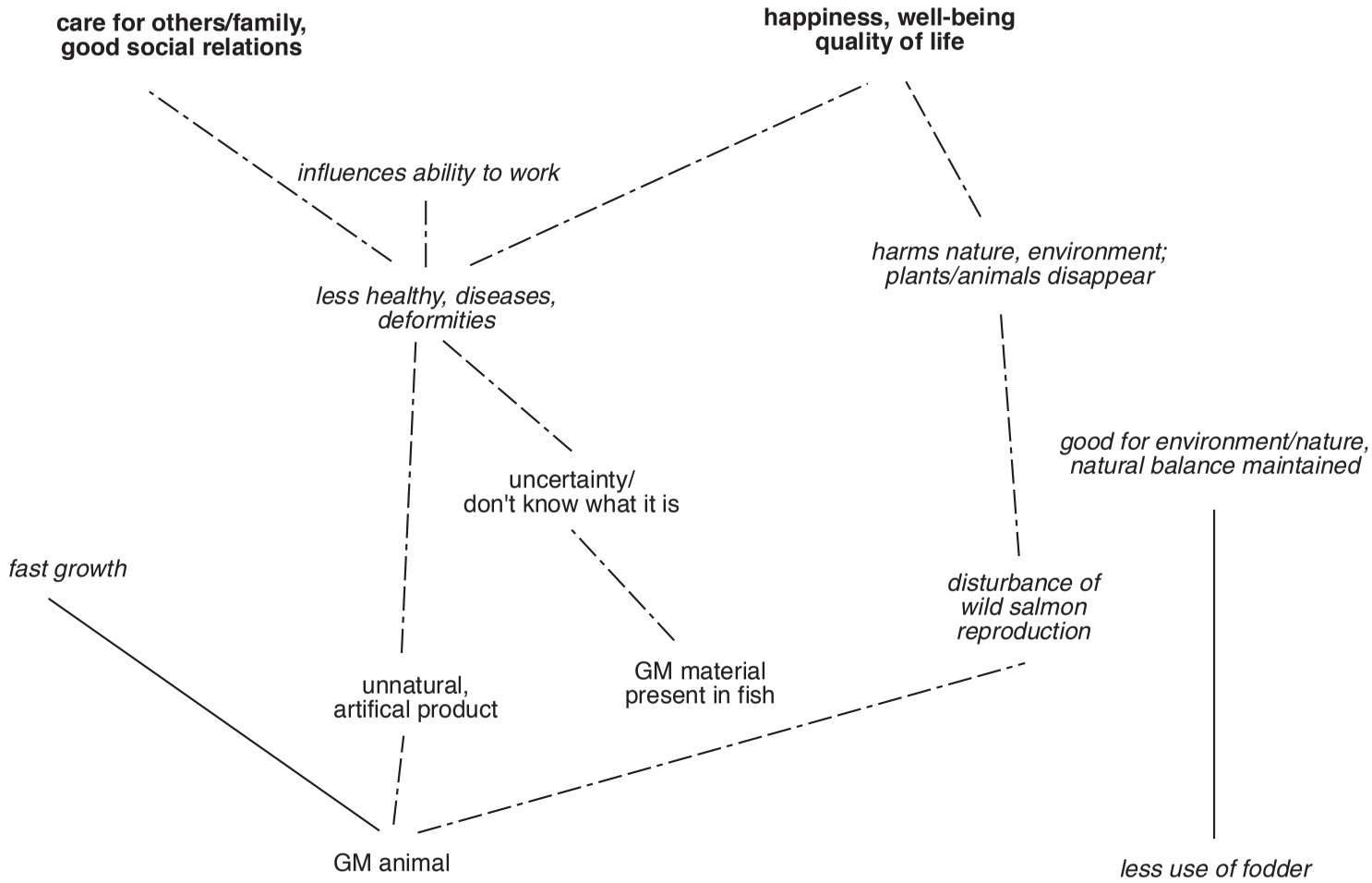


Salmon a2, Denmark

N=25
Cut-off=5

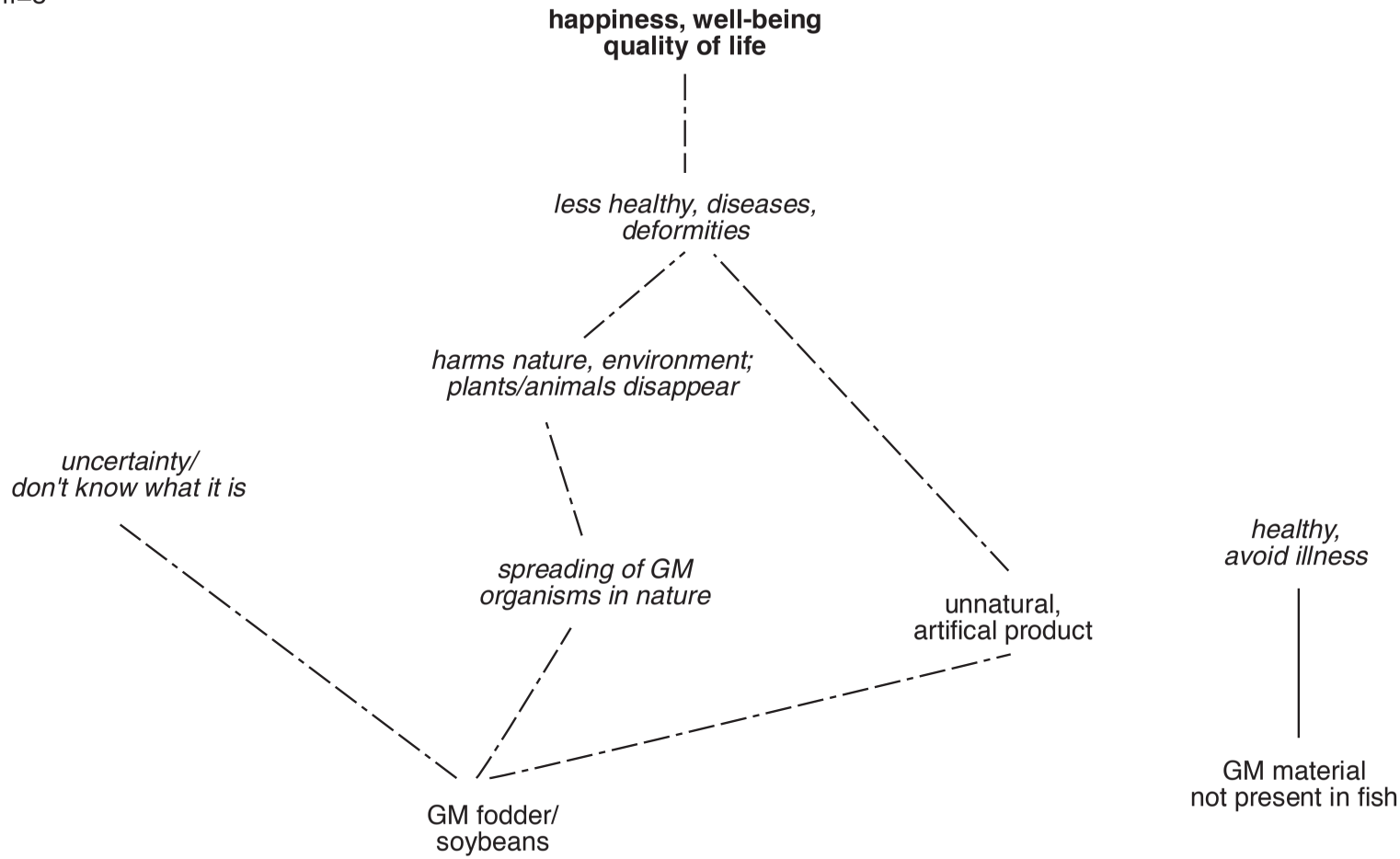
Salmon a3, Denmark

N=25
Cut-off=5

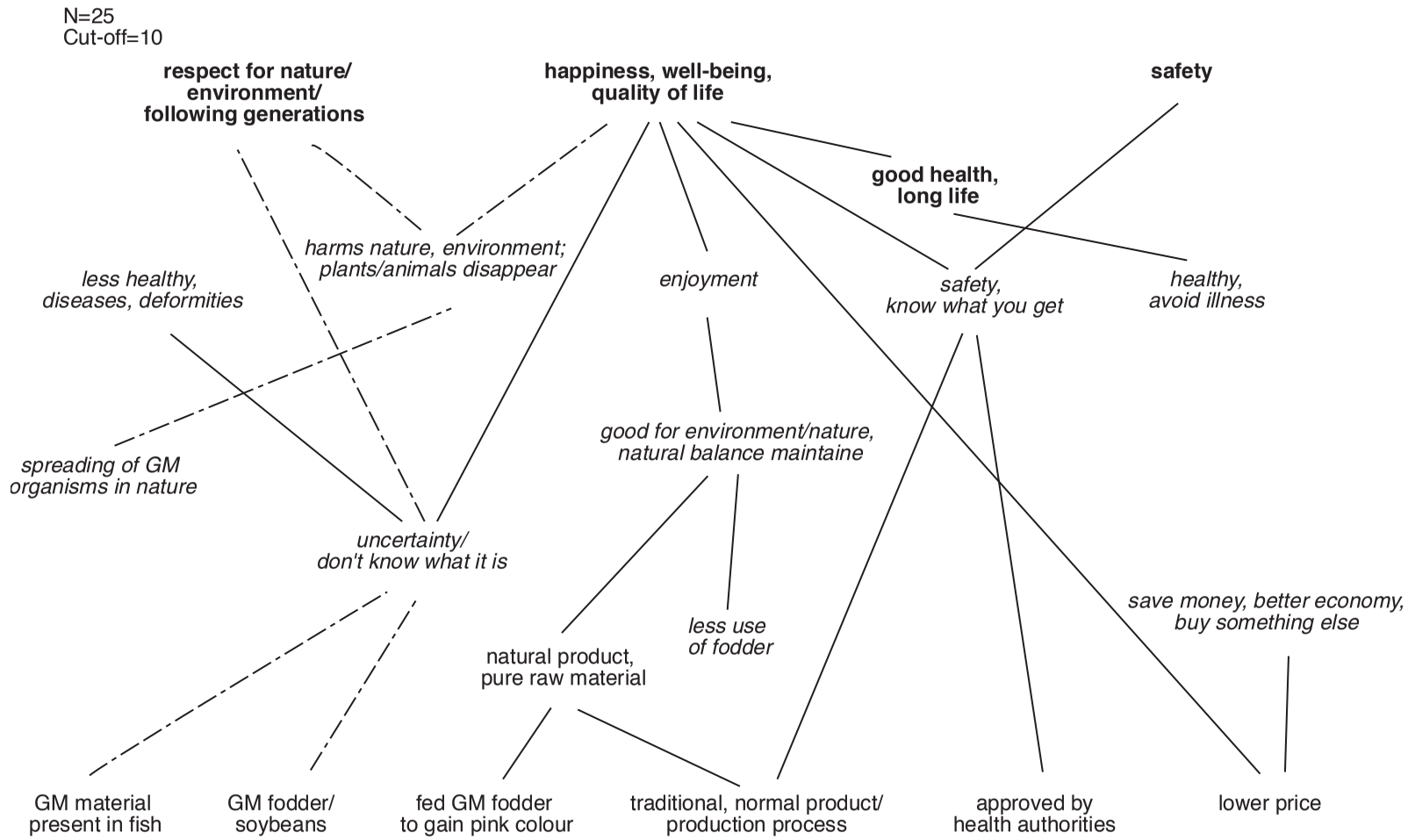


Salmon c1, Denmark

N=25
Cut-off=5

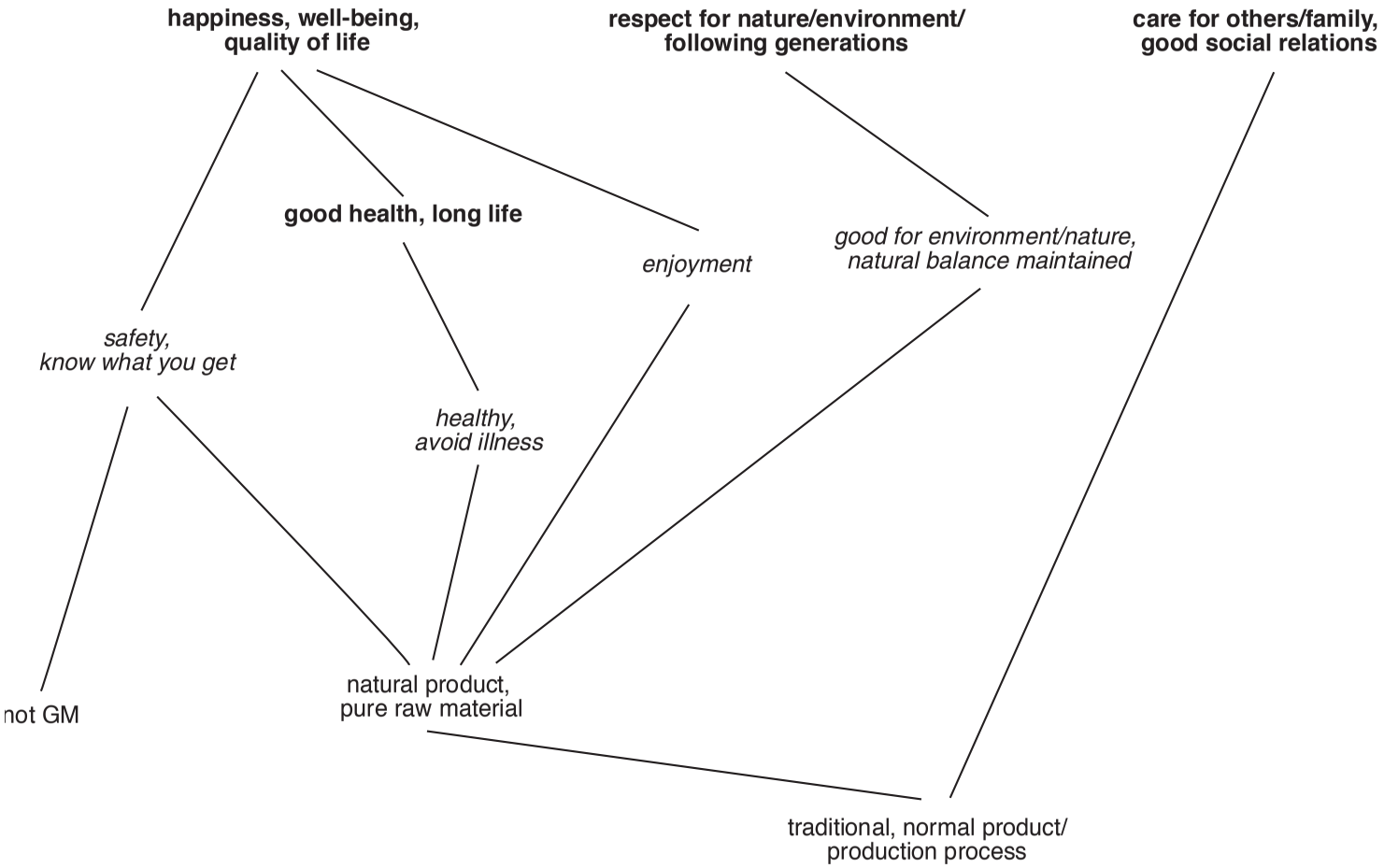


Salmon, Finland



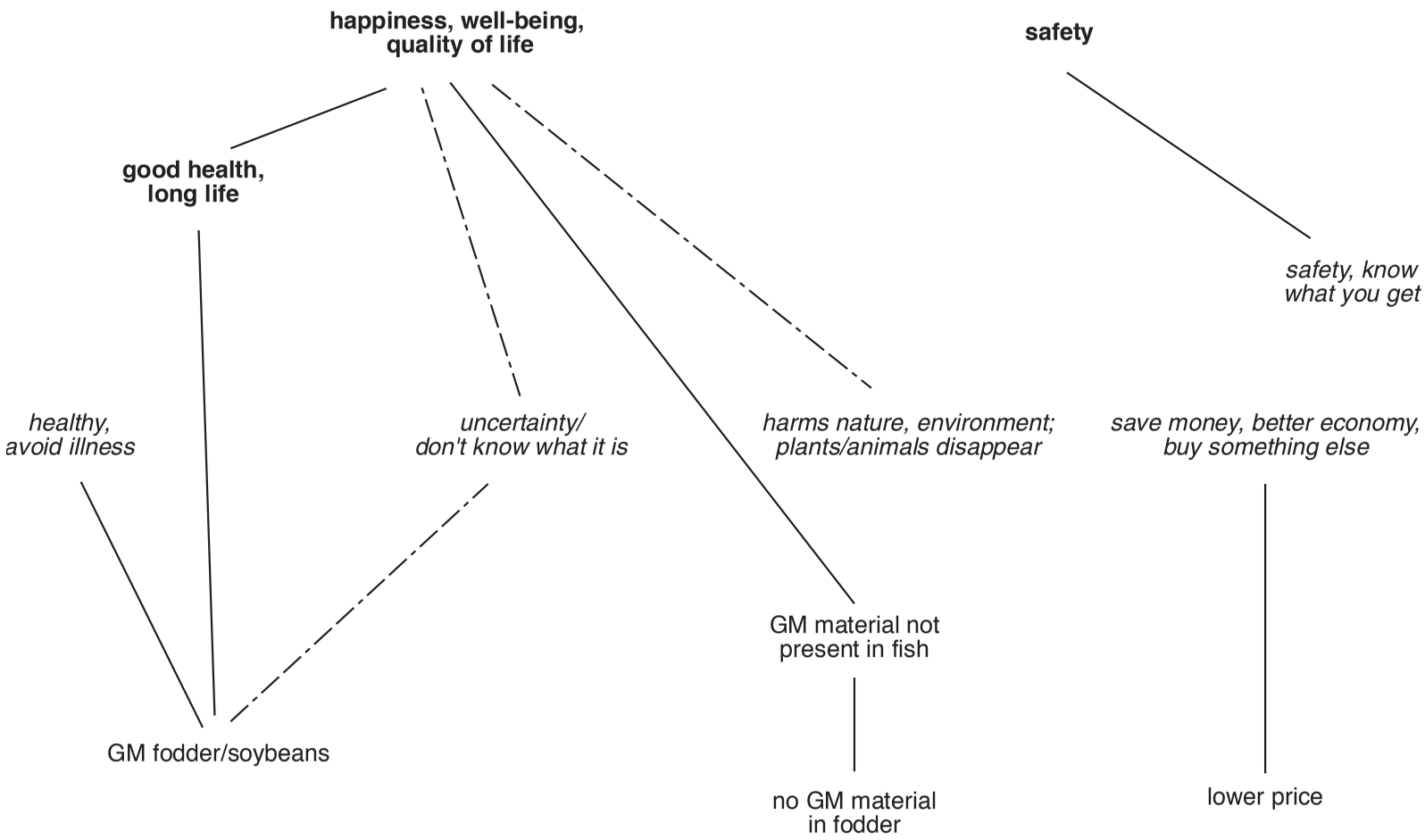
Salmon conventional, Finland

N=25
Cut-off=6



Salmon a1, Finland

N=25
Cut-off=6



Salmon a2, Finland

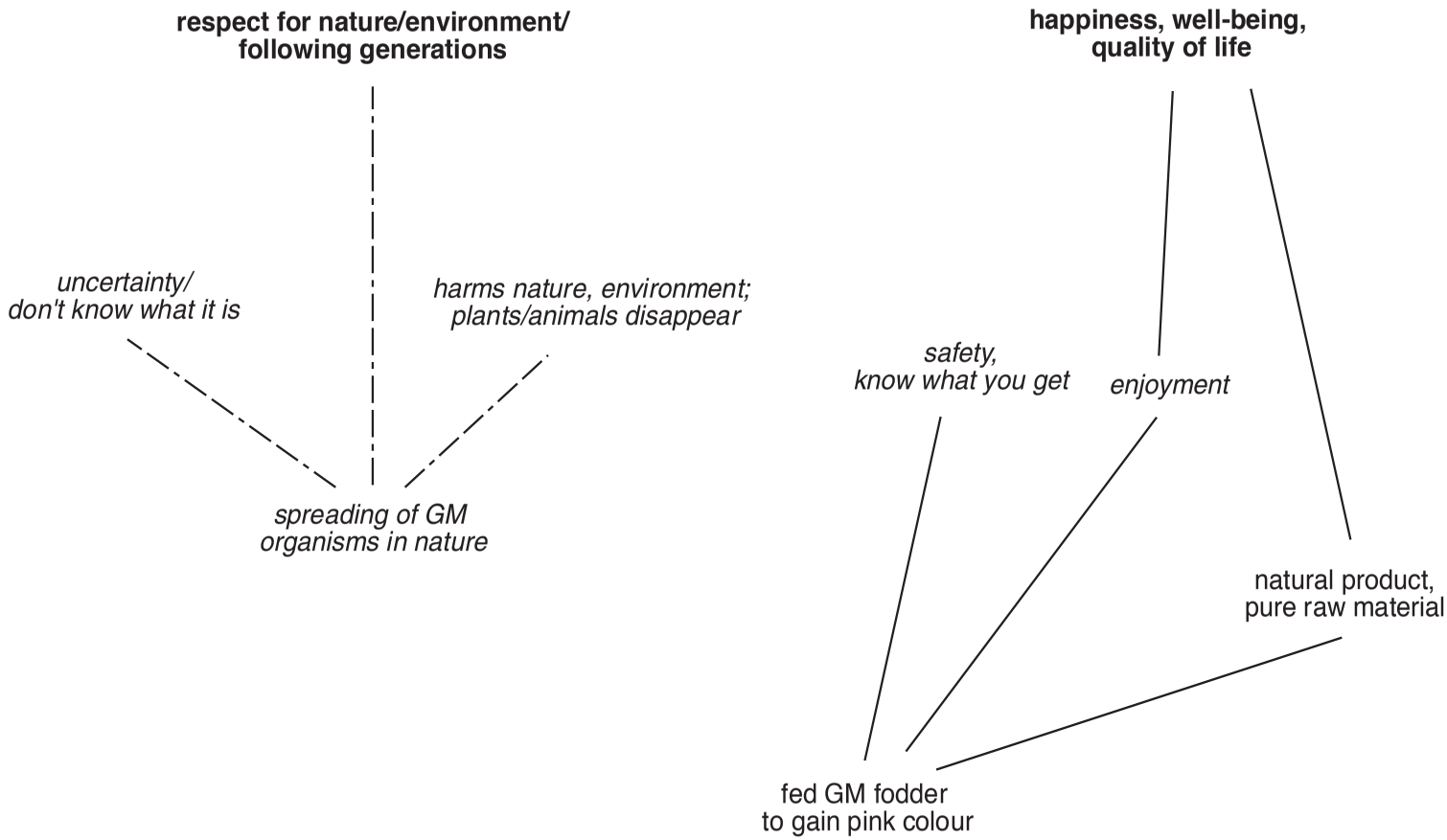
N=25
Cut-off=6

Salmon a3, Finland

N=25
Cut-off=6

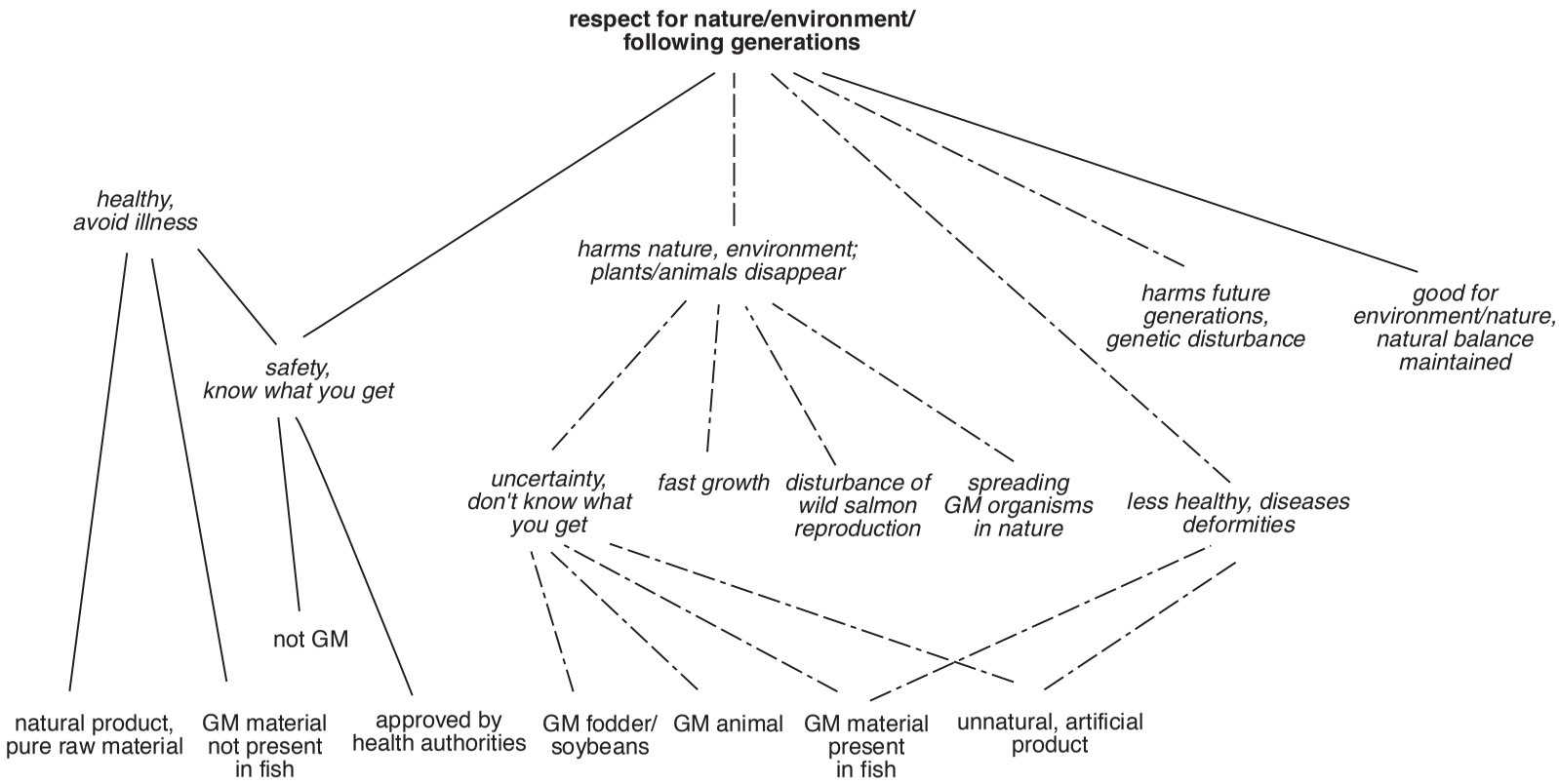
Salmon c1, Finland

N=25
Cut-off=6



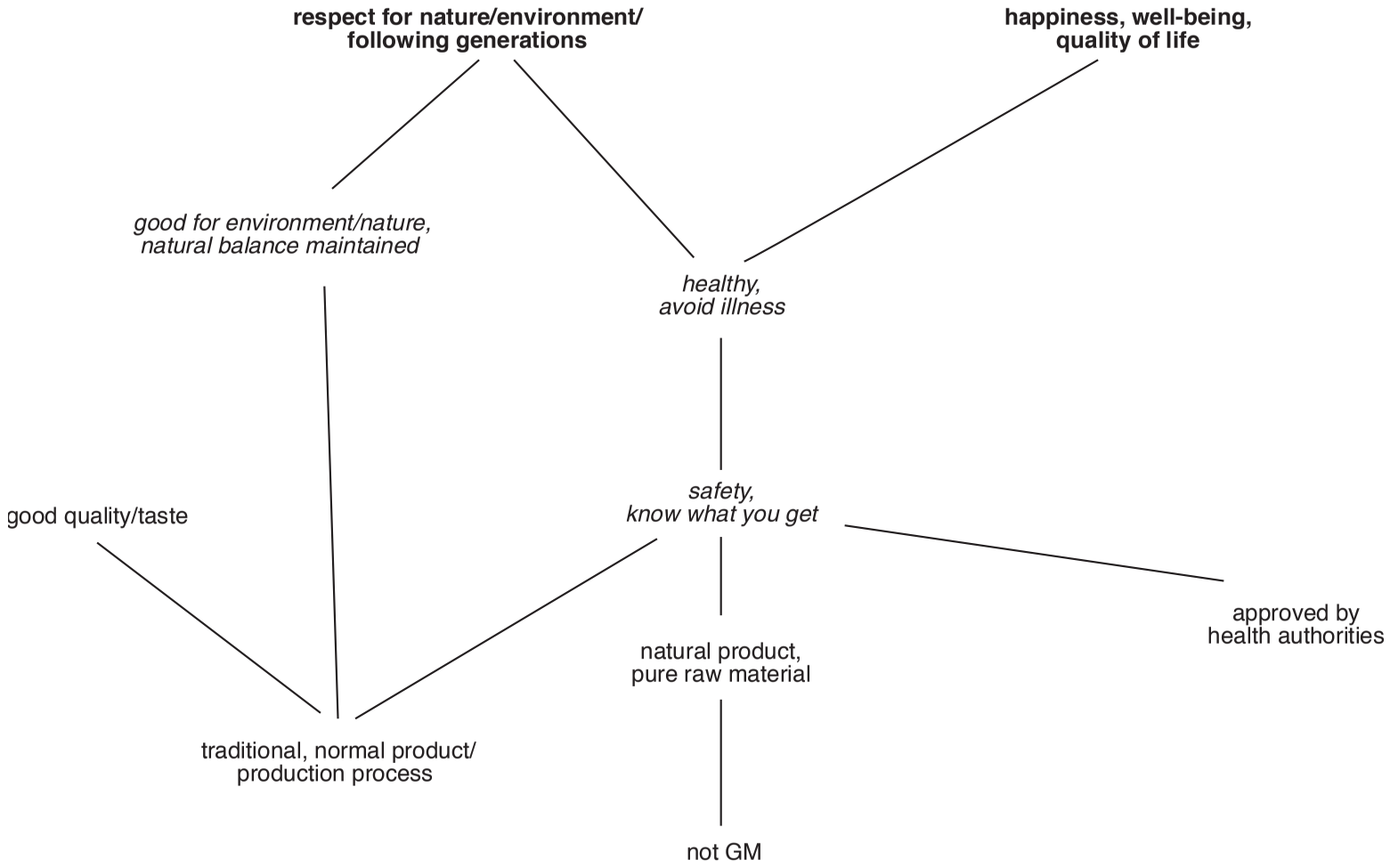
Salmon, Sweden

N=25
Cut-off=7



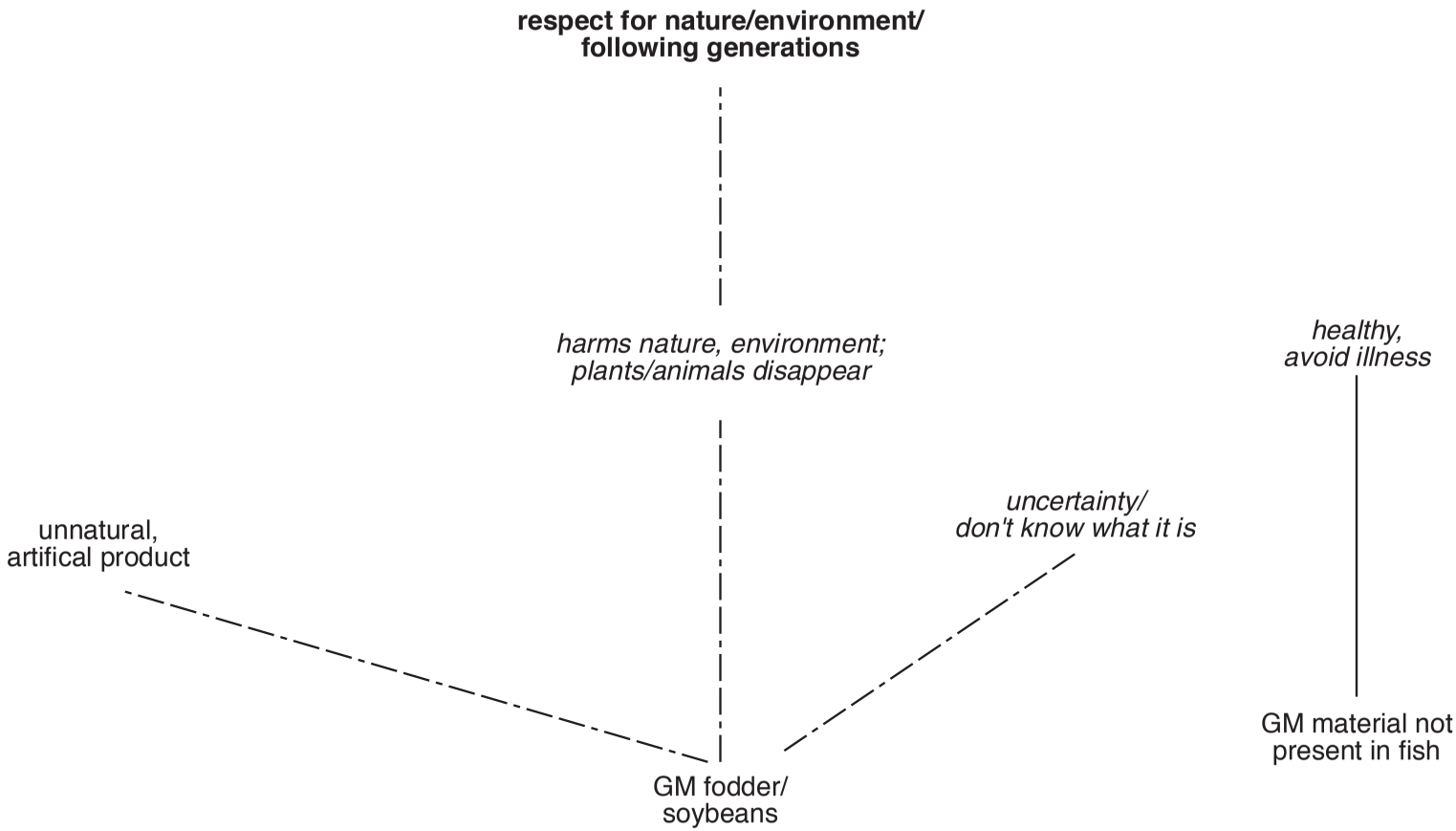
Salmon conventional, Sweden

N=25
Cut-off=4



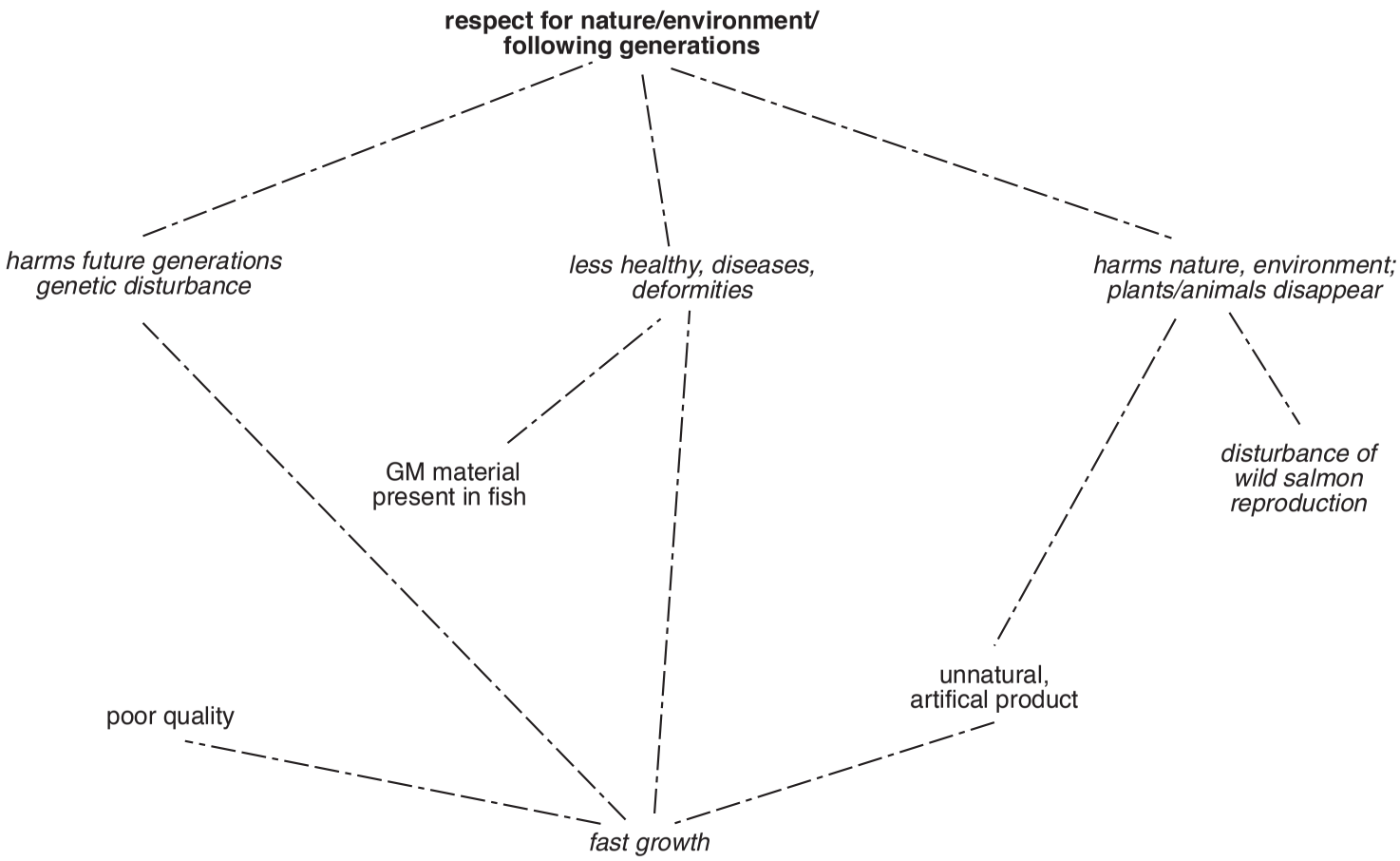
Salmon a1, Sweden

N=25
Cut-off=4



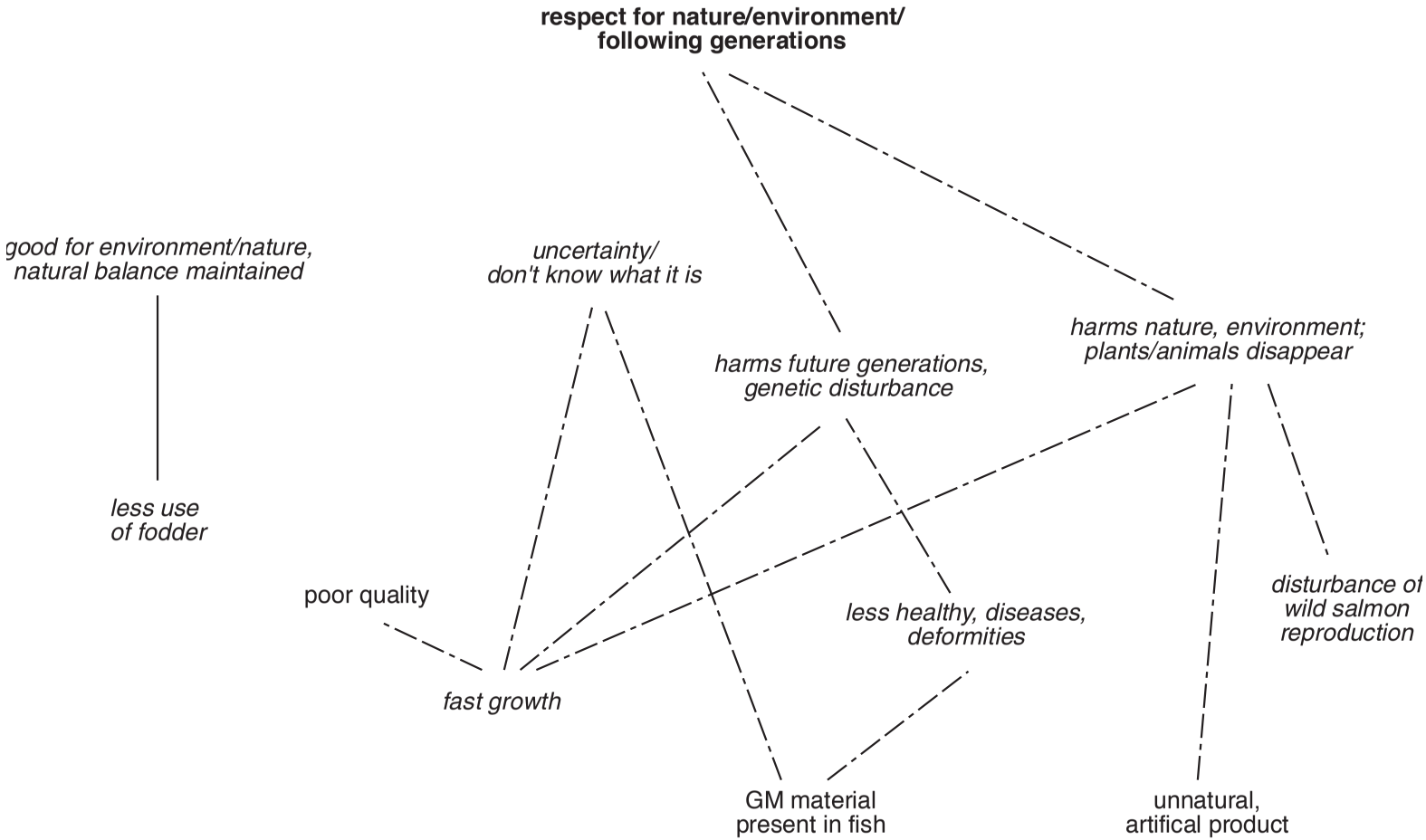
Salmon a2, Sweden

N=25
Cut-off=4



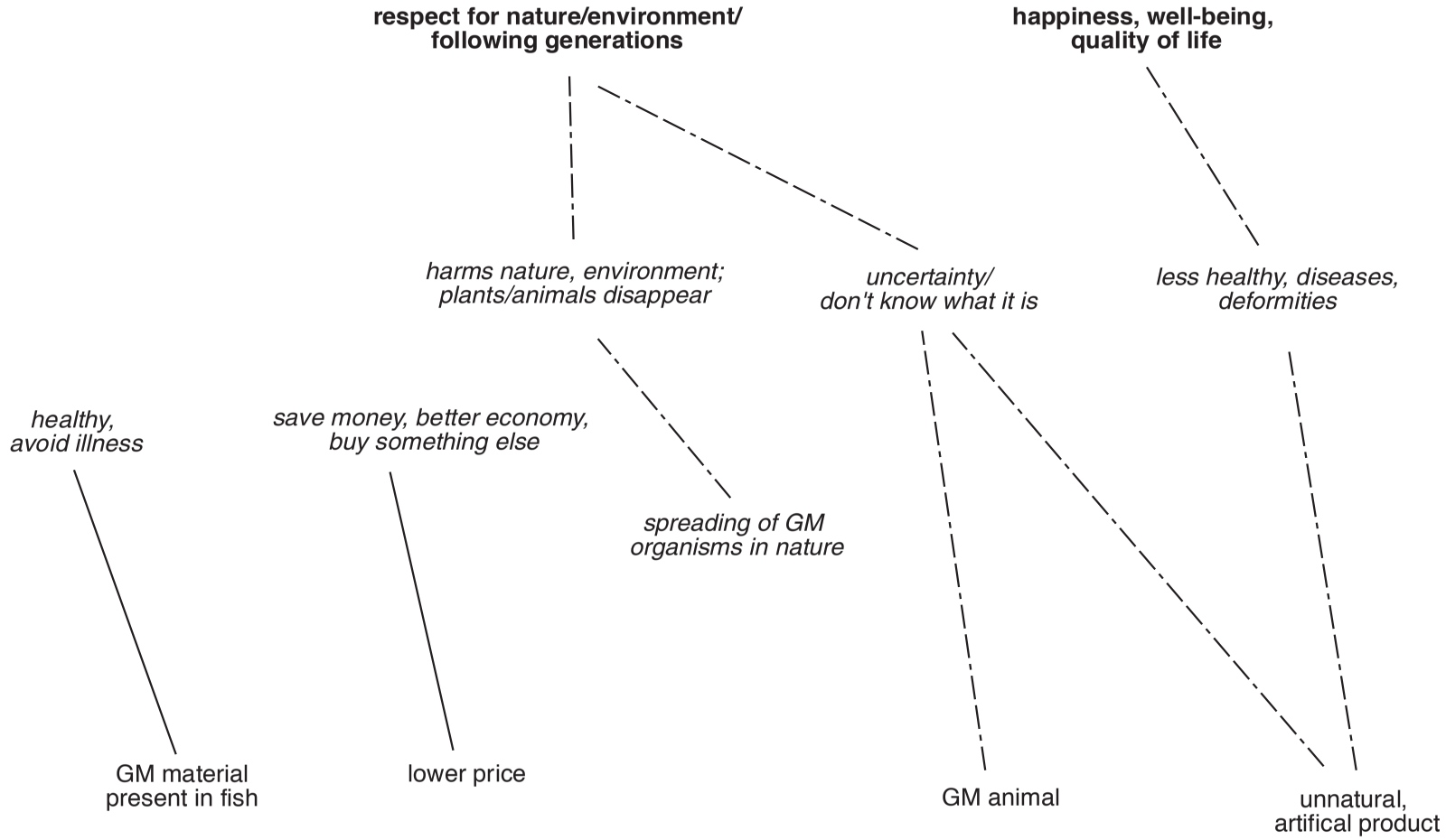
Salmon a3, Sweden

N=25
Cut-off=4



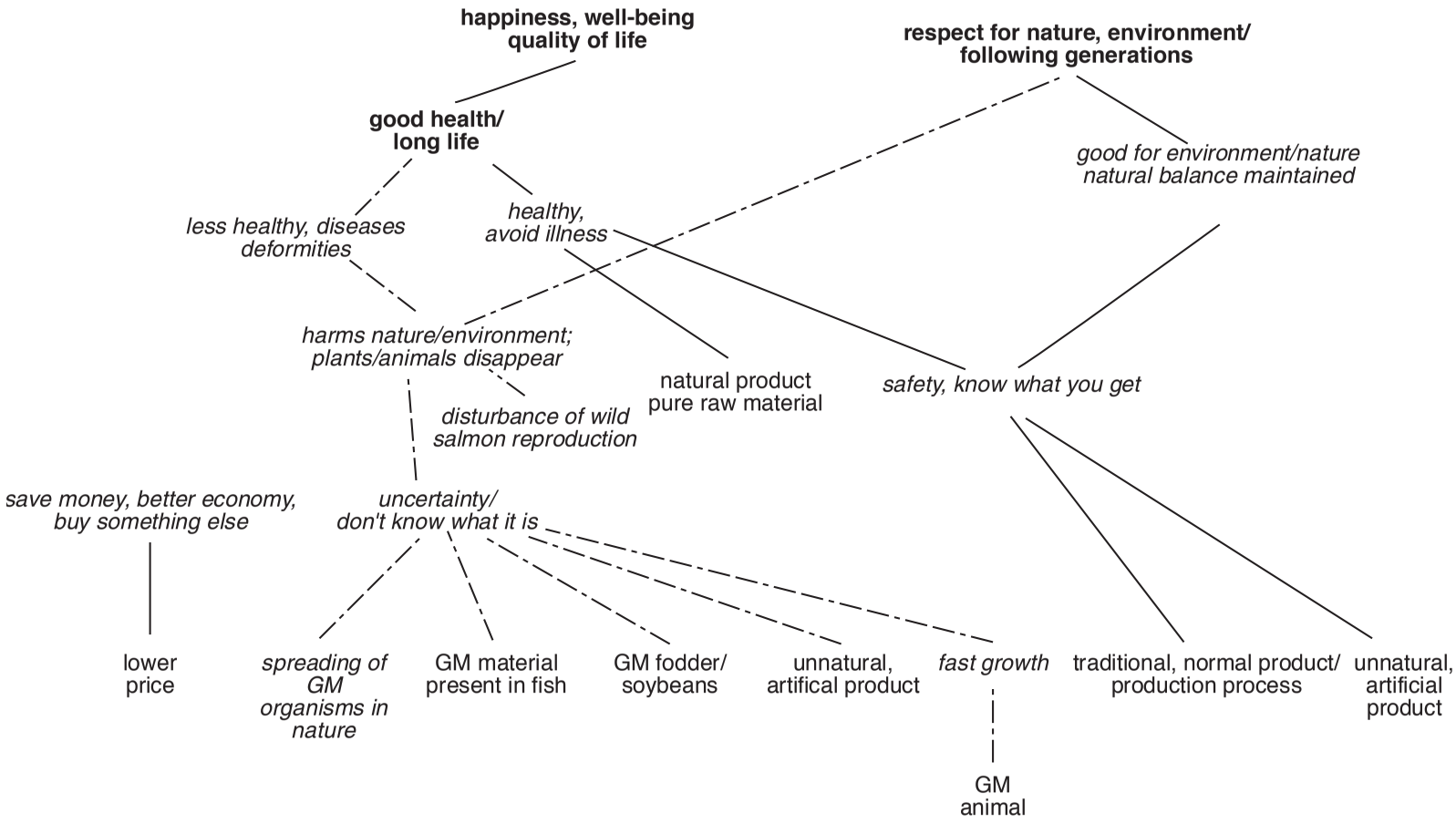
Salmon c1, Sweden

N=25
Cut-off=6



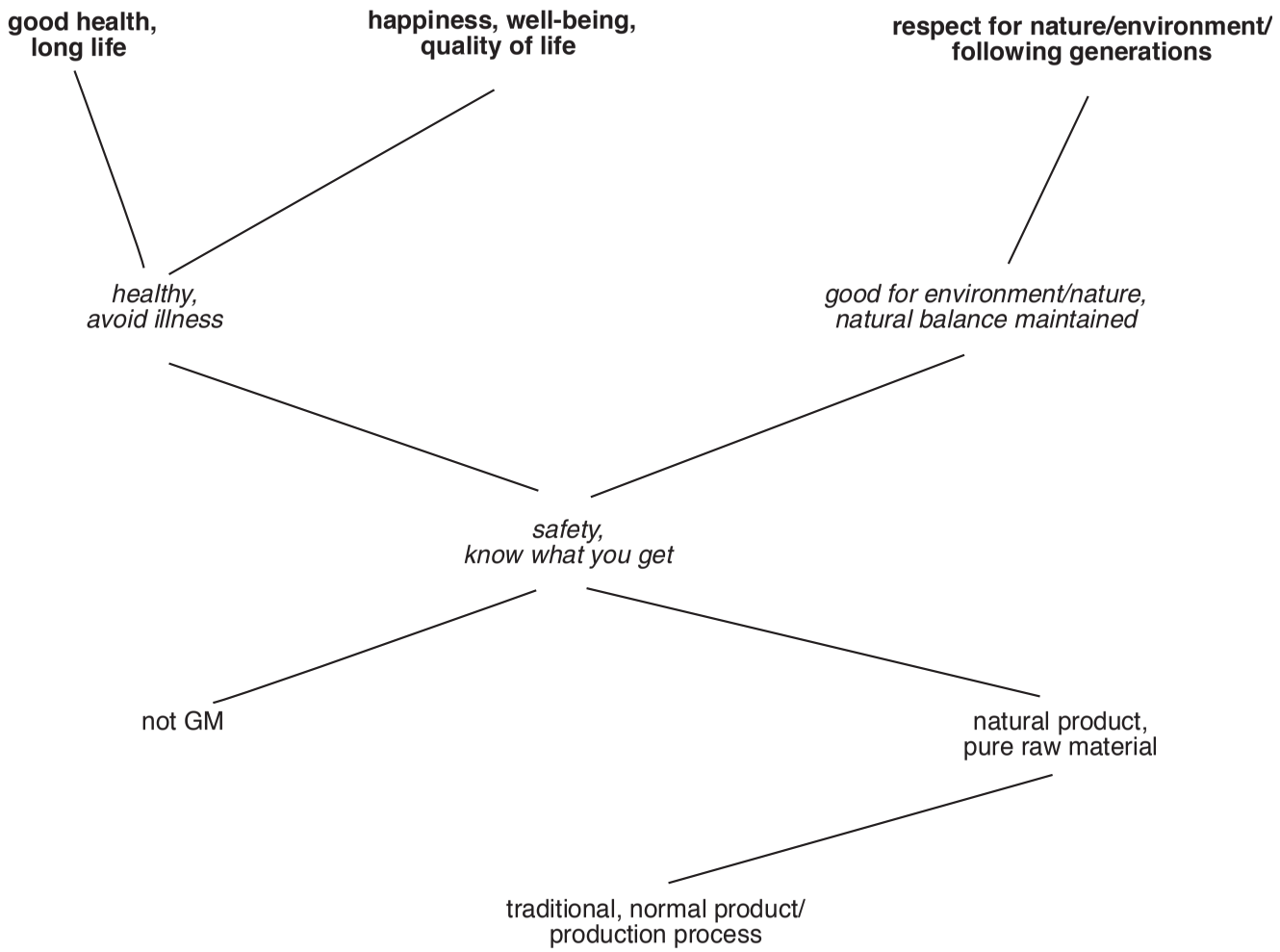
Salmon, Norway

N=21
Cut-off=6



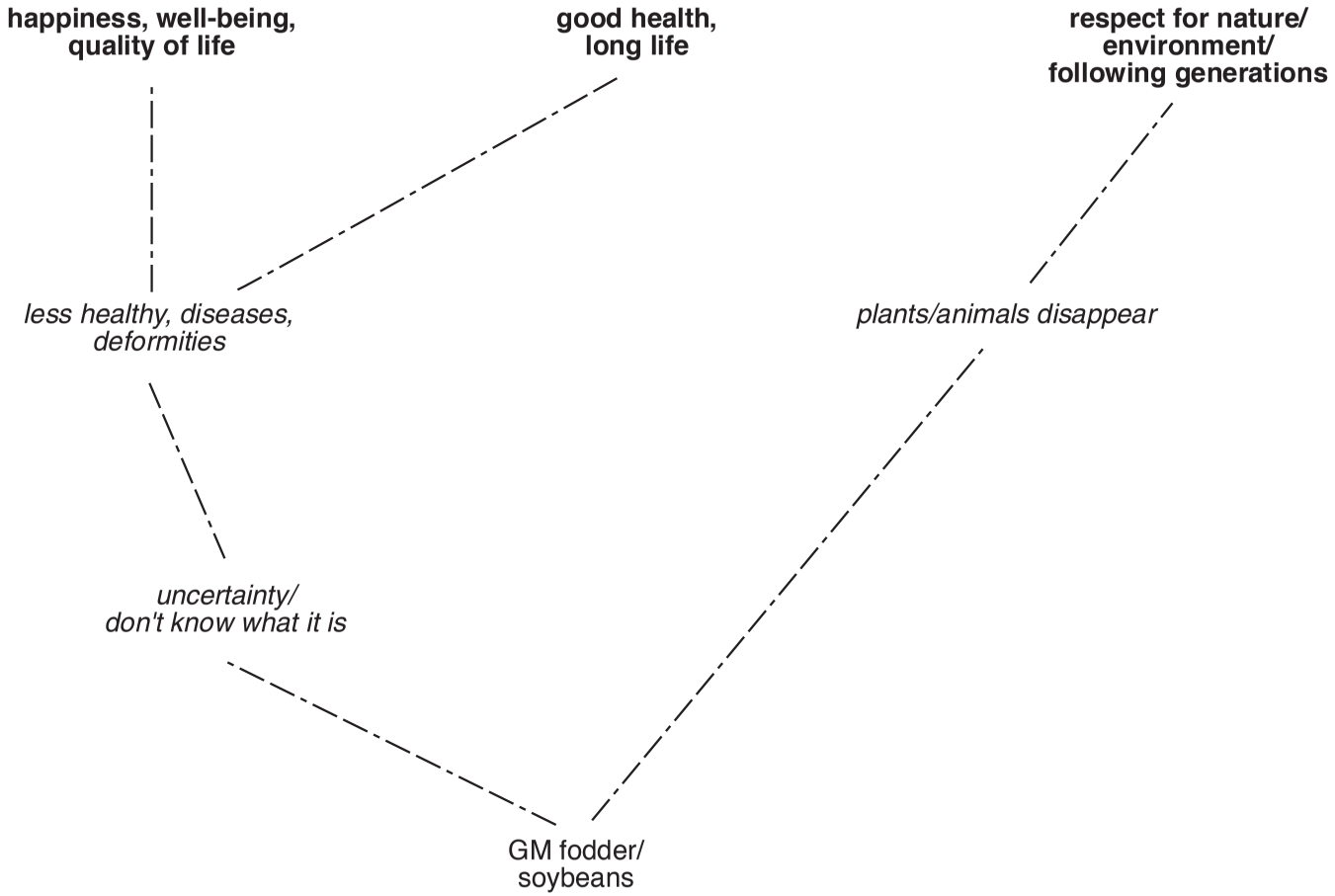
Salmon conventional, Norway

N=21
Cut-off=4



Salmon a1, Norway

N=21
Cut-off=4



Salmon a2, Norway

N=21
Cut-off=4

Salmon a3, Norway

N=21
Cut-off=4

Salmon c1, Norway

N=25
Cut-off=4