Human Brain Project

Citizens' View on Neuroscience and Dual Use

Online Consultation

Authors/Compiled by:

Nicklas Bådum, Project manager

Marie Louise Jørgensen, Senior Project Manager

Danish Board of Technology Foundation

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Content

Summary

As part of the HBP citizen consultation on dual use, an online citizen consultation for European citizens was carried out from September to December in 2017. The online consultation was actively promoted in 10 European countries. In total, 2048 Europeans from 20 European countries participated, the vast majority being from the 10 focus countries.
The focus of the online consultation was to explore the opinions, values, hopes and worries of Europeans regarding neuroscience research, when, though it is intended for civilian use, its research can be used by others for political, security, intelligence or military (PSIM) purposes; dual use for short. The consultation provided information in text and video explaining dual use and why it is important to discuss in context of a civilian neuroscience research project like Human Brain Project.

A central conclusion was that the respondents were concerned that results from neuroscience research, like the HBP, could be used by others for dual use purposes. While this was a clear conclusion, the respondents were also concerned about how neuroscience research results could have wider societal consequences. Regarding both aspects, the respondents were typically concerned about different aspects of artificial intelligence, about different aspects pertaining to risks of hacking, and lastly, they were concerned about how these developments could influence societal perceptions of what is 'normal'.
Furthermore, respondents were opposed to organisations receiving funding through HBP if they also conduct military research, just as respondents opposed military research with public funding. And if HBP researchers deliberately contribute to PSIM research, they should be subject to a sanction. Clearly, to the respondents political, security, intelligence or military (PSIM) uses should not be the purpose of carrying out neuroscience research and development.

The respondents were presented with three examples of how neuroscience research could be applied for both civilian and PSIM purposes: brain-computer interfaces (BCI), medicine and artificial intelligence (deep learning). Concerning both BCIs and artificial intelligence respondents were particularly worried about hacking, while concerns regarding medicine particularly pertained to changing social perceptions of what is normal. Of the three examples, medicine was the one found most acceptable by respondents, and uses of neuroscience for medical and health purposes was supported most generally by the respondents.
Despite the concerns, only few respondents found none of the examples of how neuroscience research could be used for PSIM purposes acceptable, which indicates that the respondents were less concerned with who used the research results, than how they were used, but it also indicates that respondents were not opposed to further neuroscience research. In addition, to the respondents it was important that information about research and its results should be made publicly available and that collaboration with other neuroscience research organisations and initiatives is a beneficial way of furthering research.

So, while there is no doubt that respondents are concerned about dual use of neuroscience research results and that they are generally worried about how these results could affect society in general, it is also clear that they were in favour of continuing the research and of using, also for some aspects of dual use. As such, to the respondents, it was a trade-off in which the positive aspects outweighed the negative ones. However, it was clear that to the respondents, PSIM uses should not be the aim of neuroscience research.

About the Online Consultation

This report presents the results of the online survey on neuroscience and dual use, carried out by the Danish Board of Technology. The survey was part of the Danish Board of Technology's citizen consultation that enquired into the values, ethical and practical opinions of European citizens with regard to the questions that arise when neuroscience research could be used by others for political, security, intelligence or military purposes, so called 'dual uses'.
These engagement activities also included face-to-face citizen workshops in 8 European countries.
The citizen consultation comprises a part of DBT's work in the Ethics and Society division of the Human Brain Project.

The survey naturally touched upon some of the same questions as the face-to-face consultations. The purpose of the dual strategy was to apply the two different methodologies in order to gain the benefits of both while compensating for the shortcomings of both. The online survey provides generalizable and naturally quantified answers, but these results provide "shallow" knowledge that lack information about the motivation for the answers given, and where the face-to-face methodology by design forces participants to deliberate and influence each other's views, the survey method will tend to collect more spontaneous responses. On the other hand, the face-to-face workshops provide in-depth and thoroughly elaborated answers to some of the questions, but despite efforts to ensure that the participants reflect national demographics, 30 respondents will not be able to provide statistical generalizability and the results are hard to quantify.

The survey was actively promoted across 10 European countries, and as a consequence, the vast majority of respondents were from Belgium, Bulgaria, Denmark, France, Germany, Italy, Lithuania, Poland, Portugal and Slovakia. In an effort to ensure demographic representativeness of the sample, the promotion efforts actively sought to ensure that the sample of respondents were representative of each country in terms of age, gender, education and area of residence. Annex 1 presents the full demographic of the respondents.

The questionnaire was divided in two parts. In the first part, respondents first read an introductory text and watched a video that presented HBP and its research, what dual use is and why it is relevant to discuss in relation to a civilian neuroscience research project. Subsequently they were asked principal questions regarding the practical, ethical and moral aspects concerning neuroscience and dual use. In the second part, the respondents were asked questions concerning specific examples of how neuroscience research could be applied for both civilian and PSIM uses. These questions centred on three specific research areas: Medicine, Brain-computer interfaces and Artificial intelligence.

Summary of Results from Face-to-face Consultation

As part of the HBP citizen consultation on dual use, citizen workshops were carried out in 8 European countries, and a total of 241 European residents took part in this face-to-face consultation.

The research showed that the citizens were generally concerned about the HBP research and the potential uses that it could be put to.
The participating citizens were most frequently concerned about how these technological advances could lead to or be used for dehumanization of society, reduction of self-determination and free will, manipulation and political and social control and, lastly, privacy and surveillance. Central to this was that it was not the user that was primary to the participating citizens' concerns. Rather, it was the use itself. To them, dual use could also be beneficial. In addition, they considered PSIM use to be inevitable.

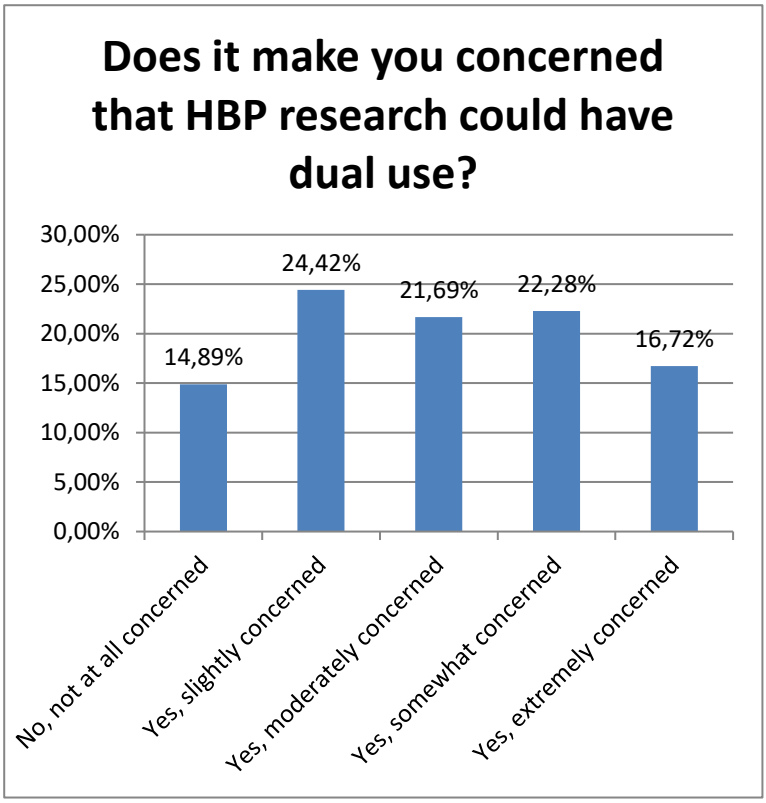
The overall conclusion of the face-to-face workshops was that the citizens, despite their concerns, were in favour of continuing neuroscience research even if it could have dual use, as long as it contributes to developing society, science and technology in a beneficial way. They generally considered the positive aspects of neuroscience research to outweigh the negative ones, and emphasized the potential benefits related to medicine, particularly in relation to medical treatment and diagnostics.
The citizens' support for continued neuroscience research was contingent on the development of international legislation and ethical guidelines for the research and use of neuroscience, and they suggested setting up a monitoring and enforcement body. To the citizens, policy-makers should play a central role in defining what neuroscience research and use is acceptable.

The full report of the results and the individual country reports from these activities can be found at:
http://hbp.tekno.dk/events/citizen-workshop-dual-use-of-human-brain-projects-research/

General Principles Concerning Neuroscience and Dual Use

The survey was sparked off with a central question concerning whether the respondents were concerned about dual use of research from the Human Brain Project. The graph below shows the results.

While non-negligible portions of the respondents were either extremely concerned or not at all concerned, most of the participants were less resolute in their responses. On aggregate, the respondents seem to be fairly evenly divided across the five-point scale; all options are within 10 percentage points, and both sides of the middle have approximately 39% of the respondents, however almost 70% of the respondents were clustered around the centre. It is worth noting, though, that there were only 15% of respondents who had no concerns. This could be because the majority of respondents considered dual use to be both positive and negative. To elaborate on this, respondents were given the opportunity to leave an explanation of why they made the choice they did; 573 chose to do so.



From the respondents who motivated their choice in text, it was apparent that most respondents were in fact concerned about dual use of HBP research to some extent, but at the same time they found that this risk was acceptable given the positive potentials of the research, particularly for health and medicine applications, and these respondents expressed faith in the EU's ability to regulate the area. In addition, a large portion of respondents also pointed to the importance of open science and science being conducted under auspices where it is subject to scrutiny. There were also quite a few respondents that found that dual use could not be prevented anyway. The respondents that were not at all concerned, often also pointed to the importance of developing science because it benefits society, and that one way of doing so, would be to cooperate with the military in research and innovation. Among the most concerned respondents, general worries about PSIM or dual use were widespread. More specifically worries pertained to mind control, manipulation, and how freedom of the individual would be affected.

This sheds some light on why the answers are distributed as they are. It appears that the vast majority of respondents are neither extremely nor not at all concerned. Their tendency to cluster around the centre appears to be a reflection of their nuanced approach to a complicated question, namely that neuroscience

is neither uniformly positive nor is it uniformly negative. Even the respondents that are somewhat concerned find aspects of the research to be positive and even necessary, despite their worries, while those who are only slightly concerned, nevertheless are concerned, particularly about military and political use.

The subsequent questions concerned elaborations on the respondents' attitudes to questions of a principal character with regard to funding of military or PSIM research, collaboration with other neuroscience initiatives that are tied to defence agencies and open science. While the first question proved to divide respondents, there was more agreement on the subsequent principal questions, particularly concerning funding of research.

The respondents generally did not find it acceptable if organisations receiving funding through the HBP also conduct military research. This was the case for 56%, which was twice as many as the amount that found it acceptable. The majority were also opposed to having public research programmes funding research with intelligence and/or military purposes, and, in addition, almost all respondents found that HBP researchers deliberately conducting PSIM research should be subject to a sanction. In the same vein, there were close to 60% of respondents that were not opposed to HBP collaborating with other neuroscience initiatives that had financial ties to defence agencies. However, this support was for most respondents contingent on the other organisation being placed in a country that has signed and ratified relevant international treaties, in EU member states or allies hereof. It should be mentioned that a sizable portion of respondents (35%) were opposed to such collaboration.

The respondents tended to answer consistently across these questions. There was between substantial and very strong correlation between what respondents answered to either of these questions and what they answered to any of the others, i.e. if they answered no to whether it is acceptable that organisations receive funding through the HBP they also tended to answer negatively to the other questions, whereas if they had no concerns about dual use of research they tended to answer yes the other questions. Among the first six questions one differed substantially from this tendency. To the question of whether the concept of open science should also apply to research that has potential dual use, respondents generally answered yes (53%, 32% answered no). What separates this question from the others is that the correlation between this and all the other questions is substantially lower than it is between the others. This indicates that while the respondents tended to be either relatively consistent with their support or opposition with regard to the other questions, this question proved much more divisive.

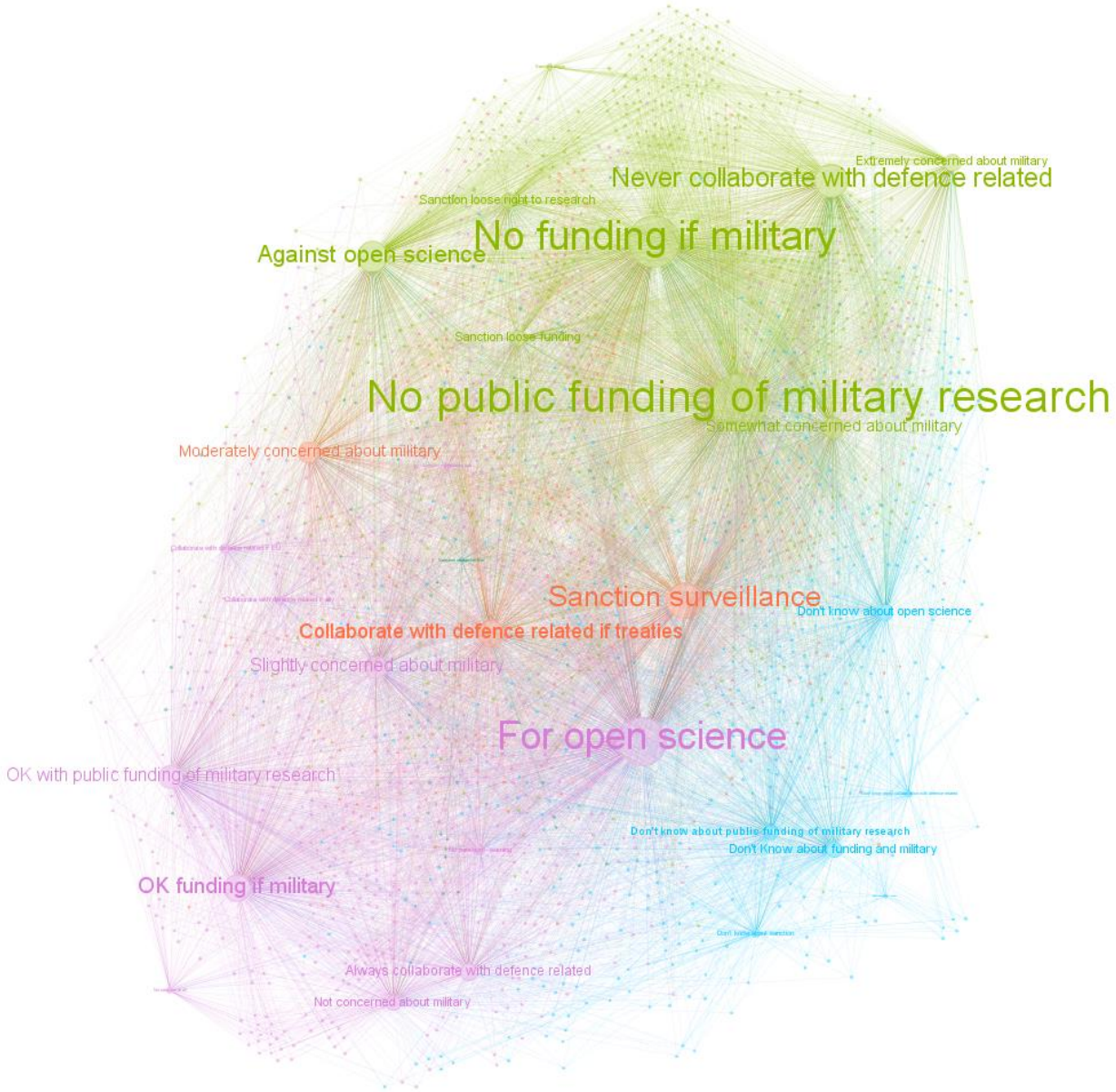
Summing up

The respondents were generally in favour of neuroscience research, even if it could have dual use, but it is important to them that publicly funded research should not have PSIM purposes. PSIM research and civilian research should be kept separate. But it clearly does not mean that they were not concerned about dual use. From the first question alone, it is clear that only 15% were not concerned about the prospect that HBP research could be used by others for PSIM purposes, and there was consistent opposition towards publicly funded dual use research. So, even though they considered the benefits to be worth the risks, they did have significant concerns. This interpretation is somewhat supported by the fact that the majority of respondents agreed that the open science agenda should also apply to research that had dual use potential, even though this was a question that challenged the respondents' consistency, especially for those respondents who were otherwise comparatively sceptical. This reaffirms the analysis of the written

answers provided to the first question, in that, while respondents might be concerned about the research being used for PSIM purposes, the positive aspects are still dominant, and this is the case to the extent that they are in favour of research results should be made public. This was also pointed out by some respondents in their written answers, which were provided prior to reaching this question.

Grouping the respondents

The map below represents a network of all answers that respondents gave to the first six questions.
The larger circles with text represent an answer category to one question, while each small coloured dot represents one respondent. Each dot is connected by a line with the answers that they have given to each question. The map is generated in Gephi, which is a data-visualisation program. The program uses an algorithm to place answer categories and respondents in a map where, very roughly, answer categories to



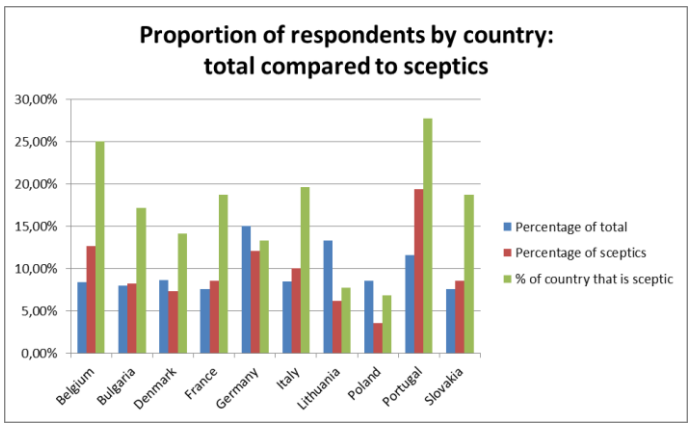
the same question repel each other, while the lines between respondent and answer pulls answer categories that respondents tend to choose. The size of the answer category corresponds to how many respondents have chosen it. Thus, if 10 respondents choose the same 6 categories across 6 questions these 6 categories will be pulled together. In the map above, such a tendency is clear for the blue area, where the 'I do not know / wish to answer' categories are placed, which indicates that there is a tendency for people to repeatedly chose these answers. The colour coding is the algorithm's attempt at dividing the map into segments. Thus, the blue dots, tend to answer, 'do not know/wish to answer'. Of more interest are the green and purple clusters, clearly juxtaposed at either end of the map. The green cluster represents the respondents that have tended to be more sceptical across the six questions, while the purple represents the more positive respondents.

The Sceptic Group

Looking into the numbers it becomes possible to sketch these groups out a little more. Of the total 2048 respondents, there are 192, or 9,2% of all respondents, who were extremely concerned about the dual use potential of HBP research, and who did not find acceptable that an organization receives HBP funding if it at the same time conducts military research and who were against the HBP collaborating with any organization receiving funding from or working for defence agencies, who were in favour of a sanction against HBP researchers deliberately contributing to dual use of HBP research and who did not believe that pubic research programmes should fund research with intelligence or military purposes. This group could be designated the very sceptical.

If those who were somewhat concerned about dual use of HBP research are included, the group comprises 340, or 17% of the total sample. It is very interesting to note that to the question of open science, this group is split in half: 147 were for, while 153 were against and 40 did not know. This reinforces the tendency described above for the question of open science to be a question which disrupted the otherwise fairly consistent pattern of choices.

All the focus countries are represented in the sceptic group. The biggest contributor to the group is Portugal, with 19% of all sceptics. Belgium and France contributes with 13% and 12%, respectively. The least represented country in the group of sceptics is Poland with only 4%, followed by Lithuania (6%) and Denmark (7%). When comparing the proportion of sceptics belonging to each country with proportion of respondents belonging to each country among the total sample, it is clear that particularly Portugal and Belgium, and to a lesser extent Italy, have a greater proportion of sceptics than of the total sample. Portugal makes up 12% of the total sample, but 19% of the sceptics, Belgium makes up 8% of the total sample but makes up 13% of the sceptics, while Italy makes up 8% of the total sample but 10% of the group of sceptics. On the other hand, particularly Lithuania and Poland, but also Germany, have a far smaller representation among the sceptics, compared to their representation among the total sample.

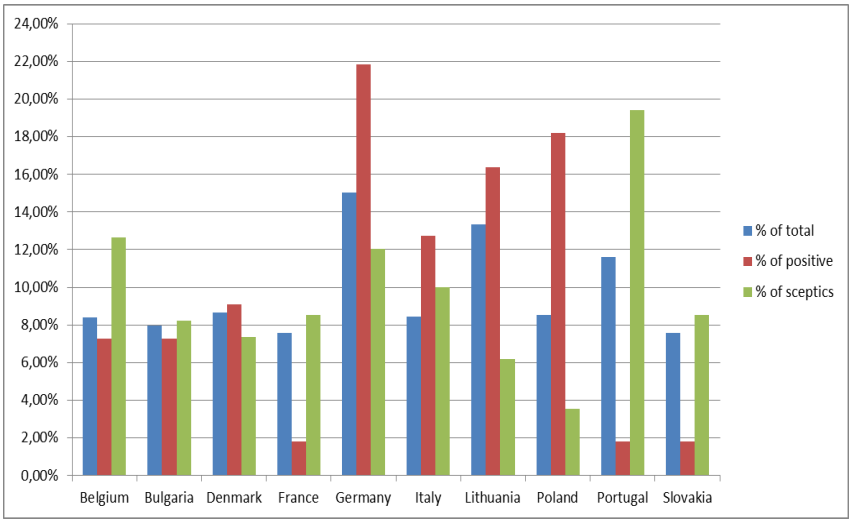


Lithuania makes up 13,33% of the total sample, but only 6,2% of the sceptics. Poland makes up 8,5% of the total sample but only 3,5% of the sceptics, while Germany make up 15% of the total sample and only 12% of the sceptics.
The representation of these countries in the group of sceptics, generally reflect the respondents from that country vis-à-vis the general sample. Portugal, Belgium and Italy tend to have more respondents that choose the negative options than the total sample, while the Polish, Lithuanian and German respondents tend to be more positive than the total sample. However, the question about open science once again proves to be an exception to this rule. Here, Portugal is similar to the total sample, while Belgium and Italy are more positive. On the other side, Lithuania and Poland are more negative towards open science than the total sample.

The sceptical group can be tested statistically against the demographic data. Testing for the other demographic criteria reveals that there is a low correlation between higher levels of education and being sceptic. When it comes to age, there is a correlation between higher age and belonging the sceptic group, though the respondents over 70 years of age break with this tendency. At the same time, there appears to also be connection between gender and being sceptic. The total sample consists of equal amounts of men and women, but of the respondents belonging to the sceptic group 52% are women and 46% are men, however there is no statistical correlation between these two. The observed difference could be caused by differences in gender samples, where Portugal, for instance, has almost twice as many women as men.
It thus transpires that the group of sceptic respondents tends to have high levels of education and be older, and are particularly well represented in Portugal and Belgium, while not being very well represented in Germany, Lithuania or Poland.

The Positive Group

An opposite group of this can also be established, though it is considerably smaller. A group of very positive respondents, is comprised of 27 respondents who were not at all concerned about dual use of HBP research, while at the same time being alright with an organization receiving HBP funding if it also conducts military research, unconditionally in favour of the HBP collaborating with organizations that work for or receive funding from defence agencies, opposed to sanctioning HBP researchers who deliberately contributes to dual use of research, in favour of open science and of public research programmes funding research with intelligence and/or military purposes.



Slightly relaxing the criterion by including those who were slightly concerned about dual use of HBP research and those who were conditionally for collaboration with organizations or initiatives that work for or receive funding

from defence agencies increases the group to 55. It is first and foremost remarkable how much smaller this group is, than the group of sceptics.
All of the focus countries of the survey are represented in the positive group, with Germany and Poland being the most prominently featured, with 12 and 10 respondents, respectively. For both it goes that their proportional representation in the positive group is much larger than it is in the total sample. Comparing the different countries' proportion of the positive group to their proportion of the total sample, it is clear that Germany and Poland are very well represented, as is Lithuania and Italy. With the exception of Italy which was also prominent in the sceptical group, this fits very well with the analysis of the sceptic group above. On the other hand, Portugal, Slovakia and France is almost absent from the positive group.

Looking at gender it also becomes clear that men make up the vast majority of the positive group with 78%, whereas the total sample is divided almost 50/50 between men and women. Testing for statistical significance it is clear that gender substantially influences belonging to the positive group, meaning that men have a much greater tendency to be members of the positive group than women. In contrast, there appears to be no correlation between age and belonging to the positive group.

The groups in short

These results indicate that there are far more respondents that are consistently sceptical about neuroscience research and dual use, than there are respondents that are consistently positive about it, and that while there is no statistical correlation between gender and being sceptical, there is a substantial correlation between being man and belonging to the positive group. The most positive countries when it comes to the principal questions concerning dual use of neuroscience appears to be Poland, Lithuania and Germany, while Portugal, Belgium and Italy are generally more sceptical.

The one question that disrupts all patterns of choice for the first six questions is the one concerning open science. Those who are consistently sceptic are split in half over this, countries that are generally positive to the other questions are sceptical of this, while the sceptical countries are positive.

Conclusions on the principle questions of neuroscience and PSIM use

The respondents were generally concerned about the fact that neuroscience research could have dual use. Only a minority had no concerns in that direction. Despite their concerns, though, the respondents were generally in favour of neuroscience, even if it could have dual use, but it is important to them that publicly funded research should not have PSIM purposes. It is clear that the respondents were opposed to military research and development being conducted under the auspice of the HBP or in any other publicly funded research programme. This is further illustrated by their opposition to organisations receiving funding through HBP if they also conduct military research, and that they were in favour of sanctioning researchers who carried out research under the auspice of HBP but at the same time deliberately contributed to dual use of their research.

However, the respondents were not opposed to HBP collaborating with other research organisations and/or initiatives that receive funding from or work for defence agencies, just as they were, generally, in favour of retaining the *open science* agenda, even for research that has potential dual use.

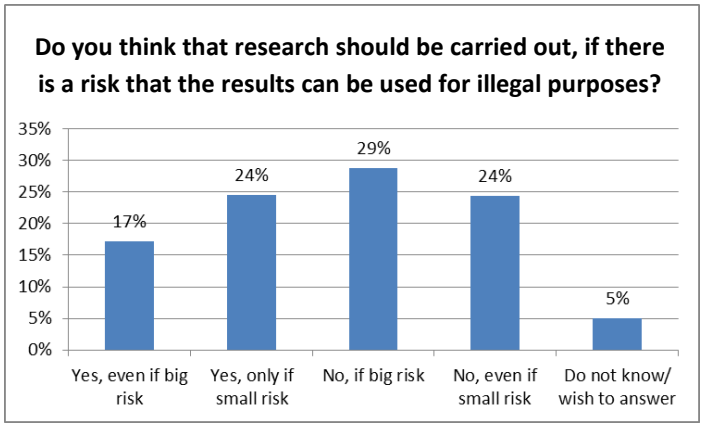
Thus, to most of the respondents it is not acceptable that the HBP directly or indirectly supports or conducts military research. But, to most of them, it is ok if the project engages in collaboration with other organisations that conduct research for military agencies or receive funding from them, and they are in favour of continuing the open science agenda. From this it could be inferred that the respondents were in favour of neuroscience research as long as its purpose is civilian applications, and that the results of this research should be made widely available, whereas public funding of research with PSIM uses in general, and of neuroscience research with PSIM uses specifically, was not endorsed by the participants.

The second part of the questionnaire presented respondents with examples of how neuroscience research could be used, both for military and civilian applications. The questions focused on three specific areas that neuroscience research could contribute to, namely medicine, artificial intelligence (deep learning) and brain-computer interfaces. For each of the areas, there was text explaining the research and technologies involved, in order to help the respondents' reflection on the questions.

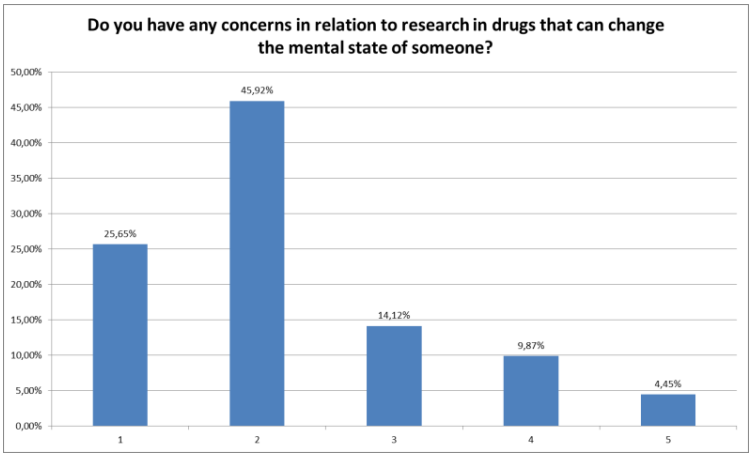
Medicine

The questionnaire contained two questions concerning research in medicine.

The first question[1] asked whether research in drugs should be continued if there is a risk that it can be used for illegal purposes. The greatest share (29%) answered that if the risk is great then it should not be allowed. 25% answered that if there is a small risk it should be allowed, while 17% were in favour of continuing, even if there is a big risk that it can be used for illegal purposes. 24% answered that even if there is a small risk of illegal use, it should not be allowed. Although not vastly at odds, this does deviate some from the results of the first question regarding concern about dual use, which might indicate that to some of the participants, the risk of dual use is more acceptable than the risk of illegal use is. It is also remarkable that 41% found that research should be carried out even if there is a risk.



When answering whether they had any concerns about drugs that can be used to change someone's mental state[2], the largest share of respondents were concerned that it would become normal to change the mental state of a person, which 46% answered. 26% answered that they were not concerned because there are already drugs in use that do this. 14% were worried that it could result in more violent robberies, fights etc., while 10% were concerned that if treating soldiers is easier and more effective, there will be fewer concerns about what they experience. It might be worth remembering here, that some of the worries that were frequently expressed by respondents in the text answers to the question of whether respondents were concerned about dual use of HBP research



[1] Full question: Do you think that research should be carried out, if there is a risk that the results can be used for illegal purposes?

[2] Full answer text: 1. No, we already today have different kinds of drugs that change the mental state of a person; 2. Yes, I'm concerned that it becomes normal to change the mental state of a person; 3. Yes, I'm concerned that drugs used to remove anxiety or remorse will result in more violent robberies, fights etc.; 4. Yes, I'm concerned that if it becomes easier to treat soldiers then there are fewer concerns about what they experience; 5. I do not know / wish to answer.

in the questionnaire concerned mind control and manipulation as well as how research results could affect the individual's freedom of mind.

There is a statistical correlation between answers given to these two questions. Those who were more relaxed about research in new medicine in relation to illegal use more often tended to also be unconcerned about research in drugs that can change someone's mental state, while those who did not think research should be carried out if there is a risk that it can be used for illegal purposes more often tended to be concerned that it becomes normal to change the mental state of a person.

But in general, it seems that the participants are more risk averse when it comes specifically to research the results of which could be used for illegal purposes than they are regarding research that could have dual use. In addition, their primary concern when it comes to research in medicine, appears to be that it could become normal to change someone's state of mind.

Thus, while 70% of respondents worry about drugs that affect the mental state of someone for one of the above mentioned reasons, the respondents were less in agreement about research in medicine that could be used for illegal purposes. Predictably, those who are not worried about drugs that can change someone's behaviour, are also more likely to be in favour of continuing research even if there is a big risk that it can be used for illegal purposes. In fact, of those who answered that even if there is a big risk of illegal use research should be continued 53,4% answered that they were not worried about these drugs. For those who answered that, if there is only a small risk of illegal use research should be continued, the same number was 35%. The same number for those who answered that if there is a big risk or a small risk research should be discontinued was 18% and 11,6%, respectively. The respondents that wanted to allow research if there was only a small risk of illegal use were more or less divided with regard to drugs that can change the mental state of someone. Generally, either they had no concerns or they were concerned that it would become normal to changes someone's mental state of mind.

Revisiting the group of sceptics, it is not surprising to see that they are predominantly to be found among the respondents that did not think that research should be carried out if there was a big risk (32%) and those that did not think it should be carried out even if there is a small risk (47%). There is a substantial statistically significant correlation between being sceptic and being opposed to carrying out research in medicine if it can be used for illegal purposes, whether the risk is big or small. Likewise there is a strong, statistically significant, correlation between belonging to the positive group and wanting to allow research in medicine regardless of the risk of illegal use. The group of positive respondents tend to be believe that even if there is a big risk that it can be abused research should be continued (47%) and that if there is only a small risk it should be continued (30%).
The same tendency is clear from the second question, regarding concerns over drugs changing someone's state of mind. Only 15% of the sceptics are not concerned, while 56% are concerned that it becomes normal to change someone's state of mind. Supporting this, there is a moderate statistically significant correlation between being sceptic and being concerned about one of the three examples. Contrary to this, 67% of the positive group answered that they were not concerned, since these kinds of drugs already exist, while 27% answered that they were worried that it would become normal to change someone's state of

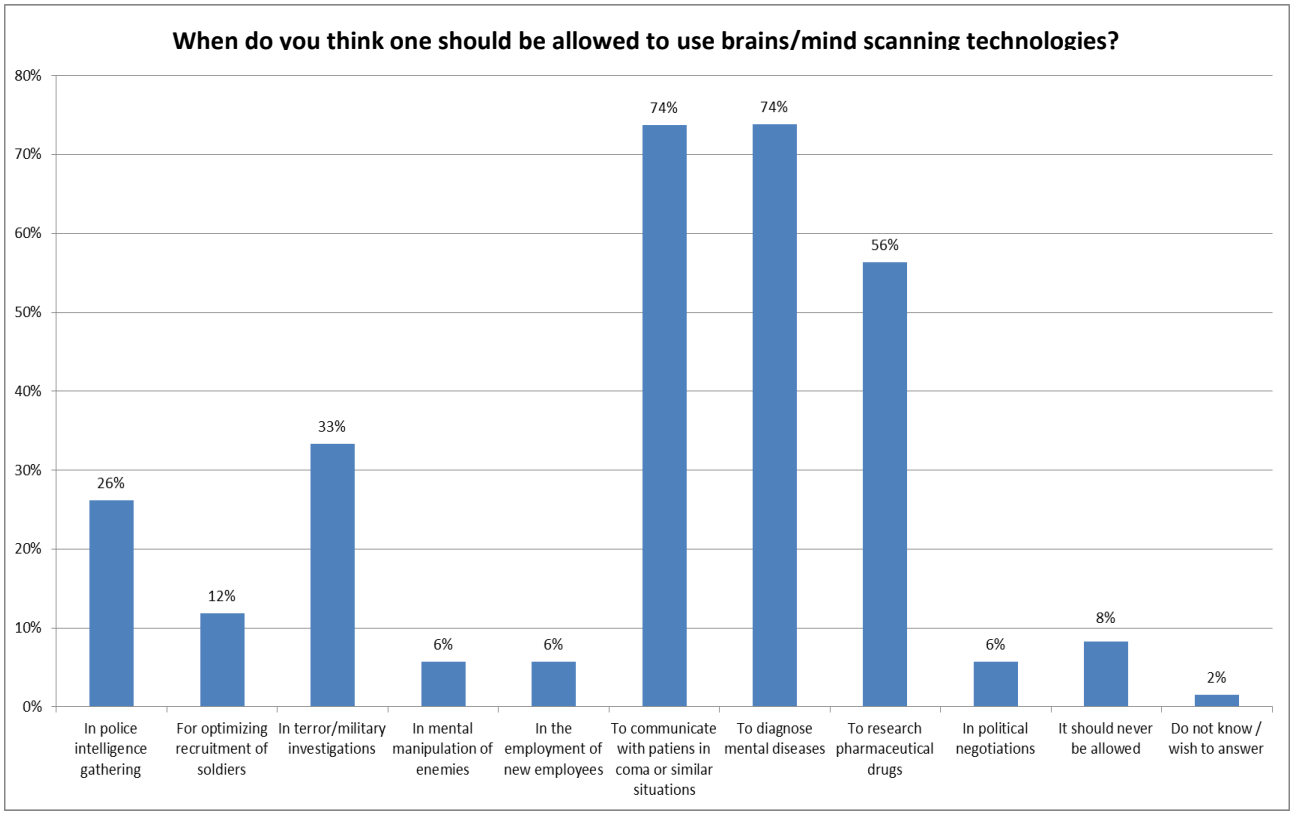
mind. Here there is a very strong correlation between belonging to the positive group and not being concerned about these drugs.

Looking at the demographic data, it is clear that women are less likely to want to allow research in drugs that have a risk of illegal use than men, while men tended to be less concerned about drugs that can alter someone's state of mind. There were also differences between countries. While particularly Bulgaria, France and Portugal were less inclined to let research be carried out if it could be used illegally, the respondents in Poland and Germany were less concerned about this. For the second question, the Slovak and Italian respondents had the greatest proportion of unconcerned respondents, while this proportion was lowest for Portugal. Especially in Portugal, but also in Belgium, respondents were particularly concerned about drugs that can change someone's state of mind because it could lead to this becoming normal. The only other deviance from the average is Lithuania, where there were almost as many that were concerned with it could result in more violent robberies or fights if drugs can remove remorse or anxiety. So again it appears that the Portuguese respondents are generally more sceptical than the average. There was no correlation between age or level of education and attitude to either of the two questions.

Brain-Computer Interfaces

The respondents were asked two questions that were exclusively about brain-computer interfaces (BCI) and one question that concerned both BCI and artificial intelligence (AI).

To the question of when brain/mind scanning technology should be allowed to be used, the respondents were allowed to choose as many of the 9 pre-given choices they wanted. Option 10 and 11 logically excluded the others and could only be chosen as such. A total of 6217 choices were made.

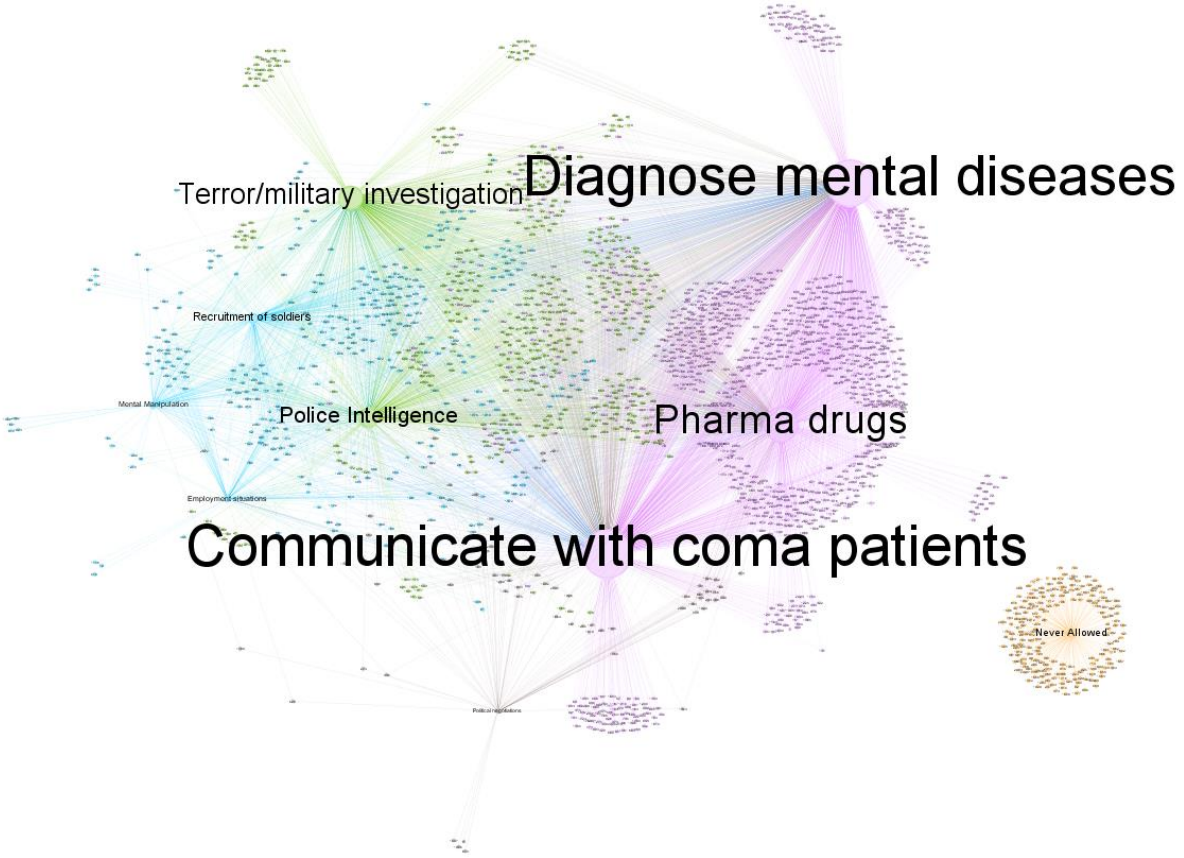


There were particularly two uses that respondents favoured: to use it for communicating with patients in coma and to diagnose mental health diseases, which 1509 and 1512 respondents chose, respectively. This amounts to these two uses being favoured by 73,7% and 73,8% of all respondents, and in combination they accounted for 49% of all chosen answers. A third use, which was favoured by 56% of respondents, was to research pharmaceutical drugs. This tendency was accentuated by the fact that the most frequent combination of choices was these three together, which was chosen by 475 (23%) of the respondent, second to which was the combination of the above two uses, communication with coma patients and diagnoses of mental health diseases, which was chosen by 168 (8%) respondents. In total there were 957 who had at least chosen these three options, which amounts to 47% of the respondents.

33% of the respondents believed that it should be allowed to use this technology in terror/military investigations, while 26% believed it should be allowed for police intelligence gathering, while only few

thought it should be allowed to use it for mental manipulation of enemies (6%), employment situations (6%) or in political negotiations (6%). 10% believed that it should never be allowed to use this kind of technology.

It is clear then, that most respondents were not generally against the use of this kind of technology, but the use which generally gathered most support was in relation to health and medicine. Though there was less support for uses that could be designated 'dual use', there were nonetheless 26% and 33%, respectively, that found use for police intelligence gathering and terror/military investigation should be allowed.

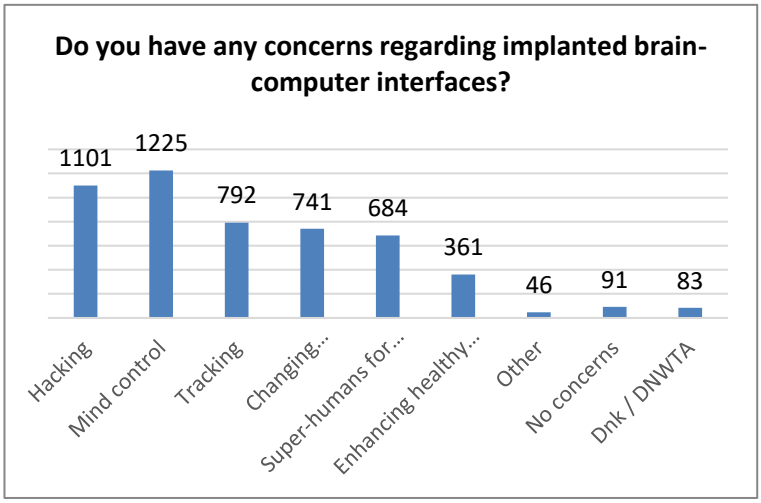


The map above shows how respondents were distributed on to the question about what uses of BCI was acceptable to them. The value labels are sized proportionate to how frequently they were chosen.
At first view it clearly confirms the above analysis that communicating with coma patients and diagnosing mental diseases are by far the most popular responses, with researching pharmaceutical drugs on a third place. The map also shows, however, that the respondents are roughly divided into four segments: the purple segment are those who only answered the three most frequent options and who were thus primarily proponents of using BCI for medical purposes; the green segment consists of those respondents that are in favour of using BCI for dual uses like police intelligence gathering and terror/military

investigations; the blue segment which is those who are in favour of using BCI for recruitment of soldiers, for mental manipulation of enemies and in employment situations; the orange segment is those who do not find any of the uses acceptable. There is a fifth group outside the picture, which consists of those that answered 'do not know / wish to answer'.

What is particularly remarkable about the network is that the purple segment tends to have answered the three medical options but not any of the other options. Only in fewer cases have they also chosen some of the 'green' answers, while the respondents in the green segment tend to also find the medical uses acceptable, and to a lesser extent, the options of the blue segment. The blue segment tends to also choose the options in the other two segments. In other words, while the purple segment does not find the other uses acceptable, the other segments tend to find the purple uses acceptable. This serves to further underline the conclusion above, that medical use of BCI is acceptable to almost all respondents. In fact, there were only 309 respondents that did not choose one of these three options, of which 196 were the ones who did not find any uses of BCI acceptable and 31 that did not know / wish to answer. This leaves only 82 respondents (0,4%) who did not find either of the medical uses acceptable but found one of the other 6 options acceptable.

To the question of whether they had any concerns regarding implanted BCIs[3], the respondents were given six options and a possibility for text response, of which they were allowed to choose up to three. 5127 answers were chosen, and 27 respondents chose to provide text response.



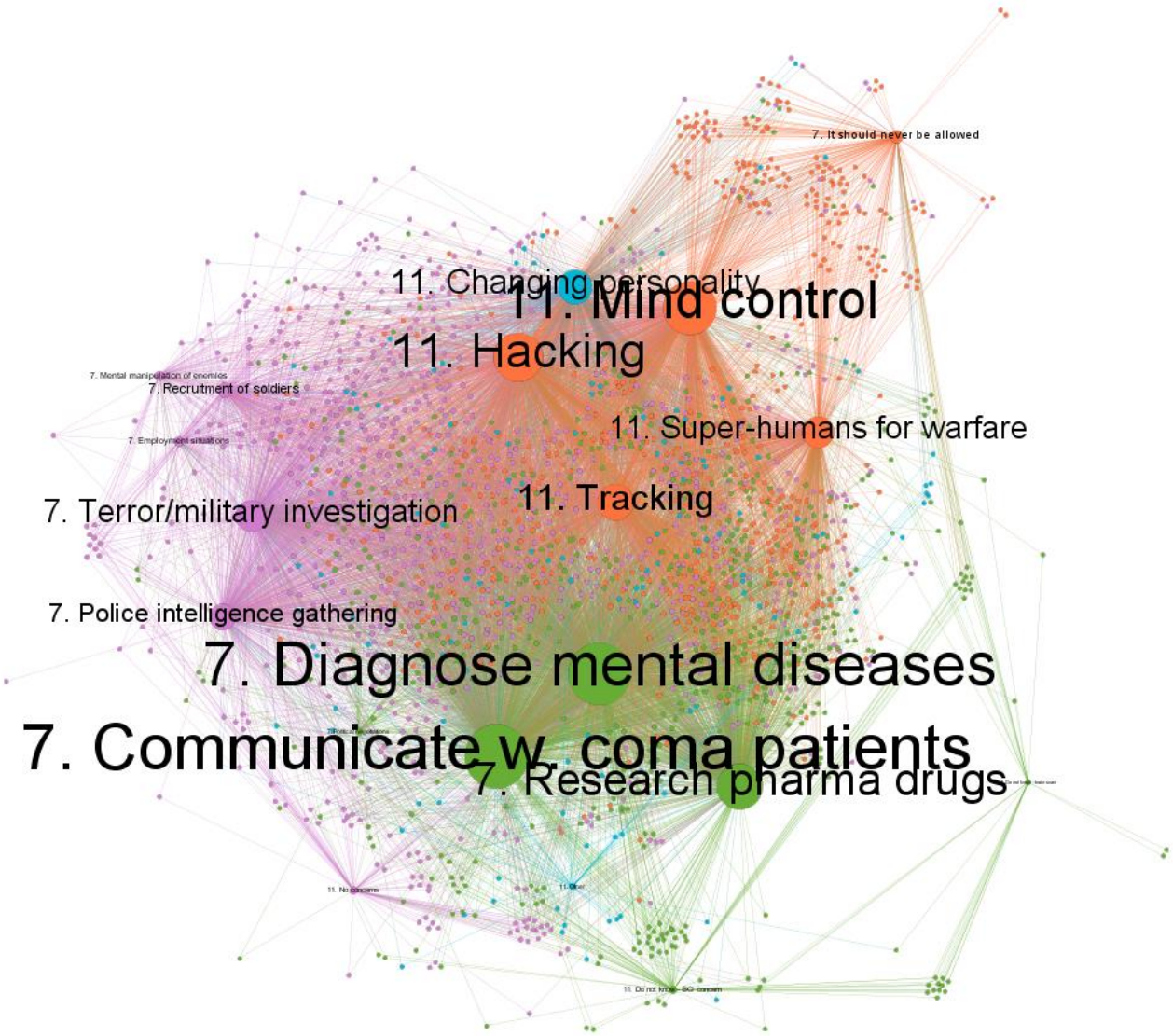
It was particularly mind control via BCIs and hacking of BCIs that concerned the respondents. These two answers were chosen by 60% and 54% of all participants, respectively, and the two were chosen in combination with each other by 37% of all respondents. The most frequent combination of options was hacking, mind control and tracking, which 278, or 13,6%, of participants chose, while 221, or 10,8%, chose hacking, mind control and changing personality, and 159, or 7,8%, chose hacking, mind control and the development of super-humans for warfare.

The use that fewest respondents were worried about was that BCI would be used for personal enhancement of otherwise healthy people, but even then, it was still selected by 361, or 18% of respondents. It is noteworthy that only 91 respondents, 4,4% of all respondents, did not have any worries.

[3] Full answer text: 1. Hacking, someone gets control over the device; 2. Mind control, that someone can control the mind through the interface; 3. Tracking, signals from the device is picked up and used for surveillance; 4. Changing personality, the device changes you – for example by lowering your aggression level or preferences; 5. The development of Super-Humans for warfare; 6. That otherwise healthy civilian people will start to use it for personal enhancement; 7. Other (answer in textbox); 8. I don't have any concerns; 9. I do not know / wish to answer.

Among the 27 who chose to leave a text answer, eight answered that they were worried about all the examples listed and did not want to confine themselves to just choosing three. Another theme is that they find it ok if it is used for medical purposes, which, however misplaced in this question, confirms the conclusions to the previous question.

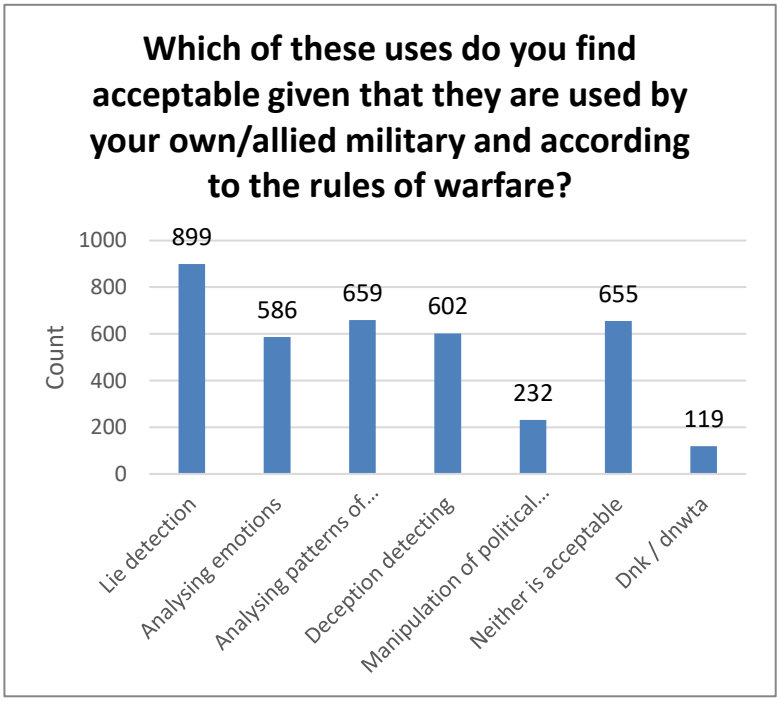
It indicates that almost all respondents did in fact have worries about implanted BCI, particularly mind control and hacking. When keeping in mind that a central concern among respondents when it came to drugs that could change the mental state of someone, was that this could become normal, it is worth noting, that the concern that implanted BCIs could change someone's personality was prominent. It seems to indicate that, at least some respondents are worried about how this research and development could influence societal norms.



The map above[4] shows how respondents were distributed across these two questions. Looking at it, it is not surprising to see that the categories that were most frequently answered in either question are in the centre of the map. In fact, 26% of all respondents chose all of these four categories, clearly underlining the conclusions for each of the questions.

It is noteworthy that if grouping the respondents by what use of BCI they found acceptable, the groups have more or less the same proportion of what the respondents are worried about regarding implanted BCIs. The largest number of respondents in each group had the same two concerns about implanted brain-computer interfaces, hacking and mind control, with tracking fairly consistently being the third most frequent worry. Similarly, the proportion of the other categories of worries about brain-computer interfaces is also similarly sized regardless what uses of BCI respondents found acceptable. Thus, for the most part what use of BCI the respondents found acceptable had very little influence on what worries they had about implanted BCI. The biggest exception is those answering that they have no concerns regarding BCI uses. These have a greater tendency of finding it acceptable to use BCI technology for police intelligence gathering and in terror/military investigations, whereas they are far less likely to find it acceptable to use BCI technology for communicating with coma patients, to diagnose mental diseases and to research pharmaceutical drugs, while they are more likely to accept using BCI technology in political negotiations.

Since BCIs and AI in some respects go hand in hand, the respondents were given five examples of how these could be employed by the military, and asked which, if any, they found acceptable if it was used by their own or allied military according to the rules of warfare[5]. Among these uses it was particularly lie detection that was popular (44%), while three options were also fairly popular, namely analysis of patterns of thought or behaviour (32%), deception detection (29%) and analysing emotions (29%). The option that fewest respondents found acceptable was manipulation of political systems, public opinion and media in other countries (11%). Almost a third of all respondents did not find any of these uses acceptable. Respondents were



[4] Numbers correspond to the number of the question.

[5] Full answer text: 1. Lie detection; 2. Analysing emotions e.g. aggression/sympathy to specific pictures, postulates, arguments etc.; 3. Analysing patterns of thoughts of behaviour – e.g. mapping aggressive/protective tendencies; 4. Deception detecting, detecting and predicting patterns of thoughts, emotions, behaviour…; 5. Manipulation of political systems, public opinion and media in other countries; 6. I don't find any of them acceptable; 7. I do not know / wish to answer.

allowed to choose as many of the 5 suggestions as they liked, and 68 respondents chose all of them. 332 (16%) participants chose both lie detection, analysis of emotions, and analysing patterns of thought or behaviour, while 251 (12%) in addition also chose deception detection. There is a clear tendency that those who were in favour of analysing emotions also were in favour of analysing thoughts or behaviour as well as deception detecting. Even clearer than this, is that those who were in favour of these three, were also in favour of using it for lie detection.

These results indicate that if a respondent finds one use acceptable, they are likely also to find the other uses acceptable, with the exception of manipulation of political systems, public opinion and media, which is very isolated. The tightest connection there is between this option and any other, is to deception detection. Almost a quarter of those who answered that deception detection is acceptable, also answered that they found this kind of manipulation acceptable.

When comparing this to the two previous questions on BCI, it is interesting to note that 62% of the respondents were supportive of their own or allied military using BCI for one or more of these purposes, considering that only 26% and 33%, respectively, found it acceptable that BCI be used for police intelligence gathering or terror/military investigations, and that 54% of all respondents did not find either of the dual use examples mentioned in that question acceptable. An explanation for this apparent disparity could be found in the explanations provided in text to the very first question, where some respondents pointed to the use itself being important to them, rather than dual use as such. So while, the dual use examples provided in the first question regarding BCI were not acceptable to 54% of respondents, there were still 64% of respondents that found it acceptable that their own or allied military use BCI or AI for one or more of the uses listed above. Which either indicates that the respondents valued these uses differently, or that some respondents were at odds with themselves.

It is interesting to note as well that though 655 respondents answered that neither of the listed use examples are acceptable if used by own or allied military, only 196 answered that neither of the BCI examples listed in the question regarding when brain/mind scanning should be allowed, but only 115 of these answered no to both. Not too surprising, those that found that BCI should be used for police intelligence gathering and military/terror investigations also found quite a few of the military uses acceptable, but still with the exception of manipulation.

That surveillance and tracking was a prominent worry is interesting and perhaps a little surprising, given that analysing patterns of thought and behaviour as well as analysing emotions and deception detection is among the PSIM uses that most respondents found acceptable, as this type of use would be difficult to carry out without precisely tracking and surveillance, at least to some extent.

Groups and demographics

Looking at the group of sceptical respondents it is clear that they are also consistently less enthusiastic about use of BCI. Where 7% of those who are not categorised as sceptics answered that they did not find any of the uses acceptable, the same was the case for 20% of the members of the sceptic group. At the same time, there were proportionally far fewer sceptics that found the example uses acceptable than was the case for non-sceptics. Meanwhile the opposite is true for the group of positive respondents. Neither of

them believed that none of the uses should be allowed, while they were significantly more in favour of all the uses than non-positive respondents.

Looking at concerns about implanted BCIs, the positive respondents are more frequently concerned about mind control than non-sceptics (respondents not belonging to the sceptic group), but significantly less often concerned about all other examples apart from hacking, and while 4% of non-positive respondents have no concerns, the same goes for 13% of positive respondents. The group of sceptic respondents is, with the exception of hacking, consistently more frequently concerned than non-sceptics, and only 2 (0,6%) sceptics has no concerns.

Considering the two groups' answers to the question regarding their own or allied military's use of AI and BCI, the proportion of sceptics is consistently remarkably lower for each of the examples than for non-sceptics; in most cases 20 percentage points lower than for non-sceptics. And unsurprisingly 59% of sceptics do not find any of the examples acceptable, compared to 27% of non-sceptics. The group of positive respondents is almost a negative mirror image of the sceptics. There is almost consistently 20 percentage points more positive respondents that find the examples acceptable than non-positive respondents, and while 33% non-positive respondents do not find any of the examples acceptable, the same number for the positive group is 11%.

It is interesting to note that there were only insignificant differences between what men and women found it acceptable to use BCI for, and there are almost the same amount that found neither example acceptable. The male respondents found 3,2 options acceptable one average while the female respondents only found 2,9 options acceptable on average, which could be an indication that women tend to find fewer uses acceptable. Nor are there any great differences between the genders when it comes to what they are concerned about regarding BCI, with the exception for men being slightly more often concerned about tracking, while women were more often concerned about the development of super-humans for warfare. To the question of what military use of BCI and AI they find acceptable, men are again slightly more accepting than women on all options, as a matter of fact, whereas there is a slightly higher proportion of women who find neither of the options acceptable.

Looking at how many choices the individual countries have made it appears that particularly Denmark and Lithuania are keen on the use of BCI, as respondents here have on average found 3,2 and 3,3 uses acceptable, respectively, while Belgium (2,7 choices on average), Bulgaria (2,8), Italy (2,6) and Slovakia (2,6) are less enthusiastic. Looking at the individual choices, it seems that the medical uses are particularly popular in Germany, Portugal and Denmark, while they are least popular in Bulgaria, Poland and Slovakia. On the other hand, the PSIM uses are more popular in Bulgaria, Denmark, Lithuania and Poland. The highest proportion of respondents that did not find any of the uses acceptable was found in Slovakia and Belgium with 14% and 18%, respectively, while Bulgaria (6,1%), Poland (6,3%) and Portugal (6,3%) had the lowest proportions.

Based on the number of options chosen by the individual country, it appeared that Belgium (2,6 choices on average), France and Germany (both 2,7 choices on average) were most concerned about implanted BCIs, while Italy (2 choices) and Lithuania (2,2) were less concerned. This also corresponds with the amount of

unconcerned respondents, as Italy and Lithuania has the highest proportion, while France and Belgium has the least respondents that are unconcerned about implanted BCI. The most widely chosen concern, mind control, particularly had Belgian (76%), French (68%), Portuguese (69%) and Slovakian (70%) respondents concerned, while Italian (49%) and Lithuanian (42%) respondents were least frequently concerned about this. The second most frequent concern, hacking (54% of all respondents), was particularly found concerning by German (65%) and Polish (64%) respondents, while Bulgarian (40%), Italian (38%) and Lithuanian (48%) respondents were less frequently concerned about it.

The countries that appeared most accepting of military use of BCI and AI, based on number of uses that the respondents found acceptable, were Poland (1,9 choices on average), Lithuania and Slovakia (bot 1,6 choices on average), whereas Belgium (1,2), France, Italy and Portugal (all 1,3) were the less accepting. This is to an extent confirmed by Poland, Lithuania and Slovakia, along with Bulgaria having the lowest proportion of respondents that find neither use acceptable, while Belgium, France and Portugal, along with Germany has the highest proportion of respondents finding neither use acceptable. While lie detection was generally the most accepted use, with 44% of all respondents finding it acceptable, this use was particularly found acceptable to Polish (56%) and Slovakian (55%) respondents, while Belgian, Bulgarian, French, Italian (all 37%) and Portuguese (36%) respondents were less keen about lie detection. On the other hand, the use that fewest respondents found acceptable, manipulation of political systems, public opinion and media in other countries, was more often found acceptable by Bulgarian (17%), Lithuanian (15%) and Polish (14%) respondents, while Belgian (8%), French, German, Italian and Portuguese (all 9%) respondents less often found it acceptable.

There were consistently higher proportions of men that found all of the uses of BCI acceptable than women, while women were there were slightly higher proportions of women that found neither of the uses acceptable. There were more men that were concerned about hacking and tracking, while women were more concerned about mind control and, in particular, that BCI could be used to develop super humans for warfare. There were slightly more men than women that had no concerns. Also in terms of the military use of AI and BCI, the male respondents consistently more often found the uses acceptable than women, who in term more often found neither of the uses acceptable.
In terms of age differences, the younger respondents tended to be more willing to accept all of the uses, particularly the PSIM uses, than the older respondents, with the notable exception of mental manipulation of enemies. The younger respondents also tended to be more concerned about hacking and tracking than the older respondents, who in turn were more concerned that implanted BCIs could change someone's personality. When it came to the examples of military use of AI and BCI, the younger respondents again tended to more often find these acceptable than the younger ones.

Conclusions on brain-computer interfaces

It was very clear that medical uses of BCI were found to be acceptable by the largest share of participants. Only 15% of the respondents did not find one of these acceptable and of these the vast majority did not find any uses of BCI acceptable. And while those who found the other uses acceptable tended to also find the medical uses acceptable, the opposite was rarely true. When it came to acceptance of PSIM examples

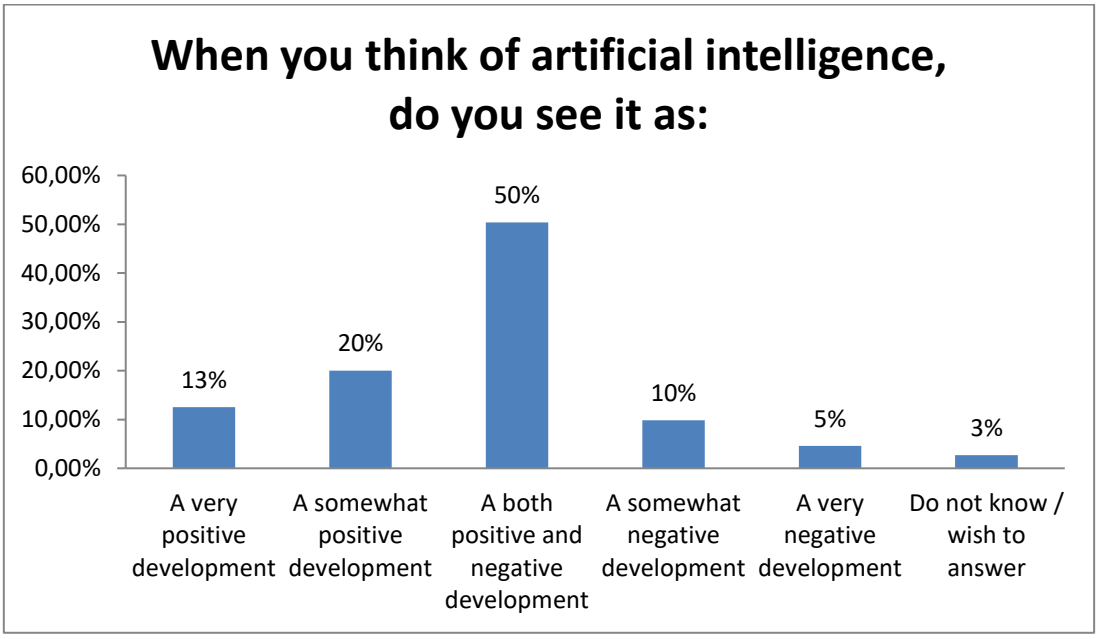
of use there were a quarter and a third of respondents that found it acceptable to use it for police intelligence gathering or terror/military investigations, respectively. In total, 54% found one of the four PSIM uses acceptable. This in turn means that 46% did not find either of these uses acceptable.

The concerns that were shared by most respondents were that the BCI could be used for mind control and that it could be hacked by others.
Among military uses of AI and BCI, the most widely acceptable use according to the respondents was lie detection, while the three uses, analysing emotions, patterns of thought or behaviour and deception detection was found acceptable by approximately a third each. However, one third of the participants found neither use acceptable.

The respondents belonging to the two groups sketched out in the first section generally behaved according to the qualities of the group. The sceptic respondents tended to find fewer uses acceptable, and to have more concerns than non-sceptics, while the group of positive respondents tended to find more uses acceptable and be less concerned.
Whereas on previous questions there had been significant differences between men and women, there was less difference when it came to BCI. They found more or less the use examples equally acceptable, and were generally worried about the same things. The men did tend to be slightly more accepting of military use of AI and BCI than women and there were slightly fewer men who found neither military use acceptable, but these differences were not remarkable.
Between countries there were great differences. Poland, Lithuania and Bulgaria tended to be more accepting of the different uses including military uses, and less concerned, while Belgium, France, Germany and Italy generally had fewer respondents that found the BCI uses acceptable and tended to have more concerned respondents. The Danish, Portuguese and Slovakian respondents tended to lie closer to the total average.

Artificial Intelligence and Deep Learning

The respondents were asked one questions about artificial intelligence, one about deep learning, two questions about autonomous weapons and the aforementioned question about military use of BCI and AI.

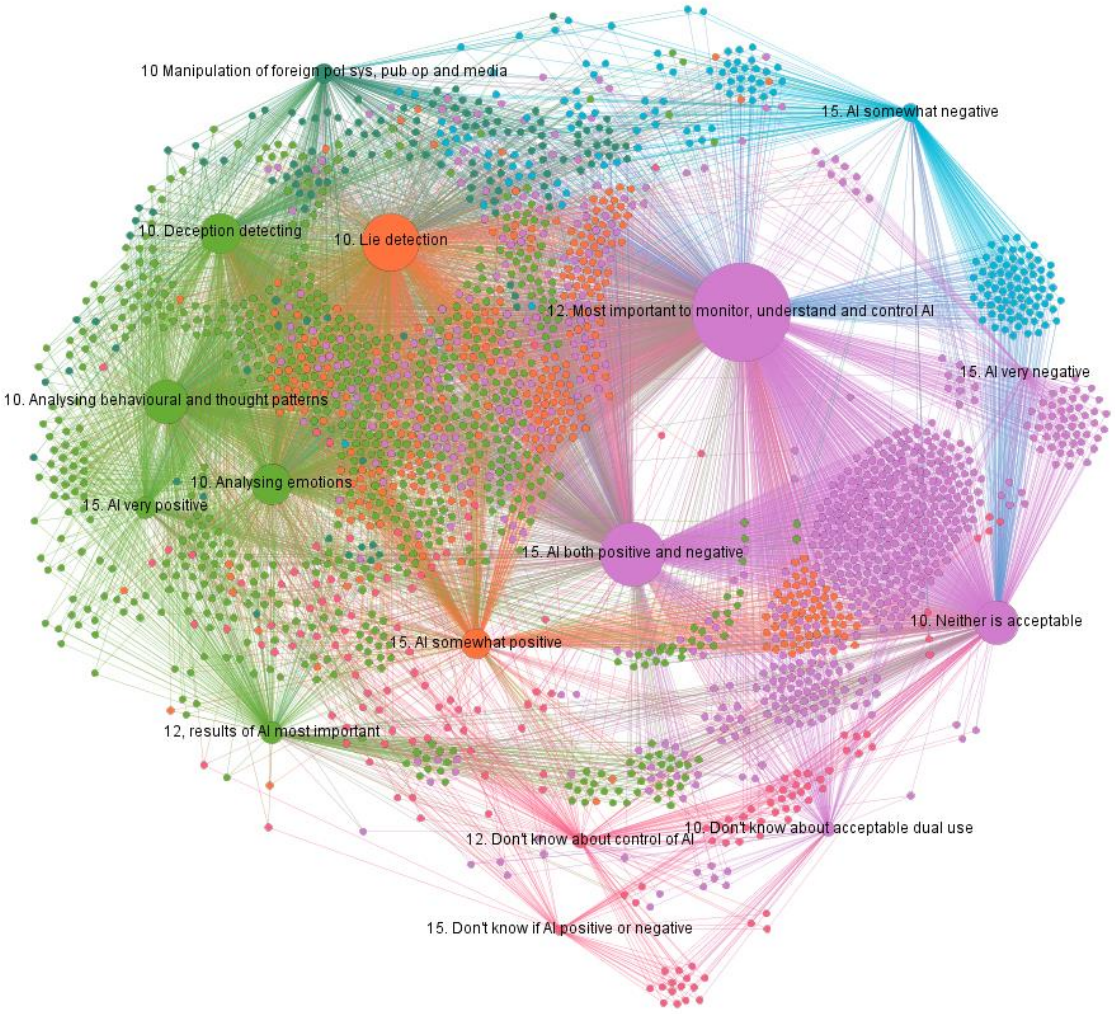


From the graph above, it is clear that just over half of all respondents consider AI to be both a positive and a negative development, however, it is also clear that there were over twice as many who considered it a somewhat or very positive development than there were that considered it a somewhat or very negative development. Compared to the first question of the questionnaire, regarding whether respondents were concerned about dual use of HBP research, it is noteworthy that fewer respondents were primarily negative or positive about AI, but were seeing it as a nuanced issue with both positive and negative aspects. This could be a result of the new information about the potential benefits and issues connected with new technology like AI that respondents received during the questionnaire.

Compared to this, there was very little ambiguity as to what the respondents thought of the trade-off between understanding and being able to control deep learning and letting it loose to obtain the best possible results. The trade-off concerned that deep learning can provide powerful tools for analysing different problems, but it can sometimes be very difficult, if not impossible, to determine how deep learning systems reach their conclusions. 87% of the respondents believed that it is most important to be able to monitor, understand and control it, while only 13% considered the results to be more important. Not surprising there is a substantial correlation between what respondents think of AI and whether they consider results or control to be more important when it comes to deep learning.

Comparing the results for these two questions with what respondents found to be acceptable that their own or allied military use AI and BCI for, the results are clear. The respondents that considered AI and deep learning as a negative development, generally tended to find fewer military applications of AI and BCI

acceptable. Vice versa, the more positive respondents considered this development to be, the more uses they found acceptable. Most of those who considered AI to be a very negative development, also answered that neither of the given uses of BCI and AI were acceptable. Among them, the most acceptable was lie detection, which 19% chose. Those who consider AI to be a very positive development, more than half found lie detecting (56%) and analysis of behavioural and thought patterns (51%) acceptable, while just under half found analysing emotions (43%) and deception detection (45%) acceptable. Only 18% found manipulation of political systems, public opinion and media in other countries acceptable, which is still considerably more than the 5% of the entire sample that found this acceptable. Thus, while respondents are fairly clear that they consider AI to be both a positive and a negative development, it is clearly important to be able to monitor, understand and control it. Regardless, they are remarkably comfortable with letting their own or an allied military use AI and BCI; of the 2048 respondents 1274 found one of the uses acceptable.



The relation between respondents' answers to these three questions is mapped out in the above network.

There are particularly two groups that stand out: a group that is optimistic about AI and a sceptic group. It is clear from the map that the majority of the applications of AI and BCI are placed in close proximity to the

answer categories that are positive to AI to the left, while the negative answer categories are placed to the right. This shows that those who are positive towards AI tend to also find more of the applications listed in question 10 acceptable. Likewise, those who consider AI to be a negative development are placed further from most of the answer categories apart from the category that neither of the listed applications of BCI and AI are acceptable. The map thus shows that those who are sceptical of AI tend to find fewer uses of AI and BCI acceptable, and vice versa. It is also clear from the map, that lie detection is the application which is considered acceptable by most respondents across the spectrum. It is also clear that those who find the results of AI to be the most important are stratified furthest from those who consider AI to be a very negative and a somewhat negative development, thus confirming the above analysis.

The group of sceptics tend, as would be expected, to be more concerned than the non-sceptics, and a statistical test reveals a substantial correlation between being sceptic and how one conceives of AI, while the positive group provides a negative mirror image of the sceptic group with regard to conception of AI. When it comes to whether results or control is more important, the sceptic group was again consistently less likely to find the results more important than non-sceptics were, while the positive group again provides a negative mirror image of the sceptic group.

To the questions of AI, there tends to again be differences between the genders, as there is a moderate correlation between gender and attitude to AI. While men tend to find AI to be a positive or both/and development, with only 11% of men finding AI to be a somewhat or very negative development, there were 18% of women who found AI to be a somewhat or very negative development, while there were considerably fewer women who found it a somewhat or a very positive development. This tendency is also visible in the results from the question concerning whether respondents find results more important than understanding and being able to control deep learning. While the vast majority of both men and women were in favour of controlling and understanding deep learning, 17% of men found results more important while the same was true for 10% of women.

Between the countries there was a tendency across all countries to consider AI both a positive and a negative development. This was particularly so for Denmark, Poland and Belgium. The countries that had fewest that found it to be a somewhat or very positive development were Belgium and Denmark, while the country with fewest that found it to be a somewhat or very negative development were Denmark and Poland. Lithuania was the only major exception to the tendency of sitting in the middle, which is clear in that Lithuania had both most that considered AI to be a somewhat or very positive development, but also most that considered it to be a somewhat or very negative development. While there were also most Lithuanian respondents that found it to be both, 52% found it to be a somewhat or very positive development. Most countries were fairly similar, when it came to whether results or control and understanding is more important regarding AI, though Portugal and Slovenia tended to emphasize control more than the other countries, while there were more respondents from Lithuania and Denmark that found results more important.

There appears to be no correlation between level of education and attitude to whether AI is a positive or a negative development, neither were there any correlation between level of education and whether the most important in development of AI is control or results.

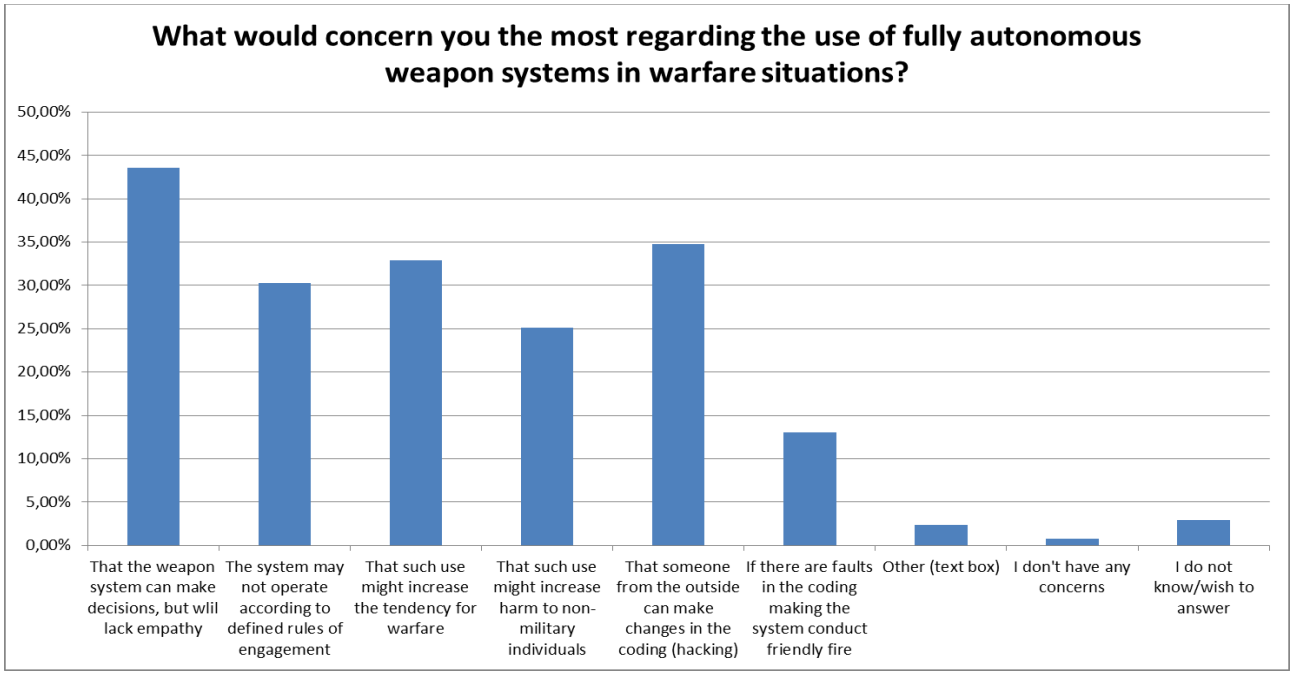
In terms of age, there was no linear correlation between age and attitude to AI, but the younger respondents tended to be spread out more on the spectrum from very negative to very positive than the

older respondents, the result of which was that the younger respondents had the highest proportion that found AI to be a very negative development, but also the highest proportion that found AI to be a somewhat positive development and above average of respondents that found AI to be a very positive development. However, the younger respondents tended more often to find results to be more important than control when it came to development of deep learning, than did the older respondents.

Considering the previous results, it is not surprising to find that the male respondents more often found AI to be a very or a somewhat positive development than women did, who on the other hand more often found it to be a somewhat or a very negative development. Neither is it surprising that the male respondents more often answered that results are the most important thing in development of deep learning than women, who tended to be significantly more in favour of being able to monitor, understand and control deep learning.

Autonomous weapons

When asked about the use of fully autonomous weapons systems in warfare, respondents were particularly concerned about the weapons' lack of empathy when making decisions. This was chosen by 44% of the respondents, while large portions of the respondents were also concerned that it could be hacked (35%), that it could lead to an increased tendency for warfare (33%) and that they might ignore the rules of engagement (30%). Only 0,8% did not have any concerns. The respondents that chose to leave a text response typically wrote that they wanted to choose all of the listed options or they were concerned that they could limit the freedom of mankind.

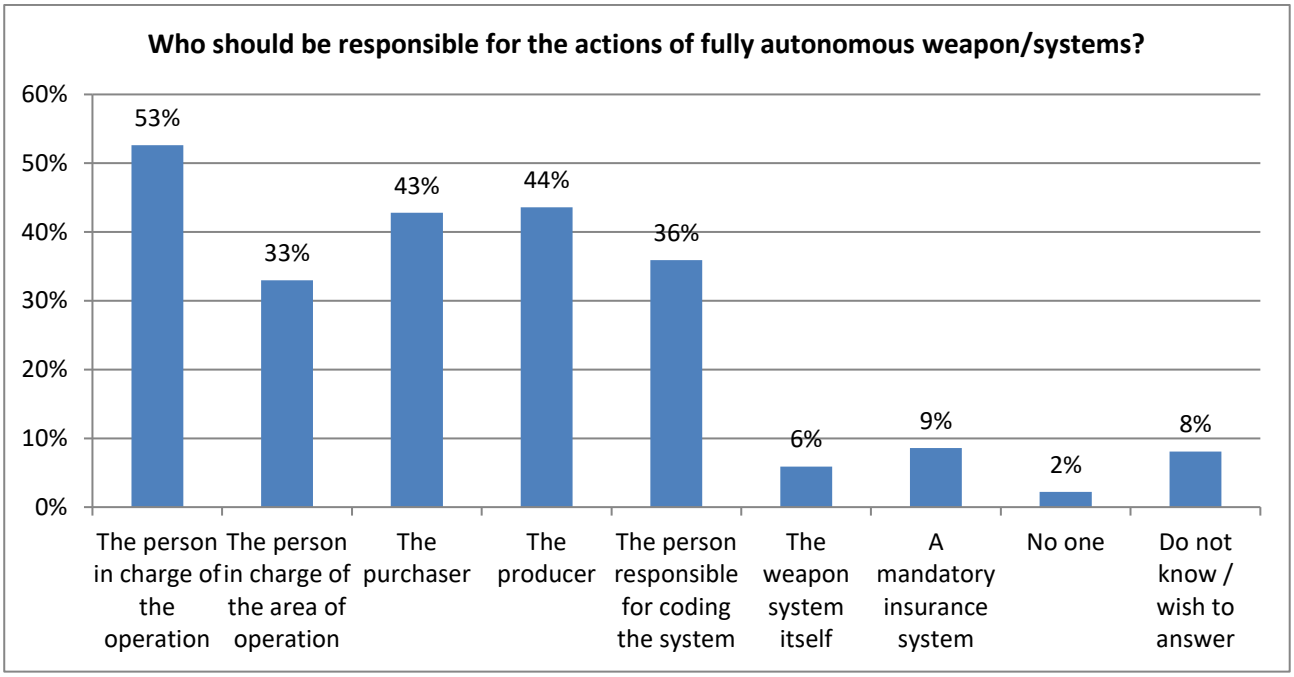


While the risk that autonomous weapons systems could be hacked was the predominant concern among the respondents that found AI to be a very or a somewhat positive development, for those who found AI to be a very or a somewhat negative development the primary concern was that the system would make

decisions without empathy, which was also the primary concern among those who found AI to be both a positive and a negative development.

The respondents were also asked who should be responsible for the actions of fully autonomous weapons systems. The most frequent answer was that it should be the person in charge of the operation (53%), while 44% thought it should be the company that produces them and 43% that it should be the purchaser of the systems. Only 6% found that the system should be responsible for its own actions. That it should be the person in charge of the operation that should be responsible according to the respondents, aligns well with the sentiment among respondents that being able to monitor, understand and control is more important than the results, and it also aligns with the 36% of respondents that believe that the person coding the system should be responsible.

The two most frequent topics among the respondents that left a text response was that it is a political responsibility, which the state, government or politicians are responsible for. The other topic was that there should not be any such weapons in the first place.
While there were not any great differences between them, the respondents that found that the results were more the most important part in developing deep learning tended to provide fewer answers than those who were proponents of retaining control and understanding of deep learning, though the most marked difference was that the latter more frequently tended to say that those coding the system should be responsible.



The respondents that found AI to be a somewhat or very negative development most frequently chose that the producer should be responsible for the actions of the system, while those that were either very positive or somewhat positive most frequently chose that the person in charge of the operation should be responsible, which was also the most frequently chosen option among those who found AI to be both a positive and negative development.

Among the focus countries, it was particularly the Belgian, German and French respondents that were concerned, at least they on average chose 1,9 of the options, while the Bulgarian respondents tended to be less concerned with only 1,7 choices pr. respondent. Notably 68% of the Belgian respondents were concerned about autonomous weapon systems making decisions without empathy, while only 25% of Lithuanians chose this. The Lithuanian respondents were however those that were most frequently concerned that these systems would ignore the rules of engagement. Of the countries Italy had the most respondents that had no concerns, but this was still only 2%.

In terms of age, there was no clear tendency regarding which age groups were more concerned or what they were concerned about. But the younger respondents more often tended to believe that the purchaser and the producer should be responsible for the actions of autonomous weapon systems than the older respondents, who on the other hand tended to believe that it should be the person in charge of the area where the operation takes place, though all age grades had the most respondents answering that it should be the person in charge of the operation.
When it came to gender differences, women were more concerned that autonomous weapon systems would lead to an increase in harm to non-military individuals than men, who on the other hand more often were concerned about friendly fire, however it was the case for both that the primary concern was that these systems would make decisions without empathy. When it came to responsibility for the actions of the AI systems, women tended to emphasize the person coding the system more than men, who more often found that it should be the purchaser and producer of the systems. Again though, the most frequently chosen option was that it should be the person in charge of the operation.
In terms of education, there was no great difference between what respondents with different levels of education were most concerned about when it came to autonomous weapon systems, whereas there were some differences when it came to who should be responsible for these systems. Respondents with primary or lower secondary education most often found that this should be the purchaser of the system, unlike all other levels of education that found that it should be the person in charge of the operation. In the same way, they were also less likely to answer that the person in charge of the area of operation should be responsible for the systems.

Concluding on artificial intelligence and deep learning

The vast majority of respondents considered that AI was both a positive and a negative development, but there was little doubt that the vast majority of respondents, when presented with the trade-off whether results are more important than being able to monitor, understand and control AI, found the latter to be more important. This corresponds well with the primary concern regarding autonomous weapons systems among respondents being that they would make decisions without empathy, and that the responsibility for the actions of these systems should lie with the person in charge of the operation the system.

Conclusions

The online citizen engagement activities of the Ethics and Society division of the Human Brain Project gathered attained 2048 respondents from European countries, with the majority placed in the 10 focus countries: Belgium, Bulgaria, Denmark, France, Germany, Italy, Lithuania, Poland, Portugal and Slovakia.

In conclusion, it seems that the majority of respondents to the online survey were concerned about the dual use potentials and risks of neuroscience research, but at the same time they considered the positive potentials to outweigh the risks. While it was, by many respondents, considered a source for concern, they were not unconditionally against dual use or political, security, intelligence or military (PSIM) use of neuroscience research. Most respondents found one or more examples of how the neuroscience research areas in focus could have dual use acceptable; even in the 'sceptic group', i.e. the respondents that were most consistently sceptic about the principle questions concerning neuroscience and dual use, there was over a third that did find at least one PSIM use acceptable.

Though it generally proved to be a divisive question, the overwhelming support for retaining the *open science*-agenda also for research that could have dual use supports that dual use was not something the respondents wanted to prevent with all means. Though it raised concerns they also saw it as a risk that they would need to accept if they wanted the benefits of the research. It seems that the respondents found neuroscience research to constitute a trade-off between positive and negative aspects, but that to them the benefits were considerable enough that the research should be carried out. This is maybe also exemplified by the 50% of respondents who found artificial intelligence (AI) to be both a positive and a negative development, and only 13% and 5% that found it to be very positive or very negative, respectively.

Though the respondents did find some uses that are unmistakably PSIM uses acceptable, it was also clear that this should not be the intended use that research is developed for, particularly not when research is publicly funded. Likewise, they did not find it acceptable if organisations that receive funding through the HBP also conduct military research, and there was very clear agreement among them, that if a HBP researcher deliberately contributes to PSIM research he or she should be subject to sanctions.

However, a majority of respondents also found that the HBP should be allowed to collaborate with other neuroscience research initiatives, even if these work for or receive funding from defence agencies. This could at first sight seem to contradict the previous conclusion about PSIM research, but that is not necessarily so. It is more likely that it is an expression of a line that respondents drew between civilian research that, as a by-product, could have PSIM use and research that is intended for PSIM use. It could also be taken as a clear signal from the respondents that they find the research very important, and that progress is a key priority. It appears that it is important to the respondents that there is airtight separation between the HBP research and other civilian neuroscience research like it, and then PSIM directed research. And to avoid any conflict of interests, organisations receiving funding through HBP should not also be engaged in PSIM research, because the tight separation between civilian and PSIM would be more difficult to maintain and within an organisation, whereas when collaboration is concerned, it might be easier to demonstrate that collaboration only focuses on civilian purposes and is clearly separated from PSIM research, and that there are no conflicting interests.

(Dual) use of research

Another conclusion was, that while respondents did have concerns about how neuroscience research results could be utilized, both for dual uses and for other uses, they were still generally supportive of both the research and the examples of how it could be utilized that they were provided with. In fact, there were only 18% who found none of the AI or brain-computer interfaces (BCI) uses acceptable. The uses that were most clearly uncontroversial and that tended to gather the greatest support from respondents were related to medicine or otherwise to improvement of health. This was also elaborated in the messages from the question regarding whether respondents were concerned that research results from HBP could have dual use, where several respondents emphasized that, to them neuroscience research should benefit mankind, and especially find use in relation to medicine and health.

As is clear from the above, the respondents were not opposed to dual use of neuroscience research, as long as it is not the intention of the research from the outset. Among the examples of how results of neuroscience research could find PSIM applications, it was particularly the military and intelligence uses that respondents found acceptable, while political use was found to be unacceptable to most participants. This analysis is supported if one considers that respondents were opposed to any HBP or other publicly funded research program engaging in PSIM research, but not generally opposed to the examples of PSIM uses listed for AI and BCI.

However, it was also clear that respondents had considerable concerns about the research, both with regard to dual use and otherwise. This was evident already from the first question, where there were only 15% answered that they were not at all concerned about dual use of neuroscience research and a recurrent comment was that respondents were concerned about military use, and it was often AI that respondents were concerned about. Many examples provided about risks and negative effects of HBP research pointed to how AI could play a role in political manipulation or surveillance, and that it could be a threat to democracy. And it is telling that there were a third that found none of the uses of AI and BCI acceptable, and that for both BCI and autonomous weapons there were just 4% and 1%, respectively, that had no concerns.

Generally military use was concerning to the respondents, but there were some more specific concerns that were prominent across the different use examples. The possibility of hacking was a concern mentioned both as a reason for respondents' answer to the first question, but it was also the second most frequently concern regarding both implanted BCIs and autonomous weapons systems. Likewise, that the research results could come to influence societal perceptions of what is normal was also a prominent, particularly in relation to medicine and BCI.

Demographic differences

Throughout the questionnaire there were some considerable differences between the different demographic groups. Most notable was the gender difference. Men were fairly consistently less concerned than women, across all categories and types of questions, just like they tended to find more uses acceptable and more often had no concerns than women.

When it came to age, the younger respondents tended to find use examples slightly more acceptable, and to be slightly less concerned than the older respondents, though there were some notable exceptions to this tendency, particularly in terms of tracking and hacking in relation to implanted BCIs.

Level of education tended to have inconsistent and often no correlation with what respondents answered.

There were great differences between countries, and there was no one country that was entirely consistently more sceptic or negative nor was the opposite the case. There were, however, some countries that were far more often sceptic, namely Portugal which was very often among the most sceptical along with Belgium and France. On the other hand, Poland and Lithuania tended to be very positive about most things and to be less concerned than the other countries.

Concluding remarks

In conclusion, there are severe concerns regarding the possible risks and consequences of neuroscience in terms of the possibility of its use for PSIM purposes, but also in terms of the societal changes and consequences. These are concerns that should be addressed. However, despite the concerns it is also clear that there is widespread support for neuroscience research in general, and the research being carried out in the HBP. Support was particularly emphatic with regard to research in medicine, and other aspects related to improving health.

Annex 1: Demographic Data

Respondents pr. country:

Belgium	172
Bulgaria	163
Denmark	177
France	155
Germany	308

Italy	173
Lithuania	273
Poland	175
Portugal	238
Slovakia	155

Total sample size: 2048

Age:

	18-29	30-39	40-49	50-59	60-69	70+
Belgium	53	33	13	22	35	16
Bulgaria	31	44	17	24	34	13
Denmark	42	19	13	30	40	33
France	42	44	15	21	27	6
Germany	240	43	14	7	3	1
Italy	48	48	35	23	16	3
Lithuania	194	27	13	19	17	3
Poland	65	32	37	22	14	5
Portugal	30	59	62	67	18	2
Slovakia	63	26	28	23	13	2
Total sample	**808**	**375**	**247**	**258**	**217**	**84**

Gender:

	Men	Women	Intersex / other
Belgium	80	91	1
Bulgaria	79	84	-
Denmark	98	76	3
France	76	79	-
Germany	231	72	5
Italy	86	87	-
Lithuania	98	174	1
Poland	71	103	1
Portugal	83	155	-
Slovakia	78	77	-
Total sample	**1015**	**1018**	**15**

Annex 2: The Questionnaire of the Online Consultation on Neuroscience and Dual Use

Introduction

Human Brain Project is a large research project on the human brain and brain-inspired computing. It is expected to make great progress in science in the nervous system, information and communication technology, and robotics and artificial intelligence.

As an EU-funded project, the Human Brain Project is committed to solely engage in non-military research. However, the resulting research may be of military interest for political, security, intelligence and military purposes.

History shows that science and engineering intended for civilian use can also contribute to new military tools. Chemical and biological agents, the atomic bomb, precision and long distance weapons, and more recently, semi-autonomous drones, all provide well known examples of military uses of scientific and technological research. This makes military use sound very violent. And it can be. But most of us actually use things in our everyday lives which also come from military research. The Internet, GPS, microwaves ovens, and the EpiPen (which is used to treat extreme allergic reactions) all derive from military research. In addition the military do a lot of research which benefits civil society. Such as research on the diagnosis and treatment for mental illnesses, such as Post-Traumatic Stress Disorder (PTSD) and depression, and research on prosthetics, such as prosthetic feet and robotic arms, is also beneficial for civil society.

Only civilian focus

Human Brain Project is funded by the European Union through Horizon 2020. All research in Horizon 2020 must focus solely on civil use. This also goes for the Human Brain Project. But it does not exclude military partners as long as the research is focused on civilian use.

Dual use and PISM

'Dual use' is a term used to describe in science, technology and research that can be used for both civilian and military purposes. A more precise definition is 'PISM', which stands for political, security, intelligence and military uses of e.g. science and technology.

It is difficult to ensure that the research in our project will not be used for military purposes. It is hard to control what will happen once the research has been made public. It is often difficult to assess if something has the potential for military use. Military applications may benefit civil society. And finally, some will argue that military use is just as valid as civil use.

The goal of this consultation is to explore the values, concerns and opinions of citizens in Europe regarding the use of neuroscience, even if it can potentially be used for political, security, intelligence or military purposes.

Watch an introduction to the Human Brain Project and dual use issues on: https://youtu.be/hVw-_MvyAo0

Research on the human brain and the potential dual use

The Human Brain Project does not engage in any military-research, but some may want to use our research for military purposes, or we might work together with other research projects with military funding. We would like to learn what you think about it.

1) Does it make you concerned that the research from the Human Brain project can be used for political, security, intelligence and military purposes? *(choose one option) You can use the text box to explain your choice (e.g. "I answered b because…").*
   a) No, not at all concerned
   b) Yes, slightly concerned
   c) Yes, moderately concerned
   d) Yes, somewhat concerned
   e) Yes, extremely concerned
   f) I don't know/do not wish to answer
   >> textbox for additional responses<<

2) Is it acceptable if an organisation receives funding through the Human Brain Project, if they at the same time do military research? *(choose one option)*
   a) Yes
   b) No
   c) I don't know/Do not wish to answer

3) As a European funded project we are not allowed to do military research. However, other research initiatives on the human brain may be funded by defence agencies. Should the project collaborate with other brain research initiatives or organisations that work for or receive financial support from defence agencies e.g. the American *"Brain Initiative"* or the Chinese *"China Brain Project"*? *(choose one option)*
   a) Yes, the most important thing is to make progress in the research.
   b) Yes, but only if it is based in another EU member state.
   c) Yes, but only if it is based in an allied country of the European Union
   d) Yes, but only initiatives or organisations in countries, who have signed and ratified international treaties on e.g. chemical or biological weapons
   e) No, the research project should not collaborate with initiatives or organisations funded by military or defence agencies.
   f) I don't know/do not wish to answer

4) Should there be some kind of sanction if a researcher in the Human Brain Project deliberately contributes to research with political, security, intelligence and military purposes? *(choose one option)*
   a) Yes, the researcher should be put under ethical surveillance.
   b) Yes, the researcher should receive a fine.
   c) Yes, the research organisation should receive a fine.
   d) Yes, the researcher should lose his/her funding.
   e) Yes, the researcher should lose the right to conduct research.
   f) Yes, the researcher should be sentenced to prison.
   g) No, there shouldn't be a sanction, but a warning.
   h) No, there should not be a sanction at all.
   i) I don't know/do not wish to answer.

5) The European Commission has big focus on open science, where research data and analysis are public for everyone. Should this also be the case with research that could have dual use potential? (*Choose one option)*
   a) Yes
   b) No
   c) I don't know/do not wish to answer

6) Do you believe that the public research programmes (in your country or in the EU) should fund research with intelligence and/or military purposes? (*Choose one option)*
   a) Yes
   b) No
   c) I don't know/do not wish to answer

Applications of brain research to political, security, intelligence and military use

In the following we will look at different ways brain research can be used for dual use. We would like to learn how you think about these possible uses, and what you find acceptable, and what concerns you.

Some dual use of brain research could for example be the increase of performance of military personnel, new investigation techniques, development of brain-inspired computers and autonomous robots, and the production of new types of biological and chemical weapons.

7) The idea of mind-reading has been a steady focus of military research over the years. We can't do it yet. But we can do brain scanning, that shows activity in the brain, which we then can try to read. Advanced forms of brain/mind scanning can probably be used for interrogations, lie detectors, for analysing sympathies/ideological tendencies or to support manipulation (i.e. "brain washing") etc. But they can also be very useful in health care. When do you think one should be allowed to use brains/mind scanning technologies? *(Choose as many answers as you like)*
   a) In police intelligence gathering
   b) For optimising the recruiting of soldiers
   c) In terror/military investigation
   d) In mental manipulation of enemies
   e) In the employment of new employees
   f) To communicate with patients in coma or similar situations
   g) To diagnose mental diseases
   h) To research pharmaceutical drugs
   i) In political negotiations
   j) It should never be allowed
   k) Don't know /do not wish to answer

8) The research in the Human Brain Project can also be used to study how medicine or neurotoxins can change the behaviour of people without providing lethal threats. This could for example be airborne compounds that make people lose memory, become more passive, trusting, aggressive, or sleepy, have greater endurance, or lower their threshold for pain. These compounds can be used in legal and illegal ways, and some compounds may be illegal in themselves. Do you think that research should be carried out, if there is a risk that the results can be used for illegal purposes? (*Choose one option)*

Drugs to change mental states
Around 7-8% of all people worldwide will at some point in their lives have Post-Traumatic Stress Disorder. Different events can trigger it, which often involves a trauma or injury. Soldiers are at a greater risk of it. To avoid or minimize the risk of Post-Traumatic Stress Disorder, researchers are looking to develop drugs, which minimize feelings of anxiety and remorse.

   a) Yes, even if there is a <u>big</u> risk that it can be used for illegal purposes, the research should be allowed
   b) Yes, if there is only a <u>small</u> risk that it can be used for illegal purposes, the research should be allowed.
   c) No, if there is a <u>big</u> risk that it can be used for illegal purposes, then the research should not be allowed.
   d) No, if there is a <u>small</u> risk that it can be used for illegal purposes, then the research should not be allowed.
   e) Don't know /do not wish to answer

9) Do you have any concerns in relation to the research in drugs than can change the mental state of someone? (*Choose one option)*
   a) No, we already today have different kinds of drugs that change the mental state of a person
   b) Yes, I'm concerned that it becomes normal to change the mental state of a person
   c) Yes, I'm concerned that drugs used to remove anxiety or remorse will result in more violent robberies, fights etc.
   d) Yes, I'm concerned that if it becomes easier to treat soldiers then there are fewer concerns about what they experience
   e) I don't know/do not wish to answer

10) We are going to list some potential dual use of brain analysis and artificial intelligence. Which of them do you find acceptable given that they are used by your own/allied military and according to the rules of warfare? *(Choose as many answers as you like)*
   a) Lie detection
   b) Analysing emotions e.g. aggression/sympathy to specific pictures, postulates, arguments etc.
   c) Analysing patterns of thoughts or behaviour –e.g. mapping aggressive/protective tendencies
   d) Deception detecting, detecting and predicting patterns of thoughts, emotions, behaviour…
   e) Manipulation of political systems, public opinion and media in other countries
   f) I don't find any of them acceptable
   g) I don't know /do not wish to answer

Brain-computer interfaces
Brains-computer interfaces refer to devices that communicate with neural brain signals, allowing the user to control a computer, prosthetic, enhancing the brain etc. There are two types of brain computer interfaces, invasive and non-invasive. Invasive devices installed inside the body through surgery, where non-invasive are devices you can put on, like a helmet.

11) One research area in the Human Brain Project is to connect the nervous system to computers through implantation of brain-computer interfaces. This could for example be done in order to analyse the brain/nervous system; adjust emotional reactions; enhance memory; let the human body control mechanical equipment; or let the mind control prostheses. Do you have any concerns regarding implanted brain-computer interfaces? *(Choose up to three options; add other concerns or comments in the text box)*
   a) Hacking, someone gets control over the device/brain
   b) Mind control, that someone can control the mind through the interface
   c) Tracking, signals from the device is picked up and used for surveillance
   d) Changing personality, the device changes you – for example by lowering your aggression level or preferences
   e) The development of Super-Humans for warfare
   f) That otherwise healthy civilian people will start to use it for personal enhancement
   g) Other [insert box]
   h) I don't have any concerns
   i) I don't know /do not wish to answer

Mimicking the human brain - Artificial Intelligence, autonomous weapons, and deep learning

A large effort is done in the Human Brain Project to develop new computer systems which can mimic the human brain – both as programmes in 'normal' computers and as computers that in principle are built the same way as the brain. This could lead to strong artificial intelligence and so-called deep learning, which can be used for identifying early signs of cancer in the blood, better weather forecasts or self-driving cars. However, it could also lead to dual use functions, such as fully autonomous weapons or weapon systems, or autonomous enhancement of equipment.

Artificial Intelligence

Is a kind of machine intelligence that resembles the functions of the human mind, and can do things such as problem solving, learning and planning.

Deep learning

Mimics the way the brain works in order to recognize patterns in digital sound and images in large data sets, while it keeps improving itself by learning from its mistakes.

12) Deep learning is very complicated, and we cannot fully understand *how* the computer systems learn and how they reach certain conclusions. Do you think it is problematic if we cannot understand how the artificial intelligence thinks, acts, and learns? (*Choose one option)*
    a) Yes, it is most important that we can monitor, understand, and control artificial intelligence.
    b) No, the results are more important.
    c) I don't know.

13) Autonomous weapons in the purest form are systems operating independent of human control. The systems would recognise and engage with targets without asking permission or collaboration with a human operator. What would concern you the most regarding the use of fully autonomous systems in warfare situations? *(Choose the two options that concern you the most)*
    a) That the weapon system can make decisions, but will lack empathy
    a) The system may not operate according to defined rules of engagement
    b) That such use might increase the tendency for warfare
    c) That such use might increase harm to non-military individuals
    a) That someone from the outside can make changes in the coding (hacking)
    b) If there are faults in the coding making the system conduct friendly fire
    c) Other [blank text box]
    d) I don't have any concerns
    e) Don't know/do not wish to answer

Autonomous robot

is a robot that can act or do tasks on its own. In its purest form it can operate without human control. It can for example identify and engage with targets without asking permission and without a human operator.

14) Who should be responsible for the actions of fully autonomous weapons/systems? *(Choose up to three choices, and use the box to comment or add suggestions)*
    a) The person in charge of the operation
    b) The person in charge of the area that the weapon system is operating within
    c) The purchaser (military)
    d) The company that produced them
    e) The persons responsible for the coding of the system
    f) The robotics/weapon system itself
    g) Some sort of mandatory insurance system
    h) No one
    i) Don't know/do not wish to answer

15) Deep learning and artificial intelligence in general are very powerful tools for Big Data analysis. They have the potential to help us understand diseases and develop cures, to improve weather-forecasts, or to predict and prevent traffic accidents. On the other hand, the same tools and data are in risk of abuse, for instance, as a means of increased surveillance by companies or suppressive governments. So it has the potential to save lives, but also to harm people. When you think of artificial intelligence, do you see it as: (*Choose one option)*
    a) A very positive development
    b) A somewhat positive development
    c) A both positive and negative development
    d) A somewhat negative development
    e) A very negative development
    f) I don't know/do not wish to answer

We would like to get to know a little bit more about you to better understand who the people answering this survey are.

16) Year of birth:
17) Sex:
    a) Male
    b) Female
    c) Intersex/other

18) Country of residence:

19) Postal code:

20) Area of residence
    a) City or urban area
    b) Suburban area
    c) Rural area

21) Education:
    a) Primary and lower secondary education
    b) General upper secondary education
    c) Vocational Education and Training
    d) Bachelor or equivalent
    e) Masters or equivalent
    f) Doctoral degree or higher
    g) I don't know / Do not wish to answer

Your personal data will not be shared with anyone, but as we are committed to open data, your anonymized answers could be shared with others for research purposes.