Japanese Attitudes toward Genetic Engineering

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Abstract
Whether or not the general public supports biotechnology and genetic engineering is an important current problem. In this paper, we report that people's attitudes toward the terms "biotechnology" and "genetic engineering" are highly dependent upon their knowledge of the fields. For this reason, it is necessary to promote activities that provide the general public with information on the current states of biotechnology and genetic engineering so that they can form educated opinions.

Key Words: biotechnology, GM (genetically modified) foods

1. Introduction

Many people starve to death because they are unable to grow enough crops in their impoverished countries. Food shortage has become one of the most serious problems in the world. Some people expect that genetic engineering can solve this problem because genetically modified plants can grow more easily in barren land[1].

However, some people worry that genetically modified foods may do harm to our health and the environment. It is often reported that Japanese people tend to avoid genetically modified foods. Sure enough, previous surveys of attitudes toward genetic engineering showed that, in Japan, more people had "negative" or "neutral" opinions regarding genetically modified foods than people in other nations.

These findings piqued our interest in the Japanese public's views on genetic engineering and made clear to us the importance of active discussion on the subject of genetic engineering. In conjunction with other university students in Japan, we designed questionnaires asking for subjects' impressions of genetic engineering and carried out a nationwide survey in order to clarify the reasons for Japanese people's attitudes toward the subject[3].

In this paper, we suggest that educational differences have created a gap between the attitudes of students and adults of their parents' generation.

2. Methods

We carried out our attitude survey with 5 Japanese iGEM (the International Genetically Engineered Machine competition) teams: Osaka, KIT-Kyoto, Tokyo Metropolitan and UT-Tokyo. We all used the same paper-based questionnaires in all locations.

2.1. Terms and Places

We conducted this survey from June 30 to September 26, 2010, in areas near our universities. We distributed and collected the questionnaires from students from July 12 to September 26, 2010 at Kyoto University. The non-student surveys were conducted on August 28 and 29 at Masukata Shopping Street and on September 11 and 12 at the Coop Shimogamo. All sites are located in Kyoto city, Japan.

2.2. Questionnaires

We prepared two questionnaires, "Attitude Survey of Genetic Engineering" and "Attitude Survey of Biotechnology." We interchanged the terms "genetic engineering" and "biotechnology" in order to assess subjects' different associations with these two terms.

2.3. Search of "Biotechnology" and "Genetic Engineering" in Japanese in Google

On October 31, 2010 we performed a Google search of these terms in Japanese.

3. Results

We obtained 1,511 answers in total: 955 from students and 556 from non-students—primarily adults of the students' parents' generation. These data are analyzed in 3.1., 3.2. and 3.3. We also focused on the change in the government's curriculum guidelines.

In this paper, we regard "genetic engineering" and "biotechnology" as the same unless we distinguish them explicitly.

3.1. Knowledge of the Subjects

We assumed that the subjects' knowledge of biotechnology would influence their attitudes toward it. In order to confirm this assumption, we investigated how many words associated with biotechnology they knew. We supposed that the more words they know, the more knowledge of biotechnology they have. First, we compared the students with adults of their parents' generation. Figure 1-A shows that the students have more knowledge than adults of their parents' generation ($p<0.01$). Second, we

compared science students with arts students. Figure 1-B shows that the science students have more knowledge than the arts students ($p<0.01$).

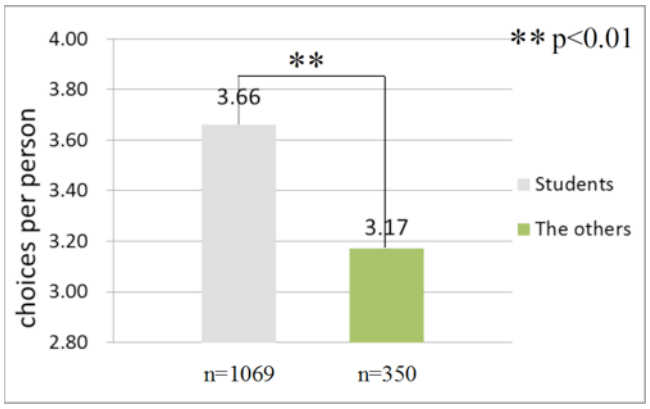

Fig. 1-A: Students vs. Others

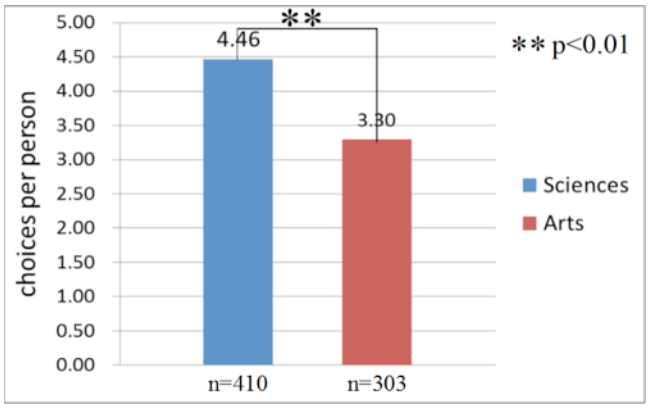

Fig. 1-B: Sciences vs. Arts

Figure 1-A, B: These figures show the results of Q2: "What do you associate with (genetic engineering / biotechnology)? (※Please circle all that apply)."

3.2. The Differences among Subjects' Attitudes

In Japan, arts and sciences classifications are important. Most Japanese students learn different subjects beginning in high school, depending on their classification, because the entrance examinations of colleges and universities are specific to either arts (literature, law, etc.) or science (engineering, medicine, etc.). For this reason, we expected that there might be some differences between the attitudes of arts students and those of science students.

The subjects who were not students were primarily adults of the students' parents' generation. Our survey showed that the others tend to buy non-genetically modified foods more often than students do (Figure 2-A). Also, our survey showed that arts students tend to buy non-genetically modified foods more often than science students (Figure 2-B).

We also surveyed subjects' opinions on artificial genetic mutation. These responses showed similar results. Students were more likely to feel positively about artificial genetic mutation than the others were, and science students were more likely to allow artificial genetic mutation than arts students were. The results of our survey are consistent with previous surveys about genetic engineering [3,7]

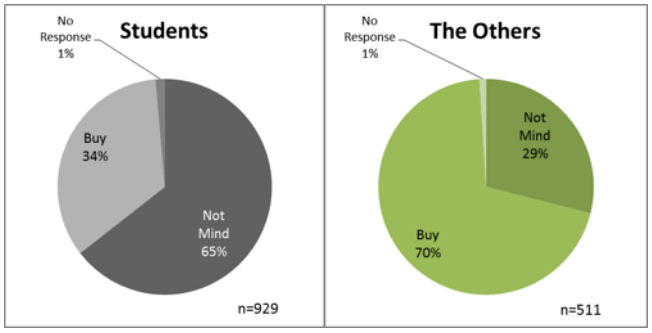

Fig. 2-A (Q1)

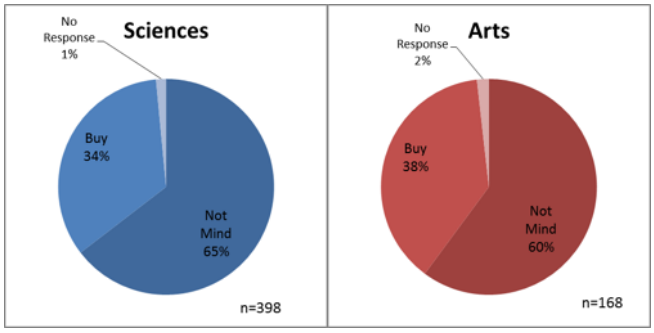

Fig. 2-B (Q1)

Figure 2-A, B: Attitudes toward "Non-genetically Modified Foods" These figures show the results of Q1: "When shopping do you buy 'non-genetically modified foods'?" The "Buy" category represents subjects who answered, "not mind so much" and "never mind."

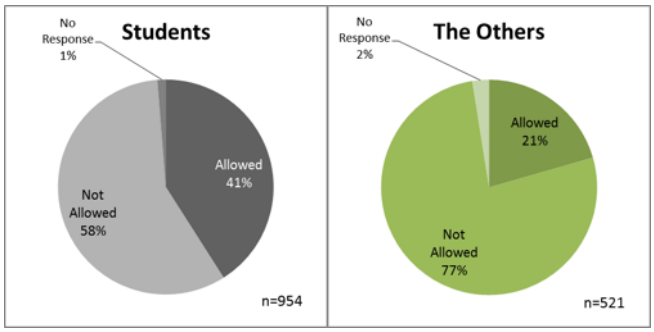

Fig.3-A (Q4)

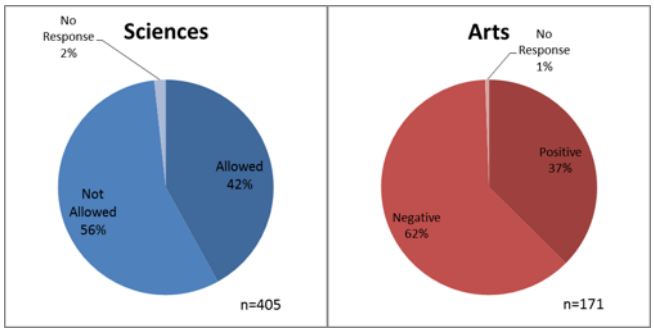

Fig. 3-B (Q4)

Figure 3-A, B: Attitudes toward Artificial Genetic Mutation These figures show the results of Q4: "What do you think about artificial genetic mutation through (biotechnology / genetic engineering)?" The "Allowed" category represents subjects who answered "OK" and "not bad." The "Not allowed" category

represents subjects who answered "not good" and "bad."

3.3 The Difference between Biotechnology and Genetic Engineering

The subjects who were science students tended to exhibit a positive attitude toward genetic engineering. They may have relatively more knowledge of genetic engineering than subjects who are arts students or others. Thus, we predicted that the amount of knowledge one has of genetic engineering has a great impact on one's attitudes toward genetic engineering.

To confirm this hypothesis, we performed a Google search of the terms "biotechnology" and "genetic engineering." Figure 4 shows the result: "biotechnology" is used more often than "genetic engineering." Table 1 shows that subjects' attitudes toward "biotechnology" are more positive than those toward "genetic engineering".

These findings show that subjects' knowledge of biotechnology or genetic engineering has a great impact on their attitudes toward these fields.

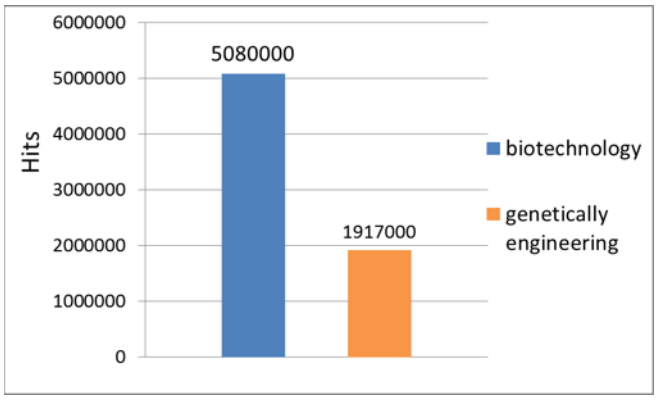

Figure.4: Comparison of the Number of Websites that Contain the Words "Biotechnology" and "Genetic Engineering" in Japanese
This figure shows the number of Google search results for the terms "biotechnology" and "genetic engineering" in Japanese.

Table.1: Differences among Attitudes (Q4, 7)

Q4			Q7		
	Negative	Positive		Negative	Positive
Biotechnology	57.3	41.9	Biotechnology	8.8	88.5
Genetic Engineering	65.8	32.2	Genetic Engineering	13.6	82.5

This table is the result of Q4 and Q7. (Q4 is "What do you think about artificial genetic mutation by (biotechnologies / genetic engineering)?" and Q7 is "Do you think that the research on (biotechnology / genetic engineering) should be continued?") In Q4, "Negative" represents subjects who answered "OK" and "not bad," and "Positive" represents subjects who answered "OK" and "not bad." In Q7, "Negative" includes subjects who answered "the research should not be continued" and "Positive" includes subjects who answered "the research should be continued." 1259 subjects answered Q4 and Q7.

3.4. The Governmental Curriculum Guideline

Given the results in 3.3., we believe that amount of knowledge can account for the difference in attitudes. As stated above, subjects consisted primarily of students and adults of their parents' generation. To confirm the difference in the amount of knowledge between the two groups, we looked up words that were included in the choices for Q2. A chapter on biotechnology doesn't exist in the government's curriculum guidelines for high schools in 1978 and 1989. However, the chapter does exist in the 1999 and 2009 guidelines.

We then counted the number of the words related to biotechnology and genetic engineering found in textbooks over a range of years[2,5,6]. The results are described in Table 2. From these results, we saw that the number of words has increased over time.

Table 2: Number of Words in Textbooks[2,5,6]

Year	1962	1985	2006	Year	1962	1985	2006
Clone	0	0	13	Virus	0	3	19
GM crops(foods)	0	0	1	Artificial life	0	0	0
Patent	0	0	1	Nobel Prize	0	2	0
DNA	0	86	176	Environment	58	42	38
Genome	0	0	11	Biological weapon	0	0	0
Medicine	0	15	4	iPS cell, ES cell	0	0	6
Cosmetic	0	0	0	Biofuel	0	0	0
Bioethics	0	1	0	Biohazard	0	0	0

This table shows the number of words related to biotechnology and genetic engineering found in textbooks from 1962, 1985 and 2006. The results show that there are significant differences between past and present textbooks.

3.5. Words Associated with Biotechnology and Genetic Engineering

In addition to counting the words associated with biotechnology and genetic engineering that were found in textbooks, we also looked at the words subjects associated with the two terms.

Table 3: The Proportion of Choices (%) (Q2)

Clone	56.1	Virus	9.8
GM crops(foods)	71.0	Artificial life	14.0
Patent	7.0	Nobel Prize	5.6
DNA	52.9	Environment	11.8
Genome	24.4	Biological weapon	9.9
Medicine	13.3	iPS cell, ES cell	22.7
Cosmetic	5.0	Biofuel	12.7
Bioethics	22.6	Biohazard	9.3

Table 3 shows the results of Q2: "What do you associate with (genetic engineering / biotechnology)? (※Please encircle all that apply.)" This result shows that people tend to think "clone," "GM crops (foods)" and "DNA" are words associated with biotechnology and genetic engineering. 1057 people answered to this question.

3.6. Conflicting Opinions on Genetic Engineering Research

We have shown that one of the reasons for Japanese people's negative or neutral attitudes toward genetic engineering is their lack of knowledge. We also sought other reasons for these attitudes. Table 4 shows that the reasons why some subjects support biotechnology research oppose the reasons why others oppose it. This finding suggests that people may have both positive and negative ideas about the results of genetic engineering, so they cannot accept genetic engineering easily.

Table 4: Reasons for Believing that Research Should (or Should Not) Be Continued (Q7)

Should Continue		Should Not Continue	
solution to food crisis	63.8	harmful to environment and humans	56.9
solution to environmental problems	42.3	harmful to ecosystem	62.1
solution to energy problem	38.9	harmful to human body	53.8
application to medicine	63.3	unethical	31.8
a business opportunity	19.5	people say dangerous	5.1
preservation of the species	15	application to evil use	27.2
development of science	17.8	not enough laws	15.9
practical use in many countries	6.7	replication with other technologies	6.2
many possibilities	41.1	less potential	1.0
interesting as an academic	22.4	somehow uneasy	26.7
others	2.1	others	2.1

This table shows the results of Q7: "Do you think that the research on (biotechnology / genetic engineering) should be continued?" 1259 people answered to this question.

4. Discussion

4.1. The Correlation between Knowledge and Attitude

(1) Differences in Knowledge Depending on Subjects

The answers to Q2, "What do you associate with (biotechnology / genetic engineering)?" can be used to indicate subjects' amount of knowledge of biotechnology and genetic engineering. Thus, Figures 1-A and B reflect each group's amount of knowledge of these subjects. Students, especially science students, were more familiar with biotechnology and genetic engineering than arts students and adults of their parents' generation. The difference in amount of knowledge may be attributed to the change in the government's education curriculum. The older generation has not been educated on more recent developments in the life sciences. Likewise, arts students generally have fewer opportunities to learn about biotechnology and genetic engineering than science students do.

(2) Differences in Attitudes Depending on the Subjects

In Figures 2 and 3, it shows that students are less inclined to have negative attitudes toward biotechnology and genetic engineering than adults of their parents' generation. It also showed that arts students are more inclined to avoid biotechnology and genetic engineering than science students.

Considering the results of both (1) and (2), we suggest that people less familiar with the terms "biotechnology" and "genetic engineering" are more likely to consider the products of these fields to be unknowable and to have possibly harmful effects.

4.2. Reasons for Subjects' Avoidance of Biotechnology or Genetic Engineering

Table 1 shows that genetic engineering had a more negative reputation than biotechnology. In Q2 (Table 3), "GM foods (crops)," "clone" and "DNA" were chosen often as words associated with genetic engineering and biotechnology. These words are popular news topics and are directly associated with the word "gene." Thus, these words may have a significant influence on the differences in people's attitudes toward genetic engineering.

As seen on the left side of Table 4, the three most popular reasons chosen for why "the research should be continued" were "usefulness for food crisis," "application to medicine" and "solution of environmental problems." As seen on the right side of Table 4, the three most popular reasons chosen for why "the research should not be continued" were "harmfulness to the ecosystem," "harmfulness to human and environment" and "harmfulness to human body." These responses are contradictory. From these contradictions, it is evident that people have both worries and hopes for biotechnology and genetic engineering. Providing lectures about genetic engineering that increase people's knowledge of the subject can alleviate their worries and encourage more positive attitudes toward genetic engineering.

5. Conclusion

We investigated the reasons for the significant difference between the opinions of students and those of their parents' generation, and we suggested that one of the reasons for this difference was the education gap. Twenty years ago, for instance, the field of molecular biology was immature, and new technologies like genetic engineering were just beginning to develop. Thus, only scientific experts or those with experience in the field of biology may have been familiar with those new fields such as genetic engineering. Therefore, most older adults are unfamiliar with genetic engineering and as a result, tend to avoid genetically modified foods. Meanwhile, biotechnology has developed, and the amount of information about genetic engineering in textbooks has increased dramatically. As a result, current students can more easily assess the advantages and disadvantages of genetic engineering and make an informed decision about whether they support it.

In this study, we find that many people think genetic engineering research should be continued and expect the research will solve both the food crisis and health problems. At the same time, there are also many people who worry about genetic engineering and require more information about the safety of genetic engineering and better explanations of the scientific terms associated with the field. With these conclusions, we suggest that it is important to encourage science communication between scientists and adults of the older generation so that the adults can know the field deeply. In fact, there are already some organizations delivering lectures about genetic engineering and genetically modified foods, among other subjects. For example, "Let's Study Bio Lecture" was held in Shiga and "Science Agora" was held in Tokyo. In fact, the data on "Let's Study Bio Lecture" show that lectures are very effective through questionnaire research[4,7]. There are still only a small number of lectures being held, so it is necessary to increase the number of lectures on genetically modified foods so that people can gain sufficient knowledge of the current issues regarding genetic engineering. To carry out this educational project, scientists' support is essential. However, most scientists are reluctant to deliver lectures on genetic engineering. Perhaps they want to concentrate on their own studies. We suggest that scientists with enough knowledge of genetic engineering should play an important role in communicating with other scientists and the general public. They can define difficult scientific terms and discuss how the field of genetic engineering has changed over time so

that those whom they teach will gain sufficient knowledge of genetic engineering.

6. Acknowledgements

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Supplementary Information

Supplementary information is available online at http://2010.igem.org/Team:Kyoto/HumanPractice

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