

Quantitative evaluation of positive or negative feelings for biotechnology- or health-related scenes in movies

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Public attitude toward biotechnology- and health-related scenes in movies influences the development of the biomedical science itself and thereafter of our health- and technology-conscious society. We have developed a new quantitative indicator to evaluate positive and negative feelings toward such scenes. Thirty movies including nine biotechnology-related, twenty health-related, and one both-related movies were evaluated into 0 (0%) highly negative, 10 (33%) negative, 17 (57%) neutral, 3 (10%) positive, and 0 (0%) highly positive feeling movies. Biotechnology-related movies were negative, while health-related movies were neutral. This indicator is useful for rating the perception of biotechnology and health in movies.

Introduction

In scientific publications, there are simple bibliometric indicators for ranking scientific journals and papers, for example, the famous “impact factor” established by Eugene Garfield more than 30 years ago. Using these bibliometric indicators as a basis, several new evaluation methods have been developed. One example is the development of indicators of the relationship of research papers with the real world of innovation and healthcare.¹

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Concerning biotechnology, there have been several controversial issues regarding genetically modified food, embryonic stem cell research, human cloning, *in vitro* fertilization, DNA test, etc. (for example, Refs 2 and 3). People have to constantly make choices even though they do not know the exact nature of the products and services. The reasons for people either accepting or not accepting new biotechnology include several important factors such as law, guideline, discipline, a sense of value, religion, ethics, money, benefit, culture, society, etc. We have thought that these factors seem to be by and large influenced by personal emotional attitude which was built up unconsciously through mass media.

We have, therefore, started to study on the public perception of biomedical sciences in mass media from point of view of positive and negative feelings. We have previously evaluated positive and negative feelings toward biotechnology- and health-related information in major Japanese newspapers.⁴⁻⁶ The result is that articles pertaining to “gene” or “medicine” give quite positive feelings, whereas articles pertaining to “genetically modified food” or “clone (human)” give highly negative feelings. Thus, Japanese newspapers are found to send the public biased-messages of biotechnology and health. In this study, we will analyze movies.

The news media are expected and believed to provide people with accurate scientific information. Moynihan et al.,⁷ however, reported that although the news media are an important source for providing information about new medical treatments, there is concern that some coverage may be inaccurate and overly enthusiastic. News media stories about medications may include inadequate or incomplete information regarding the benefits, risks, and costs of drugs. This is because the general public reads newspapers only for pleasure.^{8,9}

On the other hand, there are some mass media, including movies, television, video games, and the internet, which are not necessarily expected and believed to describe accurate scientific information. However, we have felt that many people, particularly the young and non-experts, are apt to believe that this information is based on almost (at least partially) accurate scientific facts.

Flores¹⁰ stated that cinematic depictions of physicians can potentially affect public expectations and the patient-physician relationship; however, limited attention has been devoted to the portrayal of physicians in movies. A negative cinematic portrayal of physicians is on the rise; this may adversely affect patient expectations and the patient-physician relationship.

McDonald & Walter¹¹ also warned that electroconvulsive therapy (ECT) in movies is being increasingly perceived as a negative and cruel treatment, leaving the impression of a brutal, harmful, and abusive maneuver with no therapeutic benefit.

Movie ratings have been conducted since 1968 in the USA. Depending on the scenes of sex, drug use, nudity, coarse language, and violence, the movies

are rated as G (General Audience), PG (Parental Guidance Suggested), R (Restricted-Under 17), and NC-17 (No One 17 and Under Admitted) [<http://www.mpa.org/movieratings/about/index.htm>]. This rating provides people, particularly parents, with prior information regarding movies and helps them make judgments concerning movies they want their children to see.

However, no information pertaining to rating a movie in terms of the science-related scenes is available. We have been studying the evaluation of mass media from the viewpoint of positive and negative feelings toward biotechnology- and health-related things. In this paper, we have developed a new quantitative indicator of positive and negative feelings toward biotechnology- and health-related scenes in movies as we will describe below.

Method

Selection of biotechnology- and health-related movies

This study was aimed at analyzing the public attitude toward biotechnology- and health-related scenes in movies. However, there was no ready-made category of biotechnology- and health-related movies. Using appropriate keywords for biotechnology- and health-related things, movies were, therefore, selected from the database in “All-Movie Guide” (<<http://www.allmovie.com/>>) for English titles and from the database in “Kinema Junpo” (<<http://www.walkerplus.com/movie/kinejun/>>) for Japanese titles. “Kinema Junpo” is the most popular movie magazine in Japan. Hence, using appropriate keywords listed in Table 1, we found 839 movies from the All-Movie Guide during the years 1921–2003 and more than 1,707 movies from Kinema Junpo during the years 1950–2000.

In order to establish an international standard of movie rating and based on the fact that approximately 70% of the movies shown in large movie theaters in Japan are not-produced-in-Japan movies, we selected not-produced-in-Japan movies screened in Japan during the years 1990–2000. These criteria resulted in the selection of a total of 442 movies: 17 biotechnology-related and 35 health-related movies from the All-Movie Guide and 50 biotechnology-related and 340 health-related movies from Kinema Junpo.

Of the 442 movies, we selected more influential movies based on the criterion of listing in the “best movies in this year” in Kinema Junpo. This criterion narrowed down the selection to a total of 187 movies: 15 biotechnology-related, 169 health-related, and 3 both-related movies.

From the list of 187 movies, we rented 31 VHS videos subtitled in Japanese from Jumbo Theater Kashiwa Shop, as listed in Table 2. They were 9 biotechnology-related, 21 health-related, and 1 both-related movies.

Table 1. Keywords for biotechnology- and health-related movies

Biotechnology-related keywords	Health-related keywords
genetic engineering	clinic
biotechnology	cure
clone	disease
DNA	doctor
embryonic stem cell	drug
ES cell	examination
gene	health
gene insertion	hospital
gene manipulation	medical
gene polymorphism	medicine
gene therapy	nurse
genetic code	pain
genetic map	pharmacy
genetics	red cross
genome	therapy
human genome	treatment
implant	
organ transplant	
personalized medicine	
regeneration medicine	
regeneration therapy	
reproductive medicine	
stem cell	
tissue engineering	
transplant	
vector	

Development of positive-negative feeling evaluation method for biotechnology- and health-related movies

The movies are dynamic motion picture with voice and music, which totally differs from the newspapers-written media that is static. However, we hold the same concept and scale of evaluation as those used in the evaluation of newspapers.⁵ The evaluation was finalized in a score (referred to as PN score for Positive-Negative score) from 0 to 10 after counting two places of decimals over 1/2 as one and disregarding the rest and is indicated by two significant figures, e.g. 4.6. The mid-point was 5.0 representing neutral feelings, scores from 4.9 to 0 were representing increasingly negative feelings, and scores from 5.1 to 10 were representing increasingly positive feelings. The five divisions of the PN score range (shown in parentheses) corresponded to the feelings of strongly negative (0–2.0), negative (2.1–4.4), neutral (4.5–5.5), positive (5.6–7.9), and strongly positive (8.0–10.0).

Table 2. Selected movies, database, and PN scores

1	2	3	4	5	6	7	8	9
1990	Field of Dreams	1989	USA	A-H	50 (10 + 40 + 0)	0.2 (8.4)	0.8 (0.3 + 0.5)	5.4
	Crimes and Misdemeanors	1989	USA	A-H	-14 (0 -14 + 0)	0.6 (51.3)	0.8 (0.4 + 0.4)	4.7
1991	The Sheltering Sky	1990	Britain	K-H	-	-	-	-
	The Match Factory Girl	1990	Finland	K-H	-30 (0 -10 -20)	0.2 (2.8)	0.9 (0.4 + 0.5)	4.7
1992	Night on Earth	1991	USA, Japan	K-BT	-40 (0 -20 -20)	0.2 (5.9)	0.8 (0.3 + 0.5)	4.7
	Life on a String	1990	China	A-H	-40 (0 -40 -0)	0.2 (2.0)	0.7 (0.3 + 0.4)	4.7
1993	The Story of Qiu Ju	1992	China, Hong Kong	K-H	10 (0 + 10 + 0)	0.2 (2.6)	0.9 (0.4 + 0.5)	5.1
	Jurassic Park	1993	USA	A-BT, K-H, K-BT	-51 (-10 -16 -25)	1.0 (100)	0.8 (0.4 + 0.4)	3.0
	IP5: The Island of Pachyderms	1992	France	K-H	27 (0 + 17 + 10)	0.2 (15.0)	0.8 (0.4 + 0.4)	5.2
1994	Short Cuts	1994	USA	A-H, K-H	70 (20 + 20 + 30)	0.2 (19.7)	0.9 (0.4 + 0.5)	5.6
	Intersection	1994	USA	K-H	46 (20 + 16 + 10)	0.2 (8.5)	0.8 (0.4 + 0.4)	5.4
	Cold Moon	1991	France	K-H	10 (10 + 0 + 0)	0.2 (1.0)	0.7 (0.3 + 0.4)	5.1
1995	Mary Shelley's Frankenstein	1994	USA	K-H	-56 (-14 -22 -20)	1.0 (100)	0.8 (0.4 + 0.4)	2.8
	Species	1995	USA	K-BT	-36 (12 -8 -40)	1.0 (100)	0.8 (0.4 + 0.4)	3.6
1996	Terrorizers	1990	Taiwan, Hong Kong	K-H	-11 (10 -11 -10)	0.6 (43.9)	0.7 (0.3 + 0.4)	4.8
	The City of Lost Children	1996	France, Spain	K-BT	-66 (-20 -16 -30)	1.0 (100)	0.8 (0.4 + 0.4)	2.4
	Shallow Grave	1990	Britain	A-H	-40 (0 -40 -0)	0.8 (60.2)	0.7 (0.3 + 0.4)	3.9
1997	The English Patient	1996	USA	A-H	40 (14 + 16 + 10)	0.4 (32.3)	0.9 (0.4 + 0.5)	5.7
	Breaking the Waves	1996	Denmark	K-H	25 (10 + 25 -10)	0.4 (34.2)	1.0 (0.5 + 0.5)	5.5
	Crash	1996	Canada	K-H	-10 (10 -20 + 0)	0.4 (24.2)	0.7 (0.3 + 0.4)	4.9
	Tykho Moon	1997	France, Italy, Germany	K-BT	-32 (0 -12 -20)	1.0 (100)	0.7 (0.3 + 0.4)	3.9
	The Lost World: Jurassic Park	1997	USA	A-BT, K-BT	-50 (0 -40 -10)	1.0 (100)	0.8 (0.4 + 0.4)	3.0
1998	Good Will Hunting	1997	USA	K-H	38 (0 + 28 + 10)	0.6 (40.1)	1.0 (0.5 + 0.5)	6.1
	Alien: Resurrection	1997	USA	A-BT	-56 (-20 + 4 -40)	1.0 (100)	0.8 (0.4 + 0.4)	2.8
	Gattaca	1997	USA	A-BT, K-BT	-29 (0 + 11 -40)	1.0 (100)	0.8 (0.4 + 0.4)	3.8
1999	Eternity And A Day	1998	Greece, France, Italy	K-H	36 (10 + 16 + 10)	0.2 (5.9)	0.8 (0.3 + 0.5)	5.3
	Passion Fish	1992	USA	A-H	9 (10 + 9 -10)	0.8 (78.4)	0.8 (0.4 + 0.4)	5.3
	Heart	1998	Britain	K-BT	-26 (0 -8 -18)	1.0 (100)	0.7 (0.3 + 0.4)	4.1
2000	The Wind Will Carry Us	1999	Iran, France	K-H	20 (0 + 20 + 0)	0.2 (7.3)	0.7 (0.3 + 0.4)	5.1
	Wonderland	1999	Britain	K-H	29 (10 + 13 + 6)	0.2 (6.5)	0.8 (0.4 + 0.4)	5.2
	Hilary and Jackie	1998	Britain	K-H	20 (10 + 0 + 10)	0.2 (2.7)	0.8 (0.4 + 0.4)	5.2
						Average	4.6	

1: Year of screening in Japan; 2: Title in English; 3: Year of release; 4: Country of production; 5: Database*; 6: Content (Environment + Character + Theme); 7: Time (% of relevant scenes); 8: Affect (Impact on individual evaluator + Rating given by movie critics); 9: PN score.

* A: All-Movies Guide, K: Kinema Junpo, BT: Biotechnology-related, H: Health-related.

Table 3. Points in positive-negative feeling evaluation

Category	Subcategory	Point range
Content point	Total	-100 to +100
	Environment	-20 to +20
	Character	-40 to +40
	Theme	-40 to +40
Time point	Total	0 to 1.0
	80% ≤ tt ≤ 100%	1.0
	60% ≤ tt < 80%	0.8
	40% ≤ tt < 60%	0.6
	20% ≤ tt < 40%	0.4
	0% < tt < 20%	0.2
	0%	0.0
Affect point	Total	0.6 to 1.0
Impact on individual evaluator	Excellent	0.5
	Very good	0.4
	Good	0.3
Rating given by movie critics	Top 10	0.5
	Below 11th	0.4
	Out of list	0.3

Formula is:

$$PN\ score = [Content \times Time \times Affect + 100]/20.$$

In this formula, the PN score was a function of six characteristics of a movie as perceived by an evaluator as well as a standard rating given by movie critics. The six characteristics were Environment, Character, Theme, Time, Impact, and Rating (Table 3).

Environment, Character, and Theme were put together into Content that was whether they dealt positively or negatively with the subjects of biotechnology and health. Environment point lay in the interval -20 to +20. Both Character and Theme points lay in the interval -40 to +40. Therefore, Content point lay in the interval -100 to +100 and was the only component of the PN score that could be negative. Time was a time devoted to biotechnology and health in movie. Time point was a variable that could range between 0 and 1. Affect point was a simple summation of the points in 2 subcategories of Impact on individual evaluator and Rating given by movie critics. Affect point was a variable that could range between 0.6 and 1. Therefore, Time × Affect was also a variable that ranged from 0 to 1.

More properties of the components were as follows.

Environment rating was defined as feelings toward screen images of buildings of hospital, laboratory, etc. For example, a new, bright, and modern hospital was given a higher point, while a decrepit, dark, and weird hospital was given a lower point. Character rating was defined as feelings toward screen images of characters in the

movie. For example, a beautiful female doctor with a good personality was given a higher point, while a mean abnormal researcher was given a lower point. Theme rating was defined as feelings toward ideas of the movie. For example, scenes appealing to the importance of biomedical research received a higher rating, while scenes portraying the risk and danger of biomedical research were given a lower rating.

Time rating which was classified as the percentage of the total time (tt) of screen images of biotechnology- and health-related scenes in the movies comprised 6 grades of 0, 0.2, 0.4, 0.6, 0.8, and 1.0; $0\% = 0$, $0\% < tt < 20\% = 0.2$, $20\% \leq tt < 40\% = 0.4$, $40\% \leq tt < 60\% = 0.6$, $60\% \leq tt < 80\% = 0.8$, and $80\% \leq tt \leq 100\% = 1.0$. In case of 0%, the movie was not analyzed further, because this does not correspond to the definition of biotechnology- and health-related movie.

Affect rating which was Impact on individual evaluator + Rating given by movie critics comprised five grades – 0.6, 0.7, 0.8, 0.9, and 1.0, which were assigned scores irrespective of biotechnology- and health-related scenes. Impact rating on individual evaluator was defined as feelings toward the movie after the first viewing and comprised 3 grades – 0.3, 0.4, and 0.5; excellent = 0.5, very good = 0.4, and good = 0.3. Rating given by movie critics was defined as the ranking by professional movie reviewers in Kinema Junpo and comprised 3 grades, 0.3, 0.4, and 0.5; within the top 10 rankings = 0.5, below the 11th ranking = 0.4, and out of the list = 0.3.

The movie reviews were performed in an isolated quiet atmosphere. VHS videos were watched and analyzed with a Sharp LC-15E1 plasma television connected to a Victor HM-HDS4 video recorder with an earphone. For the first show, the movie was watched without a break and was given Impact rating. During the second show, the movie was analyzed with frequent breaks. The time duration of biotechnology- and health-related scenes was measured with a time counter of the video recorder. Content point was rated with extracting every element of the scenes, for example, typical lines of the characters in the script.

PN scoring of the movies was performed by a single person (KF), who was a senior biology major. Every scoring was extensively examined by a university professor (RH), who had been working in the field of cell biology for more than 30 years and in the field of science and society for more than 10 years. This means that the main evaluator had limited professional knowledge of biotechnology and health science and expressed naïve feelings, similar to that of ordinary people, and the results were examined professionally from both biomedical and sociological aspects. To maintain a steady standard, the evaluation was performed by the same person throughout this study.

Results

Positive-negative indicator of biotechnology- and health-related movies

An example of the evaluation for the movie “The City of Lost Children (1996)” was described below.

Content rating was –66 based on the grades from the following three subcategories. Environment rating was –20, because the main setting was a weird off-shore laboratory. Character rating was –16 from the summation of –4 (weird doctor who made clones), –8 (dwarf beauty), –8 (genius human clone), 0 (six human clones), and +4 (brain). Theme rating was –30, because it portrayed a very negative image of biomedical research.

Time rating was 1.0. The entire story was to a great extent related to biotechnology, and the time was counted as 100% although the total time duration of the screen images of scientists and human clones was exactly 44 min of the 112 min duration of the movie.

Affect rating was 0.8. The movie was perceived as very good after the first viewing, and Impact rating on individual evaluator was 0.4. It was ranked 34th in “best movies in this year” in 1966 in Kinema Junpo and Rating given by movie critics was 0.4.

We evaluated 9 biotechnology- related, 21 health-related, and 1 both-related movies screened in large theaters in Japan from 1990 to 2000 using the positive-negative feeling evaluation method. To our surprise, the movie “The Sheltering Sky (1990)” had no biotechnology- and health-related scenes. On rechecking the keywords, we realized that the movie was selected because it contained the statement, “...like the desert without a doctor...” Hence, “The Sheltering Sky (1990)” was not a biotechnology- and health-related movie and was omitted for further analysis.

The PN scores of the 30 movies were shown in the last column of Table 2. The average PN score was 4.6, indicating that biotechnology- or health-related movies did not strongly bias the feelings toward biotechnology- or health-related things on an average. The highest PN score was 6.1, which was awarded to “Good Will Hunting (1997)”, a human drama concerning an elusive young genius. The lowest PN score was 2.4 to “The City of Lost Children (1996),” which was described above.

Distribution of the PN scores

Distribution of the PN scores of the 30 movies including 9 biotechnology- related, 20 health-related, and 1 both-related movies were 0 (0%) highly negative, 10 (33%) negative, 17 (57%) neutral, 3 (10%) positive, and 0 (0%) highly positive feeling movies (Figure 1).

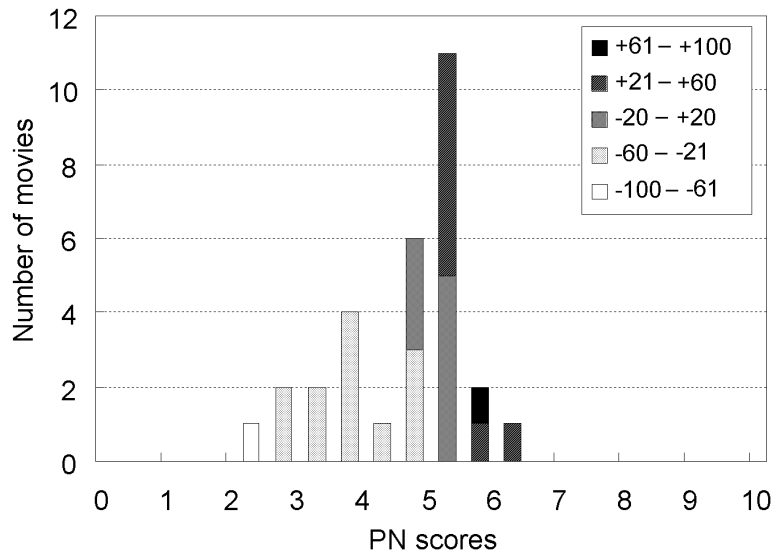


Figure 1. Relationship between PN score and Content rating. The PN score pattern of 30 movies was characterized on the basis of the 5 grades of the Content rating as strongly positive (+61 – +100), positive (+21 – +60), neutral (–20 – +20), negative (–60 – –21), and strongly negative (–100 – –61).

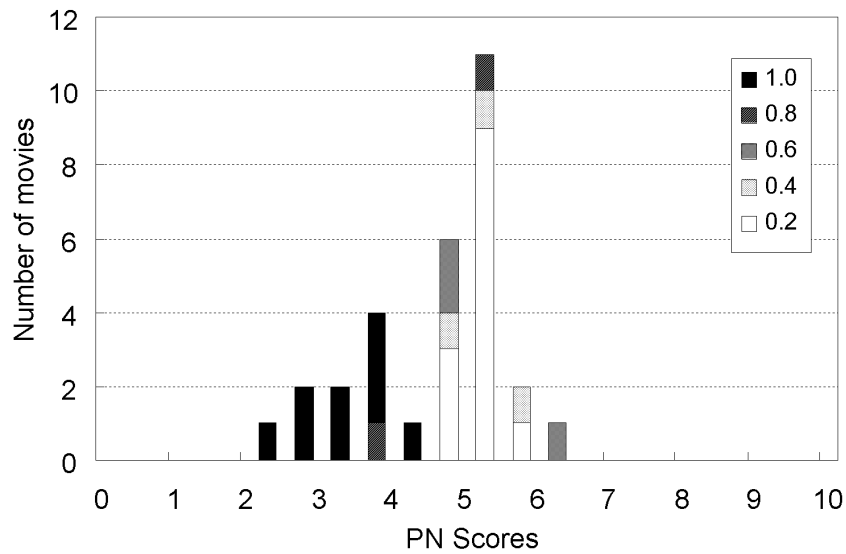


Figure 2. Relationship between PN score and Time rating. The PN score pattern of 30 movies was characterized with 5 grades of the Time point of 0.2, 0.4, 0.6, 0.8, and 1.0.

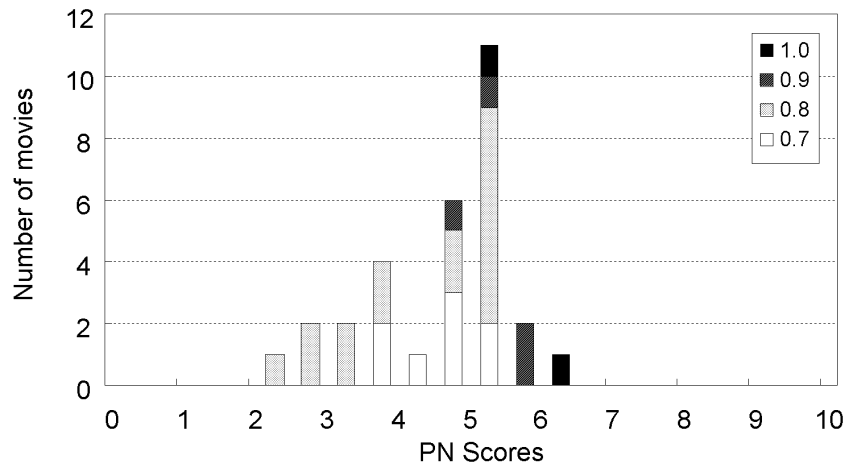


Figure 3. Relationship between PN score and Affect rating. The PN score pattern of 30 movies was characterized with 4 grades of the Affect rating of 0.7, 0.8, 0.9, and 1.0.

Table 4. PN score, database, and search keywords

Database	Biotechnology-related keywords (number of movies)	Health-related keywords (number of movies)
All-Movie Guide	3.3 (3)	5.0 (7)
Kinema Junpo	3.6 (8)	4.9 (16)
Total	3.5 (9)	4.9 (22)

One movie was related to both of biotechnology and health.
Four movies were from both databases in All-Movie Guide and Kinema Junpo.

The Content rating was increased with the PN score, although there was only one exception out of 30 movies (Figure 1). This indicated that the PN score reflected the viewers' feelings toward biotechnology- or health-related scenes in the movies. There were, however, 10 (33%) negative feeling movies. What made them negative feeling?

Concerning Time rating, 9 out of 10 movies in the negative group received a rating of 1.0 (Figure 2). Thirteen movies, which received a time rating of 0.2, were in the neutral group. The remaining 7 movies, with a time rating of 0.4–0.8, were non-specifically distributed from negative to positive groups. These grades indicated that the longer the biotechnology- and health-related scenes were, the lower the PN scores were.

Affect rating was distributed into 0.7 (8 movies), 0.8 (16 movies), 0.9 (4 movies), and 1.0 (2 movies). There was no distinct distribution of the Affect rating over the PN scores (Figure 3). This indicated that the Affect point did not bias the PN score.

Were the movie database and search keywords related to the PN score? Table 4 showed that the movies obtained after searching with biotechnology- and health-related keywords received PN scores of 3.5 and 4.9 on an average, respectively. There was no considerable difference of the PN scores between the databases in the All-Movie Guide and Kinema Junpo. These indicated that the biotechnology-related movies were negative, while the health-related movies were neutral.

The pattern of PN score distribution was not related to the year of release (data not shown). The number of movies analyzed was not sufficient to determine the relationship between the PN score and the country of production (data not shown).

Discussion

In the present study, we have presented a simple and quantitative evaluation method of positive and negative feelings toward biotechnology- and health-related scenes in movies. The PN score (positive-negative score) was expressed by two significant figures from 0 to 10. The method was applied to 30 biotechnology- or health-related movies exhibited in large movie theaters in Japan from 1990 to 2000.

To date, there is no information available with regard to movie rating on scientific subjects. The PN score could serve as a popular rating scale, similar to the existing system of rating the scenes related to sex, drug use, nudity, coarse language, and violence, namely, G (General Audience), PG (Parental Guidance Suggested), R (Restricted-Under 17), and NC-17 (No One 17 and Under Admitted). We hope that the PN score can be useful for general audiences, parents, and school-teachers as the movie rating for biotechnology- and health-related scenes in movies. It can be also useful for policy makers who care about the future of science and technology of the society. They can choose, recommend, support, or restrict movies according to the PN score.

The reproducibility of the PN score by the same person has not yet been confirmed. This is not easy because an impression of the movie, once made, is difficult to erase. To establish the objectivity of the PN score, we have repeatedly asked ourselves if several reviewers are required. For example, several senior biology majors should have probably reviewed the same movies. For the time being, our need was to establish objectivity and not average scores of several reviewers. Hence, we have refined the definition of the formula to some extent with clear-cut explanations. Reproducibility of the PN score with many reviewers will be the next step.

The PN score may, however, not be an absolute score. In some measure it is a kind of score which fundamentally depends on the sense of value and professional knowledge of the reviewer. That is, there must be specific variations in the PN score

with different groups of reviewers. For example, Theme rating may depend on their occupation, education, religion, culture, nationality, gender, and age, because it is rated at least in significant part in relation to the scenes about importance, risk, and danger of biomedical research. It must reflect a wide variety of sense of value and professional knowledge about biomedical research of different groups of reviewers. It should be also mentioned that if one takes another normalized combination of variables, one might not get exactly the same PN score.

Two days were required to determine the PN score for one movie. The evaluation time needs to be reduced by improving the methodology for evaluation. For achieving this, some automatic measures may be effective. We have not tested these measures in this study; however, they may be tested in future studies. The tone of the background music appears to be similar to the mood of the movie. The type of laughter in the movie appears to relate to scenes responsible for positive or negative feelings. The physical brightness or darkness on screen also seems to relate with the scenes responsible for positive or negative feelings.

Feature movies are sources of commercial entertainment and amusement but have a strong power to influence the sense of values of both people and society. Particularly with regard to young people, movies may even help in establishing their sense of values, humanity, and even their lives. In fact, several scientists and physicians have chosen their careers because they have been influenced by some images of great scientists or great physicians in a movie, television, novel, the other media, or in real lives in their teens and twenties.

When the public attitude toward biotechnology- and health-related issues is negative, biomedical science hardly develops. However, the media is not a textbook of ethics. Wilkes⁸ pointed out that the general reader reads a newspaper only for pleasure, although newspapers are the media which are expected and believed to provide scientifically accurate information. On the other hand, the main purpose of a movie is entertainment and amusement. It is not expected and believed to be scientifically accurate. General audiences, however, believe that the science in movies is based on almost (at least partially) accurate scientific facts.

Smoking amongst adolescents in New Zealand has increased due to a favorable portrayal of smoking in the media.^{12,13} In case of a historical analysis of passive smoking, the media has depicted it as a social problem even though scientific evidence and discussions about the health problems related to passive smoking are limited.¹⁴ The media, thus has a great influence on the public opinion. Nelkin¹⁵ stated that media messages help to create the beliefs and assumption that underlie personal decisions, social policies, and institutional practices. The lives of great scientists in the movies are one of the best indicators of public attitude toward science and technology in contemporary society.¹⁶ Movies and television programs depicting biotechnology- and health-related issues can serve as useful gauges of public opinion regarding the

biomedical profession, as tools for biomedical education, and as instruments of positive social change in efforts to reform the biomedical system.^{10,17} Our results in this paper indicated that the biotechnology-related movies gave negative feelings, while the health-related movies gave neutral feelings. Furthermore, the longer the biotechnology-related scenes in movies, the more negative feelings they gave for biomedical sciences. This is extremely dangerous to our health- and technology-conscious society. Therefore, we must keep studying quantitatively on the public perception of biomedical sciences in mass media from point of view of positive and negative feelings.

There is, however, another idea. Science writers working in media are usually not sufficiently trained with regard to scientific information. Therefore, it is necessary that the scientists themselves take on the responsibility of communicating scientific information to the public.^{18,19} In fact, the proportion of science-trained reporters in the American news media is rapidly growing, and a few have reached the higher ranks of journalism, for example, immunologist Laurie Garret at *Newsday*, molecular geneticist Rosie Mestel at *The Los Angeles Times*, and molecular geneticist Sue G. Ambrose at the *Dallas Morning News*.⁸ Scientists should also be responsible for the accuracy of the description of scientific concepts in movies. Abbott²⁰ described that “Finding Nemo (2003)” impressed several marine biologists with its scientific accuracy, because Adam Summers, a postdoc in fish biomechanics, at the University of California, Berkeley, was deeply committed to the movie and organized around 20 lectures on subjects ranging from swimming mechanics to the social behavior of fish for the benefit of the film-maker.

Even if scientists are fully committed to this cause, there is still a limitation with regard to communicating established “science” knowledge through media. Our contemporary society is facing a complicated reality that even scientists cannot attribute as being good or bad, right or wrong, safe, or dangerous, and even true or false. So science media might be better to change at the level of more fundamental attitude. Instead of delivering established “science”, we may deliver ongoing processes of “research”. The public, therefore, needs to understand what research is being conducted, why it is being done, and what the potential implications may be.²¹ Nevertheless, it is necessary to study quantitatively on the public perception of “science” and “research” in mass media from point of view of positive and negative feelings.

Finally, we would like to cite a phrase from Sternheimer’s book.²² “Why are we so often encouraged to believe that media are the root of several social problems?”

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