

Comparing direct-to-consumer genetic testing services in English, Japanese, and Chinese websites

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Abstract Direct-to-consumer genetic testing (DTC-GT) has rapidly become available and affordable throughout developed countries. However, comparative research on DTC-GT services beyond Western countries has remained scarce, particularly in East Asian countries such as Japan and China. Hence, this study's hypothesis is that although DTC-GT services in three languages might utilize the same underlying testing technology, such services are likely to represent the social, economic, and political characteristics of each country. For the study, a total of 267 websites (182 English, 32 Japanese, and 53 Chinese) were analyzed and coded reflexively into five categories for content analysis before interpretation using cluster and factor analyses. The results demonstrated variation between the three languages that reflected their respective consumer cultures: English, Chinese, and Japanese genetic testing websites focused on empowerment and ancestry; cultural values, especially familism; and health and beauty, respectively.

Key words: direct-to-consumer genetic testing, media, culture

Introduction

Recent years have seen a variety of applications of genome information such as the diagnosis of rare genetic diseases, cancer therapy, pharmacogenomics, prenatal testing, neonatal screening, and preimplantation diagnosis. Multiple researchers have conducted studies on the social and ethical impacts of human genomics. These research topics have been often collectively been called ethical, legal, and social issues (ELSI). The term has been used as an umbrella term since the Human Genome Project. The ELSI research program under the Human Genome Project has aimed not only to gain a deep understanding of ELSIs but also to scan various impacts for daily living and society. Moreover, it intends to encourage social broad discussions that include various actors to identify better methods for sharing information across studies on the human genome (McEwen et al., 2014).

To date, ELSI studies have elucidated issues such as approaches for obtaining informed consent and informed

assent, regulatory frameworks on biobanks, genetic discrimination in insurance, treatment of incidental findings, rights to know and not to know, topics on anticipatory autonomy rights, racism, the relationship between personal information protection and use of genome information, and direct-to-consumer genetic testing (DTC-GT) (Robertson, 2003; Hogarth et al., 2008; Patch et al., 2009; Presidential Commission for the Study of Bioethical Issues, 2012; Biesecker et al., 2012; Wolf et al., 2012; Kaye, 2012; Dondorp and de Wert, 2013).

Given these contexts, the focus of this study is GT issues with applications of human genomes. Genome researchers are currently examining DTC-GT implications, with the treatment of incidental findings and the guarantee of the right not to know being major themes in the discourse. What is the appropriate scheme for delivering results? Which entities should turn over results and to whom? What will be the legal conditions and duties of medical doctors, companies, and other related individuals? Such discussions have progressed along varying paths in different countries (Dondorp and de Wert, 2013; Clayton et al., 2013; Green et al., 2013; Inoue et al., 2014).

Another concern of DTC-GT is the relationship between genetic ancestry testing through DTC-GT and racism (American Society of Human Genetics (ASHG), 2018; Panofsky and Donovan, 2019). White nationalists currently

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use DTC-GT to justify racism. Conversely, individuals who practice racism ignore, misinterpret, or explain away as conspiracy theories inconvenient DTC-GT results (American Society of Human Genetics (ASHG), 2018; Panofsky and Donovan, 2019).

DTC-GT advertising has taken hold in multiple countries, and these services have spread rapidly. Given this, there is value in scrutinizing the different portrayals of DTC-GT in the advertisements in countries. For instance, what is the current GT representation and rhetoric? What GT features do different countries highlight? What knowledge can be extracted from GT representation? To examine these aspects, we conducted a comparative analysis of the contents and rhetoric of representations in commercial communications for DTC-GT service websites across three languages: English, Japanese, and Chinese.

The expanding market for DTC-GT

Despite the concerns of researchers, the DTC-GT market has expanded worldwide. In the United States, some companies started offering diagnostic tests 15 years ago, and the market developed rapidly, but many implications arose that had not been considered. The US Food and Drug Administration called for the cessation of DTC-GT sales, and for a time, relevant companies heeded the request. However, sales were reinitiated in 2013 (Hollands et al., 2016). Today, the United States is the largest market in the world, and its consumption of DTC-GT is reported at US\$73 million as of 2017. Regalado (2019) reported that more than 26 million consumers in the world had provided DNA to testing companies as of January 2019.

The Japanese market, meanwhile, is expected to reach 6.6 billion yen in 2022, considerably more than the 4.3 billion yen in 2017 (Takezawa, 2018). DTC-GT has gained familiarity since the appearance of Masahiro Tanaka, a baseball player for the New York Yankee, in one of the earliest television commercials in Japan in 2018 (Sugiura and Aruga, 2018). The GT market in China is also gradually expanding in size. Kang et al. (2021) reported that one million DNA tests were performed between 2013 and 2018. In fact, the Chinese market for GT is projected to increase from US\$1.43 billion in 2017 to US\$4.33 billion by 2023 (Research and Markets, 2021). In other words, continued expansion of the DTC-GT market is foreseeable.

Academic concerns about DTC-GT

With this study, we focused on the DTC-GT-related issues of human genome research. Academic societies have discussed such issues actively, particularly regarding quality control and regulation, after the release of large-scale advertisements by DTC-GT companies in the 2000s.

In 2012, the Presidential Committee on Bioethics of the United States published *Privacy and Progress in Whole Genome Sequencing*. In general, this report holds the position that reading the human genome is good for public health, and it focuses on a balance between reading the genome and protecting constitutionally guaranteed rights to privacy (Presidential Commission for the Study of Bioethical Issues, 2012). The committee then published *Ethical Management of Incidental and Secondary Findings*

in the Clinical, Research, and Direct-to-Consumer Contexts in 2013, which discussed incidental findings related to respect for persons, beneficence, justice and fairness, intellectual freedom, and responsibility (Presidential Commission for the Study of Bioethical Issues, 2013).

Additionally, in the United States, the American College of Medical Genetics and Genomics published related guidelines and encouraged discussions (e.g. Inoue et al., 2014); however, in the United States, the use of DTC-GT was generally regarded as a personal preference. As a legal framework, the study referred to the Clinical Laboratory Improvement Amendments of 1988. However, it was intended to regulate the accuracy of testing, and in fact, government options for regulatory intervention were limited. Academic communities discussed DTC-GT-related issues as well. For example, the American Society of Human Genetics (ASHG) published a statement about DTC-GT in 2007 that addressed testing technology levels, privacy protection, and scientific evidence from related services. The statement requested that DTC-GT companies be transparent to ensure people's right of choice. Simultaneously, previous studies discussed issues regarding the return of results (Hudson et al., 2007).

Finally, the European Union (EU) took proactive approaches to addressing the issues with DTC-GT. First, the Data Protection Directive (Directive 95/46/EC on the protection of individuals regarding the processing of personal data and on the free movement of such data) controlled genome information as sensitive information. Second, GT was included in healthcare services as part of social services.

Moreover, academia published reports and guidelines that considered the EU context. For example, the European Society of Human Genetics published recommendations to establish practical and clinical guidelines at the local, national, and international levels and to encourage the sharing of experiences among experts. Additionally, they discussed various implications, such as how to address uncertainty and unsolicited findings, the balance of benefits and drawbacks for patients, informed consent, biobanking, balance between patients' right not to know and professional responsibilities, enhancement of genetic education, and literacy of the public (van El et al., 2013).

In Japan, studies on human genomes were regulated under the Japanese ethical guidelines for human genome/gene analysis research (Ministry of Education, Culture, Sports, Science and Technology, 2013), and several academic societies governed certain clinical applications. For example, the use of genome information for preimplantation diagnosis was regarded as a specific medical technology, and thus, no specific legal frameworks were considered necessary. Today, however, the guidelines of the Japanese Society of Obstetrics and Gynecology are treated as the major framework.

The Japanese Society of Human Genetics (JSHG) published statements and recommendations on the matter. For example, in 2008, the JSHG published a report titled *Considerations on Genetic Testing* and posed key questions on scientific validity, the qualifications of the current DTC-GT services, information sharing regarding the interpretations and limitations of testing, and the protection of

personal information and privacy (Japan Society of Human Genetics (JSHG), 2008). JSHG published another *Considerations on Genetic Testing* in 2010 for the public and recommended establishing a monitoring system for DTC-GT, the participation of qualified medical experts during the testing, prevention of harmful effects to consumers, and enhancement of public understanding (Japan Society of Human Genetics (JSHG), 2010). In 2011, the Japanese Association of Medical Science published *Guidelines for Genetic Tests and Diagnosis in Medical Practice* and emphasized the legal regulatory monitoring system for DTC-GT services (Japanese Association of Medical Science, 2011).

In China, meanwhile, Du and Wang (2020) examined the measures of privacy and data protection by Chinese DTC-GT services. They concluded that the industry was mainly self-regulated and that the country needed a comprehensive legal framework for regulating DTC-GT considering its rapid spread (Du and Wang, 2020).

Despite the voices of academic societies in Japan, discussions on regulatory frameworks on DTC-GT among the government and related ministries remain lacking. One of the significant agendas among regulatory agencies such as the Ministry of Economy, Trade and Industry (METI) was establishing a working group composed of experts to discuss DTC-GT. In 2013, METI regarded GT services as an economic promised land and encouraged their sound development. Moreover, it discussed the signs of problems and possibilities of a certification system for compliant companies to eliminate the need to constrain their economic activities provided that they are established within the legal frameworks. However, the majority of ministries did not participate in these discussions (Ministry of Economy, Trade and Industry (METI), 2013). In summary, nearly all guidelines and recommendations discuss the necessity of the participation of medical experts in the GT service process and emphasize the effectiveness of legal frameworks to monitor the quality of testing.

The genetic testing literature

Human genome researchers argued for the importance of communication regarding genome testing, although health communication regarding the risk of DTC-GT by itself is insufficient to change people's behavior. Rather, the more salient the information, the more individuals recognize it (Chen and Chaiken, 1999). People who receive results indicating genetically inherited diseases can think that the disease is inevitable and take no proactive actions to respond (Marteau and Lerman, 2001). Individual knowledge and experience related to genetics influence the understanding of genes. However, risk communication does not motivate individuals to reduce the risk and the use of GT (Hollands et al., 2016). As indicated by previous studies, researchers on human genomes might not regard communication on DTC-GT as problematic.

However, the media, which most people are exposed to in daily life, are one of the sources of information regarding GT. The media influences the public image of the service. Healthcare providers consider that media-driven consumers will be interested in GT (Adair et al., 2009), and indeed, media reporting on personalized medicine plays a role in

promoting healthcare (Marcon et al., 2018). Moreover, television campaigns can influence people to participate in preventive care programs (Cram et al., 2003). In other words, the media can construct and frame the image of issues related to science (Nisbet et al., 2003).

Meanwhile, scholars on science communication argue that the new online media environment exerts a major influence on the public's understanding of science (Brossard and Scheufele, 2013; Brossard, 2012). For example, Brossard and Scheufele (2013) identified that increasing numbers of people are obtaining their information on science from the Internet and that its influence is substantial; Wagner et al. (2012) also found that blogs play an effective role in public health information. These study findings suggest that media attention on the topic can increase public interest and maybe eagerness to investigate GT.

Considering the increased expansion of DTC-GT markets, there is a growing need to focus on advertising communication to construct public perceptions of GT (Haran and Kitzinger, 2009). In fact, the trend of DTC-GT is rapidly spreading worldwide across products (Bennett, 2019), and researchers are beginning to focus on representations of DTC products in advertisements. DTC advertisements related to healthcare provide consumers with educational information about drugs, which can lead to inappropriate usage (Shin and Moon, 2005) or to improvement in the interactions between patients and physicians (Fain and Alexander, 2014).

DTC advertisements are composed of elements based on social and cultural contexts to attract consumer attention (Forehand et al., 2002; Willis, 2017), and they invoke emotional reactions and discussions about its content from consumers (Ball and Mackert, 2013). Hence, analyzing the commercial communication regarding DTC-GT is useful for understanding consumers' recognition of GT technology. Previous studies on websites that offer DTC-GT found that they provide information on GT as a risk for disease (Goddard et al., 2009), health improvement (Einsiedel and Geransar, 2009), health decisions among consumers (Lachance et al., 2010), and dietary and lifestyle decisions (Sterling, 2008). These sites also provide consulting services (e.g. genetic, medical, physician, and nutrition) (Covolo et al., 2012; Hennen et al., 2010; Lachance et al., 2010; Lewis et al., 2011). The websites scarcely mention scientific evidence about GT but refer to certification to add scientific prestige (Goddard et al., 2009; Hennen et al., 2010; Einsiedel and Geransar, 2009). These studies reported the function of DTC-GT through commercial communication. However, diverse sociocultural representations of DTC-GT remain lacking.

With this study, we aimed to understand the contents and rhetoric of representations in commercial communication regarding DTC-GT. We conducted a comparative study of the commercial portrayal of GT by analyzing the contents of DTC-GT service websites from three countries in their native languages, namely, English, Japanese, and Chinese. We hypothesized that although these services are based on common technology, each country likely presented different communications that reflect their particular societal, economic, and cultural circumstances.

Materials and Methods

For this study, we only analyzed business websites that supply personal consumer GT kits through direct ordering (see Appendix 1 for details). From December 2018 to March 2019, we identified potential DTC-GT websites using search engines from neutral terminals that do not require log-in information. We used Google to search for English and Japanese services and Baidu for Chinese websites. The keywords used were fixed by trial and error, such as ‘genetic test’ or ‘DNA test’ in English; ‘*idenshi kensa* (genetic test)’ or ‘DNA *kantei* (DNA identification)’ in Japanese; and ‘*ji yin jian ce* (genetic testing)’ and ‘*jian ding* (DNA identification)’ in Chinese. We (details below) independently searched and added to the list of services on a shared file, and redundant sites were removed from the list. After data collection, all websites were manually reviewed, and only sites providing DTC-GT services that matched the study definition were used for further analysis.

We analyzed a total of 267 websites, comprising 182 English, 32 Japanese, and 53 Chinese sites. We focused on the contents mentioned on each landing page. Several websites (41 out of 226; 15%) did not display DTC-GT services on their landing page, although they supplied these services; for these sites, we only analyzed the page that specifically addressed the GT services. For all sites, we documented the site’s primary language, URL, and location of company headquarters (Appendix 2).

Coding and coding sheet

Coding rules were arranged reflexively for content analysis. For our purposes, the coding rule needed to be appropriately commensurate to all websites in the three languages and depict differences among them in an adequate manner. Toward this end, we deductively composed a category list based on the salient contents and characteristic messages from each website. After several trials, we finally established a complex table for coding (Table 1, Appendix 3).

The coding table consisted of five major codes we arrived at through an inductive analysis of the sites’ contents: wellness and life, fitness and sports, disease, ancestry, and family. Several minor codes were not categorized along with these major codes. In addition to the codes we derived inductively, we added visual image as a major code to clarify the differences in the sites’ different visual representations of the websites, and we added marketing strategies to distinguish the economic strategies of each culture. The coders classified all codes as binary (whether the site includes a certain factor or not).

Three coders from Waseda University (graduate students from the journalism course, Graduate School of Political Science) performed the actual coding. Chinese was the mother tongue for all coders, but all three also exhibited excellent linguistic skills in English and Japanese. After training, the coders were requested to code 16% of all websites to calculate intercoder reliability. The result indicated that all coders displayed reliable Fleiss’ *k*-statistic scores in full codes: 0.719, 0.788, and 0.73 in English, Japanese, and Chinese, respectively. These scores are considered sufficiently trustworthy given the required coding numbers.

Data analysis

Following the content analysis, we conducted cluster and factor analyses to interpret the results. Cluster analysis is a typical method for identifying topics embedded in text, and we applied hierarchical cluster analysis to the coding results as well as calculating the complete Euclidean distances. However, cluster analysis is insufficient for producing interpretable categorization results, and therefore, we also applied factor analysis with promax rotation to further elucidate the results. Throughout the process, we used R 3.5.2 for calculation.

Results

GT is ‘knowing yourself’

The websites of the DTC-GT services displayed different tendencies in representing GT according to the linguistic environment (Table 1). However, we did observe several common characteristics, such as ‘know yourself and your genes’ narratives, observed by Zwart (2018) as the ‘know thyself’ motif. This phrase and this theme are found on websites that offer a wide range of services, such as testing for health and sports and preventing and predicting diseases. Overall, 65% of all English websites adopted similar expressions, compared with 47% for the Japanese sites, and 32% in Chinese.

Wellness

The concepts of ‘wellness’ and ‘well-being’ are unique to Anglophone cultures, although the terms evidently do occur occasionally in Japanese and Chinese. However, ‘wellness’ and ‘well-being’ do not have direct Japanese translations, and thus the latter is written in katakana as the borrowed English word *weru-beingu*. Aggregating the data from the accumulated websites revealed that Japanese and Chinese represent the concepts of wellness and well-being with, respectively, *kenkou* and *jian kang*; both translate into English as just ‘health,’ but it was clear to the site reviewers that these various words in the three different languages were treated as corresponding concepts. Notably, however, the proportions of English, Chinese, and Japanese websites that mentioned these concepts were 35.2%, 26.4%, and only 12.5%, respectively. It is possible that so few Japanese websites mentioned well-being because they emphasized the practical benefits of GT more than any amorphous concepts. Moreover, 46.7% of the English websites stressed that their DTC services would improve customers’ lives, whereas the Japanese (28.1%) and Chinese (24.5%) sites used the concept less frequently. Finally, 40.7% and 43.8% of the English and Japanese sites, respectively, referred to dietary improvements, but only 13.2% of the Chinese sites did so.

Disease

Disease prediction and prevention are long-term prevalent themes in DTC-GT, although the clinical value of such information remains contested (Hudson et al., 2007). However, Chinese websites were enthusiastic about these possibilities for genetic information, such that 38% of the websites emphasized the possibility of diagnosis and pre-

Table 1. Summary of coding the English, Japanese, and Chinese website content of DTC-GT companies

	Code	English		Japanese		Chinese			
		N	%	N	%	N	%		
Content	Know yourself and your gene		119	65.4%	15	46.9%	17	32.1%	
	Wellness and lifestyle	Wellness/wellbeing	64	35.2%	4	12.5%	14	26.4%	
		Improvement of life	85	46.7%	9	28.1%	13	24.5%	
		Diet	74	40.7%	14	43.8%	7	13.2%	
		Sleeping	12	6.6%	0	0.0%	1	1.9%	
		Recovery	22	12.1%	0	0.0%	0	0.0%	
	Fitness, Exercise and Sports	Muscle	24	13.2%	4	12.5%	1	1.9%	
		Weight	64	35.2%	9	28.1%	12	22.6%	
		Cardio	18	9.9%	0	0.0%	0	0.0%	
		(Pro) Athlete	44	24.2%	1	3.1%	0	0.0%	
	Nutrition		84	46.2%	7	21.9%	11	20.8%	
	Skin care		22	12.1%	9	28.1%	9	17.0%	
	Baldness		4	2.2%	2	6.3%	1	1.9%	
	Disease	Common disease		32	17.6%	9	28.1%	18	34.0%
		Genetic disease		14	7.7%	0	0.0%	14	26.4%
		Heart disease		27	14.8%	0	0.0%	6	11.3%
		Cancer		21	11.5%	4	12.5%	20	37.7%
		Diabetes		17	9.3%	2	6.3%	6	11.3%
		Other disease		17	9.3%	2	6.3%	9	17.0%
		Mental illness		15	8.2%	1	3.1%	4	7.5%
		Stress Tolerance		20	11.0%	2	6.3%	1	1.9%
		Reaction to drug		33	18.1%	0	0.0%	17	32.1%
		Allergy		40	22.0%	1	3.1%	4	7.5%
		Reaction to Alcohol		9	4.9%	4	12.5%	8	15.1%
		Prevention of Disease		25	13.7%	4	12.5%	20	37.7%
Family		For kids	6	3.3%	1	3.1%	14	26.4%	
		kid's health	9	4.9%	6	18.8%	12	22.6%	
	kid's talent	5	2.7%	0	0.0%	1	1.9%		
	Testing pre pregnancy	11	6.0%	2	6.3%	23	43.4%		
	Testing in pregnancy	38	20.9%	7	21.9%	24	45.3%		
Paternity, maternity, and relationship test		9	4.9%	0	0.0%	1	1.9%		
Family planning		5	2.7%	0	0.0%	0	0.0%		
Ancestry	Classical Race		21	11.5%	0	0.0%	1	1.9%	
	Ethnicity and Nation states		14	7.7%	0	0.0%	2	3.8%	
	Geographic region		3	1.6%	0	0.0%	0	0.0%	
	Other		95	52.2%	20	62.5%	32	60.4%	
Visual	Unknown		119	65.4%	19	59.4%	34	64.2%	
	People	Man	135	74.2%	26	81.3%	43	81.1%	
		Woman	65	35.7%	14	43.8%	25	47.2%	
		Family	24	13.2%	1	3.1%	3	5.7%	
		Lovers	28	15.4%	8	25.0%	28	52.8%	
		Child	29	15.9%	0	0.0%	6	11.3%	
		Elders	17	9.3%	3	9.4%	4	7.5%	
	Animal		77	42.3%	14	43.8%	9	17.0%	
	Food		64	35.2%	13	40.6%	16	30.2%	
	Plant life		91	50.0%	15	46.9%	28	52.8%	
Scenery		141	77.5%	24	75.0%	50	94.3%		
Scientific Presentation		36	19.8%	3	9.4%	10	18.9%		
Map/Globe		22	12.1%	3	9.4%	7	13.2%		
Graph		85	46.7%	15	46.9%	27	50.9%		
Procedure		75	41.2%	8	25.0%	17	32.1%		
Follow-up Service		15	8.2%	2	6.3%	6	11.3%		
Apps		70	38.5%	10	31.3%	3	5.7%		
Testimonial		14	7.7%	0	0.0%	3	5.7%		
Marketing strategies	Catch-phrase, promotional statement	Text	94	51.6%	9	28.1%	29	54.7%	
		Video	12	6.6%	0	0.0%	2	3.8%	
	Staff, coach, experts	Fitness experts, proplayer	22	12.1%	3	9.4%	1	1.9%	
		scientific experts	30	16.5%	2	6.3%	5	9.4%	
	Media coverage		50	27.5%	8	25.0%	8	15.1%	
	Authentication	Scientific references	Institutional approved	47	25.8%	9	28.1%	25	47.2%
			Academic paper/books	7	3.8%	2	6.3%	1	1.9%
			Academic society	5	2.7%	2	6.3%	0	0.0%
	Communication	SNS	25	13.7%	5	15.6%	16	30.2%	
		Blog	13	7.1%	3	9.4%	2	3.8%	
		News	16	8.8%	9	28.1%	21	39.6%	
		Registrations	51	28.0%	0	0.0%	1	1.9%	
		Popup	18	9.9%	2	6.3%	14	26.4%	
	FAQ		17	9.3%	9	28.1%	18	34.0%	
Privacy policy		45	24.7%	12	37.5%	14	26.4%		

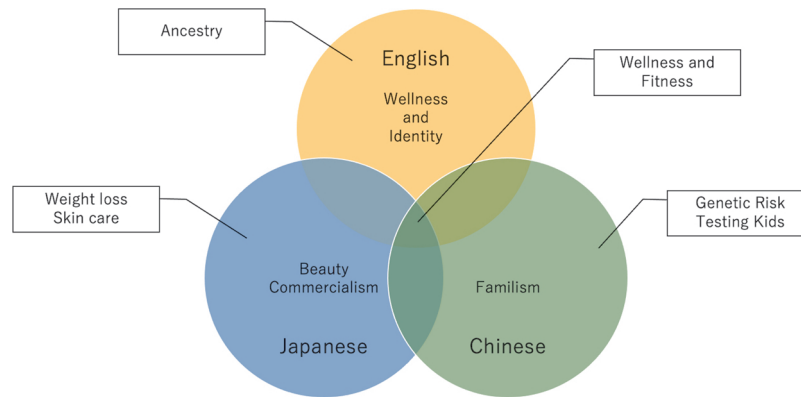


Figure 1. Representations of genetic testing on English, Chinese, and Japanese DTC-GT websites. These circles are the cultural-commercial characteristics of each language area that influence GT representations. Wellness and fitness were seen as common representations. On the other hand, due to the commercial-cultural characteristics of each language, knowing one's ancestry is linked to one's identity in English, GT was represented for the family in the Chinese site and as a technique for beauty in the Japanese site.

vention of diseases. Specifically, 34%, 26.4%, and 32.1% of the Chinese websites referred to diseases, hereditary diseases, and drug responses, respectively, and 37.7% mentioned cancer; the Chinese sites mentioned the latter nearly three times as often as the English and Japanese sites at about 12% each. The English websites mentioned diseases less frequently overall but did highlight a few specific diseases such as cardiac diseases (14.8%) and diabetes (9.3%). Slightly more of the Japanese websites featured diseases than the English sites, but Japanese sites only used the word *byoki* ('disease') briefly and provided no descriptions of actual diseases.

Fitness, nutrition, and beauty

The English (58.8%) and Japanese (56.3%) websites presented knowledge regarding genetic predispositions as beneficial for fitness, but nearly half as many Chinese sites did so. In fact, the English websites emphasized potential athletic prowess, with pictures of people with toned bodies running. Additionally, nutrition was a popular topic on English websites (46.2%) but accounted for less than half of the attention on the Japanese and Chinese websites (about 21% each).

In contrast to some of the earlier categories, weight control was a common topic across the websites in all three languages (English, 35.2%; Japanese, 28.1%; and Chinese, 22.6%). One of the clear traits of the Japanese websites was the emphasis on skin care, mentioned on 28.1% of the sites. This find could reflect Japan's overall emphasis on DTC-GT because of the importance of beauty services; the fact that elderly adults were not mentioned at all on Japanese sites could also reflect this tendency.

Ancestry

The English websites heavily (30.2%) emphasized the provision of ancestral information as benefits of GT, but the Japanese and Chinese websites, at about 9% each, focused much less on this. The English-language websites promised to specify full genetic ethnicity including nationality, whereas the Japanese and Chinese websites intended to satisfy customers who are interested in learning their ancestral

history by stimulating their archaeological curiosity. Several Japanese websites narrated the ancient long-distance migrations of the ancestors of each haplotype, whereas a few Chinese websites advertised more limited ancestral migration patterns, from one region to another within mainland China.

Family and children

The sites for all three languages recommended DTC-GT for families. Possibly reflecting their high priority on family values, 83% of the Chinese websites recommended the test to consumers' families, and the code for family included tests for children and paternity or relationships. In fact, paternity and relationship tests occupied certain aspects of the DTC-GT business. By language, 20.9% of English sites, 21.9% of Japanese sites, and 45.3% Chinese sites offered these types of tests. Furthermore, Chinese websites (43.4%) frequently recommended DTC-GT during pregnancy, whereas the English and Japanese websites rarely mentioned this aspect (about 6% each).

Another salient difference in the three language environments was GT for children. Such services were eagerly offered on Chinese (37.7%) and Japanese (21.9%) sites, but only 8.8% of English companies even mentioned it. In more detail, 26.4% of the Chinese websites emphasized the benefits of testing for children's health and knowledge about their talents (22.6%), and 18.8% of Japanese services highlighted the latter benefit of GT. These tendencies could reflect certain cultural and societal realities, such as China's previous one-child/one-family policy or Japan's declining birth rate, but also just general national emphases on education. Many of these GT websites in Asia are supplying tailor-made educational services for 'identified talents,' and we found evidence of this tendency in the frequent use of children's pictures on the Chinese sites: 52.8%. The percentages for the other two languages were 25% and 15.4% for Japanese and English sites, respectively.

Pictures of DTC-GT websites

To promote purchase, companies must attract customers within the social and cultural contexts of the market. En-

Table 2. The results of the cluster analysis

	Cluster 1: miscellaneous (including wellness and fitness)	Cluster 4: wellness, fitness, children	Cluster 3: wellness, fitness, disease, drag	Cluster 5: disease, children health and talent	Cluster 2: ancestry and pater- nity relationships, other	Total N (%)
English	64 (35)	10 (5)	20 (11)	0 (0)	88 (48)	182 (100)
Japanese	11 (34)	1 (3)	0 (0)	0 (0)	20 (63)	33 (100)
Chinese	2 (4)	8 (15)	6 (11)	3 (6)	34 (64)	53 (100)
Total	77 (29)	19 (7)	26 (10)	3 (1)	142 (53)	268 (100)

Table 3. Results of the factor analysis

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Know yourself		0.707	0.201		
Wellness	0.662	0.156			
Fitness	0.756				0.100
Nutrition	0.847		-0.140		-0.119
Skin	0.258		0.225	0.110	0.168
Disease				0.754	
Children			-0.119		0.702
Relationship		-0.673	0.239		
Ancestry	-0.101		0.663		-0.104

English (27.5%) and Japanese (25%) websites refer to the media coverage of their services and products; the Chinese sites tended to use more scientific images and references to scientific research. For instance, 94.3% of the Chinese websites used scientific images or icons, whereas the patterns for the English and Japanese websites were 77.5% and 75%, respectively. Moreover, more than half (55%) the Chinese websites mention a relationship with a scientific organization (English, 36%; Japanese, 31%), and nearly half (47.2%) reported approval from certain scientific institutions (English, 25.8%; Japanese, 28.1%). The English and Chinese websites supplied follow-up services, such as professional advice about diet or customized workout routines with a personal trainer, and the Chinese websites supplied actual medical services after the gene testing. Meanwhile, websites in all three language environments displayed images of families: English, 35.7%; Japanese, 43.8%; Chinese, 47.2%.

Customers' perspective

Consumers prefer that companies provide other consumers' opinions about their services in their promotional materials. Despite a few of mentions of user experiences on Chinese sites, respectively, 38.5% and 31.3% of the English and Japanese websites emphasized customer testimonials. Testimonials are a common strategy for online marketing as a means of leveraging the power of narratives, which adds to the appeal of the products (Caulfield et al., 2013; Hawke et al., 2019).

The English, Japanese, and Chinese websites all explained GT testing kits in everyday language to reassure potentially anxious consumers, and the Chinese (34%) and Japanese (28.1%) sites tended to offer a frequently asked questions section; these were less common on English sites.

Additionally, the Japanese sites (37.5%) emphasized their privacy policies slightly more than did the English (24.7%) and Chinese (26.4%) sites.

Statistical Analysis

To elucidate the relationships between the characteristics we identified from the content analysis, we also performed cluster and factor analyses. Hence, we removed the codes for visual and communication that we had identified through content analysis from further cluster analysis. We also only used large category levels for factor analysis.

Table 2 presents the most probable classification, which consisted of five clusters. First, cluster 5 only includes Chinese websites and consisted of diseases, children's health, and talent codes, which represent typical Chinese DTC-GT services. Next, most English and Chinese websites sorted into cluster 3: wellness, fitness, and diseases. Cluster 1 consisted of wellness and fitness. A relatively large number of websites in three languages are classified cluster 2. The cluster 2 constituent codes are ancestry, paternity tests, and several small and less-coded websites, which are typically Chinese and Japanese.

Table 3 provides the factor analysis results based on the content analysis, and the cumulative contribution ratio reached 0.508; the prime factors were wellness, fitness, and nutrition, which indicated that these variables were co-occurring. Next, in factor 2, the codes 'know yourself' and 'paternity relationships' were in opposing loci, which indicated their independence. The factors 'ancestry' and 'paternity relationship' contributed to factor 3, factor 4 consisted of disease and skin care, and the theme of factor 5 was genetic testing.

Discussion and Conclusion

DTC-GT web services in different languages utilize similar genetic polymorphisms, such as mtDNA haplotypes, the Y chromosome, and autosomal single-nucleotide polymorphisms. However, this technical information is only part of what DTC-GT advertisements describe as part of their services. Moreover, the representation of DTC-GT varies among languages, which could reflect the differences between consumer cultures. In summary, the representations of DTC-GT services on websites in different languages appear similar but differ in terms of the aspects being emphasized according to their cultural contexts (Figure 1).

The English DTC-GT services focus on empowerment by frequently adopting phrases, such as ‘know yourself.’ The phrases typically go along with the motto ‘know thyself’ (Zwart, 2018). This emphasis is found for services that target ancestry testing and promise better health and well-being. The phrases may be a common underlying concept, as they are also used on the Japanese and Chinese sites. The concept is that genetic testing is one of the ‘technologies of the self’ (Foucault, 1988) that can use our genetic information to clarify our identities (Pálsson, 2012). Although the English-language websites included the United States, the United Kingdom, and Canada, we did not identify significant differences from our content analysis between these three English-speaking countries websites; this indicates that these countries share social and consumer cultures on DTC-GT.

The Chinese DTC-GT services appear to highlight the cultural values of familism, that is, future benefits for the family (Kim and Kim, 2013). They provide information services about current diseases in both adults and children as well as disease risk for all and children’s potential talents. Although disease risk and talent appear to have little in common in terms of genetics, these websites aim to meet consumers’ needs to know their families in detail, especially their children. Even when sites advertise testing for specific diseases, they still advertise these services as benefiting the whole family, which is likely linked to the fact that China’s once long-standing one-child/one-family policy made family planning important (Sleeboom-Faulkner, 2011).

Finally, we identified clear differences in how the different countries represented their DTC-GT services, particularly between Japan and the other two. The Japanese culture has been identified as realistic, aiming for attainable goals (Iwao, 1993), and believing in “the transformative power of beauty technology” (Miller, 2006). In that context, DTC-GT is presented as a valuable tool for achieving beauty goals, such as effective exercise, weight loss, and skin care. The messages on the Japanese websites entice people toward beauty objectives they claim can only be achieved through knowledge of one’s genetics, and the sites emphasize poetic language that triggers a vague desire for beauty. Meanwhile, the Japanese sites also present GT as a parental duty for learning about their children’s talents.

One reason the Japanese websites focused so much more on children’s talents than on their health, in contrast to the

Chinese-language sites, could be the cultural aversion to genetic disorders (Kato and Sleeboom-Faulkner, 2009). The Japanese also heavily emphasized privacy protections, which could have reflected political trends such as the Act for Protection of Personal Data enforced in April 2005.

Although we identified a number of differences, there were common tendencies as well, primarily centered on appeals to the notion of ‘family’ manifested through technological affordances. Furthermore, this finding suggests that a particular “sociotechnical imaginary” (Jasanoff and Kim, 2009) supports DTC-GT with respect to genes and kinship.

This tendency occasionally manifests as the reformism of conservative ideas on kinship, setting family and heredity as aspects of “invented tradition” (Hobsbawm and Ranger, 1983). Furthermore, from the perspective of conservatism, we cannot overlook the fact that the DTC-GT is a service function to cultivate healthism and nationalism and that it is the conservative nationalist party in Japan that tends to adopt and promote these invented ideas about kinship. Although academic societies advise caution against the misuse and misunderstanding of DTC-GT services (Japanese Society of Human Genetics (JSHG), 2008, 2010; Hudson et al., 2007; American Society of Human Genetics (ASHG), 2018, van El et al., 2013), their websites frequently promise highly comforting if not misleading outcomes from genetic testing, such as that doing so brings well-being from knowing oneself, knowing oneself also improves quality of life, and enhances dignity rooted in ancestors. We find that DTC-GT services satisfy and even foster these obsessions across cultural differences. We also contend that these representations pose a direct risk to genetic determinism.

As with any study, this study also has its limitations. First, although we collected data on and analyzed as many sites as possible, we only analyzed landing pages. We were also confined to three languages and superficial content analysis because of the limited linguistic abilities of the authors. However, this study should inspire diverse future research on the commercial representations of DTC-GT services, for instance, a deeper analysis of the trends we identified by language and the subtle difference between the disease subcategories among three language groups.

We also believe it would be of research interest to further analyze how DTC-GT websites represent families and lifestyles. For instance, they advertise that DTC-GT can promote a ‘healthier lifestyle,’ but sites do not give details on what that entails, how much it depends on the individual, and so on. There are also more in-depth questions related to the types of family images these sites present and whether there common trends in the images such as ethnicity, class, and heterosexuality.

Notably, Sleeboom-Faulkner (2011) argued that “neoliberal eugenics” underlies DTC-GT services and that promoting the services might reinforce these beliefs. Conversely, Swan (2013) saw genetic testing results as a form of “quantified self” that will ultimately lead consumers to realize that genetically perfect individuals and genetic lineages are illusions. In a different direction, scholars have argued that this emphasis on individual choice and convenience masks the structures that allow companies to accumulate large

amounts of genetic data (Harris et al., 2013). Gaining such deeper insight requires discourse analysis of sites' text and images including subpages.

Finally, we observed exaggerated expressions of familial benefits from DTC-GT, and we recommend vigilance in recognizing how these services take advantage of the innate desire to 'know ourselves' because it is no longer possible to contain the technology and its social and cultural uses.

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Declaration of interest statement

The authors declare no conflicts of interest associated with this manuscript.

Data availability statement

The data that support the findings of this study are available from the corresponding author, K.N., upon reasonable request.

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