Aspects of scientific Japanese revealed by JECPRESE

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This study examines the language used by researchers in science and engineering, where clarity is essential. We prepared The Japanese-English Corpus of Presentations in Science and Engineering (JECPRESE) to examine how language is used in science and engineering to clearly and accurately present information. JECPRESE contains transcriptions of presentations given in Japanese and English by researchers. Analyses revealed vagueness in Japanese arising from the tendencies of the Japanese language to sometimes omit subjects and to lack specificity in conveying discourse strategies, verb tense, and mood. Such vagueness is considered to have roots in traditional Japanese society and culture that aim to maintain harmony in a community. However, in an age of global communications, this can be an obstacle to projecting an understandable message. Suggestions are made as to how to make scientific Japanese present clearer messages to a professional community based on linguistic considerations.

Areas of interest: scientific Japanese, sensitivity for discourse strategies, traditional Japanese for harmony, politeness, vagueness, missing subjects, verb tense and mood

1. Introduction

Language and the culture practiced by a society continually undergo change as circumstances around them change. Japanese language and culture are no exception. One event that has had a great impact on both was the Great East Japan Earthquake disaster of 2011. The disaster left more than 300,000 refugees in the Tōhoku region of Japan, and resulted in shortages of food, water, shelter, medicine, and fuel for the survivors. What surprised the world was the fact that even under such emergency circumstances, neither insurrection nor pillaging broke out and most of the Japanese people remained quiet and calm.

In traditional Japanese culture, the world is thought to move with the collective flow of nature, and all things are constantly in the process of change. Reflecting this background culture, the Japanese language starts an explanation of a situation from the beginning and leaves the outcome until the end. In this natural flow of events, self-assertion is not encouraged. The emphasis is less upon reason and argument than upon intuition and immediate feeling. Arising from zen concepts is the notion that "truth is considered to be in 'the discarding of words,' it lies 'outside words'" (Lu, 1997, p. 611). In discussing this, Noguchi

(2006, pp. 69-70) points out that such a communication style can "offer a situation that is purposefully rich with possible interpretations." To those unfamiliar with this concept, such a "higher tolerance level of vagueness in Japanese that encompasses even the extent of how much an individual has 'the right to know' can be puzzling." On March 25, 2011, shortly after the Tōhoku earthquake and tsunami disaster, American University in Washington, D.C., held a panel discussion on the communication problems that Japan was facing (Crowe, 2011). In the report, the director of systems engineering at the university states that "he was surprised by his Japanese-born wife's willingness to accept NHK's report that a video of a smoking reactor was described as an innocuous 'puff of smoke,' even as the BBC labeled it evidence of disastrous damage" (Crowe, 2011).

In response to the Tōhoku crisis, with many countries sending search and rescue teams, the Japanese government should have immediately sent out clear reports about what was happening. However, what came out from the Japanese government and authorities were presented using phrases like the following:

> *∼de-wa-nai-ka to omo-tte-ori-mashi-te,* thinking that (without subject)
> *∼to-yuu-hū-ni kii-te-ori-masu,* hearing something like that (without subject)
> *∼kana to omoi-masu,* wondering if (without subject)
> *∼to omowa-re-masu,* it seems that
> *∼wa hitei-deki-masen,* it cannot be denied
> *∼to-wa kangae-te-i-masen,* not thinking (without subject)
> *∼to-yuu koto-de-ari-masu,* it is
> *∼motomera-re-te-i-masu,* it is asked
> *∼kana-to yuu hū-ni omoi-masu,* wondering as if (without subject)
> *∼anzenda to omo-tte-ori-masu,* thinking that it is safe (without subject)
> *∼taisaku ga isoga-re-masu,* quick countermeasure is in need

From these expressions in NHK's report, it is difficult to identify the agent or person in charge and also to judge the reliability of the information. In Japanese, a statement can be made without an agent or by using a passive form. The Japanese language itself is imbued with "vagueness," possessing a wealth of vocabulary and expressions. A good writer, rather than express a clear message, defers its interpretation to the reader (Hinds, 1987). In contrast to this, Leggett (1966), a physicist and translator, pointed out that "the connection between politeness and vagueness is completely unknown in English." The strong influence of the native language has recently been ingeniously shown by Berzak et al. (2014) who showed that "cross-linguistic structure transfer is governed by the typological properties of the native language."

Today, in a global world, where information is to be shared with people from different backgrounds, clarity becomes of utmost importance. While the Japanese language is evolving to accommodate the movement toward globalization, there is a group of people for whom this trend needs to be accelerated. The scientists and engineers who publish their work for a global audience must very quickly master the communication skills needed for a wider international audience. In this study, we present an approach that should help Japanese researchers learn how to clearly report their work in scientific Japanese. Being able to do this is an important step toward presenting their work in English for a global audience.

2. JECPRESE

The Japanese-English Corpus of Science and Engineering (JECPRESE) was designed as a language support system for oral presentations delivered in Japanese and English. It comprises 51 Japanese presentations by engineering master's degree students and English presentations by 16 researchers at an international conference on aromatic compounds and by 54 undergraduate engineering students at an American university. Japanese student scripts of presentations were obtained with the permission of the students and their laboratories. They were checked against the recordings of the actual presentations. The English presentations were recorded with permission and transcribed. See Table 1 for the JECPRESE contents.

Table 1
Japanese-English Corpus of Presentations in Science and Engineering

Year	Discipline	English	Japanese
2003	Adaptive Machine Systems	0	30
2005	Biotechnology	0	39
2006	Materials	0	34
	Applied Chemistry	0	31
	Adaptive Machine Systems	0	13
	Electronics	0	13
	Chemistry COE	0	5
2007	Naval Architecture and Ocean Engineering	7	0
	Mechanical Engineering	0	69
	International conference on aromatic compounds	37	0
	Sustainable Energy and Environmental Engineering	1	0
	Biotechnology	4	0
2008	Sustainable Energy and Environmental Engineering	0	77
	Undergraduate engineering student conference at an American university	16	0
Total		65	311

3. Results and discussion
3.1. High-frequency words in scientific Japanese
Minami (2011) revealed that English-Japanese bilingual children's English vocabulary usage was highly correlated with their vocabulary usage in Japanese, and that academic language exacts a more cognitively demanding use of language. Of course, directly comparing child bilinguals and adult second-language learners is not appropriate due to possible differences in cognitive maturity. Likewise, comparing oral language proficiencies and written language skills may not be suitable. However, the facts that language characteristics can be traced to childhood origins and are also evident in other communication modes indicate how pervasive and ingrained they are. In the present study, we analyzed the lexical frequency of parts of speech units found in 109 Japanese presentations given by graduate students in chemical and mechanical engineering, as shown Tables 2 to 8. The results revealed that the top 10 high-frequency units comprise more than 90 percent of each part of speech. Presentations from different disciplines showed about the same numbers of units for most grammatical classes, suggesting that such units are basic to the language of science and technology, and that they are not field-specific, but also common in general Japanese.

Japanese has a variety of compound particles (Table 2) and their suitable choice and usage are difficult. A limited compound particle would enable the presentation of a clear message. As shown in Table 2, the verb "*mochiiru*" was frequently used, but mainly as "*mochii-te*," which is not considered to be a compound particle. This could suggest that new Japanese expressions are being created to deal with what is being expressed in English, especially for disciplines in science. (All example sentences below are from JECPRESE.)

Table 2 presents the fundamental verbs. In particular, "*kangaeru* with a helping verb suggests the subject and aspect.

sokode hon-kenkyū de-wa ～hōhō o kangae, sarani ～o kangae-mashi-ta.
(In this study, I/we thought about how to…, and that...)
To express what was considered in this research

sokode, kinō o kaimei-shi-tai to kangae-te-i-masu.
(I am now thinking about how to clarify...)
To express what should be done in the future

kinō-teki tokusei no hatsugen ga kangaera-re,
(it is considered that...)
To present opinion with clear evidence discussion

hakai ga okoru to kangaera-re-te-i-masu
(it has been considered that...)
To present a general view, i.e., give background information

    "Kangaeru" is just one case. Additional research is required in order to deepen our understanding of sophisticated words in science and engineering.

Table 2
High-frequency Compound Particles and Verbs in Engineering

Compound particles	3,753	Verbs (with the exception of verbal nouns)	22,409
ni yori (by)	995	*suru* (do)	7,886
ni tsui-te (about)	721	*naru* (become)	1,054
ni oi-te (at)	674	*mochiiru* (use)	927
to shi-te (as)	623	*shimesu* (show)	889
ni taishi-te (towards)	339	*okonau* (perform)	835
to yuu (that)	180	*dekiru* (able)	705
ni kanshi-te (on/around)	125	*kangaeru* (consider)	601
to tomo-ni (with)	50	*wakaru* (get it)	558
ni shitagai (following)	15	*eru* (obtain)	487
ni tsure (with)	8	*aru* (exist)	424
Others	19	*miru* (regard as)	259
		yoru (depend on)	196
		motomaru (equal)	167
		yuusu(ru) (have)	136
		Others	7,353
Top 10 particles by frequency / All compound particles	99%	Top 14 particles by frequency / All verbs	67%

    Tables 3 shows that the "*are/ano*" group of general Japanese is not used in science and engineering, while the plural words such as "*korera*" and "*sorera*" are frequently used. Japanese originally lacked distinctions between singular and plural, using instead numerous counting suffixes. However, in the scientific presentations, "*korera*" and "*sorera*" were used frequently. This change may have resulted from the influence of English usage.
    Table 3 shows that the pronoun "*watashi* (I)" appears 40 times and "*wareware* (we)" only 20. Our result may support Minami (2011), who claimed that in Japanese narrations, no child used pronouns, referring to subjects that have been established as the current topic with pronouns in English and zero anaphora in Japanese.

Table 3
High-frequency Pronouns and Adnominals in Engineering

Pronouns	1,932	Adnominals	3,101
kore (this)	481	*kono* (this)	2,051
kochira [this (way)]	443	*sono* (the)	633
korera (these)	315	*onaji* (same)	133
koko (here)	202	*ookina* (big)	99
sore (it)	193	*dono* (which)	65
sorera they)	68	*chiisana* (small)	62
izure (at some stage)	42	*aru* (certain)	18
watashi (I)	40	*saranaru* (additional)	10
dochira (which)	28	*nanrakano* (some)	8
soko (there)	24	*ikanaru* (whatever)	4
wareware (we)	20	*koushita* (this)	4
Others	99	Others	13
Top 11 pronouns by frequency/ All pronouns	96%	Top 10 adnominals by frequency / All adnominals	99%

Table 4
High-frequency I-adjectives and Na-adjectives in Engineering

I-Adjectives	1,976	*Na*-Adjectives	2,583
ookii (big)	319	*kanou* (possible)	241
takai (tall)	196	*dooyoo* (similar)	166
chiisai (small)	155	*hitsuyo* (necessary)	136
yoi (appropriate)	126	*antei* (stable)	135
nai (nonexistent)	96	*akiraka* (clear)	96
ooi (many)	87	*samazama* (various)	84
nagai (long)	84	*hijou* (extreme)	81
hikui (low)	71	*juuyou* (important)	75
tsuyoi (strong)	62	*omo* (main)	71
katai (hard)	46	*arata* (novel)	45
sukunai (less)	45	Others	1,354
atsui (thick)	40		
atarashii (new)	30		
Others	689		
Top 13 *i*-adjectives by frequency/ All *i*-adjectives	53%	Top 10 *na*-adjectives by frequency/ All *na*-adjectives	44%

High-frequency adjectives are listed in Table 4. These adjectives are common in Japanese, but their usage is difficult. Hayashi et al. (2010) has reported that "*takai*" is mainly used for describing property or ratio. General Japanese uses adjectives as follows:

sokudo ga hayai: "speedy" for movement
nōdo ga koi: "thick" for a liquid

However, in science and engineering "*takai*" is used as follows:

* *sokudo no takai ryōiki wa 2men ni hura-reru yōna bunpu ni nari-masu.*
     High-speed fields show two different distributions.
* *yōshitsu nōdo ga takai bubun ga kakunin deki-masu.*
     The presence of high-concentration solute can be confirmed.
These expressions (from JECPRESE) are likely to have arisen from the influence of English expressions such as "high speed" and "high concentration."
     Also, prefixes indicating an adjective are widely used.
 kōmitsudo no seikeitai ga era-re-mashi-ta.
   High-density formation was obtained.

Table 5 shows that the adverbs *"mazu, sarani"* are also widely used. However, in science and engineering they are used not as adverbs but as conjunctions. Verbal nouns (*suru*-verbs) and nouns are field-specific, and detailed lists can be prepared for each discipline. Here are some examples of verbs and nouns that are frequently used in chemical engineering, mechanical engineering, adaptive machine systems (T6-8). Much work remains to be done to examine not only the quantity but also the quality of words.

Table 5
High-frequency Adverbs and Conjunctions in Engineering

Adverbs	1,834	Conjunctions	2,518
mazu (first)	411	*mata* (also)	614
sarani (additionally)	243	*oyobi* (and)	328
tsugini (next)	97	*sokode* (therefore)	251
hobo (approximately)	86	*tsugini* (next)	236
hotondo (almost)	82	*soshite* (and)	182
mottomo (most)	77	*shikashi* (but)	143
jissai (actually)	62	*ippou* (on the other hand)	99
tokuni (especially)	59	*tsumari* (that is)	84
yori (more)	52	*soredewa* (so)	64
mattaku (at all)	34	*tatoeba* (for example)	47
yoku (often)	27	*nao* (besides)	31
Others	581	*aruiwa* (or)	20
		Others	445
Top 11 adverbs by frequency / All adverbs	67%	Top 12 conjunctions by frequency/ All conjunctions	83%

Table 6
High-frequency Suru-verbs and Nouns in Chemical Engineering

Suru-Verbs	9,784	Nouns	13,624
hannou-suru (react)	1,015	*sakutai* (complex atom)	358
seisei-suru (produce)	367	*bunshi* (molecule)	340
sanka-suru (be oxidized)	299	*shokubai* (catalyst)	294
shinkou-suru (progress)	223	*kassei* (activity)	228
gousei-suru (synthesis)	220	*hikari* (photo-)	205
kentou-suru (examine)	213	*kouzou* (structure)	198
kenkyuu-suru (research)	209	*tanso* (carbon)	181
ketsugou-suru (couple)	208	*kishitsu* (substrate)	129
sentaku-suru (select)	202	*keikou* (fluorescence)	128
hai-su (set up)	178	*kinzoku* (metal)	124
Others	6,650	Others	11,439
Top 10 *suru*-verbs by frequency / All *suru*-verbs	32%	Top 10 nouns by frequency / All nouns	16%

Table 7
High-frequency Suru-verbs and Nouns in Mechanical Engineering

Suru-Verbs	13,683	Nouns	21,503
kenkyuu-suru (research)	451	*ryuushi* (particle/grain)	341
keisan-suru (calculate)	353	*jouken* (condition)	329
kakou-suru (process / work)	331	*zu* (figure)	302
jikken-suru (experiment)	321	*netsu* (heat)	236
seigyo-suru (control)	220	*shisutemu* (system)	222
setsumei-suru (explain)	211	*houkou* (direction)	218
henka-suru (change)	199	*jiku* (axis)	215
hassei-suru (occur)	184	*sokudo* (velocity)	197
eikyou-suru (affect)	173	*kougu* (tool)	196
kaiseki-suru (analyze)	168	*moderu* (model)	182
Others	11,072	Others	19,065
Top 10 *suru*-verbs by frequency/ All *suru*-verbs	19%	Top 10 nouns by frequency/ All nouns	11%

Table 8
High-frequency Suru-verbs and Nouns in Adaptive Machine Systems Presentations

Suru-verbs	5,701	Nouns	8,639
gakushuu-suru (learn)	164	*hyoumen* (surface)	168
kenkyuu-suru (research)	156	*robotto* (robot)	167
kesshou-suru (crystallize)	151	*ondo* (temperature)	145
keisan-suru (calculate)	136	*zairyo* (material)	138
soshiki-suru (organize)	132	*moderu* (model)	126
youyuu-suru (melt)	118	*nano* (nano-)	122
henka-suru (change)	103	*netsu* (heat)	118
jikken-suru (experiment)	95	*keijou* (shape)	97
kaiseki-suru (analyze)	83	*genshi* (atom)	91
gyouko-suru (congeal)	80	*tokusei* (property)	85
Others	4,483	Others	7,382
TOP 10 *suru*-verbs by frequency/ All *suru*-verbs	21%	TOP 10 nouns by frequency / All nouns	15%

3.2. "*Wa*" compared with subject

The passive has usually been considered as one of the principal means of achieving impersonality in a text, as it enables the removal of any explicit agency. It has therefore often been presented as a structure particularly suitable for scientific writing (Rowley-Jolivet & Thomas, 2005). In the case of Japanese, Minami (2011) suggested that the lack of many pronouns and the extensive use of nominal ellipsis make it quite different from English. In English, the voice is kept constant (e.g., using the active voice throughout) by changing the subject. In Japanese, on the other hand, the subject is kept constant by switching from the active voice to the passive voice. Minami (2011) claimed that keeping the subject constant (along with subject omission) is an effective or even sophisticated strategy, and the distribution of English pronouns and that of Japanese ellipses are similar.

This study revealed that impersonality in Japanese can be expressed without agent or passive by using the "*wa*"-structure as follows:

(1) *hon-kenkyū wa* ～*okonai-mashi-ta.*
    (did this study…) not passive, without agency
(2) ～*chizu wa* ～*mappu o mochiite hyōki-shi-te-i-masu.*
    (the map shows, using ~ a map) not passive, without agency
(3) *atsuen wa* ～*mokuteki de okonai-mashi-ta.*
    (did the rolling for the purpose of…) not passive, without agency

The basic Japanese sentence structure is topic–comment, and the subject or object of a sentence need not be stated if it is obvious from the context. As a result of this grammatical permissiveness, there is a tendency to gravitate

towards brevity; Japanese speakers tend to omit pronouns because they can be inferred from the previous sentence and are therefore understood. Unfortunately, in English, this can lead to the lack of a sense of subject or sentence structure.

3.3. Tense and aspect

The Japanese language is characterized by visual concepts that are highly context-specific in terms of both time and space. The emphasis is "on-the-spot" personal experience, and Japanese verbs are conjugated to show only two tenses: past and non-past, with the latter being used for the present and the future. For verbs that represent an ongoing process, the *–te-i-ru* form indicates a continuous (or progressive) aspect, similar to the suffix *ing* in English. For others that represent a change of state, *-te-i-ru* form indicates a perfect aspect. For example, *kite-i-ru* means "He has come (and is still here)," but *tabete-i-ru* means "He is eating."

   Sentence (1) below would be equivalent to the *ing* form in English, whereas sentence (2) would be the perfect aspect.

   (1) *sokode, kinou o kaimei-shi-tai to kangae-te-i-masu.*
        Thus, we are thinking about clarifying the function.
   (2) *hakai ga okoru to kangaera-re-te-i-masu*
        It has been thought that destruction occurs.

The perfect aspect is not considered to exist in Japanese. However, the "*-naru*" expression is used to suggest the result of a change, in other words, the perfect aspect.

   (3) *OM-zō chū de kuroku mieru ten ga boido ni nari-masu.*
        Here, the black point in the OM image turns the void.

Minami (2011) claimed that the Japanese perfective aspect, unlike its English counterpart, has the pragmatic characteristic of expressing the idea that the results of an action cannot be reversed and/or something happened unexpectedly, so it serves wider linguistic functions than the English perfective aspect.

   With respect to verb tense in general Japanese, explanations are expressed using "*tame*" after the verb present form to express aim while "*tame*" after the verb past form means cause/reason:

   Tōkyō e iku tame kisha ni nori-mashi-ta.
      I took a train to go to *Tōkyō*.
   Tōkyō e it-ta tame ki-masen-deshi-ta.
      As he went to Tokyo, (he?) didn't come.

In Japanese, after something has happened and then something else occurs, the former may be considered to have caused the latter in such a sentence. However, in scientific Japanese, the mechanism needs to be explained, thus, "*tame"* after the verb in present form should mean cause/reason:

> *hyōmen sō nomi o shori-suru tame, yori sukunai tōnyū enerugī de sumu.*
> If only the surface layer is treated, it would be take less energy.

This is another example of how the usage of scientific Japanese has been influenced by English.

3.4. Discourse organization

According to Minami (2002, 2011), from early childhood on, Japanese people learn specific discourse styles in the cultural context or situation in the process of language acquisition. Japanese narrators include more emotional terms or affective statements in their narratives than English narrators who tend to emphasize more logical orientations.

In our corpus, we observed the academic IMRDC (Introduction, Methods, Results, Discussion, Conclusion) discourse style. As students were well trained in their laboratories for presentations in the IMRDC discourse style, we could not examine the students' own discourse sense with our corpus. As one of the aims of this study was to examine the discourse strategies used by Japanese students, we devised another way to observe their sense of discourse organization. Described next is a test using the structure of an e-mail message.

3.4. 1 Examining e-mail message structure

The original e-mail message was from the Japanese Language Aptitude Test 2009-2, level 3.

Table 9 shows the discourse of an e-mail structure in Japanese, which is considered to be the accepted order as it is the correct exam response. We conducted a study on the positioning of an opinion statement in the e-mail message. The sentences were scrambled and the examinees were asked to put them in the order that they thought was appropriate. The main opinion statement is "*eigo o tsukatte sukina-koto o sure-ba benkyō ga tanoshiku-nari-masu-yo.* (Studying will be fun for you, if you do something interesting using English.)", which we labeled "l".

Table 9

Example From the Japanese Language Aptitude Test 2009-2, level 3

Mondai 4 tsugi no bun o yon-de shitsumon ni kotae-nasai. Kotae wa 1, 2, 3, 4 kara ichiban ii mono o hitotsu erabi-nasai.	Q. Read the sentences below and answer the question. Choose the best one from 1, 2, 3, and 4.	
(Jon-san wa takeshi-kun no chūgakkō de eigo o oshie-te-i-mashi-ta. Tsugi no bun wa Jon-san kara Takeshi-kun e-no meiru desu.)	John was teaching English at Takeshi's junior high-school. This is a mail from John to Takeshi.	
Takeshi-kun	Dear Takeshi	c
meiru arigatou.	Thank you for your mail.	o
mae no meiru ni "eigo no benkyō wa tsumara-nai" to kaite-ari-mashi-ta ga, mazu sukina koto kara hajime-tara dō-desu-ka.	You wrote "Studying English is boring," in your mail. How about starting your favorite ones first?	i
boku ga nihongo no benkyō o hajime-ta-no wa chūgaku 1nen no toki desu.	I started studying Japanese when I was in junior-high 1st.	a
tomodachi no ie de hajime-te nihon no manga o mimashi-ta.	The first time I saw a Japanese *manga* was at my friend's house.	e
sono toki wa nihongo ga zenzen wakara-naka-tta-no-desu ga, e ga aru kara hanashi wa daitai wakari-mashi-ta.	At that time I couldn't understand Japanese at all, but recognize the story by pictures.	j
nihongo de yome-ru-yōni-nari-tai to omo-tte, jibun de benkyō o hajime-mashi-ta.	Because I wanted to read Japanese *manga*, I started to study Japanese by myself.	b
kanji wa muzukashika-tta-desu ga, manga o nan-satsu mo yon-de-i-tara, kanntanna kanji wa oboe-te-shimai-mashi-ta.	*Kanji* is difficult, but I could memorize easy *kanji* characters after reading many *manga* books.	g
mannga wa yoku-nai to-yuu hito mo i-masu ga, donnna-mono ni mo ii-mono to warui-mono ga aru to omoi-masu.	Some people say *manga* is not good, but I think that depends on the *manga*.	d
dakara, manga mo era-n-de yome-ba ii to omoi-masu.	So, it's better to choose the *manga* to read.	p
hito o ijimeru-yōna manga wa yoku-nai-desu ga, sakka-ya basukettobōru nado supōtsu no manga wa omoshiroi-shi, yomu-to genkini-nari-masu.	*Manga* about bullying others is not good, but those of soccer or basketball are so interesting that people feel fine after reading.	f
takeshi-kun wa nani ni kyoumi ga ari-masu-ka.	What are you interested in?	h
ongaku desu-ka, eiga desu-ka.	Music or movies?	k
( )		l
ja, mata meiru shi-masu.	I will write to you again.	m
jon	John	n
50. ( ) ni-wa nani o ire-masu-ka.	**50 What would you put in the brackets?**	
1. eiga ga kirai demo mainichi mire-ba wakaru-yōni nari-masu-yo.	1. If you watch the movie every day, you can understand it even if you do not like it.	
2. nihongo no manga o yome-ba, kanji ga oboe-rareru-yōni nari-masu-yo.	2. If you read *manga* in Japanese, you can learn *kanji* easily.	
3. mainichi renshū-sure-ba, sakka ya basukettobōru ga jōzuni nari-masu-yo.	3. If you practice every day, you will be good at soccer or basketball.	
4. eigo o tsukatte sukina-koto o sure-ba benkyō ga tanoshiku-nari-masu-yo.	*4. Studying will be fun for you, if you do something interesting using English.*	

As stated previously, Japanese has been labeled a "reader-responsible" language (Hinds, 1987), because the writer does not presume to impose his/her opinion upon the reader. In contrast, as English is a "writer-responsible" language (Hinds, 1987), the writer's opinion is stated as soon as possible, and then clearly supported in order to present a clear message. To find whether or not Japanese students and those with other language backgrounds would show a preference for the location of an opinion statement in a text, we had 478 Japanese and 60 international students studying at Japanese universities respond to the scrambled e-mail message exercise. To examine the perceptions of text organization, we asked students to rearrange the e-mail text based on what they considered would be appropriate for the message.

Here, let us focus on the following sentence that expresses the main opinion and advice. Students were asked where they would place the opinion statement in this Japanese e-mail message, i.e., near the beginning or the end of the text. Figure 1 shows where it was placed in the text by Japanese and international students. In the acceptable Japanese e-mail, this opinion statement would be located toward the end, and the overall sentence order aims at sharing the situation, and then gradually expressing opinion in a spiral manner with the aim of attaining agreement in the end. Thus, the main assertion comes at the end.

Interestingly, international students who had mastered Japanese gave responses that matched those of the ideal exam response. In contrast, Japanese students majoring in science and engineering showed a tendency to write their opinion first. American, European and Chinese students (all studying Japanese) also tended to declare their opinion first. On the other hand, students from Vietnam, Laos, Israel, and Russia chose to place the opinion statement last.
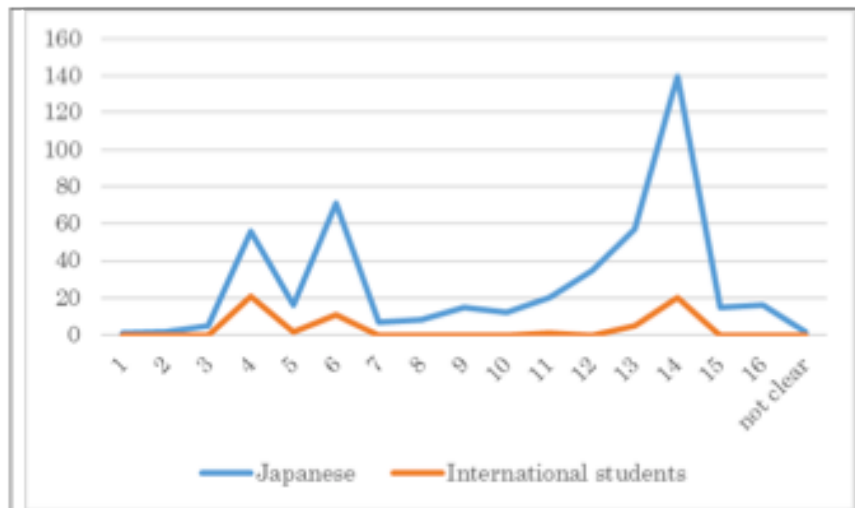
Figure 1. Perceptions of discourse organization in a Japanese e-mail message by Japanese (*n* = 478) and international students (*n* = 60).
 "l: *Studying will be fun for you, if you do something you like using English.*"

Although further work needs to be done, the results from this experiment suggest cultural differences in communication styles. When people with different communication cultures try to communicate with each other, care needs to be taken to avoid misunderstanding.

4. Discussion
4.1. Traditional Japanese
The Japanese desire for consensus decisions and avoidance of personal confrontation is well known (Doi, 1981). Presenting suggestions or illustrations take precedence over sharp, clear statements. Vague consensus can maintain *wa* (good relationship for harmony). If circumstances change, vague agreements can be subject to various interpretations that can end in misunderstanding. The "*honne-tatemae* (one's real intention and what one says on the surface)" divide remains important in Japanese society (*The Economist*, 2013). Of course, this communication style can have its advantages, as pointed out by Nonaka, Takeuchi, and Takeuchi (1995, pp. 14-15):

> *Ambiguity can prove useful at times not only as a source of a new sense of direction, but also as a sense of alternate meanings and a fresh way of thing about things. In this respect, new knowledge is born out of chaos.*

> *People do not just receive new knowledge passively; they interpret it actively to fit their own situation and perspective. Thus what makes sense in one context can change or even lose meaning when communicated to people in a different context. As a result, there is continual confusion as new knowledge is diffused in an organization.*

Thus, language can be considered to have two aspects, one to send and receive information and the other to form relationships with other people. In the case of the Japanese language, the latter seems to take precedence over the former.

4.2. Scientific Japanese
Following Minami (2011), a considerable amount of vocabulary is acquired via the primary language in the preliterate stage, and academic language requires more and more cognitively demanding use of language. In this study, we have suggested the need for sophisticated vocabulary usage in order to avoid ambiguity in science and engineering. In the case of the language of science, the transmission and receipt of information is of the utmost importance. Thus, problems could arise if a Japanese-language user approached an information

exchange situation without an awareness of its requirements, especially if the information could become available, through translation or interpretation, to an international audience. As we have pointed out above, some such problems with miscommunication occurred after the Tōhoku earthquake and tsunami disaster.

Our analyses of the features of Japanese have revealed features that can be obstacles to the clarity of information transmission. Leggett (1966) advised Japanese scientists to "make sure that your argument runs as a logical sequence and that no essential steps are left unwritten, be as precise, unambiguous and explicit as you can, and don't hesitate to state your conclusions boldly and definitely." Even with a cultural background emphasizing a harmonious community, Reischauer (1978) pointed out that "The Japanese language itself is fully up to the demands of modern life." Scientific Japanese must be able to present clear messages to a professional discourse community and also to an international audience.

What we would like to propose is active education in academic writing and presentation skills that can incorporate clarity and assertion into the texts that are produced. The examples presented above offer suggestions as to how this is beginning to occur in scientific Japanese and in the manner in which younger Japanese speakers communicate. The fact that students who receive presentation training in their laboratories displayed the opinion-first discourse style in the e-mail message structure shows that younger Japanese speakers can adapt to using scientific Japanese.

Our comparative analyses revealed that to promote efficient sharing of information with people of different backgrounds, scientific Japanese has adapted by:

1. paying attention to the rhetorical organization of a text;
2. changing the topic-comment structure to a subject-predicate structure;
3. changing the verb tense and aspect from expression of a personal to one of an objective stance;
4. changing ambiguous particles to definitive compound particles, and investigating Japanese relative clauses, pronouns, and adverbs;
5. changing personal impression to objective expression based on the evidence.

Such changes lead to a form of Japanese that is more suitable for professional discourse and can expand the horizons of what can be expressed by Japanese.

4. Conclusion

The Japanese language is considered to be conducive to valuing group communication over information transmission. This is realized by various structures that imbue the language with a "vagueness" that allows for multiple interpretations according to the situation. While being valuable for maintaining a harmonious community, such a communication style can be problematic in situations where information transmission becomes paramount. This can be in

crisis situations as well as in the transmission of knowledge in science and engineering, where clarity becomes essential. We have tried to show how Japanese can be used with minimization of vagueness and that there is evidence of changes in the Japanese language to make possible the embracing of this new type of communication style.

In Japan, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) launched the "Global 30" project to encourage universities to offer undergraduate and graduate programs taught completely in English to attract more international students (MEXT, 2009). However, we hope that the Japanese language will continue to develop and progress in response to new demands as the circumstances of use change. Only in this way can Japanese retain the robustness to express everything from delicate literary expression to precise scientific expression to aggressive business expression.

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