intractable pain, phantom limb pain, neuropathic pain, and in the management of postoperative pain in sub-anesthetic doses (Stannard and Porter, 1993; Roytblat et al., 1993; Nikolajsen et al., 1996). In the present study, low doses of ketamine suppressed pain-SEFs and pain sensation. In addition, after ketamine administration, the mean latency of 1 M components following pain stimuli carried by Aδ fibers was significantly slower than that before administration (Figs. 4 and 5). These results indicate that inhibition of glutamate-induced excitatory postsynaptic potential elicits delayed onset of spike discharge due to the slow activation time course of the potential. Thus, ketamine suppresses NMDA receptors mediating excitatory synaptic transmission in the trigeminothalamic tract, thereby preventing pain-related neuronal activity from reaching the cerebral cortex, and finally exerting an analgesic effect. We propose that, in this manner, intravenous administration of a low dose of ketamine was effective in suppressing perception of pain conveyed via Aδ fibers from the orofacial area. In the present study, fentanyl, a μ-opioid receptor agonist, elicited no reduction in pain-SEFs or VAS scores (Figs. 4 and 5), although administered by bolus injection in a 100 μg dose, which, clinically speaking, should be sufficient to obtain an analgesic effect. The μ-opioid receptors are presynaptically located on C fibers and inhibit release of neurotransmitters via blocking calcium channels of the presynaptic terminal, thereby providing analgesic action (Taddese et al., 1995). Therefore, one possible explanation as to why fentanyl failed to affect CO_2 laser-induced pain sensation or SEFs here is that this type of pain is mediated mainly by Aδ fibers rather than C fibers. An alternative possibility is that C fiber activity elicited by CO_2 laser stimulation was substantially suppressed by concomitant activation of Aδ fibers, as reported in previous studies (Kenton et al., 1980; Bromm, 1984).

In conclusion, the SII cortex was activated in an intensity-dependent manner by the application of noxious stimulation to trigeminally innervated skin. This suggests that it participates in pain perception and differentiation of stimulus intensity. Ketamine suppressed magnetic response to pain stimulation. We propose that ketamine inhibits NMDA receptor-mediated neurotransmission in a pathway conveying pain information to the cerebral cortex via Aδ fibers, thereby exhibiting analgesic properties. On the other hand, fentanyl, acting via opioid receptors, was ineffective for Aδ fiber-mediated pain. These results suggest that ketamine is efficacious for Aδ fiber-mediated pain from the trigeminal nerve-innervated mandibular region, whereas opioid receptor antagonists, such as fentanyl, are not.

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Research report

Cognitive neuropsychological and regional cerebral blood flow study of a Japanese–English bilingual girl with specific language impairment (SLI)

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ABSTRACT

We report here on an investigation into the possible factors which might have contributed to language impairment (LI) in EM, a 14-year-old Japanese–English bilingual girl. EM was born in the UK to Japanese parents with no other siblings, and used English to communicate with all other people except for her parents. A delay in her English language development was identified at primary school in the UK, which was attributed to her bilingualism. The deficiency in her English language skills persisted into her adolescence despite more than adequate educational opportunities (including additional language support). At the start of her secondary education, language ability/literacy attainment tests were conducted in both English and Japanese, and the results suggested specific language impairment (SLI) in both languages. Further, her brain Single Photon Emission Computed Tomography (SPECT) revealed significantly lower Regional Cerebral Blood Flow(rCBF) in the left temporo-parietal area, which is also similar to the area of dysfunction often found among Japanese individuals with SLI.

1. Introduction

Approximately half the children in the world are exposed to more than one language (e.g., De Houwer, 1995). However, the literature on bilingual development is very limited in comparison to the literature on second language learning in terms of both the number of studies reported and the number of subjects per study (Hoff-Ginsberg, 1997). An often addressed question on bilingual development is whether bilingual children demonstrate a developmental delay in each language compared with monolingual children. Some studies have supported the idea that there is a significant developmental

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language delay in bilingual children (e.g., Rosenblum and Pinker, 1983; Umbel et al., 1992). For example, Rosenblum and Pinker (1983) found that bilingual children aged five and over had smaller comprehension vocabularies in each of their languages than age-matched monolingual children. However, Pearson et al.'s (1993) longitudinal study following bilingual and monolingual children from the age of 8 months to 30 months revealed that the bilingual children had comprehension vocabularies in each language comparable to that of monolinguals. Hoff-Ginsberg (1997) therefore argued that bilingual development might cause some delay in the development of each language but not so much as to cause these children to be outside the normal range of variation in the rate of language development.

Bishop (1997) has extensively discussed abnormal monolingual language development, in particular children with specific language impairment (SLI). In brief, SLI is defined as a disorder in the development of language despite adequate educational opportunities and normal intelligence. It requires a significant discrepancy between the child's verbal and nonverbal abilities in the absence of any additional disorders (e.g., mental retardation or autism) (e.g., Bishop, 2001; Williams et al., 2000; Botting and Conti-Ramsden, 2003). Most children with SLI are poor at acquiring new vocabulary, which is reflected in their performance on tests for receptive vocabulary. For example, research on incidental learning of word meanings revealed that children with SLI understood fewer new words than age-matched normal controls after a few brief exposures to the new words in the naturalistic context of a television program (Oetting et al., 1995). Gleitman (1994) postulated the following process for the acquisition of new vocabulary in children: (1) the acquisition of knowledge of the concepts that words express, (2) the extraction of phonological patterns from incoming speech, and (3) the mapping of (1) and (2), that is, mapping each concept to a phonological pattern. Conceivably, poor word learning in children with SLI may be linked with a deficit at one of these processing stages. Bishop (1997) argued that deficient vocabulary learning in children with SLI is not attributable to abnormal conceptual development or lack of symbolic representation. Rather, it is attributable to poor phonological perception and memory in these children. This is because vocabulary acquisition depends on the setting up of long-term phonological representations in the lexicons, and phonological representations in these children's lexicon may be under-specified.

More recently, research into language impairment (LI) or SLI in bilingual children started to emerge, although the numbers are still few. Hakansson et al. (2003) revealed for example that Swedish–Arabic children with LI developed both languages "in the same implicational way" (Salameh et al., 2004, p. 66) as those bilingual children without LI, but showed slower development in both languages. Salameh et al. (2004) in their longitudinal study followed the grammatical development of Swedish–Arabic bilingual children with LI and normal children (aged between four and seven) for 12 months. Their results also confirmed that their children both with and without LI developed grammatical structures in both languages in the same implicational way. However, it was found that the children with LI seemed to be more vulnerable to language exposure. They were more affected by lack of the language exposure than the bilingual children without LI. Moreover, Paradis et al. (2003) compared French–English bilingual SLI children (mean age = 6:11) with age-matched monolingual French and English SLI children, and found that these bilingual and monolingual children both showed a difficulty in processing grammatical morphology to the same extent. Paradis et al. (2003, p. 123) therefore concluded that "their dual language knowledge was not causing them to have different patterns in this domain of morphosyntax than monolinguals".

Further, Bishop (1997) also discussed etiological factors in SLI (albeit in monolinguals), including the language environment, genetics and neurobiology. She argued that genetic factors have been strongly implicated in the etiology of SLI. For example, the concordance of SLI among monozygotic twins is said to be almost 100% (Bishop et al., 1995). Similarly, Plante (1991) argued that developmental language disorders such as SLI are biologically transmittable, as her study revealed family aggregations of SLI.

Ors et al. (2005) considered identifying neurobiological features for SLI as one of the main lines of SLI research and cited studies of morphometric analyses of magnetic resonance imaging (MRI) (e.g., Plante, 1991; Plante et al., 1991) or studies using functional imaging techniques such as single photon emission computed tomography (SPECT) and positron emission tomography (PET) (e.g., Saper et al., 2000). For example, Plante et al.'s (1991) morphometric study with MRI revealed an atypical perisylvian asymmetry in SLI children – the asymmetry was seen by an atypically larger right perisylvian area compared to normal controls, while the left perisylvian area was of the same size as that of the normal controls. Plante (1991) further stated that for the majority of normal controls the asymmetry was seen with the left perisylvian area it being greater than that of the right. Plante et al. (1991, p. 63) thus argued that the atypical perisylvian asymmetry in the SLI children might be due to the brain's "overproliferation of neurons that migrate out to the cerebral surface" during its development, and a possible "failure of regressive events which occur late relative to the prenatal developmental course of the affected region".

In SPECT/PET studies, it has been shown that there is a linear relationship between local changes in the cerebral blood flow (CBF) and glucose consumption, thus indicating local neuronal activity (Saper et al., 2000). Ors et al. therefore argued that there are morphological and functional differences in children with SLI compared to children without SLI.

Ors et al. (2005) using SPECT compared the regional cerebral blood flow (rCBF) of children with SLI and children with attention deficit hyperactivity disorder (ADHD), and found that the SLI children had symmetrical rCBF values in the left and right temporal areas whereas the ADHD children showed a typical asymmetry with the left temporal region predominant. Further, SLI children showed lower rCBF values in the right parietal as well as the subcortical regions, while the ADHD children showed symmetrical rCBF values in these areas. Both ADHD and SLI children, however, revealed lower rCBF values in the right frontal area compared to the left frontal area.

Researchers in Japan have also investigated these neurobiological abnormalities in Japanese SLI children using SPECT

(e.g., Uno et al., 1997, 1999; Haruhara et al., 1999), and have reported abnormalities in the rCBF in the left temporo-parietal regions, that is, the rCBF values in the left temporo-parietal regions were significantly reduced compared to those of the right.

Moreover, Jodzio et al. (2003) asserted that rCBF SPECT has a significant contribution to neurolinguistic research, although their patients were all neurological patients with left-hemisphere cerebral vascular accidents (CVAs).

They revealed a significant correlation between the language processing abilities (measured by BDA – Boston Diagnostic Aphasia Examination) of 50 neurological patients with left-hemisphere CVAs with a wide range of pathologies, and rCBF SPECT imaging. In particular it was found that the most prominent deficits in Wernicke's aphasia were found in the left temporal and parietal areas. Wernicke's aphasia is characterized as a receptive language aphasia with comprehension deficit.

In the present study, we report on a case study of a Japanese–English bilingual adolescent girl residing in the UK, whose behavioral data in both Japanese and English suggested that she might have SLI. Her brain SPECT also indicated that the etiology of her SLI might be due to neurobiological functional deficit rather than language environment. Parental consent for publication of the case notes/data was obtained.

2. Case report

The patient, EM was 14 years old at the time of assessment. She was born in the UK as the only child of Japanese parents who own a business in the UK. She was initially left-handed as was her father, but is now more right-handed. Her handedness changed from left to right when her puberty set in. She now uses her right hand for scissors, chopsticks, and pencils and is ambidextrous for throwing balls, threading needles and using knives (personal communication with EM's mother). Her early developmental history was normal, and she was a healthy child. She had no problems with hearing.

Her first language was Japanese, which is spoken at home, and she started to learn English at the age of four when she started attending a private English nursery school. She subsequently attended a private English primary school and a Japanese Saturday school in order to maintain proficiency in Japanese. English became dominant once she started her education in English schools. She is now a weekly boarder at a private boarding school in the UK. She goes to Japan during school holidays (at least once a year) to see her grandparents and cousins, and converses with them in Japanese.

At the age of 8/9 years EM's mother first became aware that EM was struggling with reading and writing in English as well as in Japanese (although she had much less opportunity to read and write in Japanese). Her mother initially suspected that EM might be dyslexic, and consulted EM's school counselor. The counselor maintained that her problems were related to EM's bilingualism, and that they would resolve in time, especially if she were encouraged to use English at home. As her parents felt unable to provide an English language environment at home, they decided to send her to a private boarding school at the age of 11 years. However, the problems persisted despite the extra curricula support including an English for Speakers of Other Languages (ESOL) course, and her mother decided that EM should be assessed professionally for her English and Japanese language development when she was 14 years old. At this stage her mother's main concern was whether EM might be dyslexic.

3. Assessments

Due to the availability of the appropriate examiners and the types of assessment tests, the assessments in English took place in the UK on 3rd July, while the assessments in Japanese took place in Japan on 27th July within the same year.

4. Assessments in English

An English cognitive/educational psychologist who assessed EM's English language development wrote: "... When she first started school, she understood English less well than Japanese. At the age of eleven, the decision was made to enroll her at an English boarding school (as a weekly boarder) so that she could be supported with her English. Here she receives English for Speakers of Other Languages (ESOL) support. She now feels happy with her general understanding of spoken English, although she sometimes has difficulty with vocabulary when she is reading. Both she and her teachers at school are aware that, in addition to poor spelling and punctuation, she lacks organization skills in her writing ...".

A summary of EM's results on the standardized ability and literacy attainment tests (Matrix Analogy Test (MAT), British Picture Vocabulary Scale (BPVS), Wide Range Achievement Test (WRAT3) – Spelling, Wide Range Achievement Test (WRAT3) – Word Reading, and WORD Reading Comprehension) is given in Table 1.

Table 1 shows that EM's performance on the MAT and reading (the stimuli from WRAT3) was average, while her performance on comprehension tests (BPVS and WORD Reading Comprehension) as well as spelling (the stimuli from WRAT3) was below average. Thus these tests revealed that EM has a comprehension deficit.

Table 1 – Standardized ability and literacy attainment tests in English

Test	Age equiv.	Standard score	
MAT		102	Average
BPVS	11y10m	82	Below average
WRAT3 Spelling	10y6m	82	Below average
WRAT3 Word Reading	13y6m–14y6m	98	Average
WORD Reading Comprehension		81	Below average

85–115 – Average (high average: 100–115; low average: 85–100).
70–84 – Below average (expected from 14% of the population).
70 – Low (expected from 3% of the population).

Table 2 – English language tests

Test	Standard score
TOAL	
Listening Grammar	75 Below average
Speaking Vocabulary	75 Below average
Reading Vocabulary	95 Average
Reading Grammar	90 Average
Writing Vocabulary	64 Low
Writing Grammar	75 Below average

85–115 – Average (high average: 100–115; low average: 85–100).
70–84 – Below average (expected from 14% of the population).
70 – Low (expected from 3% of the population).

Results of the Test of Adolescent and Adult Language (TOAL) including Listening Grammar, Speaking Vocabulary, Reading Vocabulary, Reading Grammar, Writing Vocabulary, and Writing Grammar are summarized in Table 2.

The results revealed that apart from EM's scores on Reading Vocabulary and Grammar, which were within the normal range, her performance on Listening Grammar, Speaking Vocabulary and Writing Grammar was below average, while Writing Vocabulary was low (which is expected from 3% of the population). The results from the second tests in general suggest that she has a smaller vocabulary for her age.

The results of diagnostic tests for dyslexia including the Test of Word Reading Efficiency (TOWRE) and Phonological Assessment Battery (PhAB) are summarized in Table 3.

Table 3 shows that EM's performance on phonemic decoding efficiency was average but sight word and digit span efficiencies were low average. Her performance on the PhAB, however, was within average except for Spoonerisms, which was low average. It was revealed that phonemic decoding skills, which are often used as diagnostic tools for dyslexia, appear to be normal, hence suggesting that EM is not dyslexic.

Table 3 – Diagnostic tests for dyslexia in English

Test	Age equiv.	Standard score
TOWRE		
Sight word efficiency	12y3m	87 Average (low)
Phonemic decoding efficiency	13y9m	98 Average
Digit span memory test		88 Average (low)
PhAB		
Naming speed – pictures		97 Average
Naming speed – digits		102 Average
Fluency – alliteration		94 Average
Fluency – rhyme		98 Average
Fluency – semantic		103 Average
Spoonerisms		87 Average (low)

85–115 – Average (high average: 100–115; low average: 85–100).
70–84 – Below average (expected from 14% of the population).
70 – low (expected from 3% of the population).
TOWRE consists of sight word efficiency, phonemic decoding efficiency, and a digit span memory test.
PhAB comprises picture-naming speed, digit-naming speed, fluency in alliteration and rhyme, semantic fluency, and Spoonerisms.

5. Assessments in Japanese

Briefly the Japanese orthography consists of three qualitatively different scripts (see Wydell et al. (1995) for more details) – logographic Kanji characters, and syllabic Hiragana and Katakana characters as shown in Table 4. Kanji is used to transcribe nouns, root morphemes of inflected verbs, adjectives and adverbs, while Hiragana is used to transcribe grammatical morphemes (i.e., function words such as but, and, etc.), inflected parts of the verbs/adjectives/adverbs and a small number of nouns as well as low frequency/complicated Kanji characters. Katakana on the other hand is used to transcribe foreign loan words (e.g., T.V., or radio). Because of this, the frequency of occurrence of Katakana is in general lower than that of Kanji or Hiragana scripts.

Table 5 shows a summary of EM's results on the tests conducted in Japanese consisting of Wechsler Intelligence Scale for Children-III (PIQ),[2] Raven's Coloured Progressive Matrices (RCPM), reading/writing single Hiragana/Katakana characters and Hiragana/Katakana words, Standardized Comprehension Test of Abstract Words (SCTAW)[3] (Haruhara and Kaneko, 2003), Rey's Auditory Verbal Learning Test (RAVLT) (immediate recall and delayed recall), and arithmetic (addition and subtraction).

The results revealed that EM's performance on these tests was well within normal range including PIQ, except for writing Katakana characters ($z = -4.30$, $p < .0001$) as well as Katakana words (we stopped the test after presenting half the total number of the stimuli, as it was apparent that she was struggling), and SCTAW (with age-matched controls) ($z = -5.09$, $p < .0001$). The former results can be explained by her lack of exposure to the Japanese orthography, and the fact that the Katakana occurs in text less frequently than Kanji or Hiragana. We therefore do not necessarily think that her poor performance on Katakana writing was abnormal. In contrast, the latter results (i.e., her performance on the SCTAW) indicated that she had a severe comprehension deficit.

6. EM's SPECT

SPECT is known to be one of the most widely available functional brain imaging techniques (Ryding, 2003), and according to Jodzio et al. (2003) SPECT imaging is instrumental in the

[2] EM's VIQ in Japanese was not assessed, because EM (though she is Japanese) has been educated in English in the UK.

[3] SCTAW is a word and picture matching task, and the pictures are all picturable abstract concepts. Please see examples of pictures in the Appendix (e.g., for the target word, KYORYOKU (cooperation) there are two phonological distracters, KYOORYUU (dinosaur) and KYUSHOKU (school dinner); two semantic distracters, SHINSETSU (kindness) and AYASU (humouring a baby); and unrelated distracter, HIMONO (dried fish).

Table 4 – Characteristics of the Japanese orthography – Kanji, Hiragana and Katakana

Script	Word	WD-class	Pronunciation	English
Kanji	花束	Noun	hana-taba	Bouquet
Hiragana	りんご	Noun	ri-nn-go	Apple
Hiragana	しかし	Function word	shi-ka-shi	But
Kanji + Hiragana	美しい	Adjective	utsuku-shi-i	Beautiful
Kanji + Hiragana	忙しく	Adverb	isoga-shi-ku	Busily
Katakana	テレビ	Noun	te-re-bi	T.V.

identification of decreased blood flow, which may be functionally relevant to neuropsychological impairments.

7. SPECT data analysis

The SPECT scans were obtained using ^{99m}Tc-ECD on a SIEMENS E.CAM Gamma Camera. The CBF values were then measured from the SPECT scan data. Each single SPECT slice located 7–8 mm above the orbito-meatal line was examined for the CBF values. Standardized three-dimensional regions of interests (ROIs) were examined for the frontal, thalamic, temporal, parietal and occipital areas, as well as for the whole left and the right hemisphere. All measurements were performed by a radiology technician, who was naïve to EM's diagnoses and her conditions, at a hospital in Japan where one of the authors' works.

Fig. 1 shows EM's rCBFs obtained by SPECT where ^{99m}Tc-ECD was used as radioactive tracer.

Her brain SPECT revealed significantly lower rCBF in the regions of the left temporal and parietal lobes.

8. Discussion

Table 6 shows a summary table for the results of the tests in English and Japanese conducted on EM.

The results of the current study can be summarized as follows:

(a) EM's phonemic decoding skills, which are often used as diagnostic tools for dyslexia, were within the normal range, hence suggesting that EM is not dyslexic,
(b) EM had a language deficit, in particular a comprehension deficit, and difficulties in listening/writing grammar as well as a smaller vocabulary for her age in both English and Japanese languages compared to her same age peers, despite the additional ESOL support (unlike AS studied by Wydell and Butterworth, 1999 who was an English–Japanese bilingual with monolingual dyslexia in English),
(c) Her language deficit was not caused by general cognitive deficits as EM's WISC, MAT, and RCPM results were all well within the normal range (the latter two are often considered as easily administered IQ tests), and
(d) EM's brain SPECT revealed significantly lower rCBF in her left temporal and parietal areas.

These behavioral data both in the English and Japanese languages thus presented a typical SLI profile as defined by other SLI researchers (Bishop, 1997; Gleitman, 1994) rather than dyslexia or within the normal range of developmental language delay often expected for bilingual children (Hoff-Ginsberg, 1997; De Houwer, 1995). Most children with SLI are poor at acquiring new vocabulary (Gleitman, 1994; Oetting et al., 1995; Bishop, 1997). Although some studies on the acquisition/development of language in children suggest that there is some developmental language delay in bilingual children (Rosenblum and Pinker, 1983; Umbel et al., 1992),

Table 5 – ME's performance on IQ-score, RCPM, reading/writing, SCTAW, RAVLT, and arithmetic in Japanese

Tests	Score control (s.d.)	Score EM	Accra. (%)	
WISC-III PIQ (age-matched)		97		Low average
RCPM (age-matched)	33/36 (3.8)	33	91.70	Normal
Reading single Hiragana character	19.95/20 (.21)	20	100	Normal
Writing single Hiragana character	19.84/20 (.51)	20	100	Normal
Reading single Katakana character	19.98/20 (.15)	19	95	Normal
Writing single Katakana character	19.90/20 (2.07)	11	55	Below −2 s.d.
Reading Hiragana words	19.95/20 (2.6)	20	100	Normal
Writing Hiragana words	19.70/20 (1.9)	20	100	Normal
Reading Katakana words	19.90/20 (.2)	20	100	Normal
Writing Katakana words	19.40/20 (2.2)	7/10	40	Below −2 s.d.
SCTAW (age-matched)	28.3/32 (3.2)	12	37.5	Below −2 s.d.
RAVLT				
Immediate recall	13.0 (2.6) words	13 words	86.7	Normal
Delayed recall (30 min)	11.2 (1.9) words	11 words	73.3	Normal
Addition	4.9 (4.8)	5/5	100	Normal
Subtraction	4.8 (.6)	5/5	100	Normal

Control mean data are from the 6th Grade (11–12 yrs) of the Japanese primary school children ($n = 240$).
RCPM: Raven's Coloured Progressive Matrices.
SCTAW: Standardized Comprehension Test of Abstract Words.

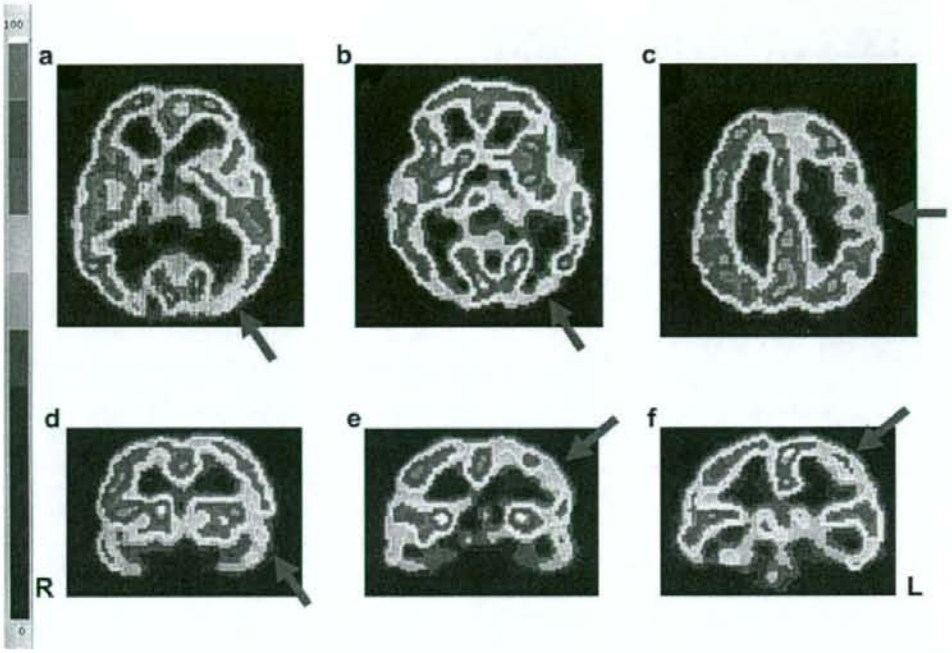

Fig. 1 – EM's brain SPECT (R = right side; L = left side). Horizontal section: (a), (b) and (c); Coronal section: (d), (e) and (f). A significant reduction in the regional cerebral blood flow (rCBF) (indicated by an arrow) can be seen in the left temporal lobe (a, b, d, & e) as well as in the left parietal lobe (c, d, e, & f) compared to the same regions in the right hemisphere.

Appendix – Examples of pictures from SCTAW.

Table 6 – A summary table for the results of the assessment tests in English and Japanese

English		Japanese	
General intelligence			
MAT	Average	WISC-III PIQ	Average (low)
		RCPM	Normal
Language development			
BPVS	Below average	Abstract Word Comprehension (SCTAW)	Below −2 s.d.
Speaking and listening			
Speaking Vocabulary (TOAL)	Below average		
Listening Grammar (TOAL)	Below average		
Reading and spelling/writing attainment			
Spelling (WRAT3)	Below average	Reading single Hiragana character	Normal
Word Reading (WRAT3)	Average	Writing single Hiragana character	Normal
WORD Reading Comprehension	Below average	Reading single Katakana character	Normal
Reading Vocabulary (TOAL)	Average	Writing single Katakana character	Below −2 s.d.
Reading Grammar (TOAL)	Average	Reading Hiragana Words	Normal
Writing Vocabulary (TOAL)	Low	Writing Hiragana Words	Normal
Writing Grammar (TOAL)	Below average	Reading Katakana Words	Normal
		Writing Katakana Words	Below −2 s.d.
Phonological processing ability and word reading fluency			
Sight word efficiency (TOWRE)	Average (low)		
Phonemic decoding efficiency (TOWRE)	Average		
Naming Speed – pictures (PhAB)	Average		
Naming Speed – digits (PhAB)	Average		
Fluency – alliteration (PhAB)	Average		
Fluency – rhyme (PhAB)	Average		
Fluency – semantic (PhAB)	Average		
Spoonerisms (PhAB)	Average (low)		
Digit span and recall			
Digit span memory test (TOWRE)	Average (low)	Digit span memory test (WISC-III)	Normal
		Immediate recall (RAVLT)	Normal
		Delayed recall (30 min) (RAVLT)	Normal
Calculation			
		Addition	Normal
		Subtraction	Normal

TOAL, Test of Adolescent and Adult Language; TOWRE, Test of Word Reading Efficiency; PhAB, Phonological Assessment Battery; WRAT3, Wide Range Achievement Test; SCTAW, Standardized Comprehension Test of Abstract Words; RAVLT, Rey's Auditory Verbal Learning Test.

recent general consensus suggests otherwise (e.g., Pearson et al., 1993; Hoff-Ginsberg, 1997; Hakansson et al., 2003).

Further, as discussed earlier, Paradis et al. (2003) in their study of French–English bilingual children with SLI (aged 6:11), and Salameh et al. (2004) in their longitudinal study of Swedish–Arabic bilingual children with SLI (from aged 4 to 10) both concluded that these children's bilingualism was not the cause of their SLI.

It is therefore reasonable to assume that EM's language deficit, in particular, comprehension deficit and difficulties in listening/writing grammar coupled with a small vocabulary might not be due to her being bilingual. Instead, we believe that EM's profile is commensurate with SLI, and also her profile is very similar to that of children with SLI depicted by other researchers (Bishop, 1997; Williams et al., 2000).

Bishop (1997, p. 43) further pointed out that the average child needs only "a small amount of verbal stimulation" for normal language development. Pinker (1984) also emphasized the robustness of language acquisition in normally developing children in the context of diverse environmental experiences. Thus, in the context of normal language development, a developmental deficit such as SLI can be identified while children are still young regardless of the language environment, be it monolingual or bilingual (Bishop, 1997; Paradis et al., 2003; Salameh et al., 2004). However, EM was already 14 years old when she was tested for her language deficit. Up until then, her deficit had always been attributed to her being bilingual.

Therefore rather than the language environment, i.e., bilingualism, genetic factors could be suggested as the etiology of EM's SLI (e.g., see Bishop et al., 1995 for their twin study). Robinson (1991) argued that SLI children often have a family history of a language disorder, and this view was echoed by Plante (1991). The only tantalizing evidence for a genetic link with EM's SLI is (as EM is an only child) that one of her male cousins is reported to be having similar language problems in Japan.

It is plausible, though the genetic mechanism is not well understood, that the timing of early neuro-developmental events such as neuronal migration might be disrupted (Lyon and Gadisseux, 1991). Other studies have suggested that SLI children have cytoarchitectonic abnormalities (Cohen et al., 1989).

Indeed EM's brain SPECT revealed significantly lower rCBF in her left temporal and parietal lobes, suggesting that SLI might be attributable to a neurobiological abnormality (though Ors et al., 2005 for SLI children's SPECT data showed a symmetrical rCBF in the left and right temporal regions). Uno et al.'s (1999) SPECT study reported the reduced rCBF in the left temporal area of six Japanese children with SLI. Haruhara et al. (1999) also examined the CBF of a Japanese boy (aged 11) with semantic–pragmatic deficit syndrome[4] using SPECT, which also revealed a similar abnormal blood flow in the left temporal area. They argued that the dysfunction of the left temporal lobe might have caused the deficit in his language comprehension.

As revealed by Jodzio et al. (2003), the neurological patients with the left-hemisphere CVAs, in particular, the patients with Wernicke's aphasia (a receptive language aphasia with comprehension deficit) revealed lower rCBF in the left temporal and parietal areas. They thus showed a significant correlation between the language processing abilities of these neurological patients and rCBF SPECT imaging. Thus the SPECT results reported by Jodzio et al. (2003), Uno et al. (1997, 1999) and Haruhara et al. (1999) were comparable to EM's SPECT results.

Finally, there is one more issue that we should discuss here, which is EM's shift in handedness from the left to the right in relation to potential influences on lateralization and language functions.[5] Annett (1996) argued that left-hemisphere language dominance is expected in about 80% of healthy individuals, and that about 20% have about a 50–50 chance of becoming either left or right-handed, thus explaining the 6–16% incidence of left-handedness and ambidextrality in the population.

Interestingly Siebner et al. (2002) investigated the long-term consequences of switching handedness using PET and a writing task (as a motor rather than language task). They found that natural right-handers showed predominant activation in the left parietal and premotor association regions during a right-hand writing task. In contrast, converted left-handers showed more bilateral activation in the right lateral premotor, parietal, and temporal cortex.

Moreover, Hoosain (1991) asked his Chinese–English bilingual converted left-handers (undergraduate students) to participate in a hemi-field word recognition task in Chinese and English. He found that switching handedness during childhood did not seem to affect lateralization of language functions either in Chinese or English, although he suggested that other motor functions might be affected.

[4] A semantic–pragmatic syndrome is thought to consist of fluent speech with normal syntax/prosody and poor comprehension, which sometimes leads to an inability to hold appropriate conversation.

[5] We are grateful to one of the reviewers to point out this important issue.

It is thus reasonable to assume that EM's language function might still be lateralized to the left-hemisphere, which in turn might not be functioning normally.

It is also reasonable to assume that her functional deficit was reflected in her SPECT with reduced rCBF in the left temporal and parietal regions.[6]

It is therefore more likely that EM's comprehension deficits, difficulties in listening/writing grammar and below average vocabulary development in both Japanese and English, when compared to same age peers, were attributable to her SLI rather than her language environment. However, we cannot discount the possibility that her bilingualism might have contributed to the clinical presentation of the data.

9. Conclusion

The present study was conducted in order to investigate the apparent delay in the development of both Japanese and the English languages in EM, a 14-year-old Japanese–English bilingual female. The research questions that we addressed in the study were (a) whether the delay in the development of both languages might be due to her being dyslexic, (b) whether this might be due to some environmental factors, in particular, her bilingualism, or (c) whether this might be due to some neurobiological factors. We used both behavioral and neuroimaging (i.e., SPECT) assessments. The behavioral data in both languages did not support the conjecture that EM might be dyslexic. The results instead indicated that EM might be SLI. The SPECT data revealed that rCBF in EM's left temporal and parietal regions was significantly lower than right equivalent areas, often seen in Japanese individuals with SLI. Thus

[6] One of the reviewers drew our attention to the study conducted by Mechelli et al. (2004) who have shown that grey-matter density in the inferior parietal cortex was greater in bilinguals than monolinguals, and that the effect was statistically significant in the left, though only a trend was observed in the right hemisphere. They further revealed that the effect was greater for early bilinguals than later bilinguals. It was also found that the grey-matter density was positively correlated with second language efficiency and negatively correlated with age of acquisition. Mechelli et al. thus demonstrated that the structure of the human brain can be changed by environmental factors such as the acquisition of a second language.It should be pointed out that there is no clear direct relationship between the brain's grey-matter density and rCBF. For example, Matsuda et al. (2002) investigated neurological patients with Alzheimer's Disease (AD), who underwent both structural MRI and SPECT. They found that the medial temporal areas showed a faster and more extensive reduction of grey-matter volume than of rCBF, while the rCBF reduction in a more posterior part of the associative temporal cortex was more apparent than the reduction in grey-matter volume. In general, however, if the grey-matter density decreases, rCBF also tends to decrease.Given that EM was an early-bilingual, EM's grey-matter density particularly in the left temporo-parietal area should also have been increased as with Mechelli et al's study, so that rCBFs in this area would also have been increased. The fact that EM's SPECT revealed a significant rCBF reduction rather than an increase tends to suggest that EM might have a genetic predisposition to show this effect. The environment (i.e., bilingualism) must have exasperated EM's weakness and exaggerated her SLI.

both the behavioral and neuroimaging data suggested that EM might be SLI. As to the etiology of her SLI, it is likely to be neurobiological in origin, however, we cannot discount an environmental contribution to the current clinical presentation of EM's language deficit.

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Short Report

Knowledge and impressions regarding the concept of mutation among Japanese university students

Ando N, Saito Y, Takemura K, Takada F, Iwamitsu Y. Knowledge and impressions regarding the concept of mutation among Japanese university students.
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Although the term *mutation* is frequently used in genetic counseling, it may carry negative connotations and create misunderstanding. Our objective was to investigate the relationship between the impressions regarding three Japanese terms *mutation of gene*, *change of gene*, and *lesion of gene* as well as to investigate the depth of understanding regarding mutation. A total of 175 university students and auditing students were included and responded to two questionnaires that were *Impressions regarding the term* in the semantic differential method and *Knowledge about the concept of mutation*. In factor analysis, three factors (Value, Change Rate, and Intention) were extracted. Participants were divided into three groups depending on their knowledge, and a two-way analysis of variance (Term × Knowledge Group) was conducted on the factor score for each. Results showed that the main effect of the 'Term' was significant for the Value Factor and that interaction was significant for the Change Rate Factor, and that the main effect of Knowledge Group was significant for the Intention Factor. The findings suggest that healthcare professionals should demonstrate an awareness of varying impressions of the different terms used to refer to the identical concepts of mutation. This is of particular importance when communicating with patients and their families.

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Key words: education – genetic counseling – health communication – knowledge – mutation – public understanding of science

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Significant new knowledge regarding the biological basis of heredity and the genetics of human traits has accumulated during the past 100 years. As discoveries continue to be made about genetic factors in diseases, it is anticipated that genetic-based medicine will become more routine in future clinical settings (1). With the development of medical genetics, geneticists and genetic counselors are increasingly providing genetic information to clients and helping them to adapt to the medical, psychological and familial implications of genetic contribution to disease (2) using unfamiliar technical terms.

It has been shown that medical and biological terms used in medical examinations are widely misunderstood by many lay people (3–6) and that this is also similar with genetic terms and concepts (7). The term *mutation* is frequently used in genetic counseling, but mutation is a complicated concept that may carry negative connotations. The primary meaning of mutation is 'the action or process of changing (8)'. This definition is neutral and simply means changing biologically and physically. However, through time, the term *mutation* has become increasingly negative in its connotations, particularly because of the general fear of nuclear radiation in the public mind and the direct association between this fear and genetic mutation (9). A study on the bias against the four terms *mutation*, *variation*,

alteration, and *change* has revealed that most people had a strongly negative bias against the term *mutation* that was perceived as being an unintended change, whereas the term *alteration* was perceived as being an intended change (10). The authors suggested that healthcare professionals avoided using the term *mutation* when informing patients and families that they, or their offspring, carried a disease-associated allele. In an Australian study, some participants found the term *mutant gene* offensive and suggested that the careful choice of words might reduce the risk of labeling and stigmatization as well as prevent unnecessary anxiety (11). These results have highlighted that the term *mutation* has a negative connotation and have suggested that healthcare professionals should demonstrate awareness when using the term *mutation*.

Our objective was to investigate the relationship regarding the impression of three Japanese terms *mutation of gene*, *change of gene*, and *lesion of gene* (all having a similar meaning in Japanese) as well as to investigate the depth of understanding regarding mutation.

Materials and methods

Participants

Participants were 193 students in the Faculty of Arts at Kitasato University and Social Psychology at Waseda University who participated voluntarily. Of these, 188 responded to our questionnaire. We excluded four participants who had healthcare professional experiences and nine who filled out the questionnaires incompletely. Therefore, a total of 175 undergraduate and auditing students were included in this study (male: $n = 62$, female: $n = 113$, age: mean = 19.8 years, SD = 3.0 years, and range: 18–54 years).

Questionnaires

Impressions regarding the terms

The three Japanese terms (*mutation of gene*, *change of gene*, and *lesion of gene*) were rated on 14 dimensions using a semantic differential scale with adjective sets (5-point scale). Before preparing the questionnaire, 18 lay people and 7 healthcare professionals (doctors, nurses, clinical technologists and speech therapists) were asked about their impressions regarding six Japanese terms (*mutation*, *change*, *lesion*, *mutation of gene*, *change of gene*, and *lesion of gene*; the last three terms have a similar meaning in Japanese). We selected 14 adjective sets based on these responses as well as adjectives that were used by Condit et al. (10). The 14 selected adjective sets were good/bad, sudden/not sudden, changing/unchanging, evolved/degenerated, normal/abnormal (not normal), natural/unnatural, avoidable/unavoidable, healthy/unhealthy, intended/unintended, adapted/maladapted, scary/not scary, desirable/undesirable, fast/slow and able to develop/unable to develop. Values given were 5 for the adjectives on the left and 1 for the adjectives on the right.

Knowledge about the concept of mutation

Thirteen items were designed to measure knowledge regarding the basic concept of mutation. Four of 13 items were original questions based on high school biology textbooks approved by the Japanese Ministry of Education, and 9 of 13 items were questions that were used by Condit et al. (10). Participants were asked to respond to the 13 questions by choosing one of the three responses (*true*, *false*, and *I don't know*). Value of 1 was given for correct answer (*all true*) and 0 for the others.

Procedure

Participants were asked to anonymously rate their impressions regarding the three terms and to complete a questionnaire concerning the basic concept of mutation. The three terms were indicated randomly in the *Impressions regarding the terms* questionnaire to counterbalance the order effects. The procedure of the study was approved by institutional review board.

Data and statistical analyses

Firstly, the percentage of correctly answered questions and the mean and standard deviation (SD) of the total number of questions answered correctly in the knowledge assessment questionnaire were calculated. Secondly, to reveal the factor structure of the three terms that connoted the same concept of changes in genetic information, we performed a factor analysis (varimax rotation) on impressions regarding the three terms. Finally, we calculated the percentage of questions answered correctly to assess the knowledge of the participants regarding mutation, and they were divided into three groups based on the total score for knowledge about mutation: low-knowledge group ($n = 53$, 3–7 correct answers), middle-knowledge group ($n = 51$, 8–9 correct answers) and high-knowledge group ($n = 71$,

10–13 correct answers) based on the 33.3 percentile (8 questions answered correctly) and the 66.7 percentile (10 questions answered correctly). To reveal whether knowledge about mutation had an effect on the impressions of the three terms, a two-way analysis of variance (ANOVA) [Term (*mutation of gene*, *change of gene*, and *lesion of gene*) × Knowledge Group (low, middle, and high)] was conducted on the factor score of each. Data analyses were performed using SPSS statistical software version 15.0.

Results

Knowledge about the basic concept of mutation

The mean of correctly answered questions was 8.77 (percentage of correct answer: 67.7%) and SD was 2.24. The percentage of correct responses to each question in this study in comparison to Condit et al.'s study is shown in Table 1 (10). It can be seen that the correct response rate for 10 of 13 question statements was above 64.0%. However, correct response rates to the statements, 'changes in genes can occur over a lifetime', 'changes in genes can be caused by the sun', and 'changes in genes of somatic cells cannot be inherited' were below 37.1%.

Factor structure of the three terms *mutation of gene*, *change of gene*, and *lesion of gene*

Firstly, to reveal the factor structure of the three terms, an unconstrained factor analysis for the number of factors was conducted dependently for the three terms. Three factors were extracted for the three terms, and the cumulative rate was 44.7% (Table 2). Factor 1 was interpreted as positive–negative connotations and was named the Value Factor. Factor 2 was interpreted as changing rate and was named the Change Rate Factor. Factor 3 was interpreted as going as planned and was named the Intention Factor. Cronbach's alpha scores for each factor were 0.87, 0.48 and 0.62, respectively.

Knowledge effect on the impression of the three terms

To reveal whether knowledge about mutation had an effect on impressions regarding the three terms, two-way ANOVA [Term (*mutation of gene*, *change of gene*, and *lesion of gene*) × Knowledge Group (low, middle, and high)] was conducted on the factor scores for each extracted factor. A significant main effect of Term was observed for the Value Factor ($F_{2,344} = 212.4$, $p < 0.01$). Post-hoc analysis (Bonferroni method) revealed that the factor score of the Value Factor for *lesion of gene* was significantly higher than those for *mutation of gene* and *change of gene* and that the factor score for the Value Factor of *change of gene* was significantly lower than those for *mutation of gene* and *lesion of gene* (Fig. 1a). The interaction of the Change Rate Factor (Term × Knowledge Group) was significant ($F_{4,344} = 3.619$, $p < 0.01$). The simple main effect of Knowledge Group on *mutation of gene*

Table 1. Understanding of the basic concept of *mutation*: the percentages of correct responses for each question are shown

Question	Question statements	Percentage of questions answered correctly	
		This study, $n = 175$	Condit et al.'s study (10), $n = 848$
Q1	Changes in your genes can be inherited[a]	78.9	81.0
Q2	Changes in genes can lead to disease[a]	92.6	83.1
Q3	Changes in genes can be caused by radiation[a]	88.6	76.2
Q4	Changes in genes can be caused by chemicals[a]	71.4	77.0
Q5	Every gene is able to mutate or change[a]	80.0	69.2
Q6	Chemicals can change the genes in the sperm of a man[a]	68.0	75.9
Q7	Chemicals can change the genes in the reproductive eggs of a woman[a]	65.1	76.6
Q8	Changes in genes can be spontaneously caused at a constant frequency[b]	64.0	
Q9	Changes in genes can occur over a lifetime[a]	27.4	63.3
Q10	Changes in genes can be caused by the sun[a]	37.1	41.6
Q11	Changes in genes of somatic cells cannot be inherited[b]	32.0	
Q12	Changes in genes concern biologic evolution[b]	88.0	
Q13	Some changes in genes cannot lead to disease[b]	84.0	
Percentage of common questions answered correctly		67.7	71.5

[a]Cross-questions with Condit et al. (10).
[b]Original questions in this study.

Table 2. Factor loading of *mutation of gene*, *change of gene*, and *lesion of gene* (varimax rotation): the values in bold indicate the items that loaded on each Factor

	Factor 1, Value	Factor 2, Change Rate	Factor 3, Intention	Communality
Good/bad	**0.836**	−0.040	−0.036	0.701
Healthy/unhealthy	**0.747**	−0.177	−0.103	0.600
Desirable/undesirable	**0.743**	−0.206	−0.024	0.595
Adapted/maladapted	**0.676**	0.027	−0.040	0.459
Scary/not scary	**0.619**	−0.333	−0.063	0.498
Normal/not normal	**−0.615**	0.268	0.034	0.452
Evolved/degenerate	**0.599**	−0.299	0.195	0.485
Natural/unnatural	**0.586**	0.131	0.039	0.361
Able to develop/unable to develop	**0.465**	0.130	0.022	0.233
Sudden/not sudden	−0.101	**0.577**	0.049	0.346
Fast/slow	−0.371	**0.474**	0.008	0.362
Changing/unchanging	0.239	**0.395**	0.163	0.240
Avoidable/unavoidable	0.027	0.094	**0.719**	0.526
Intended/unintended	−0.075	0.048	**0.627**	0.402
Cumulative percent (%)	29.681	37.592	44.723	

was also significant ($F_{2,172} = 7.202$, $p < 0.01$). That is, the middle- and high-knowledge groups had a significantly higher score than the low-knowledge group (Fig. 1b). Concerning the Intention Factor, the main effect of Knowledge-Group was significant ($F_{2,172} = 7.909$, $p < 0.01$). The low-knowledge group had higher factor scores for the Intention Factor (Fig. 1c) than the middle- and high-knowledge groups (Fig. 1c).

Discussion

Knowledge about the basic concept of mutation

Participants' knowledge about the basic concept of mutation was significantly different for each question, with the correct response rate ranging between 92.6% and 27.4%. The correct response rate for 10 of 13 questions was above 64.0% and that for 3 of 13 questions was below 37.1%. When compared with Condit et al.'s results (10), the correct response rates to the nine questions that were common to the two questionnaires were similar. However, close examination of details revealed differences in responses to Q9 (changes in genes can occur over a lifetime), and the rate of correct response for Q9 in our study (27.4%) was lower than that of Condit et al.'s study (63.3%) (10). The low correct response rate for Q10 and Q11, observed in both studies, indicated that lay people had little knowledge regarding somatic mutation. These results also indicated that Japanese university students in our study had less knowledge of somatic mutation compared with American students who participated in Condit et al.'s study. A comparison of Japanese and American high school biology textbooks indicated that American biology textbooks contain more information about genetics than Japanese textbooks (12, 13). In particular, American biology textbooks included information on cancer genetics and human genetics, but this was not the case in Japanese books. These facts suggested that the quality of biology

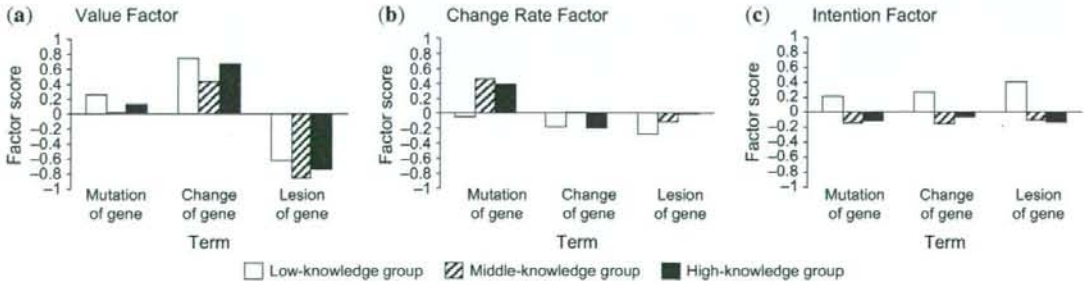

Fig. 1. Factor scores of *mutation of gene*, *change of gene*, and *lesion of gene*: means of the factor scores for the three terms in each knowledge group are shown.

education affected knowledge of genetics. Moreover, new educational guidelines from the Japanese Ministry of Education (2003) have deleted the topic of mutation from Biology Course 1 taken by many high school students. There is concern that lay people have impediments to understanding genetic diseases caused by mutation, which is a central point in genetic counseling. Moreover, it is essential to have knowledge regarding somatic mutation because cancers are often caused by somatic mutation. Knowledge regarding somatic mutation is very important when we consider genetic counseling for familial cancers.

Some studies assessing knowledge of genetics among lay people have revealed that knowledge of lay participants (14–16), patients (17) and their spouses (18) was limited. Moreover, even physicians, with the exception of geneticist (19, 20), had insufficient knowledge of genetics. Knowledge on genetics in physicians and lay people has become necessary because of the recent Human Genome Project as well as because of the discovery that genetic knowledge is helpful for human healthcare.

Factor structure of the three terms *mutation of gene*, *change of gene*, and *lesion of gene*

As the result of factor analysis, three factors were extracted for the three terms: Value Factor contained the general positive–negative concept, Change Rate Factor contained the static–dynamic concept and Intention Factor contained the accidental–intentional concept.

Results of two-way ANOVAs (Term × Knowledge Group) suggested different impressions of the three Japanese terms for the concept of mutation: *mutation of gene*, *change of gene*, and *lesion of gene*. Firstly, *lesion of gene* in Japanese had the most negative impression without relation to knowledge on Value Factor. According to the Japanese dictionary (21), the term *lesion* has the meaning of (i) physical damage or psychological damage, (ii) breach, break, cleft, fissure, fracture or split line, (iii) fault or imperfection and (iv) abasement, shame or disgrace. The term *lesion* (in Japanese: *Kizu*) includes concepts relating to physical wounds and also mental trauma. It seems that the negative impression of the term *lesion of gene* depended on the fundamental negative impression of the term *lesion* (*Kizu*). Japanese healthcare professionals might think that it is easy for lay people to understand mutation by using the term *lesion of gene* during genetic counseling, or at a heredity clinic, because *Kizu* is a familiar term for lay people. But using a negative term might lead to psychological distress for clients with anxiety and stress who are recipients of genetic counseling (22). Healthcare professionals giving genetic counseling to clients and working in heredity clinics should keep in mind that clients and patients might have a negative impression of the term *lesion of gene* regardless of their knowledge. The Japanese term for *change of gene* resulted in the most positive impression without relation to knowledge on Value Factor, probably because the term *change* has a neutral impression.

Secondly, an interaction between Term and Knowledge was observed on Change Rate Factor such that the low-knowledge group had a lower impression of *sudden*, *fast*, and *changing* with *mutation of gene* on Change Rate Factor because *Totsuzen*, in the Japanese term for *mutation* (*Totsuzen-Hen'i*), means sudden. Japanese high school biology textbooks teach about the concept of mutation (*Hen'i*) by using *Kankyo-Hen'i* (environmental variation) and *Totsuzen-Hen'i* (gene mutation and chromosomal mutation), so it appears that middle- and high-knowledge groups had an impression of the term *Hen'i* that included sudden.

Finally, data on the Intention Factor indicated that the low-knowledge group perceived mutation as being more intentional compared with the middle- and high-knowledge groups, suggesting that the middle- and high-knowledge groups held a stronger belief that mutation is a natural phenomenon and therefore is unavoidable in comparison to the low-knowledge group. Condit and O'Grady (23) have explored interpretations of the term *mutation* held by lay and expert audiences. Both groups regarded mutations as being a variation but not as a planned or an intentional one. Experts regarded mutations as being necessary and not as being undesirable, whereas the lay group tended to be significantly less likely to see mutations as being necessary or as desirable. That the factor score for the Intention Factor, including intended/unintended and avoidable/unavoidable, was affected by knowledge about mutation suggests that the intentional impressions of the term *mutation* might be different in lay people. Differences of knowledge regarding the concept of mutation might affect the acceptance of the process of genetic diseases. Iwamitsu (24) has stated that it was important for patients and their families to be provided with at least a minimum amount of medical information about their diseases as soon as possible. This is also true in the area of genetic counseling and educational intervention.

Regarding the term *mutation*, the relationship between the image of genetics and the depth of understanding regarding genetics should be noted. However, there are a few reports regarding the image of genetics in relation to knowledge about genetics. Genetic developments have been found to evoke both positive and negative feelings in public and professional groups, but with the public being less positive overall than the professionals (25). That study compared lay people with experts; however, there are no studies that have investigated differences between different groups of lay people with different degrees of knowledge.

The usage of the term *mutation* is problematic as a scientific word because of the confusion regarding its use (26). Along with the popularization of genetic testing, in clinical practice, this confusion might result in confusion in the understanding of lay people. It is a very important clinical issue that public understanding and attitudes regarding genetics affect the attitudes of lay people regarding genetic testing. As a whole, lay people (including patients and caregivers) with a high level of knowledge about genetics had more positive attitudes about genetic testing (27–33), but higher levels of knowledge about genetics were also related to negative attitudes (33). Geneticists and genetic counselors should provide accurate information to their clients after taking into consideration how the term should be used in order to encourage the acceptance of genetic testing. Moreover, not only it is important for healthcare professionals to provide accurate information but also they should check with clients about the meaning that the terms used have for each individual. These considerations may be helpful for better communications between clients and healthcare professionals.

Limitation and perspectives

In this study, we suggested that the three Japanese terms *mutation of gene*, *change of gene*, and *lesion of gene* have different impressions, although they have similar meanings. In previous studies, certain terms including 'change', 'variation', 'version of gene' (10), 'faulty gene', 'altered gene' (11), and 'functionally challenged gene' (23) have been proposed as alternatives to the term *mutation*, which has a negative impression. In the study on communicating with cancer patients, Dunn et al. (34) showed that exposure to the word 'cancer' in a questionnaire, as opposed to the word 'illness', increased anxiety of these patients about the use of euphemism. However, they also described that the use of the word 'cancer' did not affect psychological adjustment, and it might have enabled patients to think about their cancer realistically. As is the case with genetic counseling, the term *mutation* is the accurate term for change in genetic information. We should discuss how to reduce ambiguity in genetic terms and become aware of using the term *mutation* in the clinic.

This study has several limitations that should be noted. The findings suggest that there were significant insights even in the limited participants consisting of Japanese university students and auditing students who agreed to participate in this research. There are several clinical implications of the present findings, but further research on the impressions of the term *mutation* on patients with genetic diseases and their families is needed to understand more useful implications for genetic counseling. Erblich et al. (35) have demonstrated that women with the stress of having a family history of breast cancer exhibited more interference on a stroop task with cancer-related stimuli compared with women without a family history of cancer, although this bias was not mediated by the significantly higher perceived risk, general distress, or cancer-specific distress in women with a family history of cancer. Constans et al. (36) have suggested that the level of heart-related worry and emotional distress in myocardial infarction (MI) patients were not associated with the degree of attention bias to cardiac stimuli in the post-MI participants but were associated with their monitoring coping style. These findings suggested that maladaptive alterations in processing of disease stimuli might have important clinical implications. This is particularly the case with genetic disease patients and their families who must process complex genetic-related information critical to their health.

In conclusion, when applied to the area of genetic counseling, the findings of this study suggest that healthcare professionals should demonstrate an awareness of the different terms that are used to refer to the identical concept of mutation. This is of particular importance when communicating with patients and families.

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資料

意思決定における“日本版後悔・追求者尺度”作成の試み[1]

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Construction of a Japanese version of the "Regret and Maximization Scale" in decision making

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This study developed a Japanese version of the "Regret and Maximization Scale" in decision making, which was originally constructed by Schwartz, Ward, Monterosso, Lyubomirsky, White, and Lehman (2002). This scale measures assess the tendency to experience regret, and individual differences in the desire to maximize or to satisfy. In Study 1, the original version of the "Regret and Maximization Scale" was translated into Japanese and administered to 307 Japanese university students responded the scale. Factor analysis did not replicate the finding of Schwartz et al. (2002). In Study 2, we developed new items, and constructed a "Japanese Version of the Regret and Maximization Scale", based on the interpretation of the factor analysis in Study 1. This new version of the scale was administered to 163 Japanese university students. The result of factor analysis and reliability analysis indicated that this "Japanese Version of the Regret and Maximization Scale" had a considerably high Cronbach's alpha and conceptual validity.

Key words: decision making, maximization, satisfaction, regret, Regret and Maximization Scale.

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消費者の意思決定を理解する上で経済学などの社会科学においては，期待効用理論（von Neumann & Morgenstern, 1947; Savage, 1951）による解釈がよく用いられる。この理論の背後には，意思決定に際して人間は合理的であり合理性を示す一群の選好関係の基準を満たすという仮定が含まれている。意思決定者がこの一群の選好関係に関する公理を満たすなら，この選好関係は期待効用理論では効用（utility）を最大化することと等価になる。

しかしこれまでの意思決定研究は，人間が期待効用理論の公理や条件に反する選好関係を示すことを明らかにしている（Allais, 1953; Kahneman, 2003; 竹村, 2005, 2006）。特に Simon（1955）は意思決定者は情報処理能力の限界から，全ての選択肢を正確に把握することは不可能であることを指摘した。意思決定者は限定された能力や時間の中で自らが満足（satisfying）可能な最低限の基準である満足化基準を満たす選択肢を選ぶ。

また，意思決定において個人の感情を考慮に入れる動きが見られる。Bell（1982）や Loomes & Sugden（1982）は，人間は実際の結果と他の選択肢を選んだ場合に得られる結果とを比較して後悔を回避する選択肢を選ぶことを導出した。

これらの知見をもとに，Schwartz, Ward, Monterosso, Lyubomirsky, White, & Lehman（2002）は自ら作成した“後悔・追求者尺度（Regret and Maximization Scale）”の因子分析研究によって，意思決定スタイル

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