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DIFFICULTY OF JAPANESE STUDENTS IN PRONUNCIATION OF CERTAIN WORDS AND NUMERALS IN SCIENTIFIC ENGLISH: PROBLEMS ARISING FROM THE SPEAKER'S NATIVE TONGUE AND PRIOR EXPOSURE (PART 2)

F. W. FOONG¹, Yumi FUJIWARA², Erina SATO³

¹ Department of English for Pharmaceutical Communication, Kyoto Pharmaceutical University, 5 Nakauchi-Cho, Misasagi, Yamashina-Ku, Kyoto 607-8414, JAPAN affw78@mb.kyoto-phu.ac.jp, 78imexfw@gmail.com

² Department of Education, Kyoto University of Education, Kyoto, JAPAN

³ Department of Language Development, Imex Japan Co. Ltd., 3F Imex Japan Building, Shichiku, Kita-Ku, Kyoto 603-8425, JAPAN

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ANNOUNCEMENT

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We invite like minded researchers to come aboard and join us in the search of knowledge and wisdom through enlightened discussion and brainstorming. With inspired vision and a shared mission we can all create a better quality of life for all.

This event is an inclusive interdisciplinary research and publishing project that aims to bring together researchers from a wide variety of areas to share ideas and explore ways to improve global Quality of Life which are innovative and exciting.

We are proud to be holding this year's event will be held in Kyoto, Japan, a city whose living traditions integrating nature and human activity perfectly complement the themes of the conference. During their trip to the conference, we will support all participants as they enjoy Kyoto's timeless beauty, sights, and attractions, suitable for all tastes and interests, that this year's event venue has to offer.

Difficulty of Japanese Students in Pronunciation of Certain Words and Numerals in Scientific English: Problems Arising from the Speaker's Native Tongue and Prior Exposure (Part 2)

F. W. FOONG¹, Yumi FUJIWARA², Erina SATO³

¹ Department of English for Pharmaceutical Communication, Kyoto Pharmaceutical University, 5 Nakauchi-Cho, Misasagi, Yamashina-Ku, Kyoto 607-8414, JAPAN affw78@mb.kyoto-phu.ac.jp, 78imexfw@gmail.com

² Department of Education, Kyoto University of Education, Kyoto, JAPAN

³ Department of Language Development, Imex Japan Co. Ltd., 3F Imex Japan Building, Shichiku, Kita-Ku, Kyoto 603-8425, JAPAN

Abstract

Mispronunciations by Japanese ESL (English-as-a-Second-Language) students learning science English (SE) involving the letters 'n' to 'z' and spoken words that combine the first with the subsequent syllable were focused upon in this study. **Methods:** Usual/common mispronunciations (UMPs) in scientific presentations by undergraduate students (n=695) were collected and analyzed. **Results and Discussion:** Typical UMPs of Japanese students are basically foreign to the Japanese language (JL). UMPs of SE (words/terms and numerals) by Japanese ESL learners are caused not merely by the shy nature of Japanese students but also by the single-pronunciation-per-kana nature of JL, as the same UMPs were noted in different words having generally the same alphabetical components (e.g, [nɔ̃ɪ] for 'ni', [pəɹ] for 'per', etc.). Ultimately, the vicious cycle of repeated UMPs is actually primarily induced by the senior educators, who themselves have had to relearn spoken English via 'refresher' courses. The incorrect sounds and rhythms of their native tongues have been so deeply rooted in their habits, behavior, and native language or JL-derived pronunciations of SE that a great deal of effort, training, and caution have to be exercised to break the vicious cycle of UMP, and enable young students to speak with internationally accepted English pronunciation; this does not have to be American or British/European pronunciation, but it must be an internationally accepted and readily comprehensible form that will allow them to carry out meaningful and useful communication. The Japanese government - any national government for that matter - should encourage and sponsor young scientists to go to foreign countries (where English is commonly spoken) for research so as to create a new generation with better SE pronunciation and ability.

Difficulty of Japanese Students in Pronunciation of Certain Words and Numerals in Scientific English: Problems Arising from the Speaker's Native Tongue and Prior Exposure (Part 2)

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1. Introduction

In Part 1 of this study,¹ we dealt with pronunciations related with word/terms and numerals using the letters 'a' to 'm' in Science English (SE). In this article (Part 2), the common/usual mispronunciations (UMPs) by Japanese ESL (English-as-a-Second-Language) students learning English for special purpose (ESP) related to SE (especially pharmaceutical and medical sciences) of terms/words and numerals involving the letters 'n' to 'z' and spoken words that combine the first with the subsequent syllable (pronunciations not found in JL) are focused upon. Although the entire scientific lexicon cannot be covered in any given review, certain UMPs typical of Japanese students are taken into consideration in this report to help make young Japanese students more aware of their shortcomings and habitual UMPs,² and to allow researchers to learn the proper manner of speaking using correctly pronounced, easily comprehensible, and generally accepted English, and thereby enable them to engage in useful and meaningful communication while working at the international level.

2. Methods and subjects

The methods and subjects have been described in a previous report.¹ Briefly, the subjects and methods are described below.

2.1 Subjects

Pronunciations used in scientific presentations given by a total of 695 undergraduate students (age-range: 18-22 yr) from Yr-2 (n=366), Yr-3 (168), and Yr-4 (n=159) enrolled in pharmaceutical university A were collected and analyzed. Yr-1 students were excluded from the study.

2.2 Methods

Students from different academic years with different speaking abilities delivered scientific presentations during their regular lectures. Certain UMPs of scientific terms/words and numerals were collected and analyzed. The pronunciations were transcribed into syllables so as to indicate and contrast the correct form with the inappropriately pronounced versions or UMPs. Not all students mispronounced the words/numerals presented herein. Note that, only certain words that needed attention or correction were analyzed in this study. It is easy to verbally correct the pronunciation of a single word; however, much more effort is required when those words arise within fully developed/articulated utterances as part of a speech act. The UMPs or mispronounced syllables are printed in red (as spoken by some - not all - Japanese ESL learners) and the "correct revised form" (**Rev**) of UMPs are marked "Rev" (below the UMP). Standard IPA (International Phonetic Alphabet) pronunciation symbols for the pronunciation are provided in order to allow students to develop self-awareness and learn to improve and correct their UMPs. The common pronunciations used here are based on American English (**Rev**); however, when and where appropriate, British/European [**Rev(BE)**] versions are also added to make students aware of and understand regional differences/perspectives in SE pronunciation. Certain additional common SE words with tricky and/or confusing pronunciations are occasionally added at the end of relevant sections as "*More examples with correct American English pronunciations indicated below (typical terms/words that Japanese students have difficulty in pronouncing)*" in order for students to learn and acquire the proper pronunciations for the corresponding words, expressions, and numerals.

3. Results

3.1 Appropriate and inappropriate pronunciations

2a) Taking care with words/terms with 'n' or a silent 'k' and 'n': Note also prefixes 'ni' (nɪt) vs 'ní' (náit) vs 'ny' (nái); 'nit' (nít) vs 'nitro' (nít'ɔr'ɔ) vs knit (nít); and 'nu' (n(j)ú:) vs 'neu' (n(j)ú:). Take note of suffixes '-ism' (nìzm) and '-nite' (nət) as well.

i) The *nitrogenous* bases of *nucleic* acids found in living *organisms* are purines and pyrimidines.

UMP: 1. *nitrogenous* (nít'ɔr'ɔdʒén'n'ə-s), 2 *nucleic* (njúkúríkú), 3 *organisms* ('ɔ:gá:nísu).

Rev: 1. (naɪtrádʒ(ə)nəs), 2 (nukléɪnk), 3 (ɔrgənɪzəmz)

Rev(BE): 3 ('ɔ:gənɪzm)

ii) Unlike **nichrome** and **nickel** or **nylon**, **nitric Oxide (NO)** - generated via the action of NO synthase using **energy** in the living system - helps in **numerous** biological functions: from **neurotransmission** to the immunodefense **mechanism**.

UMP: 1. **nichrome** (ník'ɔr'ɔəsm), 2 **nickel** (ník'érú), 3 **nylon** (nílɔ:n), 4 **energy** (énn'érú'gɪ), 5 **numerous** (njúmél'ɔsú), 6 **neurotransmission** (né'jʊətráʊnsúmí'ʃɔn), 7 **mechanism** (mék'anniz)

Rev: 1 (nɔɪkrɔʊsm), 2 (ník(ə)l), 3 (náiɪlən), 4 (énə'dʒi), 5 (n(j)ú:m(ə)rəs), 6 (nuɪəstrænz'mɪʃən), 7 (mékənɪzm)

Rev(BE): 1 (náikrəsm), 3 (náiɪlən), 4 (énədʒi), 5 (njú:ú:m(ə)rəs)

iii) Certain **nutrient** deficiencies result in a **number** of eye diseases and **definite** extremity **numbness**. Therefore, **not knowing** the functions of nutrients is disadvantageous to the maintenance of health.

UMP: 1 **nutrient** (n(j)ú:tóros(ə)n), 2 **number** (n'ʌmbáə), 3 **definite** (dé'fíní:t'ə), 4 **numbness** (n'ʌmb'ʊnés), 5 **not** (nátə), 6 **knowing** (nóʊɪŋjù)

Rev: 1 (n(j)ú:triənt), 2 (n'ʌmbə), 3 (déf(ə)nət), 4 (nʌmnəs), 5 (nát), 6 (nóʊɪŋ)

Rev(BE): 1 (njú:ú:triənt), 2 ('nʌm.bə(ɪ)), 3 (n'ət)

iv) The chief surgeon agreed with a **nod** to tie the hemorrhaging blood vessel with a **knot**.

UMP: 1 **nod** (nádá), 2 **knot** (nát'ə)

Rev: 1 (nád), 2 (nát)

Rev(BE): 1 (n'ɔd), 2 (n'ə)

vii) **Novel** findings may lead to **new** discoveries.

UMP: 1 **Novel** (nábél), 2 **new** (n(j)ú)

Rev: 1 (náv(ə)l), 2 (n(j)ú:)

Rev(BE): 1 (n'əv(ə)l), 2 (njú:)

2b) Note the differences in prefixes 'pi' (pái) vs 'py' (pái); and suffixes '-dine' (dín) vs '-mine' (mín) vs '-nine' (nín / ní:n) vs '-rine' (rá:n) vs '-sine' (sín); '-phalin' (f'ə:línz) vs '-phin' (fínz); as well as the use of 'par' (páə), 'per' (pə):

1. The smoking rate (**percent**) of **people** standing in a hotel **parlor** in the Wild West during the 1800s was believed to be two or more cigarettes **per person** per hour (or ≥ 2 cigarettes/person/hr); the rate increased with the number of **partners** they were socializing with.

UMP: 1 **percent** (pársént'ə), 2 **people** (pípár), 3 **parlor** (párúlrú), 4 **per** (pár), 5 **person** (pársán), 6 **partners** (párt'on'æs)

Rev: 1 (pə'sént), 2 (pí:pl), 3 (páə-lə), 4 (pə), 5 (p'ə:sn), 6 (pártnəz)

Rev(BE): 1 (pəsént), 2 ('pi:pəl), 3 (pá:lə), 4 (p'ə:), 5 (p'ə:sn), 6 (pá:tnəz)

2. Smoking a **pipe** on a rocking chair is a **determinant** of the lifespan of **miners** in the hill.

UMP: 1 **pipe** (pí:pú), 2 **determinant** (dít'ʌ:mɪnənt'ə), 3 **miners** (má:məz)

Rev: 1 (páɪp), 2 (dɪt'ə:mɪnənt), 3 (máɪnəz)

Rev(BE): 2 (dɪ'tɜ:mɪnənt), 3 (máɪnəz)

3. Two **purines** and 3 **pyrimidines** are all the nitrogenous bases needed for synthesizing nucleic acids found in living organisms. The purines bases are **adenine** and **guanine**, while the pyrimidines are **cytosine**, **thymine** and **uracil**. Purines and pyrimidines are different from **enkephalins** and **endorphins**. None of these chemicals or their various structural **patterns** are **patented**.

UMP: 1 **purines** (p'ʊrɪnzú), 2 **pyrimidines** (pílilidzínzú), 3 **adenine** (ətɪnín), 4 **guanine** (gwánín), 5 **cytosine** (sí:dəsin), 6 **thymine** (tjímín), 7 **enkephalins** ((ə)nkefáɪlínzú), 8 **endorphins** (endórúfín), 9 **patterns** (pát'ʌnzú), 10 **patented** (páténtə)

Rev: 1 (pj'ʊrɪnz), 2 (páɪrɪmídínz), 3 ('ædɪnɪn), 4 ('gwa:nɪ:n), 5 ('sɪtəsin), 6 ('θaɪmɪn), 7 ((ə)nkæf'ə:línz), 8 (endórú:fínz), 9 (p'ætənz), 10 (pætəntəd)

Rev(BE): 2 (pəɪrɪmídínz)

2c) Differentiating pronunciation of words with 'r' from 'l', and suffixes '-rine' (rín) from '-line'

(lám):

- i) *Lines* aligned in *rows* from high and *low* rhyme well in looks, and project a unique pattern of Japanese art and design for clothes and houses but not for *latrines*.

UMP: 1 *Lines* (lámzú), 2 *aligned* (éili:jn'ædá), 3 *rows* (rószú), 4 *low* (r'ɔ:), 5 *latrines* (lætərínzú)

Rev: 1 (lámz), 2 (əlámnd), 3 (rósz), 4 (l'æʊ), 5 (lætrínz)

Rev(BE): 4 (loʊ)

- ii) *Rabbits* are nuisance to *olive* *oil* farmers; these herbivores dig *burrows* to form a *warren* deep under the *tree*, destroying *roots* of olive trees, and thus depriving the trees of water and nutrients.

UMP: 1 *Rabbits* (rəbítzú), 2 *olive* (óláiw'ɔ), 3 *oil* ('ɔirú), 4 *burrows* (b'ɔl'ɔ:zú), 5 *warren* (w'ɔ:lén), 6 *tree* (sútrí:), 7 *roots* (rútzú)

Rev: 1 (ræbəts), 2 (óliv), 3 ('ɔil), 4 (bɔːoʊz), 5 (w'ɔ:rən), 6 (trí:), 7 (rúts)

Rev(BE): 1 ('ræbits), 2 ('ɔliv), 4 (b'ʌrəʊz)

2d) Differentiating prefixes 's' vs 'ce' vs 'z'; suffixes '-ses' (zɪz) vs '-ces' (sɪz) vs '-zes' (zɛz); and six (síks) vs sick (sík):

- i) *Zebra* hides and ornaments made of *ceramics* can sell at a substantially cost as *prizes*: *prices* may range from *several* hundred to a *zillion* yen.

UMP: 1 *Zebra* (jbrə), 2 *ornaments* ('ɔ:lɪrúnəməntə), 3 *ceramics* (seirámeikúzu), 4 *prizes* (p'ɔrízú), 5 *prices* (p'ɔrízú), 6 *several* (sébéru:), 7 *zillion* (dzá'li'ə:n)

Rev: 1 (zíbrə), 2 (ɔrnəmənts), 3 (sər'æmɪks), 4 (práizɛz), 5 (práɪsɪz), 5 (sévn(ə)rəl), 6 (zɪljən)

Rev(BE): 1 ('zɛbɪəz), 2 ('ɔ:nəmənts), 3 (sə'ɪæmɪks), 5 (praɪsɪz)

- ii) Drug efficacy and *adverse* reactions in the treatment of *diseases* are influenced by individual *difference*: *advice* from pharmacists is necessary when patients are plagued with persistent *sneezes* after drug intake.

UMP: 1 *adverse* (ədob'ə:s), 2 *reactions* (riækətɔfɔn), 3 *diseases* (dɪdʒi:zəs), 4 *difference* (díf(ə)rən), 5 *advice* (ədobáɪs), 6 *pharmacists* (fá:rúm'ásístɔz), 7 *patients* (páti:entos), 8 *sneezes* (snízi)

Rev: 1 (ædv'ə:s), 2 (riækʃənz), 3 (dɪzɪzɪz), 4 (díf(ə)rəns), 5 (ədváɪs), 6 (fárməsɪsts), 7 (péɪʃənts), 8 (snízɪz)

Rev(BE): 1 ('ædvə:s), 3 (dɪ'zɪzɪz)

- iii) *Six* of the *sixteen* *seagulls* feeding along the coast were *sick* after the oil spill near the coast.

UMP: 1 *Six* (síks), 2 *sixteen* (síksútfɪn), 3 *seagulls* (sígl'ru:zu), 4 *sick* (síku)

Rev: 1 (síks), 2 (síkstí:n), 3 (síglz), 4 (sík)

Rev(BE): 1 (síks), 2 (síkstí:n)

2e) Take care of prefix 'sa' and the subsequent adjoining syllables such as 'sap' (sàp), 'sam' (s'ʌm) and 'sar' (sàə):

- i) *Saponin* *samples* from chickens were tested for *SARS* infection. The SARS virus is not a cause of *sarcoidosis*.

UMP: 1 *Saponin* (sàpánín), 2 *samples* (s'ʌmpú:rúzu), 3 *SARS* (záru:zu), 4 *sarcoidosis* (sàruk'ɔɪdóʊsɪs)

Rev: 1 (səpánín), 2 (sæmpəlz), 3 (sárz), 4 (sàəkóʊdóʊsɪs)

Rev(BE): 4 (sà:k'əʊdóʊsɪs)

2f) Differentiating 'ti' (tí:) vs 'di' (dɪ/dai) vs 'ty' (tí/'tɪ) vs 'dy'; 'tri' (trí) vs 'tri' (trá) vs 'tre' (tré) vs 'thre' (θrí:) vs 'try' (trá); 'til' (tíl) vs 'tyl' (tɪ); and words ending with '-ted' (təd) vs '-ded' (dɪd):

- i) *Hepatitis* is caused by a viral infection, and it is not due to *tyramine* or *acetylcholine* abnormality or *dyslipidemia*. Cirrhosis derived from hepatitis may enlarge the liver more than several-fold in *centimeters*.

UMP: 1 *Hepatitis* (hèpəðíðís), 2 *tyramine* (tjílɹəmín), 3 *acetylcholine* (əsétɪl'kólɪn), 4 *dyslipidemia* (dɪsu:lípídómíə), 5 *centimeters* (séntɪlmétá-z)

Rev: 1 (hèpətáɪtɪs), 2 (táɹəmín), 3 (əsétəlkólɪn), 4 (dɪslípídí:míə), 5 (séntəmítə-z)

Rev(BE): 2 (táɹəmáɪn)

More examples with correct American English pronunciations indicated below (typical terms/words that Japanese students find difficulties in pronouncing):

[tri]	trichotoxin, trichosis, trichiasis, trick , retrieve, trigonometry
[tráɪ]	trichoroethane , trimethyl , triphosphate , trigeminal , triad , triage
[-tri]	chemistry, country, entry , oximetry, perioptometry, spectrometry
[ti]	tyranny, tyramine, tyroma, typical , tympanic, tympanitis
[táɪ(ə)]	tyrant , typhoon , typography , typhus , type , typhoid , tyrosine
[tá]	tic , tick, tickle , tip , tin , tissue , tibia , timber , tiglic acid
[tɪŋ(k)]	tincture , tinctable , tinnitus , tingle , tinkle , tincal , tint
['ti]	tie , titanus , time , tide , titrate , titation , titer , tigroid
[tʃɪl]	acetyl, butyl, cetyl, heptyl, kolantyl, lactyl, mesityl, pentyl
[θɪl]	ethyl , methyl , methylene , phenylpropyl methy lamine, thylakoid

ii) **TNT** or **trinitrotoluene** is an explosive made by the **nitrication** of **toluene**.

UMP: 1 **TNT** (tʃɪnɪtʃɪ), 2 **trinitrotoluene** (trɪnɪt'ɔər'ɔ:t'ɔlúɪ:n), 3 **nitrication** (nɪtɔlɪfɪkɪʃən), 4 **toluene** (t'ɔlúɪ:n)

Rev: 1 (tɪ:ɛntɪ:), 2 (trɪnɪtɔtɔstɔlɔjuɪ:n), 3 (nɪtɔtɔfɪkɪʃən), 4 (tɔlɔjuɪ:n)

Rev(BE): 2 (trɪnɪtɔtɔstɔlɔjuɪ:n), 4 (t'ɔlɔjuɪ:n)

iii) **Trigonometry** is applied in the determination of angles and sides of **triangles** for surveys and other usages, while **geometry** is concerned with points, lines, curves, surfaces, shapes, configurations, etc.

UMP: 1 **Trigonometry** (trɪ:gómi:tri), 2 **triangles** (trɪ:'ʌŋgl), 3 **geometry** (dʒiómɪ:tri)

Rev: 1 (trɪgənámətri), 2 (tráɪæŋgəlz), 3 (dʒiómətri)

Rev(BM): 3 (dʒi'ɔmətri)

More examples with correct American English pronunciations indicated below (typical terms/words that Japanese students find difficulties in pronouncing):

[tri]	trichotoxin, trichosis, trichiasis, trick , retrieve
[tráɪ]	trichoroethane , trimethyl , tricycle , triphosphate , trigeminal , triathlon , triad , triage , triceps
[-tri]	entry , symmetry, chemistry, country

iv) **Three tricky** siblings spanning over **thirteen** generations were found to be diabetic when their family **trees** were **traced**.

UMP: 1 **Three** (sú:trɪ:), 2 **tricky** (t'ɔrɪki), 3 **thirteen** (sàə:tʃɪn), 4 **traced** (træsd'ɔ), 5 **tree** (sútrɪ:)

Rev: 1 (θrɪ:), 2 (trɪki), 3 (θ'ə:tɪ:n), 4 ('tɹeɪst), 5 (trɪ)

Rev(BE): 1 (θrɪ:)

More examples with correct American English pronunciations indicated below (typical terms/words that Japanese students find difficulties in pronouncing):

[tɹeɪ]	tracer , tracing
[tréɪ]	training , train , trait , tray
[tr'æ]	trachea , trachoma , tract , tracheloplasty , transaminase , transcription , tranquillizer , travail
[tr'ɔ:]	trauma , traumatopathy , traumatopnea , traumatopyra
[θrɪ]	three-quarter , three-legged
[trə]	tray , travail
[tréɪ]	training , train , trait
[tr'æ]	trachea , trachoma , tract , tracheloplasty , track , traction , tractus , tractor , trance , transaminase , trasbasal , transcription , tranquillizer

v) **Digested** food and **oxygenated** blood in warm- and cold-blooded animals provide energy and oxygen to muscles and **tissues** for the maintenance of life.

UMP: 1 **Digested** (dɪdʒést), 2 **oxygenated** ('ɔ:kúsi:génɪtɔ), 3 **blooded** (b'ɔlɔ:d'ɔ), 4 **tissues** (tʃɪsjùz), 5 **maintenance** (méɪmténənz)

Rev: 1 (dáɪdʒɛstɪd), 2 (áksədʒənɛɪtəd), 3 (bláɪdɪd), 4 (tɪsjùz), 5 (méɪmt(ə)nənz)

Rev(BE): 2 ('ɔksɪdʒənɛɪtəd), 5 ('meɪmtɪnənz)

2g) Take note of words/terms with 'ta' (tʌ) vs 'tra' (træ); 'tac' (tæk) vs 'trac' (træk); 'th' (θa) vs 'ch'

(tʃ); ‘tia’ (ʃiə) vs ‘dia’ (daɪ æ); and ‘tio’ (ʃoʊ) vs ‘thio’ (θaiə):

i) *Contracts* in the *branch* of sports known as *contact* sports are usually of a short *length*. *Contact* sports can be *life-threatening* and may cause *dementia* from head *trauma*.

UMP: 1 *contract* (k'ɔ:ntʊ:l'ʌkʊt'ɔ), 2 *branch* (b'ɔ:l'ʌntʃi), 3 *contact* (k'ɔ:nt'ʌkʊt'ɔ), 4 *length* (lɛŋtʃs), 5 *threatening* (su:rɛtənɪŋgju), 6 *dementia* (dʒimɛntʃi), 7 *trauma* (tɔlrúum'ʌ)

Rev: 1 (kʌntrækt), 2 (br'æntʃ), 3 (kʌntækt), 4 (lɛŋ(k)θ), 5 (θrɛtənɪŋ), 6 (dimɛntʃ(i)ə), 7 (tr'ɔ:mə)

Rev(BE): 1 (k'ɔntrækt), 2 (brá:ntʃ), 3 (k'ɔntækt), 5 ('θret.ənɪŋ), 7 ('tɪɔ:mæ)

ii) *Inertia* from stopping a car suddenly may *initiate* a high *ratio* of *methionine* release and other amino acid *secretions* to induce certain *diameter dilation* of blood vessels.

UMP: 1 *Inertia* (in'æ:rúdí), 2 *initiate* (inítʃiá:t'ɔ), 3 *ratio* (r'ɔdiəʊ), 4 *methionine* (m'ætʃi'ɔ:nín), 5 *secretions* (sɛkkj'ɔrɪʃnɪz), 6 *diameter* (dʒi:émétá:), 7 *dilation* (dʒi:rɛʃn)

Rev: 1 (in'æ:ʃə), 2 (inítʃiét), 3 (réiʃoʊ), 4 (méθaiəʊnám), 5 (səkrɪʃnɪz), 6 (daɪ'æmətə), 7 (daɪlɛiʃən)

Rev(BE): 1 (in'æ:ʃə), 3 (réʃi'əʊ), 4 (méθaiəʊnɪm)

2h) ‘U’ is pronounced as ‘jú:’, and is differently pronounced with different adjoining alphabets such as ‘ul’ (ʌl), ‘un / u[n-]’ (ʌn / jú:[n-]), ‘um’ (ʌm), etc.

i) *Unlike* *urea*, *urea peroxide* is a white crystalline compound *used* in an *aqueous* solution as an oxidizing mouthwash. It does not cause *ulcers* and *ultrafiltration* is not needed for its synthesis.

UMP: 1 *Unlike* (ʌnláiku), 2 *urea* (úri:ə), 3 *used* (jú:zd'ɔ), 4 *aqueous* (á:kuwiəs), 5 *ulcer* (úrúsə), 6 *Ultrafiltration* (úrútrəfiltrɛiʃn)

Rev: 1 (ʌnláik), 2 (jʊ(ə)rɪ:ə), 3 (jú:zd), 4 ('eɪkwɪəs), 5 ('ʌlsə), 6 ('ʌltrəfiltrɛiʃən)

Rev(BE): 3 (éikwiəs)

More examples with correct American English pronunciations indicated below (typical terms/words that Japanese students find difficulties in pronouncing):

[jú / jʊ(ə)] *ulitis*, *unicuspid*, *uniparous*, *unit*, *united*, *univalent*, *uracil*, *uranium*, *ureter*, *urethra*, *urea*, *urethrodynia*, *uric acid*, *uridine*, *urine*, *urocyst*, *urokinase*, *use*

[j'ʊ(ə)] *urethritis*, *urethralgia*, *urinate*, *urethroscopy*, *uricosuria*, *uridrosis*, *urinometer*

[ʌl] *ulcerate*, *ulcerocancer*, *ulcus*, *Ullrich*, *ultimate*, *ultracentrifugation*, *ultrasonic*, *ultraviolet*

[ʌm] *umbrella*, *umbilicus*, *umbra*

2i) ‘V’ is pronounced as ‘ví:’, and not ‘b'vɪ’ is differently pronounced with different adjoining alphabets such as ‘va-’ (vé[ə]), ‘ve-’ (vé), ‘vi-’ (vá), ‘-vo-’ (v'ɔ), ‘-vu-’ (v'ʌ):

i) *Various* *vital* *vitamins* are *vastly* distributed in nature, and most are *vulnerable* to heat. Excessive intake of certain vitamins may cause *vomiting* even for tough *veterans* or patients without *HIV* or other diseases.

UMP: 1 *Various* (ba:riəs), 2 *vital* (baitáru), 3 *vitamins* (bí:təmənzu), 4 *vastly* (b'ʌstoli),

5 *vulnerable* (ba:rúnér'ʌbə), 6 *vomiting* (b'ɔmɛtɪg'ʊ), 7 *veteran* (béter'ʌn), 8 *HIV* (,ertʃ.ar'bí)

Rev: 1 (vé(ə)riəs), 2 (váitʃl), 3 (váitəmənz), 4 (væstli), 5 (v'ʌln(ə)rəbl), 6 (vəmɛtɪŋ), 7 (vétərən), 8 (,ertʃ.ar'vi)

Rev(BE): 3 (vítəmɪn), 4 (vá:stli), 6 (v'ɔmɪtɪŋ)

More examples with correct American English pronunciations indicated below (typical terms/words that Japanese students find difficulties in pronouncing):

[vé(ə)] *variation*, *variable*, *vanadium*, *valuation*, *valance*

[vá] *vibrate*, *vibex*, *vibrissa*, *vitality*, *virile*, *viva*, *vial*, *violet*

[væ] *valerian*, *valeridin*, *valine*, *valley*, *valve*, *value*, *valva*

[v'ʌ] *vulnerable*, *vulture*, *vulva*, *vulvectomy*, *vulvouterine*

[vá] *voice*, *void*, *volcano*, *vomit*, *volume*, *volatile*, *vomit*, *vortex*

[vé] *vermiform*, *vernier*, *venom*, *Venezuela*, *vertebrate*, *vermin*

[vi] *vicious*, *victim*, *victory*, *villi*, *virulent*, *viscous*, *vision*, *visual*

ii) Modern *vortexes* (BE: *vortices*) are without *valves*, and are useful for mixing chemical in present-day laboratories. However, the German pathologist, *Von* Hansemann (1858-1920), did not have the chance to use a *vortex* before the 1920s.

UMP: 1 *Vortexes* (b'ɔ:rútekúz), 2 *valves* (b'ɔ:rúbú), 3 *Vortices* (b'ɔ:rútəsə), 4 *Von* (b'ɔn),

5 **vortex** (b'ɔ:rútekúsú)

Rev: 1 (v'ɔəteksɪ:z), 2 (vælɪvz), 3. (BE: v'ɔ:təsəz), 4 (fo:n), 5 (v'ɔəteks),

Rev(BE): 1 (v'ɔ:teksəz), 3 (v'ɔ:təsəz), 5 (v'ɔ:teks)

2j) Note the syllables 'wo' (w'ɔ) and 'who' (həɔ) vs 'ho' (hóɔ), and 'w' vs 'h' in prefixes:

i) *Wolves* inhabiting *holes* are highly social animals and live in packs comprised of a couple of breeding (alpha) males and females. The alpha *wolf* decides when and where the pack will travel and hunt, and normally is the first to *wallop* unfriendly enemies and eat at a *whole* kill.

UMP: 1 *Wolves* (ú:lvzu:), 2 *holes* (h'ɔ:rúzu:), 3 *wolf* (ú:lvf'ɔ), 4 *wallop* (w'ɔ:rúlopu), 5 *whole* (hóɔrú)

Rev: 1 (w'ɔlvz), 2 (hóɔɪlz), 3 (w'ɔlf), 4 (wáləp), 5 (həɔl)

Rev(BE): 2 (h'əɪlz), 4 (w'ɔləp), 5 (h'əɪl)

2k) Taking care of words/terms ending with '-ase' (éz) and '-t' (t) vs '-ts' (ts) vs '-ce' (s):

i) *Carboxylase*, *kinase*, *oxidase*, *peptidase*, *protease*, and *synthase* are enzymes found in living organisms.

Note: the syllable immediately before '-ase' determines the pronunciation of the word/expression

UMP: 1. *Carboxylase* (kárúbákífilá:zéri), 2 *kinase* (kínəzí:zə), 3 *oxidase* ('ɔəksídəzéri),

4 *peptidase* (pépúdázéri), 5 *protease* (púr'ɔtíəzéri), 6 *synthase* (sɪntázéri)

Rev: 1 (ká:báksɪlíz), 2 (káméɪz), 3 (áksídéɪz), 4 (péptídéɪz), 5 ('prɔʊtɪeɪz), 6 (sɪndəéɪz)

Rev(BE): 3 ('ɔksídéɪz)

ii) *Patience* is a virtue: It takes a *patient* nurse to care for demanding *patients*.

UMP: 1 *Patience* (pá:tiənzú:), 2 *patient* (pá:tiənt'ɔ), 3 *patients* (pá:tiəntzu:),

Rev: 1 (péɪfəns), 2 (péɪfənt), 3 (péɪfənts)

2l) Words with prefix 'x' are not many, and take note of 'xa' (zæ), 'xe' (zè), 'xi' (záɪ) and 'xy' ('zai):

i) *Xanthines* - not related to *xenophobia* or *xerosis* - are a group of *alkaloids* commonly used for their effects as mild *stimulants* and *bronchodilators*, notably in the treatment of *asthma* symptoms.

UMP: 1 *Xanthines* (jántʃínzu:), 2 *xenophobia* (dzénəhóɔbiə), 3 *xerosis* (tʃélosɪzu:)

Rev: 1 ('zæθínz), 2 (zènəfóɔbiə), 3 (zèrɔʊsɪs)

ii) *Xylitol* tastes sweet, and highly toxic *xylene* (or *xylol*) tastes like gasoline; however, neither causes *anxiety* in humans.

UMP: 1 *Xylitol* (kísílitɔɔrú), 2 *xylene* (kísílen), 3 *xylol* (kísíl'ɔ:rú), 4 *anxiety* (ənzáɪəʃɪ:)

Rev: 1 ('zailitɔɪl), 2 ('zaili:n), 3 ('zail'ɔ:), 4 (ənzáɪəʃɪ)

2m) Take note of the few words with prefixes 'ze' (zí:) and 'zy' (záɪ); terms/words with (y) are usually of no problem with Japanese students:

i) Numerals with one *zero* are on the order of tens; and those with 2 and 3 *zero*(e)s denote the orders of hundreds and thousands, respectively.

UMP: 1 *zero* (tʃélo), 2 *zero*(e)s (tʃélos)

Rev: 1 (zí:roʊ), 2 (zíroʊz)

Rev(BE): 1 (zí(ə)r-)

ii) Two amino acids form a dipeptide with a peptide bond, and dipeptides usually exist as *zwitterions* or dipolar ions.

UMP: 1 *zwitterions* (tʃétəraɪənzú:)

Rev: 1 ('tsvɪtəraɪənz)

iii) A *zygote* is the diploid cell resulting from *fertilization*, i.e. the union of a sperm with a secondary oocyte or. The process may involve certain *zymogens* or proenzymes.

UMP: 1 *zygote* (dzígoʊt'ɔ), 2 (fértʃíliziʃɔn), 3 *zymogens* (dzim'ɔg'ænzú)

Rev: 1 (záigoʊt), 2 (f'æ:ʃəlɪzɪʃɔn), 3 (záɪmòʊdzɔn)

Rev(BE): 1 (záigoʊt)

2n) Differences with suffixes ‘-gen’ (dʒən) vs ‘-ger’ (dʒə); ‘-gly’ (glái) vs ‘-gli’ (glí); and prefix ‘gy-’ (dʒá) vs suffixes ‘-gy’ (dʒi) and ‘-gi’ (‘gí)

i) Allergy is hypersensitivity caused by exposure to a particular anti**gen** (allergen) resulting in a marked increase in reactivity to that antigen on subsequent exposure, sometimes resulting in harmful immunologic consequences. **Ginger** may alleviate but it does not prevent allergy.

UMP: 1 Allergy (ə'trírú:gí), 2 antigen ('ántʃíg'æ̀n), 3 allergen ('æ̀rírúg'æ̀n), 4 ginger (dʒíndʒá)

Rev: 1 ('æ̀lədʒi), 2 ('æ̀ntɪdʒən), 3 (æ̀lədʒən), 4 (dʒíndʒə)

Rev(BE): 1 ('æ̀lədʒi), 4 (dʒíndʒə)

ii) **Glycolysis**, which involves the participation of hydrogen ions, is an energy-yielding process, which converts D-**glucose** to lactic acid in various tissues (notably muscle) when oxygen is not available.

UMP: 1 Glycolysis (grí:kólísís), 2 hydrogen (hí:dóg'æ̀n), 3 energy ((ə)nnérúgi),

4 D-**glucose** (di-grókoʊs), 5 oxygen ('ə̀kíg'æ̀n)

Rev: 1 (gláikolə́sís), 2 (háıdrədʒən), 3 (énə̀dʒi), 4 (dıglú:kəʊs), 5 (áksıdʒən)

Rev(BE): 3 (énə̀dʒi), 4 (dıglú:kəʊz), 5 ('ə̀ksıdʒən)

iii) **Glycogenolysis** is the hydrolysis of **glycogen** to **glucose**; and glycogen, which is a **glucosan** of high molecular weight, resembles amylopectin in structure.

UMP: 1 Glycogenolysis (grí:kogénələ́sıs), 2 glycogen (grí:kog'æ̀n), 3 glucose (grókoʊzu),

4 glucosan (grókoʊsʌn)

Rev: 1 Glycogenolysis (gláıkodʒı:nələ́sıs), 2 glycogen (gláıkədʒən), 3 glucose (glú:kəʊs),

4 (glú:kəʊsʌn)

Rev(BE): 3 (glú:kəʊz)

More examples with correct American English pronunciations indicated below (typical terms/words that Japanese students find difficulties in pronouncing):

[glái-] glycan, glycemia, glycine, glycogen, glycoside, glycinic, glycemic, glyceride

[glí-] glycerol, glyceride, glycerin, glycine, glycol, glycolic, glycosuria, glycogenesis

[glú:] glucocorticoid, glucosidase, glutamine, glucoside, glucotransferase, glue, glutamate

[-dʒən] antigen, carcinogen, hydrogen, nitrogen, oxygen, pyrogen, mutagen

[dʒə] giraffe, GIP, ginger, gingerol, gingiva, gingivalgia, gingivitis, ginseng

[dʒı:] gene, genal, genome, genius, genus, Geneva, genin, genital, genome

[dʒ'ə:] germ, germanium, Germany, germicide, germinate, gerontology

[-dʒi] allergy, biology, ecology, geology, gynecology, pathology, psychology

[dʒáı-] gyrate, gyration, gyrometer, gyrophoric acid, gyroscope, gyrospasm, gyrus

2o) Pronouncing words with immediate-connecting vowels ‘a’, ‘e’, ‘i’, ‘o’ and ‘u’:

i) **Here are** the results: the **overall** performance of students in Class A was way above average, **whereas** that of Class B was below the average of the other classes in the same academic year.

UMP: 1 **Here are** (híəə / híəə), 2 **overall** (òʊbə'ə:rú), 3 **whereas** (wéəzú)

Rev: 1 (hi:ı, əı), 2 (òʊvə'r'ə:l), 3 ((h)wèə'æz)

Rev(BE): 1 (híə, əı), 2 ('əʊvər'ə:l), 3 (wéə'æz)

More examples with correct American English pronunciations indicated below (typical terms/words that Japanese students find difficulties in pronouncing):

Add in/on, cut in/off/out, dig in/out, eat in/out, fly in/off, go in/on/out, hide in/out, kick in/out/off,

lay off/out, munch on, put on/in/off, queue in, roll in/out/over, run into/away/ switch on/off, way off

Some examples with regional differences:

American: 1 roll (r'əʊl), 2 whereupon ((h)wé(ə)rəpən), 3 what is ((h)wátɔdʒ / (h)wátıɔz)

BE: 1 (rəʊl), 2 ((h)wé(ə)əp'ə:n), 3 (w'ɔtʃ / w'ɔtız)

4. Discussion

It is known that the typical UMPs involving the letters ‘n’ to ‘z’ by Japanese students are basically pronounced in a fashion foreign to the Japanese language (JL). The main causes of poor pronunciation or UMP of science English (SE) words/terms and numerals by Japanese ESL (English-as-a-second-language) learners are not merely due to the shy nature of Japanese^{1,3} but also the single-pronunciation-per-kana na-

ture of JL, as the same mispronunciation is noted for different words having the same alphabetical components (vide supra).¹

The UMPs spoken by Japanese ESL learners go unnoticed by their Japanese peers, juniors, and seniors as most of them have been ‘taught’ or ‘trained’ to pronounce those words/terms and numerals of concern in the same improper JL-based manner by their former teachers/lecturers and/or been exposed to these UMPs previously without being corrected in the course of learning English (pharmaceutical science English in this case): this evokes a version of the well-known parable of the blind person describing an elephant, only in this case it is to another blind person, and then these two blind people describe the elephant again to their friends and offspring (who have never seen an elephant to date), creating a continuous and extensive vicious cycle of the same UMPs being spoken without correction over generations.¹ Therefore, a foreigner listening as a third party to the conversation would wonder how two Japanese speakers could understand each other when he/she (foreign listener) would not be able to follow the ‘JL-based’ pronunciations in their conversation. Japanese students can understand English communication and conversation amongst themselves, even when the pronunciations are definitely incorrect, because they have learned English based on their same mother tongue, and followed teachers/instructors (in prior exposures) using the same ‘JL-based’ pronunciations. Therefore, the root problem is actually caused by the senior educators, who actually have to ‘relearn’ spoken English using a ‘refresher’ course. Employing the help of English-speaking scientists for SE teaching, albeit economically impractical and nonviable, is one potentially useful approach to solving this problem. A more workable alternative is to send young teachers overseas to be trained properly in order for them to terminate the vicious cycle of repeating the same JL-based UMPs over generations: In fact this approach was successfully adopted by the British colonies (e.g. Australia, New Zealand, Ghana, Hong Kong, Singapore and Malaya, etc.) to nurture local people in learning English to run the administration and function of the colonies for the British Empire in the 1930s by sending numerous indigenous students to be trained in Britain as teachers (<https://books.google.co.jp/books?isbn=0194421856>).

In my many years of teaching experience and association with Japanese students/scientists since early the 1980s, I have come to realize that they appreciate being corrected in their UMPs; however, the sound and rhythm of their native language have been so deeply rooted in their habits, behavior, speech-related buccal muscle development, and in their native language or JL-derived enunciation of literary English and SE that great effort, training, patience, and caution have to be exercised to bring them up to par with internationally accepted norms of English pronunciation; while this does not have to be American or British pronunciation, it should be an internationally accepted and easily comprehensible form:⁴ e.g. as commonly spoken by many Europeans (e.g. in Scotland, Ireland, Germany, Sweden, France, etc.) and some English-educated Africans (e.g. in Kenya, South Africa, Egypt, etc.), and Asians (e.g. in India, Malaysia, Singapore, etc.). This standard is good enough to carry out interactive, meaningful, useful, and productive communication worldwide, although ideally a near-perfect copy of native (as this term is subjectively defined) pronunciation is preferred: viz., whether American or British pronunciation is preferred will have to depend on the origin of the subjects concerned. This regional difference in English pronunciation and enunciation⁴ is, in fact, a critical factor in displacing the confidence of the Japanese ESL learners towards their pronunciation. Confidence-building in pronunciation is important indeed for Japanese to be able to learn to speak SE well. Therefore, Japanese ESL learners should focus on a particular major regional English pronunciation version first before they learn another regional English: viz., those ESL learners in British colonies first learn British English, and then realize to cope well with the regional differences of the American English and so on. Learning different regional pronunciations at one time may be confusing and diminish their confidence in being able to speak words and expressions. It is with this in mind that the revised versions (**Rev**) of their UMPs give the American version as the correct versions, since Japanese students learn American English from the time they are young. **Rev(BE)** versions are given to make them aware of the difference, and not so as examples of correct versions. All in all, delivering a clear message from one person to another is the ultimate goal of effective communication. Or in other words, it is best to communicate with the regional pronunciation, enunciation and accent at the place of dwelling: e.g. use the British version when in Britain, and the Australian version when in Australia, and so on. However, so long as regional differences in English and SE pronunciation exist,⁴ basic appropriate and easily comprehensible ‘internationally accepted’ pronunciations are preferred more than the local versions, and are important for acquiring proper spoken English and conducting productive SE conversations.

Therefore, textbooks and learning tools for Japanese ESL learners should come with recorded readings of the content – partial or all inclusive (if possible) – in the form of videos, digital media, and the like.^{5,6} Additionally, computer-based pronunciation aids available online (e.g. <http://ejje.weblio.jp>) are a useful resource for learning pronunciation for all Japanese ESL learners, although the sound quality of some words are not perfect, and the range of terms for which pronunciations are provided are sometimes limited (especially SE terms). As for ESL learners, even native speakers of English have to put in some effort to understand regional differences in speaking and pronunciation of what is still the same language – English – when communicating with those not from the same country, or for that matter not from the same state in the case of vast countries such as the United States (U.S.). There is another problem involved in learning English pronunciation, especially in countries such as the U.S., United Kingdom, Australia, etc. that have centuries-long histories as “melting pots” for people of many races and nations who have immigrated to their lands. Similar to Japanese, some non-English speakers in English-speaking countries mispronounce certain English words, and those UMPs become assimilated as part of the spoken English in that country – though the English-speaking natives first laugh and poke fun of the UMPs – these “errors” become the accepted norm over time. The ‘off-shoot’ of British English now known as American English (or the reverse: <http://www.grammarphobia.com/blog/2012/07/original-pronunciation.html>) has partly been developed over the years out of an analogous process.

Similarly, regional differences in SE exist, especially for certain chemical names and scientific expressions; however, these regional differences can be overcome with time, practice, and repeated exposure. The important steps for Japanese ESL learners to learn English pronunciation well are to: i) listen closely to English-broadcasting mass media (e.g. radio, television, U-tube, etc.); ii) attend English-speaking conferences, and communicate with foreign (especially English-speaking) scientists; iii) read English texts constantly and read them aloud; and iv) listen to digital media (e.g. CDs, videos, etc. provided in textbooks) and repeat the content using the proper pronunciations given by native speakers in order to promote proper buccal muscle development. Going to study abroad definitely helps, and the Japanese government – in fact, any national government with the intent of educating better English-speaking citizens for that matter – should encourage, support, and sponsor young scientists to venture to foreign countries (where English is commonly spoken) to do research, whereupon on their return, having learned to speak fluently with more appropriate pronunciation, they can establish a new generation of Japanese researchers with better SE pronunciation.

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