Knowledge Cycle among Theoretical Linguistics, Psycho-linguistics, and Foreign-language Learning:

Its Theoretical Implications

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Abstract

In linguistic research, theoretical linguistics, psycho-linguistics, and foreign-language learning have been studied in their own ways. To establish their organic relationship, I will propose a model of knowledge cycle. A driving force for the cycle is sentences containing grammatical errors made by foreign-language learners (e.g., *John like apples*). The ungrammaticalness of each sentence can be tested by psycho-linguistic experiments such as acceptability judgments, reaction-time tasks. Attested ungrammatical sentences can be used for theory construction in theoretical linguistics. Insights gained through such error analysis can be applied to devise effective input for efficient learning of foreign languages. Based on further learning, learners produce a new set of ungrammatical sentences, which drives the cycle again. In this paper, I will describe the proposal and discuss its theoretical implications. Particularly, I will adopt the generative syntactic framework and analyze some of the ungrammatical sentences collected from Japanese learners of English as a foreign language. The results show that among three factors (Merge, interface conditions, and natural laws), interface conditions, particularly conceptual-intentional (CI) interface conditions, are crucial to account for the ungrammaticality.

Key Words: theoretical linguistics, psycho-linguistics, foreign-language learning, knowledge cycle, ungrammatical sentences, free-writing task, Japanese learners of English as a foreign language

アブストラクト

　言語研究においてこれまで、理論言語学、言語心理学、外国語学習はそれぞれ独自の方法で研究されてきた。三者の有機的な関係を築くため、「知の循環モデル」を提案する。循環の駆動力は外国語学習者が犯す文法的誤りを含む文（例えば、*John like apples*）である。各文の非文性は言語心理学の実験（例えば、容認可能性判断や反応時間計測）によって検証できる。検証された非文は理論言語学において理論構築に使うことができる。このような「誤り分析」をとおして得られた洞察は、効率的な外国語学習を促すための、効果的な言語入力を考案するために応用できる。そのような入力によるさらなる学習によって、学習者は新たな非文を産出し、再び循環が駆動することになる。本紙では、「知の循環モデル」がどのようなものかを説明し、その理論的含意を議論する。特に、理論的な枠組みとして生成統語論を採用し、日本人英語学習者から収集した非文のいくつかを分析する。分析結果は、三つの要因（併合、インターフェイス条件、自然法則）のう

ち、インターフェイス条件、とりわけ概念・意図インターフェイスの条件が非文性を説明するのに重要であることを示している。

キーワード：理論言語学、言語心理学、外国語学習、知の循環、非文、自由作文課題、日本人英語学習者

1. Introduction[1]

Five basic questions of human language as in (1) have been raised to be answered even if you adopt any theoretical framework.

(1)   Five Basic Questions of Human Language (e.g., Chomsky & Lasnik, 1995)
     a. its nature
     b. its acquisition
     c. its use
     d. its implementation in the brain
     e. its emergence and evolution

Theoretical linguistics has investigated (1a), the nature of human language, mainly in terms of phonetics, phonology, morphology, syntax, semantics, and pragmatics. Its ultimate goal is to construct a comprehensive theory of linguistic knowledge or *competence* in the human mind/brain. Psycho-linguistics has, on the other hand, examined (1c), the use of language, in terms of production and comprehension. Its ultimate goal is to construct a comprehensive theory of *performance* in language use. A second question (1b), i.e., language acquisition, has been approached both by theoretical linguistics, whose purpose is to formalize child grammars in terms of the above areas, and by psycho-linguistics, whose purpose is to examine children's performance and compare it with adults' performance. Recently, a fourth question (1d), the brain implementation of language, is examined by psycho-linguistics (or neuro-linguistics), exploiting a variety of advanced techniques such as Event-Related Potentials (ERPs) and functional Magnetic Resonance Imaging (fMRI) and conducting experimentation with those techniques. More recently, theoretical linguistics approaches a fifth question (1e), the emergence and evolution of language, by minimizing a theory of language and gaining interdisciplinary insights into human language from biology, archeology, ethology, computational linguistics, and so on.

As above, the research interests of theoretical linguistics and psycho-linguistics are different from each other, and thus theoretical linguistics and psycho-linguistics have studied their research questions in their own ways. The goal of the current study is to establish their organic relationship. Foreign-language learning plays an important role. So far, foreign-language learning or teaching has benefited from theoretical linguistics and psycho-linguistics because they provide information mainly about (1a), e.g., the cross-linguistic comparison of a learner's native language and target language, (1b), e.g., the comparison of child language acquisition and adult language learning, and (1c), e.g., the comparison of native language users and second language users. The research question to be addressed in this paper is how foreign-language learning can contribute to theoretical linguistics and psycho-linguistics, as depicted in (2).

(2)   Research Question
    a.   theoretical linguistics and psycho-linguistics → foreign-language learning ✔
    b.   foreign-language learning → theoretical linguistics and psycho-linguistics ?

Theoretical linguistics and psycho-linguistics have contributed to foreign-language learning by providing many linguistic insights from their research as the check mark shows in (2a) (see Yamada, 2014, and references therein), whereas a question remains as to how foreign-language learning can contribute to theoretical linguistics and psycho-linguistics as the question mark indicates in (2b). In this paper, I will propose a possible answer that I will call *knowledge cycle*, which is described in detail in Section 3 below. Before that, in Section 2 we look at how ungrammatical sentences, which play a key role in the cycle, have been dealt with in theoretical linguistics, psycho-linguistics, and foreign-language learning in turn.

2. Ungrammatical Sentences in Human Language

One of the most fundamental facts about human language is that some strings of words are judged as *acceptable* or *grammatical* by native speakers of a language in question, while others are judged as *unacceptable* or *ungrammatical*, as shown in (3).[2]

(3)   a.   A boy chased a girl.
    b. *Girl a chased boy a.

Native speakers of English accept the string of words in (3a) as grammatical but reject that in (3b) as ungrammatical (an asterisk (*) means that the string of words in question is ungrammatical). This fact of ungrammaticality is related to theoretical linguistics, psycho-linguistics, and foreign-language learning.

In theoretical linguistics, ungrammatical sentences have been used as major sources for theory construction. Generative syntax, in particular, heavily depends on them for its theory construction, answering the question of why an ungrammatical sentence is the way it is (e.g., Boeckx, 2011; den Dikken, 2013). It assumes that ungrammatical sentences reflect the fact that there are rules or principles in the human mind/brain to generate sentences and that a sentence becomes ungrammatical when those generative rules or principles are violated. For example, consider the following pair of sentences:

(4)   a. *John slept Mary.
    b.   John slept.

A verb, *sleep*, becomes grammatical if it takes the subject only as in (4b), but ungrammatical if it takes both the subject and the object as in (4a). This contrast leads to the conception of *argument structure* that the number of arguments that a verb can take is fixed and a sentence becomes ungrammatical if a verb takes more or less arguments than required, or *theta-Criterion* that the number of theta-roles such as agent and patient that a verb can assign to arguments is fixed and a sentence becomes ungrammatical if an argument is not assigned a required theta-role (e.g., Williams, 2015). According to argument structure, the sentence in (4a)

becomes ungrammatical because *sleep* is an intransitive verb and can take only one argument and thus the existence of *Mary* violates this rule. According to theta-Criterion, the sentence in (4a) also becomes ungrammatical because *sleep* can assign an agent role to its subject but cannot assign any theta roles to any other arguments and thus the existence of *Mary* violates this rule. Like this, a variety of rules and principles have been proposed in generative syntax, depending on the contrast between grammatical and ungrammatical sentences. Note, however, that there is a constant criticism on using such an ungrammatical sentence as (4a) for theory construction (see, e.g., Sprouse & Almeida, 2012). That is, such a sentence as (4a) is merely an example sentence created by linguists, and that kind of sentence would never be produced or heard in daily life. Thus, it is dubious that a linguistic theory can be constructed on the basis of such data. It may be the case that the reason for why the sentence in (4a) is ungrammatical is not related to any rules or principles in our heads but is simply the fact that such sentence is not used at all in our daily life. I will call this *the issue of data reliability* in theoretical linguistics and consider it under the proposal to be described in Section 3 below.

In psycho-linguistics, ungrammatical sentences are used to examine whether language users respond differently to grammatical and ungrammatical sentences or not. Using acceptability judgments, the contrast between ungrammatical and grammatical sentences as in (4a-b) above has been examined quantitatively (e.g., Myers, 2009). For instance, the acceptability of sentences is measured, using a Likert scale (e.g., from 1 for totally unacceptable to 7 for totally acceptable). In the case of (4a-b), the sentence in (4a) is judged as close to 1.0 and that in (4b) as close to 7.0. This method is useful to examine the gradable nature of ungrammaticality, i.e., the degrees of unacceptability are different from ungrammatical sentence to ungrammatical sentence. Ungrammatical sentences have also been examined by using more advanced techniques such as self-paced reading, eye-tracking, Event-Related Potentials (ERPs), and functional Magnetic Resonance Imaging (fMRI) (e.g., Carreiras & Clifton, 2004; Gaskell, 2007). For example, consider the following pair of sentences known as *agreement attraction/interference* (e.g., Bock & Miller, 1991):

(5) a. The key to the cabinets was broken.
     b. *The keys to the cabinet was broken.

The sentence in (5a) is grammatical because the singular subject (*the key to the cabinets*) agrees with the *be*-verb (*was*) in number. On the other hand, the sentence in (5b) is ungrammatical because the subject-verb agreement is violated, although the inside element of the subject (*the cabinet*) agrees with the *be*-verb (*was*) in number. In self-paced reading, the sentences as in (5a-b) are presented in a word-by-word or phrase-by-phrase fashion. The experimental results show that there is a slowdown in reading the *be*-verb (*was*) in ungrammatical (5b), compared to grammatical (5a) (see, e.g., Wagers, Lau, & Phillips, 2009). Like this, we can gain information about the nature of ungrammatical sentences, e.g., how ungrammatical a sentence in question is, exploiting psycho-linguistic techniques. An adopted assumption is that ungrammatical sentences are harder to process than their grammatical counterparts. Psycho-linguistics provides us with performance-based data through experimentation, which may be useful to resolve the issue of data reliability in theoretical linguistics as pointed out above.

Finally, in foreign-language learning, ungrammatical sentences are pervasive. In daily practices, foreign-language learners frequently produce sentences containing grammatical errors (I will call them *ungrammatical sentences* below). For example, Japanese learners of English as a foreign language make such errors as in (6) (for clarity, the source of ungrammaticality is underlined).

(6)   a. *It's <u>a</u> my strength.
      b. *In my university life, I'd like to go __ many countries.
      c. *There are many good winter <u>song</u>.
      d. *And I <u>takes</u> photos very well.
      e. *When I can't <u>sleeping</u>, I'm very tired and can't <u>lives</u>.

In (6a), a single slot is occupied by two determiners, *a* and *my*, and thus the sentence is ungrammatical. In (6b), the missing preposition, *to*, makes the sentence ungrammatical. In (6c-d), number and subject-verb agreement fails and thus the sentences are ungrammatical.   In (6e), the verbs following the auxiliaries are mistakenly inflected, resulting in the ungrammaticality. These ungrammatical sentences are theoretically intriguing because they lead to a question of why learners produce such sentences in spite of the fact that in their learning, they rarely receive ungrammatical input. The ungrammatical sentences as in (6) are also practically/educationally helpful to learners as well as teachers. In foreign-language classrooms, teachers pursue the most effective teaching of the target language and learners seek the most efficient learning of it. For example, the ungrammatical sentence in (6a) is useful for teachers to realize that their students have difficulty in learning the determiner system in English, leading to their efforts to devise an effective way of teaching it. On the other hand, the sentence in (6a) enables learners to notice an error in their performance and to have an opportunity to develop their efficient learning of the determiner system in English. By psycho-linguistic experiments such as acceptability judgments, we can determine whether the sentences produced by learners are grammatical or ungrammatical as shown in (6). By error analysis based on theoretical linguistic insights, we can know the source of ungrammaticality as indicated in (6). Moreover, we can investigate what kind of input is effective to reduce learners' errors as in (6), considering psycho-linguistic insights, e.g., into what kinds of strategy Japanese learners use in the processing of English sentences (see Yamada, 2014, and references therein).

In summary, in foreign-language learning, insights from theoretical linguistics and psycho-linguistics are helpful both to learners for their efficient learning and to teachers for their effective teaching. How does foreign-language learning, then, contribute to theoretical linguistics and psycho-linguistics? Recall that theoretical linguistics suffers from the issue of data reliability. Ungrammatical sentences in foreign-language learning are naturally produced by learners and are not such example sentences as artificially created by linguists. Furthermore, the ungrammaticalness of each of learners' sentences can be examined empirically by psycho-linguistic experimentation. In the subsequent section, I will propose an organic relationship among theoretical linguistics, psycho-linguistics, and foreign-language learning.

3. Proposal: A Model of Knowledge Cycle

As the previous section shows, theoretical linguistics and psycho-linguistics have contributed to foreign-language learning, providing linguistic insights into the sentences produced by foreign-language learners. A question to be addressed in this paper is how foreign-language learning can contribute to theoretical linguistics and psycho-linguistics. As a possible answer to this question, I will propose a model of *knowledge cycle* as in Figure 1.
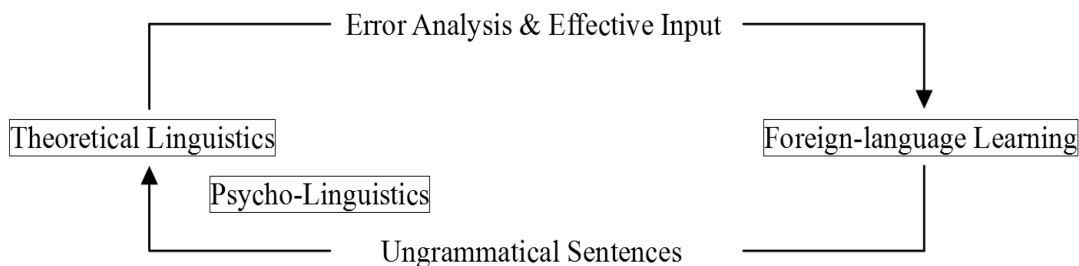
Figure 1   A Model of Knowledge Cycle

In Figure 1, ungrammatical sentences produced in foreign-language learning can be the driving force for the cycle. Those sentences are naturally produced by language learners in their daily practices. Thus, they contribute to resolving the issue of data reliability in theoretical linguistics. For data reliability, the ungrammaticalness of learners' sentences can be examined by a variety of psycho-linguistic techniques from an off-line acceptability judgment questionnaire to an on-line self-paced reading task, for example. After the ungrammaticalness is proved empirically or experimentally, each of the learners' sentences can be analyzed in theoretical linguistics to construct a theory for why the sentence in question is ungrammatical and what kind of underlying rule or principle in our mind/brain is responsible for that. Error analysis based on theoretical linguistic insights in turn contributes to foreign-language learning in that the source of ungrammaticality is made explicit and consequently it will turn out to be clear which aspects of grammar learners tend to have difficulty in learning, resulting in a number of errors. Moreover, effective input can be provided to learners for their efficient learning, considering psycho-linguistic insights into how they process the input from the target language. In foreign-language learning based on such input and the related teaching treatment, learners produce a new set of ungrammatical sentences, which drives the cycle again.

As a preliminary study, this paper focuses on collecting and analyzing ungrammatical sentences produced by Japanese learners of English as a Foreign Language (hereafter Japanese EFL learners). In Section 4, I will describe the results of the study. In Section 5, I will analyze some of the ungrammatical sentences in generative terms and discuss the theoretical implications of the proposed knowledge cycle.

4. A Preliminary Study: Ungrammatical Sentences of Japanese EFL Learners

This section describes the results of free-writing tasks that collected ungrammatical sentences from Japanese EFL learners.

Participants

There were two groups of Japanese EFL learners. One group consisted of 16 undergraduate non-English majors at Gunma University. The other group consisted of 20 undergraduate and graduate English majors at Gunma University. I will call these two groups *Group 1* and *Group 2*, respectively.

Materials

The number of topics for free-writing was different between Group 1 and Group 2. For Group 1 (non-English majors), 28 topics in (7) were provided.

(7)   28 Topics for Free-writing of Group 1
   1. Write freely about your summer vacation.
   2. Write freely about yourself.
   3. Write freely about your best/good friend(s) or family member(s).
   4. Write freely about your strengths and weaknesses.
   5. Write freely about what you did on the weekend.
   6. Write freely about your university friends.
   7. Write freely about your memory of elementary school.
   8. Write freely about your memory of junior high school.
   9. Write freely about your memory of high school.
   10. Write freely about your university life.
   11. Write freely about what kinds of food you have eaten so far.
   12. Write freely about your favorite Japanese food.
   13. Write freely about how you have fun without much money when you are with your friend(s).
   14. Write freely about how you have fun without much money when you are alone.
   15. What kinds of thing do you have in your room? How do you use them?
   16. Which room do you like the best in your house? Why?
   17. If you are allowed to have in your own house as many things as you like, what do you want? Why?
   18. If you are allowed to have only three things in your own house, what do you want? Why?
   19. Which season(s) out of four do you like the best? Why?
   20. If you were on the { hottest/coldest } day, how would/could you spend that day?
   21. What did you do during the holiday season (including Christmas, the New Year)?
   22. What should we do when a big storm is coming?
   23. Do you have any bad habits? What are they?
   24. How can you change your bad habits into new good ones?
   25. Do you like Japan? Why or why not?
   26. Do you like your hometown? Why or why not?
   27. Books are necessary for humans. Is that correct or not? What do you think about that?
   28. What is the most impressive memory in your life?

For Group 2 (English majors), on the other hand, the following five topics were provided:

(8)   Five Topics for Free-writing of Group 2
      1. Write freely about yourself.
      2. Write freely about your best/good friend(s) or family member(s).
      3. Write freely about your memory of junior high school.
      4. Write freely about your favorite Japanese food.
      5. If you are allowed to have only three things in your own house, what do you want? Why?

Procedures

Procedures used for data collection were also different between Group 1 and Group 2. For Group 1, the data were collected in an English course as follows. For one topic as in (7), each of 16 participants was given a response sheet with lines and ten minutes to write freely about it. In each class, there were two topics with a one-minute interval between them. There were 28 topics in total for free writing during the course. The participants were not permitted to use paper or electronic dictionaries in writing. Note that since there were absent students in some classes, it was not the case that all the 16 participants responded to every topic for writing.

For Group 2, the 20 participants were paid for data collection. For one topic as in (8), each of them was given a response sheet of the same kind used for Group 1 and ten minutes to write freely about it. There was a one-minute interval between topics. The participants were not allowed to use dictionaries.

Data Treatment

Data treatment was the same for both groups. First, the total number of collected sentences was calculated. To focus on grammatical errors, then irrelevant data were excluded from further analysis (for example, grammatical sentences (e.g., *We can ski*.), sentences with spelling errors (e.g., *We can eat schew*.), and sentences that are hard to understand semantically (e.g., *I like winter in the garden*.)), and the number of remaining ungrammatical sentences was calculated. Finally, the remaining sentences were categorized into the types of grammatical error.

Results

First, the total numbers of collected sentences were 2119 for Group 1 and 1800 for Group 2.

Second, the numbers of ungrammatical sentences were 592 for Group 1 (i.e., 27.9% of the data remained) and 291 for Group 2 (i.e., 16.2% of the data remained).

Third, the following five major types of error were identified: determiner, preposition, number agreement, subject-verb agreement, and tense/aspect (see Appendix for some of those ungrammatical sentences collected from Groups 1 and 2).

(9)   a.   *It's <u>a</u> my strength. (Determiner)
      b.   *In my university life, I'd like to go __ many countries. (Preposition)
      c.   *There are many good winter <u>song</u>. (Number agreement)

    d. *And I <u>takes</u> photos very well. (Subject-verb agreement)

    e. *When I can't <u>sleeping</u>, I'm very tired and can't <u>lives</u>. (Tense/aspect)

5. Generative Analysis and Theoretical Implications of the Proposal

In the current theorizing of generative syntax, only the following three factors are assumed to be involved in (the core part of) human language:

(10)   Three factors in human language (e.g., Chomsky, 2013, 2015)

      a. Merge

      b. Interface Conditions

      c. Natural Laws

The most basic property of human language is that we can create an infinite array of hierarchically structured expressions. The operation that makes it possible is called *Merge*, taking two syntactic objects, X and Y, and forming a set containing them, {X, Y}. For example, consider the following derivation:

(11)   a. the, book

      b. Merge(the, book) → {the, book}

      c. the book

First, two objects, *the* and *book*, are taken as in (11a). Second, those two objects are merged, resulting in a set containing them, *{the, book}*, as in (11b). Finally, a new syntactic object, *the book*, is created as in (11c). Merge is assumed to be *free* in that any two objects can be combined and to be *recursive* in that the operation is applied without limit, leading to the fact that we humans can create the infinite number of sentences. In this sense, Merge is not responsible for the ungrammaticality of a sentence. Thus, two other factors, *interface conditions* and *natural laws*, are responsible for that.

    Human language is assumed to be interfaced with two distinct systems, Sensorimotor (SM) and Conceptual-Intentional (CI). The syntactic objects created by Merge such as *the book* in (11c) are instructions to the two systems, and the SM system converts them into the externalized forms of language such as sounds and signs and the CI system converts them into the internalized forms of language such as meanings and thoughts. These two interfaces impose conditions on the products of Merge to examine whether they are interpretable at the interfaces. Those conditions are called *interface conditions*. For example, consider the following derivation:

(12)   a. a, books

      b. Merge(a, books) → {a, books}

      c. a books

Two objects, *a* and *books*, are taken and merged, resulting in a set containing them, {a, books}, as in (12a-b). The consequent syntactic object, *a books*, as in (12c) is then checked by interface conditions at SM and CI systems. It is no problem at the SM interface because the sequence of *a books* can be pronounced or phonetically realized in English. On the other hand, *a books* is problematic at the CI interface because an indefinite determiner, *a*, requires a singular object as its complement but *books*, which follows it, is a plural noun. Thus, the syntactic object, *a books*, is not interpretable at the CI interface.

The third factor in human language in (10c) is not specific to language but is assumed to be organism-independent. Thus, *natural laws* govern every natural phenomenon of the world. As one of them, *minimal computation* is assumed to be relevant to account for the linguistic phenomena (see, e.g., Chomsky, 2014). The basic idea of minimal computation is that more minimal is better. For example, consider the following derivation of *what you like* as in a sentence, *I wonder what you like*:

(13) a. Merge(like, what) → {like, what}
      b. Merge(you, {like, what}) → {you, {like, what}}
      c. Merge (what, {you, {like, what}}) → {what, {you, {like, what}}}
      d. what you like what

First, *like* and *what* are merged, resulting in *{like, what}* as in (13a). Second, *{like, what}* and *you* are merged, and a new object *{you, {like, what}}* is created as in (13b). Third, *what* is internally merged (i.e., *what* inside of the object *{you, {like, what}}* is taken and merged into that object), resulting in *{what, {you, {like, what}}}* as in (13c). The consequent syntactic object, *what you like what*, as in (13d) is not grammatical in English. The grammatical counterpart is *what you like*. Here, minimal computation is crucial in that at the SM interface, it requires minimal articulation. *What you like what* is ungrammatical because it violates this principle. *What you like* is grammatical because the lower copy of *what* is deleted and minimal computation principle is satisfied. In sum, when we assume three factors in human language as in (10a-c), any syntactic objects can be created by Merge but their grammaticality is checked by interface conditions and natural laws.

Now, I will analyze some of the ungrammatical sentences collected from Japanese EFL learners in terms of the above three factors and discuss theoretical implications of the proposed knowledge cycle. For analysis, I adopt the following logic of argumentation:

(14)   The logic of argumentation
        If an *un*grammatical sentence can be generated by the three factors, then other factors are needed to
        assume in order to explain the ungrammatical status of that sentence.

                                                                            (Yamada, 2016b: 11)

Following this logic, we can revise the current generative theory based on the three factors. If any of the three factors turn out to be irrelevant to the ungrammaticality of a sentence, other factors should be added to explain the ungrammaticality in human language. For analysis, I focus on the following five ungrammatical sentences (sentences in (9) are repeated as those in (15) here):

(15) a. *It's <u>a</u> my strength.

　　　b. *In my university life, I'd like to go __ many countries.

　　　c. *There are many good winter <u>song</u>.

　　　d. *And I <u>takes</u> photos very well.

　　　e. *When I can't <u>sleeping</u>, I'm very tired and can't <u>lives</u>.

First, the sentence in (15a) is generated by Merge as *{It, {is, {a, {my, strength}}}}* (*It* and *is* are contracted as *It's* at the SM system for articulation). This sentence is no problem at the SM interface because it can be pronounced properly. However, it is problematic at the CI interface because *a* expresses the indefinite property of the noun that follows it, whereas *my* expresses someone's possession or the definite property of the noun that follows it. Thus, the simultaneous use of *a* and *my* is semantically uninterpretable. A relevant CI interface condition accounts for the ungrammaticality of (15a). If a single noun can be preceded by only one determiner, minimal computation is also relevant for the ungrammaticality of (15a) because the double use of determiners, *a* and *my*, violates it. Second, the sentence in (15b) can be generated by Merge as *{I, {would, {like, {to, {go, {many, countries}}}}}}* (here, we focus on *I'd like to go many countries*, and *I'd* is a contraction of *I* and *would*). *I'd like to go many countries* can be pronounced and thus it is no problem at the SM interface. Minimal computation may be irrelevant for its ungrammaticality. The sentence might be semantically interpretable because based on the meaning of *go*, the noun phrase, *many countries*, is interpreted as the destination. If that is the case, other factors than the three should be assumed. However, if a relevant preposition such as *to* must be inserted to realize the destination interpretation, a relevant CI interface condition may be related to the ungrammaticality of (15b). Third, the sentence in (15c) is generated by Merge as *{There, {are, {many, {good, {winter, song}}}}}*. It is no problem at the SM interface because it can be pronounced. Minimal computation is also irrelevant for the ungrammaticality of (15c). Assuming that a (countable) noun cannot be interpreted as plural if a plural marker is not added to it, *song* does not agree with *many*, which requires a (countable) noun that follows it to be pluralized. Thus, a relevant CI interface condition accounts for the ungrammaticality of *There are many good winter song* in (15c). The sentence in (15d) is also generated by Merge like *{I, {{takes, photos}, {very, well}}}* (the sentence-initial word, *And*, is not considered here). The sentence can be pronounced and thus it is no problem at the SM system. If *takes* requires its subject to be the third person, the first person *I* cannot be interpreted properly with it. Thus, a CI condition may explain the ungrammaticality of (15d). Another possibility might be related to minimal computation because the addition of an unnecessary tense morpheme *-s* to *take* in (15d) violates this principle. Finally, the sentence in (15e) can be generated by Merge as *{I, {can, {not, {sleeping}}}}* (here, we focus only on *I can't sleeping*, and *can* and *not* are contracted as *can't*). Since *I can't sleeping* can be pronounced, it is no problem at the SM interface. As discussed above, minimal computation might be relevant here because the addition of an unnecessary aspect morpheme *-ing* to *sleep* violates it (*can't* requires the verb that follows it to be bare infinitive). Another possibility is related to a relevant CI condition because the meaning of *can't* does not match with the progressive meaning of *sleeping*. Like this, ungrammatical sentences can be used to examine whether the rules or principles proposed in theoretical linguistics are relevant or not to account for their ungrammaticality.

　　　As theoretical implications of the knowledge cycle, collecting ungrammatical sentences from

foreign-language learners contributes to resolving the issue of data reliability in theoretical linguistics. It is often criticized that the data used in generative syntax are problematic for theory construction because they are just example sentences created by linguists, some of which are never used at all in daily life. Since language learners naturally produce such ungrammatical sentences as collected in the current study, those sentences can be analyzed to examine whether the rules and principles proposed in generative syntax such as the three factors in (10a-c) can account for their ungrammaticality or not as demonstrated above. This contributes to revision of the current theory and, as a consequent, to new theory construction. Note that before analysis, however, the ungrammaticalness of each sentence should be empirically attested through psycho-linguistic experimentation. A future issue is what kinds of experiment are relevant to examine the ungrammaticalness of learners' sentences.[3]

6. Conclusion

I have proposed a model of knowledge cycle to achieve an organic relationship among theoretical linguistics, psycho-linguistics, and foreign-language learning. So far, insights from theoretical linguistics and psycho-linguistics have been applied to foreign-language learning. However, a question remains as to how foreign-language learning can contribute to theoretical linguistics and psycho-linguistics. As a possible answer to this question, I have presented the idea of knowledge cycle as in Figure 1 above. Based on the preliminary study, I have argued that ungrammatical sentences produced by foreign-language learners can be used for theory revision and construction in theoretical linguistics.

Notice that the proposed cycle in Figure 1 above can be applied to any foreign languages and to any theoretical linguistic frameworks. We can collect ungrammatical sentences from learners of any foreign languages, and can analyze them adopting any theoretical frameworks. In this sense, the model of knowledge cycle that I have proposed in this paper is universal and will have a far-reaching ramification for the research in theoretical linguistics, psycho-linguistics, and foreign-language learning.

Notes

1. This paper is an extended version of the manuscript (Yamada, 2016a) presented at TL/MAPLL 2016 at Waseda University on July 23rd, 2016, and portions of the paper were presented there. I would like to thank the audience for their insightful comments.

2. Strictly speaking, the notions of grammaticality and of acceptability are not interchangeable because there are sentences which are judged as grammatical but unacceptable (e.g., a famous sentence, *Colorless green ideas sleep furiously*, which sounds grammatical in English but is indeed unacceptable due to the semantic anomaly (Chomsky, 1957)). In this paper, however, I will use the term *grammaticality* as if it covered the notion of acceptability. (See Sprouse, Schütze, & Almeida, 2013, for discussions on these notions.)

3. Another future issue is the empirical fact that more performance factors are involved in a second language, compared to a

native/first language. Thus, it is necessary to exclude factors irrelevant to the nature of linguistic ungrammaticalness.

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Appendix: Ungrammatical Sentences Collected from Japanese EFL Learners

The following sentences are categorized by focusing only on the major sources of ungrammaticality, which are underlined (spelling errors are not considered here). Thus, note that some of the sentences contain more than one type of grammatical error.

Determiner

I have been playing soccer since I was 1 grade in a elementary school.

When I was 6 grade in a elementary school, I have been chosen Gunma prefecture player once.

It was so exciting experience for me.

As for my hobby, I like reading book, watching movie, and running.

Especially, I have been into watching movie now.

I also belonged the orchestra club when I was high school student.

I had stayed with host family in Maine, United States, for one year.

I often go to jim, and run however I can.

I especially like fruits, such as peaches, oranges, and cherry.

My dream is to become good wife and wise mother.

Watching movie is very fun and useful for studying.

We were able to a lot of kinds of music, so my experience in high school was good memory.

I like playing sports, so I belong to badminton club.

When I was in junior high school, the teacher taught me soccer in club.

First of all, as my strong points, I'd like to say it is the ability to perceive something with third view.

Actually, since I entered university, I've been teaching soccer to autism children.

I guess, that's why, now, I'm able to perceive something with third view.

In my university, I'm a member of kendo club.

Also, my hobbie is to go trip.

I will be second grade student two month later.

I'm looking forward to being it, but I'm anxious about harder study than first grade's study.

Besides studying, I have belonged to orchestra.

When I was a high school students, I won 8th prize at the last tournament.

I will stay with host family.

I'm positive person.

I was in track and field club when I was a high school students.

I met him when I entered junior high school.

In the last year, we're facing entrance exam.

He is so kind and shy person.

We often played baseball, soccer, card game etc.

He will come back to Gunma during spring vacation, so I want to climb mountain with him.

Older brother is Takahiro.

Younger brother is Masahiro.

She is a senior student of Gunma University same to me.

When I was second grade student, I met her.

When we were third grade student, we could be the same class.

When I was worried about my the exam of entrance university, she listened to my talking a lot.

I think we are very good friends because we could go through everything, for instance, hard time, awful teacher, lack of member, happy time and so on.

She is good at playing piano, too.

My best friend is someone in English major.

Living in other country was much more stressful than I expected, ….

He always talks to me about what happiness is, what cosmos is, and why we live.

Next person is Sota.

He is my teammate of soccer club.

He is also my teammate of soccer club.

He is really kind, and he is loved by all the students in English major.

He is a member of kendo club, and he practices kendo even after he went to San Diego.

He sometimes calls me and other friends in English major.

When I was a junior high school student, I joined tennis club.

My best memory in junior high school is school trip.

I enjoyed walking around shrine or temple.

To ride shinkansen was first things for me.

Junior high school has a lot of event, for example, sports festival and cultural festival.

First, I was a member of softball club.

When I was a junior high school, I belonged to kendo club.

All of us had very good relationship.

When I was 7th grade, I couldn't make up decision of what club activities to join easily.

When I went to just watch kendo club, all 8th or 9th grade students treated me very kindly and I felt comfortable to be there, so I made up my mind.

Even so, I just kept practicing it because I was attracted by teacher's humor and passion and inspired by my kendo friends.

They are study's memory and soccer's memory.

First, I want to write about soccer's memory.

When I was junior high school student, I have been a member of "Zasupa Kusatsu" club team.

So, it's hard for junior high school student to go there by train.

When I was first grade, I cleaned a local river as a volunteer activity with my all classmates and teacher.

I have played tennis, made some arts, placed at top ten at marathon competition, worked on calleography … and so on.

I have many memories with them, I think, it is part of my dream for being teacher.

Finally, we could get the gold prize in the our final conpetence.

My most exciting, touching, and sad memory of junior high school is club activity.

When I was in junior high school, I was a member of soccer club.

I was a member of soccer and ekiden team.

The members of ekiden team get together every three month and share the memory in junior …

When I was in JHS, I was a member of soccer club.

I was a member of tennis club when I was a junior highs school student.

My best memory of junior high school is musical festival.

All class practice hard to get good prize, so this season was very fun for me.

They were not able to sing a song with little voice in festival.

My best memory of junior high school is club activity.

I was a member of soccer club.

I especially enjoyed club activity.

I was a member of soft tennis club.

The days we spent together is good memory for me.

I joined volleyball club.

It was hard for me, but finally we joined prefectural volley-ball tournament.

I belonged to brassband and played the tube.

I was in track and field club.

I joined basketball team and baseball team.

Actually, we had four in basketball club, though we need at least five to play basketball.

Then, I loved sports, so my coach of track and field club let me join other clubs.

I joined basketball team in the morning, and our track and field club practiced in the afternoon.

I attended to baseball team, also.

I finally got uniform, and I took part in some games.

These experiments made me stronger and I became better and better in track and field club.

In my last race, I got 6th prize in Gunma Prefectural competition.

It's not near my house, so I used train.

I selected table tennis club.

Since I was small, I've liked eating sushi at sushi restaurant.

Besides, it was served to table in about three minutes.

It doesn't have nice smell like flowers, ….

And both Udon and natto is cheap, so it is good point of them, too.

Second one is to eat natto with tsukemono.

Third one is to eat natto with tuna.

Ramen was eaten by Mito Mitsukuni who is known as Mitokomon at first time.

Other style "gunkan" is popular, too.

I definitely want to say not so cute woman who loves Natto is better than cute woman who dislikes it.

When I sometimes brought a lunch box in school event, the lunch box often had some karaages.

I went to karaage shop.

In English, onigiri is rice ball.

Onigiri is very cheap meal because it is selled everywhere like convenience store and supermarket, and it's about from 100 to 300 yen.

There are various kinds of ramen shop close to campus.

Not just close to campus, but along the Sangyo Road, there are some favorite shops like Hashigoya.

So I sometimes took amtrack, which is a fast train in the US, to go to LA for ramen.

Japan is surrounded by sea and there are some lakes and thousands of rivers.

We sometimes have takoyaki party.

If I face in such a situation, I want to softly bed, kitchen goods and clock with alarm.

If I sleep in hard bed or on the floor, I won't sleep well.

Therefore, I want softly bed.

I want to make delicious meal or sweets for my friends.

Moreover, I often stop alarm, so I want hangable clock.

I want great clock ⋯

It gives me good environment to sleep.

Second, book is very important for me.

Especially I like book about world trip.

The library of Gunma University is not very useful because they are open until 9 p.m. during semester, but thet are open only until 5 p.m. during the break or weekends.

The first thing that I want in my own house is large garden enough to park more than four cars.

I park my car outside under a tree now, so sometimes birds or cat poo on my car.

If I am allowed to have only three things in my house, I want a television, an air conditioner, and DVD player.

I like wathing TV and movies, so I need television and DVD player.

I don't like cold weather.

Only human, especially beautiful woman can change that sad and dark life.

First I want TV.

Music play is also good.

However sometimes only sound is boring.

Therefore, I want TV.

Only watching TV is boring.

I like sports especially exercise which uses balls.

First of all, I want a smart phone because if I have it, we can do a lot of things, for example to contact with someone to use Internet, to enjoy music, movies and games and so on.

I think that it is most important thing whether we have smart phone or not.

Third, I want TV.

I like TV show very much.

I want foods, TV and iPhone.

Next, I want TV.

Without TV, I have nothing to do.

I can't imagine the life without TV.

First one I want are clothes.

I do not have clothes very much, so I often wear same clothes.

Second one is a foreign who can speak English.

I don't have third one.

Kotatsu can make good atmosphere.

Second, I want bath.

Third, I want bed.

We spend much time on sleeping, nice bed is necessary for our great life.

In my case, I want to have food, bed, and bath.

Bed is good for sleeping and relaxing.

We need bed to sleep well in the night.

The final one is bath.

Bath is the place where we can be cleaned.

When we take shower and bath, it gets better.

It's a symbol of strong man for me.

I want piano, book shelf, and a picture of my family.

My parents bought grand piano for me when I was 5 years old.

I play the piano not so much any more than I used to but it still good thing to me.

I love to read manga so I need book shelf, big one.

So I get a my family picture with me.

If I'm allowed to have only three things in my own house, I want bed, my smart phone, and my pets.

Because I think that if I have smart phone, I could do everything.

I need bed, TV, and desk.

First, without bed, we cannot sleep, or if we could, the sleep with bed may be much better.

So, we absolutely need bed.

Second, I like watching TV, is the reason that I choose it.

TV is the best teacher in our houses.

We can learn, study, enjoy in our house if we have TV.

That's very simple life.

Food? Radio? TV? What?

Preposition

I belong the English-major of education in Gunma University.

I belonged the wind-orchestra club when I was a junior high school student.

Now, I belonged "Gunma University Philhormony Orchestra."

I want to continue playing the trumpet, and listening to the orchestra, if I become a teacher, and if I married to someone, ⋯

What I want to try in the future, considering this situation, is to motivate students to learn English by talking them about my experience in San Diego ⋯.

In my university life, I'd like to <u>go</u> many countries.

He now works <u>for</u> Tokorozawa city hall.

I like talking, so we didn't talk <u>first</u>.

I talked to her <u>a lot of things</u>.

I spend most time <u>to</u> my club activities.

Sometimes, I wish I could go back <u>that time</u>.

In order to clean the river, we first researched <u>about</u> how dirty the river was with anb experiment material.

My Japanese teacher always point out <u>me</u> and make me read aloud the textbooks so that I wouldn't fall asleep.

I went to Kagawa just for eating Sanuki Udon <u>in</u> this spring.

The most popular style <u>about</u> sushi is "nigiri".

I think it can be one good reason to choose the place we <u>go</u>.

I like choosing and <u>looking</u> closes.

Actually, a beautiful girl has some merits to <u>live</u>.

Today, we can buy meals in supermarkets without cooking <u>ourselves</u>.

We can study and get credits if we watch some programs and lessons <u>in</u> TV.

Number Agreement

Since I was <u>a junior high school students</u>, I have been dreaming to become a teacher.

<u>The memories</u> in this school is my supreme <u>memory</u>.

I'm really happy to have such <u>a wonderful friends</u>.

He is also <u>one of my oldest friend</u>.

He has read <u>a lot of book</u> since he was a child, so He has knowledge a lot.

I didn't think we became <u>a good friends</u> at first.

<u>They</u> are <u>my softball team member</u> in Maebashi Girls' high school.

I had to participated in <u>both practice</u> all through the years, so I often fell asleep during classes.

Of course, not <u>all of the memory</u> was good, but they were very good memories.

<u>Everyone</u> except me was <u>girls</u>.

I couldn't communicate with <u>an exchange students</u> who stayed at my home at all.

Udon can be cooked in <u>various way</u>.

So, we can enjoy <u>many tastes or flavor</u> of Udon.

We have <u>much kind</u> of onigiri.

We can catch various fishes in <u>those area</u>, and the sort of fish is different from the area.

It's <u>a group of hero</u>.

To have it is <u>one of my dream</u>.

For <u>other example</u>, ⋯.

Subject-verb Agreement

Third, <u>our teachers was</u> bad.

Good friends mean <u>someone who give</u> many advices.

<u>First friends is</u> Hiromu.

<u>Their name are</u> Taichi and Zakiyama.

<u>Some people says</u> they prefer Soba to Udon.

<u>A cook slice a tuna and put it on the rice</u>.

<u>It smells so bad and taste strangely</u>.

<u>Fukushima city where is my hometown consume</u> natto more than Mito city.

I prefer a music player to <u>a simple alarm that just make</u> noisy sounds.

Tense/Aspect

I <u>have play</u> softball since 10 years old.

When I was a child, a deer suddenly <u>approach</u> me.

There, we came across a girl who <u>seems</u> some trouble occurred to her.

However, they <u>were seemed</u> to dislike this idea.

So I <u>wanted be</u> a social teacher though I am majoring in English.

That's because after eating takoyaki "aonori" usually <u>put</u> on my tooth.

Then I want <u>bring</u> only my favorite close.

Secondly, as a student, I'd like to have a desk for <u>study or read books</u>.

When we are in bed, we can feel <u>relax</u>.

We <u>take memos and scheduling the future</u> in our own dialy.