Influences of Linguistic Factors on the Acquisition of Explicit and Implicit Knowledge: Focusing on Agreement Type and Morphosyntactic Regularity in English Plural Morpheme

Kunihiro KUSANAGI
Graduate School, Nagoya University
Junko YAMASHITA
Nagoya University

Abstract

The present study investigated effects of agreement type and morphosyntactic regularity on L1-Japanese learners’ acquisition of explicit and implicit grammatical knowledge of the English plural morpheme. We adopted a timed grammaticality judgment task (TGJT) to measure implicit knowledge and an untimed grammaticality judgment task (GJT) for explicit knowledge in order to observe differences between learning difficulties in each type of knowledge. Twenty six participants completed the two tasks, and the scores were submitted to a three-way ANOVA (task types, agreement types, and morphosyntactic regularity). Only the main effect of morphological regularity was statistically significant in TGJT, while the interaction between agreement type and morphosyntactic regularity was observed in GJT. This result indicated that the two linguistic factors affect the acquisition of explicit and implicit knowledge in different ways.

1. Background

1.1 Explicit and Implicit Knowledge

Second language (L2) acquisition researchers have proposed various dichotomous distinctions of linguistic knowledge, such as explicit vs. implicit, declarative vs. procedural, and nonintegrated vs. integrated (see summary by Jiang, 2007), in order to capture dual characteristics of L2 grammatical knowledge. In this paper, we adopt the distinction of explicit and implicit knowledge. Explicit knowledge typically has the characteristics of being verbally reportable, conscious, and entailing control processing, whereas implicit knowledge is characterized by such features as being unaware, intuitive, and enabling spontaneous or automatic language use (e.g., Jiang, 2007). Many researchers, thus, recognize that attainment of native-like implicit knowledge is one of the most important goals of L2 learning, while the roles of explicit knowledge in language acquisition and use still remain theoretically controversial (R. Ellis, 2005).
Regarding the acquisition of grammatical knowledge, learning difficulties of grammatical structures, which are strongly related to L2 characteristics and L1-L2 surface differences, are quite often considered as an important topic in L2 studies (e.g., Krashen, 1982; R. Ellis, 1990), and various criteria for learning difficulty were suggested (see summary by DeKeyser, 2005). However, only a small number of researchers take the dual characteristics of grammatical knowledge into consideration. Most notably, R. Ellis (2006) highly emphasizes the importance of distinguishing the learning difficulties between explicit knowledge and implicit knowledge. Suzuki, Kubota, Itagaki, and Takeuchi (2006) also noted that examining interactions between the type of L2 knowledge and the type of grammatical structure is necessary for future studies (p. 18). In spite of these concerns, very little is known about specific effects of linguistic factors on the acquisition of explicit and implicit knowledge.

1.2 Time-pressure Technique to Measure Explicit and Implicit Knowledge

Since the early age of applied linguistics, it has been reported that L2 learners' knowledge of a specific grammatical structure strongly depends on the task features which were in the measurement. For instance, Schmidt (1980) reported that nine students who learn English as a second language in U.S. obtained relatively high scores of grammaticality judgment on English coordinate conjunctions (56% correct), while their scores of the other three productive tasks (picture description, elicited imitation, and sentence conjunction) scored much lower (0%, 11%, and 22% respectively). In addition, Larsen-Freeman (1975) examined acquisition orders of grammatical morphemes using five tasks. The results showed that the acquisition order was not consistent, and the differences of the orders depended on the tasks. Various terms such as task-related factors (Bialystok, 1979), situated variance (R. Ellis, 1985), or simply, task effects (e.g., Paradis, 2010) have been used to describe inconsistent performance of L2 learners caused by task features, demonstrating researchers' attention on the subject (including variationist studies, such as R. Ellis, 1985; Tarone, 1985; Tarone & Parrish, 1988; among others). Recent studies on L2 online sentence processing have discovered that task-specific demands are a crucial factor influencing online sentence processing (e.g., Jackson & Bobb, 2009; Williams, 2006).

Many researchers argue that the distinction between explicit and implicit knowledge may cause the performance inconsistency discussed above. Based on this conceptualization of task effects, R. Ellis (2005) dichotomously categorized tasks: a group measuring explicit knowledge (grammatical judgment task or GJT, and meta-language test), and that of measuring implicit knowledge (elicited oral imitation task, oral narrative task, and timed grammaticality judgment task or TGJT). Validity of this distinction has been supported (R. Ellis, 2005).

Although R. Ellis's distinction helps us to construct different measurement tasks, this approach may not be optimally suited to measure L2 learners’ knowledge of “specific” grammatical structures, because originally the test battery was validated with the total score of 17 different grammatical structures. It is counter-intuitive that all grammatical features develop in a
uniform manner. An amalgamated score does not shed light on how each individual grammatical feature develops.

Another potential limitation of R. Ellis’s approach is that the test battery included multiple contrasts of task features such as (a) decision/production, (b) oral/visual, and (c) accepting grammaticality/detecting errors by selection or correcting errors. However, it is argued that production/comprehension and online/offline contrasts are not qualitatively equivalent in terms of the difference of difficulties (e.g., Gruter, Lew-Williams, & Fernald, 2012, Paradis, 2010). Furthermore, it is difficult to elicit L2 learners’ knowledge of a specific grammatical structure through production tasks, while GJT can easily manipulate stimuli structures for knowledge elicitation.

We draw on R. Ellis’s overall idea of measuring explicit and implicit knowledge by using different task types, but we have taken a more focused approach. First, we aim to investigate the acquisition of one specific grammatical feature (the plural morpheme in English, details below). Second, we include only one task feature—time—to measure explicit and implicit knowledge.

Bialystok (1979) initially indicated that when learners make grammaticality judgment rapidly, they are much more likely to rely on their implicit knowledge, but if they have enough time, they rely on their explicit knowledge by utilizing control processing. R. Ellis (2004) proposed a model to explain the time-pressure effect on GJT, focusing on three processing operations for grammaticality judgment as follows: (1) semantic processing, (2) noticing, and (3) reflecting (Figure 1). In Timed GJT (TGJT), it can be assumed that reflection processing is not obligatory, because reflecting only functions as elaborating the judgment (e.g., referring to meta-language or decomposing a structure), and learners can omit that process if they had detected an error in noticing, which can be viewed as the use of implicit knowledge. In contrast, GJT allows learners to involve reflecting in their judgment by the use of explicit knowledge (Loewen, 2009; R. Ellis, 2004).

**Figure 1.** Processing operations for grammatical judgment in untimed and timed condition.
(Constructsed by the first author based on R. Ellis, 2004, p. 256)
1.3 Linguistic Factors Affecting the Acquisition of the English Plural Morpheme

Since morpheme studies in 1970s, what linguistic factors determine their acquisition order has been one of the main research topics in the field of L2 studies. Goldshneider and DeKeyser (2001) conducted a meta-analysis on L2 morpheme studies taking account of linguistic factors such as frequency, salience, sonority, morphophonological regularity, semantic complexity, and syntactic category. Their results found that those factors accounted for a large part of the acquisition orders in the previous studies. Furthermore, Luk and Shirai (2009) emphasized the role of L1 influences. For instance, they reported that the plural morpheme and articles for Japanese, Korean and Chinese native users were acquired later than predicted by so-called “the natural order”.

A series of studies by Jiang supports the L1 linguistic effect on the acquisition of the English plural morpheme. Jiang (2007) examined the highly proficient L1-Chinese ESL learners’ online processing by the use of self-paced reading task paradigm. While the participants performed quite well in GJT, they were insensitive to the agreement errors in online reading comprehension. Jiang, Novokshanova, Masuda, and Wang (2011) expanded the study including L1s (Japanese and Russian users). The results indicated that only the Russian users showed sensitivity to number agreement errors. It should be noted that Russian has the number marking system, while other two languages do not. These studies suggested that L2 learners’ online sensitivity to plural forms strongly depends on L1 congruency of morphological systems.

Processability theory offers a syntactic explanation on the acquisition of number agreement. It distinguishes the processes between phrasal procedures which include agreements within a phrase such as quantifier-noun agreement, and S-procedures which include manipulations of sentence-level units such as subject-verb agreement (e.g., Pienemann, 2005). In this account, S-procedures are supposed to be acquired later than phrasal procedures because of their higher cognitive loads of processing. Although R. Ellis (2008) claimed that this processability account is only applicable to the acquisition of implicit knowledge, few studies have investigated this possibility. This is one aspect that the present study will look at.

Morphosyntactic rules are yet another possible linguistic factor (R. Ellis, 2004). Morphosyntactic regularity has quite often drawn the attention of researchers. For instance, in a morpheme study in early age, Pica (1983) reported that L2 learners in a naturalistic learning environment tended to fail in the correct use of plural -s, and at the same time they overapplied the rules for irregular plurals, whereas formal class room environment led less plural mistakes. DeKeyser (2005) also discussed the learning difficulty of irregular words in terms of the complexity of form-meaning mapping, and redundancy.

Arguments of some cognitive theories are also relevant to the current study. In L1 studies, Bock and Eberhard (1993) conducted a series of experiments using agreement-error elicitation tasks for English L1 users, involving various factors on number-agreement such as notional numbers, lexical numbers, and morphological features. Their results indicated that
morphosyntactic regularity of nouns never elicited English L1 users’ agreement errors, which means L1 users can utilize robust number representations in both regular and irregular nouns. It should also be noted that the dual mechanism model argues that regular words are computed by the morphological decomposition, and irregular words are stored as full-form in mental lexicon (e.g., Pinker, 1999; Ullman, 2001).

However, whether or not this applies to L2 speakers’ processing is controversial (Gor, 2010, p. 10). One of recent comprehensive views of L2 learners’ morphological processing, Shallow Structure Hypothesis (SSH), postulates that L2 learners tend to rely on lexical, semantic, and pragmatic information as native speakers do, whereas syntactic information is not utilized in their real-time processing (Clahsen & Felser, 2006, pp. 31-32). Also, they claimed that L2 learners rely more on full-form storage than morphological decomposition (Clahsen, Felser, Neubauer, Sato, & Silva, 2010; similar claims are also found in the declarative/procedural model, such as Ullman, 2001). However, there is also a study which showed a different case in Swedish learners (Portin, Lehtonen, & Laine, 2007). Their lexical decision tasks indicated that the storage/decomposition choice varies depending on the frequency of a word (high frequency words are for full-form storage, low for decomposition). It has been also claimed that if L2 learners consumed the cognitive resource for lexical demands caused by frequency of words, the syntactic processing would be strongly retarded (Hashimoto, 2011). However, very little is known about the difference of learning difficulties between regular and irregular words in light of explicit/implicit distinction.

2. Research Question

The present study examines the effects of two linguistic factors (agreement type and morphosyntactic regularity) on the acquisition of explicit and implicit knowledge of the English plural morpheme. Based on R. Ellis’s (2004) framework, explicit and implicit knowledge are measured by manipulating time-pressure on GJT. The research question is as follows.

RQ: How do agreement type and morphosyntactic regularity affect the acquisition of explicit and implicit knowledge of the English plural morpheme?

3. Experiment

3.1 Participants

Twenty six participants who speak Japanese as L1 took part in this study. All of them were graduate students in a Japanese university. Their academic majors included international development, law, economics, linguistics, and cultural sciences. Their demographic information is summarized in Table 1. Their proficiency of English was relatively high for a Japanese EFL setting. All of the participants learned and used English as a foreign language. Forty-two percent
of the participants \(n = 11\) had experiences of studying in English-speaking countries for 1-2 years and the others had less or no experience.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Participants' Background</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(M)</td>
</tr>
<tr>
<td>Age</td>
<td>23.94</td>
</tr>
<tr>
<td>TOEIC score</td>
<td>813.75</td>
</tr>
<tr>
<td>Years of formal English education</td>
<td>11.23</td>
</tr>
</tbody>
</table>

*Note. \(N = 26\).*

### 3.2 Stimuli

Four types of stimuli were created. The design of stimuli and examples are shown in Table 2. There were two levels in the agreement type: quantifier-noun agreement and subject-verb agreement. The former appeared in a subject noun phrase (e.g., *Many students gave up the mathematics class.*) and the latter across the NP-VP boundary (e.g., *The young boys sing a song very well.*).

Morphosyntactic regularity also had two levels: regular and irregular. Regular type consisted of nouns which take which \(-s\) (\(\text{/s}/, \text{/z}/, \text{/z}/\)) in the plural form. Some examples of irregular nouns are such as *man-men, child-children, tooth-teeth, mouse-mice,* and *thesis-theses.* The nouns which inflect with the same form such as *sheep or fish,* and pluralia tantams were avoided in this study (see also, Bock & Eberhard, 1993).

<table>
<thead>
<tr>
<th>Table 2</th>
<th>The Design of Stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agreement type</td>
<td>Morphosyntactic regularity</td>
</tr>
<tr>
<td>1 Quantifier-noun (Phrase procedure)</td>
<td>Regular</td>
</tr>
<tr>
<td>2 Quantifier-noun (Phrase procedure)</td>
<td>Irregular</td>
</tr>
<tr>
<td>3 Subject-Verb (S-procedure)</td>
<td>Regular</td>
</tr>
<tr>
<td>4 Subject-Verb (S-procedure)</td>
<td>Irregular</td>
</tr>
</tbody>
</table>
Each condition contained 18 grammatical and 18 ungrammatical sentences, which summed up to 144 sentences. Seventy-two grammatical sentences were also included as fillers so that one participant was supposed to judge 216 sentences in total.

The sentence lengths (the numbers of words) for each condition of stimuli were controlled (condition 1: \(M = 9.83\), 2: \(M = 9.77\), 3: \(M = 9.55\), 4: \(M = 9.44\)). There was no statistically significant difference, \(F(3, 68) = 0.24, p = .86, \eta^2 = .06\). The words in the stimuli were at 1000-4000 word levels in JACET 800e in all of the conditions.

3.3 Tasks

Computer-based GJT and TGJT were adopted in this study. The tasks were created by the first author using Hot Soup Processor (HSP) programming language ver. 3.2, and the programs ran in Windows OSs. The participants were examined in a quiet room. First, the participants were instructed to read a single sentence presented on a 17-inch screen and judge the grammaticality of the sentence by pressing the grammatical/ungrammatical button of the reaction device they held. Once the judgment was given, the next stimulus was presented and the participants were not able to change the judgment or review the previous sentences. The sequence of stimuli presentation is shown in Figure 2. This sequence was repeated for each trial.

In TGJT, as the time limits for each stimulus were reached (detailed below), the sentence disappeared automatically, and the screen moved on to the next trial. If the participants did not react within the time limit, the score for the trial was calculated as zero. Due to the large number of stimuli, the participants were examined in two separate days (in average 1.83 days apart). For each day, the participants took two sets of trials for each of GJT and TGJT (each set included 54
stimuli). The orders of taking the tasks, the combinations between grammaticality of stimuli and the task types (except the fillers) were counterbalanced across participants using multiple versions of the programs. One set of a task lasted for about 15-20 minutes. The data of the participants' backgrounds were collected by questionnaires before the tasks. In order to confirm whether the time limits were appropriate for the participants or not, oral interviews were individually conducted for all of the participants after they completed the tasks.

3.4 Time-pressure

Various methods of setting time limits in GJT have been reported in the literature, including three seconds for all stimuli (Bialystok, 1979), an original formula based on sentence length and complexity (Shimada, 2010), and 20% longer than average native speakers' response time (e.g., R. Ellis, 2005; Loewen, 2009). This study adopted one standard deviation longer than the average of native speakers' response times for the time limits. This method was expected to create slightly longer time limits than the methods of other previous studies. However, the participants' proficiency of this study was expected to be lower than other studies except Shimada's, because their participants were ESL learners. Therefore, giving them a longer time was judged appropriate (the lack of reading time is a serious distractive factor).

In order to set the time limits, two pilot studies were conducted. Eighteen native speakers of English (standard American English) participated in pilot study one. The participants engaged in speeded-GJT (they were asked to make a judgment as soon as possible) and their reaction times for each stimuli were recorded as baselines of the time limits. Pilot study two was conducted with eight L1-Japanese EFL learners (TOEIC: $M = 731.21$, $SD = 67.30$). They engaged in GJT under the same conditions. The results and the time limits of this study are summarized in Table 3. Comparing the distributions of reaction times and the calculated time limits, we judged that the time limits of the present study had little possibility to cause a lack of reading time.

Table 3

<table>
<thead>
<tr>
<th>The Time Limits and the Result of the Pilot Studies ($K = 360$)</th>
<th>$M$</th>
<th>$SD$</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reaction times of L1 users</td>
<td>4366</td>
<td>1118</td>
<td>7729</td>
<td>1783</td>
</tr>
<tr>
<td>Reaction times of L2 users</td>
<td>4655</td>
<td>902</td>
<td>9703</td>
<td>1669</td>
</tr>
<tr>
<td>The time limits of this study</td>
<td>6049</td>
<td>1741</td>
<td>11711</td>
<td>2321</td>
</tr>
</tbody>
</table>

3.5 Analysis

As a result of the interview, three participants reported that they did not even have the time to finish reading the sentences. The scores of these three participants were excluded from the analysis. Therefore, the final sample size submitted to the analysis was 23. There is a possibility
that the counter-balance was unbalanced by this treatment. However, we considered that the effect was minimum.

For the main analysis, a three-way ANOVA (within-participants) was adopted. The dependent valuable was the accuracy scores for only ungrammatical stimuli, because grammatical sentences are not suitable in the design of time-pressure design (cf. Hedgcock, 1993; R. Ellis, 2005; Loewen, 2009; Shimada, 2010). The independent variables were: (1) the task types; GJT and TGJT, (2) the types of agreement; quantifier-noun agreement and subject-verb agreement, (3) the types of morphosyntactic regularity; regular words and irregular words.

Correlation analyses among accuracy scores and TOEIC scores were also adopted in order to discuss internal and external validity of the scores.

4. Results

Figure 3 represents the accuracy scores of both GJT and TGJT. The descriptive statistics are summarized in Table 4. The reliability scores in Table 4 represent Pearson’s correlation coefficients between the two sets of the task conducted on different days. All of the types of stimuli showed medium to high correlations between the two sets.

![Figure 3. Accuracy scores in each condition](image-url)
Table 4

Descriptive Statistics of Accuracy Scores in Each Condition

<table>
<thead>
<tr>
<th></th>
<th>GJT</th>
<th></th>
<th></th>
<th>TGJT</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>r</td>
<td>M</td>
<td>SD</td>
<td>r</td>
</tr>
<tr>
<td>Quantifier-noun</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>agreement</td>
<td>Regular</td>
<td>.60</td>
<td>.17</td>
<td>.87</td>
<td>.65</td>
<td>.19</td>
</tr>
<tr>
<td></td>
<td>Irregular</td>
<td>.72</td>
<td>.24</td>
<td>.67</td>
<td>.47</td>
<td>.21</td>
</tr>
<tr>
<td>Subject-verb</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>agreement</td>
<td>Regular</td>
<td>.79</td>
<td>.16</td>
<td>.55</td>
<td>.64</td>
<td>.21</td>
</tr>
<tr>
<td></td>
<td>Irregular</td>
<td>.72</td>
<td>.22</td>
<td>.57</td>
<td>.52</td>
<td>.14</td>
</tr>
</tbody>
</table>

Table 5 summarizes Pearson’s correlation coefficients among GJT scores, TGJT scores and TOEIC scores. The result showed that both the accuracy scores showed medium correlation with TOEIC scores, whereas GJT and TGJT showed weak or no correlation. In order to examine the difference between GJT and TGJT scores more precisely, the correlation matrix among the four conditions of stimuli and the task types is shown in Table 6.

Table 5

Correlation Coefficients among Total GJT Score, Total TGJT Score, and TOEIC Score

<table>
<thead>
<tr>
<th></th>
<th>TOEIC</th>
<th>GJT</th>
</tr>
</thead>
<tbody>
<tr>
<td>GJT</td>
<td>.45*</td>
<td></td>
</tr>
<tr>
<td>TGJT</td>
<td>.44*</td>
<td>-.13</td>
</tr>
</tbody>
</table>

Note: * p < .05

Table 6

Correlation Coefficients between the Accuracies in All of the Conditions

<table>
<thead>
<tr>
<th></th>
<th>GJT</th>
<th></th>
<th></th>
<th>TGJT</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quantifier-noun</td>
<td>Subject-verb</td>
<td></td>
<td>Quantifier-noun</td>
<td>Subject-verb</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Regular</td>
<td>Irregular</td>
<td>Regular</td>
<td>Irregular</td>
<td>Regular</td>
<td>Irregular</td>
</tr>
<tr>
<td>2</td>
<td>.71**</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>.29</td>
<td>.53**</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>.74**</td>
<td>.85**</td>
<td>.53**</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>5</td>
<td>-08</td>
<td>.11</td>
<td>.04</td>
<td>.19</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>6</td>
<td>-.13</td>
<td>.03</td>
<td>-.24</td>
<td>-.20</td>
<td>.47*</td>
<td>—</td>
</tr>
<tr>
<td>7</td>
<td>-.11</td>
<td>.15</td>
<td>-.04</td>
<td>-.11</td>
<td>.07</td>
<td>.50*</td>
</tr>
<tr>
<td>8</td>
<td>-.13</td>
<td>.25</td>
<td>.17</td>
<td>.32</td>
<td>.42*</td>
<td>.31</td>
</tr>
</tbody>
</table>

Note: * p < .05, ** p < .01
The correlation matrix showed that GJT scores and TJGT scores in any stimuli condition had no correlation, whereas many stimuli conditions within tasks obtained medium to high correlations. Also, no conditions were correlated between GJT and TGJT.

As the main analysis, the accuracy scores were submitted to a three-way ANOVA. The main effect of time-pressure, $F(1, 22) = 8.28, p < .01, \eta_p^2 = .27$, agreement type, $F(1, 22) = 9.43, p < .01, \eta_p^2 = .30$, morphosyntactic regularity, $F(1, 22) = 11.11, p < .01, \eta_p^2 = .34$, were all statistically significant. Since the three-way interaction was also statistically significant, $F(1, 22) = 11.11, p < .01, \eta_p^2 = .33$, a series of two-way ANOVAs with an adjusted alpha level of .25 were performed on the GJT and TGJT scores respectively.

In the two-way ANOVA for GJT scores (Figure 4), the main effect of agreement type was statistically significant, $F(1, 22) = 17.88, p < .01, \eta_p^2 = .58$. The main effect of morphosyntactic regularity was not statistically significant, $F(1, 22) = 0.92, p = .35, \eta_p^2 = .04$. Since the interaction between agreement type and morphosyntactic regularity was also statistically significant, $F(1, 22) = 22.50, p < .01, \eta_p^2 = .42$, the simple main effects in GJT scores were examined. The result was that the simple main effect of agreement type in regular nouns was statistically significant, $F(1, 22) = 30.50, p < .01, \eta_p^2 = .58$, and the simple main effect of morphosyntactic regularity in quantifier-noun agreement was also statistically significant, $F(1, 22) = 19.75, p < .01, \eta_p^2 = .47$.

On the other hand, in the two-way ANOVA for TGJT scores (Figure 5), only the main effect of morphosyntactic regularity was statistically significant, $F(1, 22) = 34.41, p < .01, \eta_p^2 = .61$, whereas the main effect of agreement type, $F(1, 22) = 0.53, p = .47, \eta_p^2 = .02$, and the interaction were not statistically significant, $F(1, 22) = 0.41, p = .41, \eta_p^2 = .03$.

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**Figure 4.** Accuracy scores of GJT

*Note.* Error bars represent ±1SDs.

**Figure 5.** Accuracy scores of TGJT

*Note.* Error bars represent ±1SDs.
The findings from the experiment are summarized as follows:

1. GJT and TGJT scores showed no correlation, whereas both of them were correlated to TOEIC scores.
2. In GJT scores, the interaction between the two linguistic factors was statistically significant.
3. In TGJT scores, the effect of morphosyntactic regularity was statistically significant.

5. Discussion

5.1 The Relationships between Explicit and Implicit Knowledge

The correlation analyses clearly supported that explicit and implicit knowledge are separate constructs (R. Ellis, 2005; 2006; among others), showing no correlation between the two tasks. In other words, the result suggests that general language proficiency, at least the one represented by the TOEIC score, involves two distinct knowledge types.

5.2 Explicit Knowledge

As is easily expected, the overall accuracy level was higher without time-pressure. However, an interesting finding is that there was a statistically significant interaction between agreement type and morphosyntactic regularity, which was not evident in implicit knowledge. The accuracy of quantifier-noun agreement of regular words marked a statistically significantly low score than others, and the performance of that condition was even as low as that of TGJT.

However, the processability account was proposed regarding the acquisition of implicit knowledge (R. Ellis, 2008). Therefore, it may not be suited to explain the acquisition of explicit knowledge. Further study is necessary to explain the mechanism underlying this result.

5.3 Implicit Knowledge

For implicit knowledge, only the effect of morphological regularity was evident. It indicates that morphosyntactic regularity is one of the factors affecting the acquisition of implicit knowledge of the English plural morpheme.

This result suggests that learners' implicit knowledge is weak in the number representation of irregular nouns. In light of the studies of morphological processing, it was assumed that irregular nouns are stored as full-forms in the mental lexicon, and regular nouns are processed by rule-based decomposition (Gor. 2010; Ullman, 2001). If this postulation was correct, the result of this study indicates that L1-Japanese EFL learners can utilize rule-based decomposition for regular nouns to some extent, by the use of attained implicit knowledge, whereas there is a deficit of number representation of irregular nouns.
Concerning interaction with sentence processing, SSH suggested that L2 learners' syntactic processing is qualitatively different from the L1 users' counterpart, at the point of utilizability of syntactic information in their real-time processing (Clahsen & Felser, 2006). The result of this study partially supported that hypothesis. The participants showed serious insensitivity to number-matching in the time-pressure condition, which can be interpreted that they primarily rely on lexical-semantic information and they tend to fail to access the syntactic information such as grammatical number (cf. Jiang, 2007). Once learners consume the cognitive resource for lexical demands, few cognitive resources may be left for syntactic processing (Hashimoto, 2011). Note that accessing the lexical-semantic information of irregular words are supposed to be cognitively demanding because of their low occurrence and the intransparency of form-meaning mapping (cf. DeKeyser, 2005).

However, the current result (better performance in regular nouns than irregular nouns) contradicts one of the claims of SSH (and also declarative/procedural model). It assumes that L2 learners rely on full-form storage of words for morphological processing than decomposition rules (see summary by Gor, 2010). This study suggests that number representation of irregular words is accessible in explicit knowledge, while there is a deficit of number representation in implicit knowledge. This means that learning difficulty of the plural morpheme in implicit knowledge for L1-Japanese EFL learners is not mainly caused by rule-driven difficulty, but the poverty of vocabulary knowledge associated with the lack of input (see N, Ellis, 1994, R. Ellis, 2004).

5.4 Limitations and Future Research

The results should be taken with some cautions below.

First, it is necessary to compare the effects of other task features. The present study only adopted the time-pressure paradigm. A self-paced reading task focuses much more on the attention toward meaning during online comprehension (Jiang, 2007). In that paradigm, the automatic reactions for grammatical errors indicate their automatized processing skills, while GJTs focus on the performance of decision making, in which learners attention is toward forms. In addition, learning difficulties in production/comprehension and online/offline are different (Grüter, et al. 2012). By the use of such other tasks, the influences of linguistic factors in the present study should be re-examined.

Second, there are alternatives to focus on the cognitive loads more directly to measure explicit and implicit knowledge such as online eye-movements (Bando, Leung, Kusanagi, Fukuta, & Sugiura, 2012) and pupil dilation during GJTs (Leung, Kusanagi, Bando, Fukuta, & Sugiura, 2012). There is a possibility that these methods will shed light on the nature of explicit and implicit knowledge.

Third, this study included only one group of learners. In order to examine developmental processes, either cross-sectional or longitudinal studies are desired.
Fourth, in the time-pressure paradigm, time limit is a critical factor to distinguish explicit and implicit knowledge in the measurement. Nevertheless, the best method for determining the time limit has not been established yet. Efforts should be made to fill this gap.

Fifth, this study examined only L1-Japanese EFL learners. Since previous studies suggested L1 influence on the L2 morpheme acquisition, future studies should include L2 learners of contrasting L1 backgrounds.

6. Conclusion

This study explored the influences of agreement type and morphosyntactic regularity on the acquisition of explicit and implicit knowledge of the English plural morpheme, using timed and untimed GJT s. The experiment provided empirical evidence that both linguistic factors affect the acquisition of the two types of grammatical knowledge in different ways. Namely, both agreement type and morphosyntactic regularity affect the acquisition of explicit knowledge, whereas only morphosyntactic regularity affects the acquisition of implicit knowledge.

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ni okeru daingengo no bunpoukeishiki ni taishu chuji no sokutei: Doukoukei keisoku deita o mochiiitete [Measuring attention toward L2 grammatical forms during a grammatical judgment task: With a focus on pupil diameter]. Oral presentation in the 76th Semi-annual conference of Chubu branch of the Japan association for Language Education and Technology.


