Processing and Interpreting Novel Compounds in EFL Reading: Focusing on the Integration of Morphological and Contextual Information

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Abstract

Although the importance and effectiveness of the combined use of both morphemes and contexts when understanding novel words have been emphasized, little is known about the on-line integration of the two sources during EFL reading. Therefore, the present study addressed this issue by employing on-line self-paced reading tasks. Target words were pseudo compounds (e.g., pricevar), whose literal meanings are either consistent or inconsistent with their surrounding contexts (transparent and opaque compounds, respectively). A total of 41 Japanese undergraduate and graduate students read the contexts for comprehension word-by-word (reading task), and then translated the contexts into Japanese (translation task) to reveal what information the readers utilized for interpretation, and its relationship with on-line integration. The comparison of the reading times for transparent and opaque targets demonstrated that EFL readers integrated contextual and morphological information during reading; readers were sensitive to semantic relation between morphemes and contexts. However, this integration did not correlate with accurate interpretation due to the greater demand of suppressing intervention from morphological information. These results suggest that difficulty in understanding novel compounds lies in flexible semantic selection, rather than in appreciating the relation of the two sources.

1. Introduction

1.1 Understanding of Compounds and Integration of Morphemes and Contexts

Successful reading first begins with an understanding of individual words, which are then used to construct coherent text representation by integrating explicitly stated ideas (Grabe, 2009). However, learners of English as a foreign language (EFL) are more likely to encounter unknown words while reading due to their smaller vocabulary size than their first language (L1) counterparts, which could inhibit lower-level comprehension, and lead to incomplete text representation as a whole. Therefore, how to address unknown words can be seen as an important element of reading.
When one tries to unveil the semantic information of unknown words, the two most frequently used information sources are word-internal information, particularly word morphemes, and contexts. They are easily available due to their locality (Wesche & Paribakht, 2009) and can often contain important semantic information (Nation, 2013).

Although both morphemes and contexts are important, they make different semantic contributions and have unique weaknesses. Morphemes often contain concrete inherent semantic information of given words. Therefore, readers can gain specific meanings by analyzing the morphemic structure and by appealing to their linguistic knowledge. However, as most words have polysemous semantics, morphemes are not always reliable because the meanings of certain words are dependent on the contexts. Thus, contexts can also provide semantic information inherent to a given scenario. However, contexts do not reveal the exact entity of words as morphemes do. Accordingly, it can be said that morphemes and contexts are complementary for revealing the meaning of unknown words, and this is why it is important to refer to both morphemes and contexts in an integrated manner.

In order to examine readers’ integration of the two sources, previous lexical inferencing studies have used compounds due to their semantic transparency (Brusnighan & Folk, 2012; Hamada, 2014; Mori & Nagy, 1999). Semantic transparency refers to “the degree to which word constituents are semantically transparent/opaque to whole-word meaning” (Brusnighan & Folk, 2012, p. 174) and is broadly categorized into three types. Transparent compounds are words where both constituents contribute to the word’s meaning; for example, in sunlight, the meaning can be inferred solely with the morphemes. Furthermore, only one of the two constituents in semi-transparent words is related to entire word (e.g., strawberry). Finally, words like honeymoon are considered opaque compounds because both constituents do not relate to the whole word’s meaning. Therefore, novel compounds create more necessity for readers to integrate both the words’ morphemes and contexts for accurate interpretation because their constituent morphemes are not always reliable for the entire word’s meanings (i.e., semi-transparent and opaque compounds).

Unfortunately, these studies have shown that the difficulty of simultaneously using morphemes and contexts, especially for less skilled second language (L2) learners. Mori and Nagy (1999) investigated English-speaking students’ interpretation of novel semi-transparent Japanese kanji compounds, and compared their performance under three conditions (i.e., kanji only condition, context-only condition, both condition). The participants were asked to choose the meanings of the targets from four choices (i.e., integrated, kanji, context, anomalous). The results showed that accurate interpretation (i.e., integrated) was highest when both kanji and context were presented. However, it was also reported that the use of context combined with morphemes was demanding for low-proficiency learners. Hamada (2014) examined the use of morphological and contextual information with pseudo semi-transparent English compounds in both morphology reliable and unreliable conditions. In morphology reliable conditions, one of the two compound...
constituents is related to contextual meanings, while in morphology unreliable conditions, the familiar constituent did not fit the context semantically. The results showed that in morphology unreliable conditions, while advanced and intermediate learners were more likely to choose context-based options, beginners tended to rely on contextually incongruent morphology-based information. She attributed the proficiency-related difference to the complex processing required in unreliable conditions; that is, readers had to suppress word part information and make an evaluation by using multiple sources.

Moreover, readers’ morphology-based interpretation may not only stem from their ignorance of the contexts. Ushiro et al. (2010) examined Japanese EFL readers’ understanding of unknown secondary meanings of homonyms in context whose primary meanings are known to them. Their detailed error analyses of translation protocols showed that some learners stick to the familiar primary meanings even if they correctly understood the surrounding contexts. Thus, for successful understanding, they concluded that readers need to flexibly change their interpretation such that their interpretation makes sense in the context being read.

The studies discussed in this section provide meaningful insights on the difficulties of interpreting semantic meanings through both morphology and word context. However, these findings are not sufficient because of the following two reasons. First, for accurate understanding, readers must be aware of the relationship between morphemes and the context before using this information for further interpretations. Therefore, it may be informative to identify at when readers experience particular difficulties in the interpretation process. Second, the tasks employed in the past studies required participants to overtly interpret the target words (e.g., lexical inference task). However, it has been demonstrated that readers, in most cases, ignore unknown words unless they are required to complete their goals (Paribakht & Wesche, 1999). It is thus necessary to examine how reading for comprehension operates. To address these issues, the next section reviews on-line integration during reading, which is the main focus of this study.

1.2 On-line Processing of Novel Lexical Items During Reading

To tap into readers’ on-line processing of novel lexical or grammatical items, previous studies have used reading time data in a self-paced reading task (Brusnighan & Folk, 2012; Hamada, 2013; Jiang, 2007; Oakhill, Cain, & Nesi, 2016). Some of them compared reading times of target words or sentences that contain either consistent or inconsistent lexical items semantically (Brusnighan & Folk, 2012; Oakhill et al., 2016) or grammatically (Jiang, 2007), and longer reading times for anomalous items are interpreted as automaticity of the examined process (e.g., integration of morphological and contextual information, grammatical knowledge).

As for the compounds processing, Brusnighan and Folk’s (2012) investigated L1 readers’ processing of novel transparent and opaque compounds in either informative or neutral contexts. Readers’ eye-movements indicated that they spent longer on opaque words as compared to transparent words, and this increased reading time reflects on-line integration of morphological
and contextual information as readers experience more processing difficulty in understanding opaque targets. However, this effect was found only for target words in informative contexts.

In relation to context characteristics, Hamada (2013) investigated the effects of context on EFL readers’ activation of unknown words meanings while reading. The participants read sentential contexts with unknown words in either strongly or weakly constraining contexts. The overall results showed that readers could activate specific meanings of unknown words from strongly constraining contexts, while weakly constraining contexts only activated the target words’ general meanings. These results, along with Brusnighan and Folk (2012), suggest that the degree to which contexts specify upcoming words can affect the integration process because if readers activate specific meanings from the contexts, it is easier to integrate them with morphological information.

A more recent study by Oakhill et al. (2016) examined the processing of idiomatic phrases in context, and its relationship with semantic interpretation. Lexical phrases (e.g., in the same boat) are presented in contexts that either elicit their literal (e.g., to be in the same boat) or novel figurative meanings (e.g., to be in the same situation). Participants’ reading times for the target sentences including target expressions and their interpretation choice (multiple-format) showed that reading times in figurative contexts positively correlated with accurate phrase interpretation. This means integrative processing has positive effects on readers’ interpretation of the phrases. This is because inflated reading times reflect how well participants detect a conflict between the two information sources, and sometimes mental effort needed for readers to infer the phrases’ meanings.

1.3 Overview of the Present Study

This study examines EFL readers’ on-line integration of morphological and contextual information in novel transparent and opaque compounds, and its relation with interpretation. To this end, the present study adapted a word-by-word on-line self-paced reading task. This task was selected because it “allows one to operationalize automaticity as a dichotomy” (Jiang, 2007, p. 12). In addition, the past lexical inferencing studies have used multiple-choice tasks to reveal how readers interpret target words (e.g., Hamada, 2014; Mori & Nagy, 1999); as a result, readers’ actual interpretation remains unclear. Therefore, this study measured interpretation through a written format to inspect readers’ interpretation in a more naturalistic way. As Hamada (2014) pointed out, it is difficult to distinguish what source readers used in case of semi-transparent words with a written format; thus, the use of transparent or opaque words would allow us to identify the source of interpretation because readers would be supposed to interpret based solely on either morphemes or contexts.

In the experiment, participants read sentential contexts including pseudo compounds whose morphemes are either semantically consistent (transparent compounds) or inconsistent (opaque compounds) with their surrounding contexts; their reading times were later compared (reading
task). Afterwards, participants translated the contexts into Japanese to examine what kind of information readers used for their interpretations (translation task). Finally, the relationship between on-line integration and interpretation was examined to reveal whether the integrative process has interpretational advantages. Through this, the present study aimed to identify the source of difficulty in understanding novel compounds. These points addressed in this study are summarized in the following three research questions (RQs):

RQ1: Do EFL learners integrate morphological and contextual information on-line?
RQ2: What types of information do EFL learners use to interpret novel compounds?
RQ3: Does on-line integration promote learners’ interpretation of novel compounds?

2. Method

2.1 Participants

The participants were 41 university undergraduate and graduate students from various majors. Every student had learned EFL in Japan for more than six years. Based on their self-report of their Eiken test grade and TOEIC® Listening & Reading Test score, their English proficiency was estimated mostly at the intermediate level (n = 35), although some were beginners (n = 6).

2.2 Materials

2.2.1 Target words

The target words consisted of 40 pseudo compounds that included two noun-based free morphemes. Following Brusnighan and Folk (2012), they were created by replacing one or two of the constitute morphemes of existing compounds with high-frequency synonyms well familiar with the present participants (level 1 or 2 in the JACET 8000 list, JACET, 2003). The existing words were chosen with reference to an inverted dictionary of English compounds (Shintomi, Yamane, & Watanabe, 1998). For example, an existing word price war was replaced with a target word price battle by changing the second constituent. The mean number of letters and syllables were 9.34 (SD = 1.15, range = 7–11) and 2.47 (SD = 0.67, range = 2–4) respectively.

A pilot study was conducted to ensure that the participants would not have difficulty understanding the target words themselves. The participants were nine undergraduates, who did not participate in the main experiment. They were presented with the 40 target words in isolation, and were asked to (a) write down one possible meaning of each target word in Japanese, and (b) evaluate how easily they could come up with the meanings on a five-point Likert scale (ranging from 1 = very easy to 5 = very difficult). Based on the results, eight target words were excluded because they elicited multiple meanings from different participants or had meanings that were difficult to construe (mean ratings over 3 [neither]). Consequently, the remaining 32 words were used as the target words in the experiment.
2.2.2 Contextual sentences

For each target word, two types of sentential contexts were developed and they provided different amounts of contextual information before the target words appeared: one context provided more information (informative context), while the other contained neutral information (neutral context). Informative contexts provided specific information pertaining to the target words, but there were still some possible candidates to distinguish which source (i.e., morphemes or contexts) readers used for interpretation. For example, in the context *The shop closed after the hard ______*, the blank can be filled with events or reasons that caused the shop’s closure, such as recession and lack of staff. On the contrary, in neutral contexts, only abstract meanings of the upcoming words could be inferred. For instance, for the context *Peter studied the reason for the ______*, any action or event could be possible. In these contexts, the target words functioned like transparent words, as their morphological information was consistent with the contexts. Every context had at least three words with neutral information after the target words’ appearance. The contexts consisted of high-frequency words (level 3 or below in the JACET 8000). The average sentence length was 12.2 words (*SD* = 2.3, range = 8–16).

Next, to prepare the opaque targets, the following manipulation was performed. The 32 target words were divided into 16 pairs of two target words. In doing so, care was taken so that the meanings of one target word did not fit to the contexts created for the other word. For example, for the pair of target words *pricebattle* and *businessbag*, the two contexts designed for *pricebattle* did not allow for *businessbag* to appear, while *pricebattle* was not semantically possible in *businessbag*’s contexts. Table 1 provides examples of the paired target words and contexts.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Example of a Pair of Target Words and Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transparent</td>
<td>Informative contexts</td>
</tr>
<tr>
<td></td>
<td>The shop closed after the hard <strong>pricebattle</strong> in the area.</td>
</tr>
<tr>
<td></td>
<td>After arriving at the office, Tim realized he had left his <strong>businessbag</strong> on the train.</td>
</tr>
<tr>
<td>Opaque</td>
<td>After arriving at the office, Tim realized he had left his <strong>pricebattle</strong> on the train.</td>
</tr>
<tr>
<td></td>
<td>The shop closed after the hard <strong>businessbag</strong> in the area.</td>
</tr>
</tbody>
</table>

*Note.* Target words are presented in boldface.

Additionally, this combination of target words served to more closely minimize the variability of the target words’ characteristics (i.e., the number of letters, syllables). Pairing target
words meant that each word had four contexts conditions, crossing 2 (transparency: transparent vs. opaque) × 2 (context: informative vs. neutral). Then, four presentation sets, in which every target word appeared only once for each condition, were created to counterbalance the target words’ presentation conditions across participants. Thus, all the participants would read every 32 target word in one of the four conditions, and encounter eight target words per each of the four conditions. Indeed, a 2 (transparency) × 2 (context) analyses of variance (ANOVA) on both the number of letters and syllables showed that there were no significant differences among the four sets (all ps > .10). This ensures that any reading time differences observed in this study can be seen as a result of the treatments (i.e., transparency, context).

To validate the transparency and the informativeness of the context in relation to the target words, a norming study was administered. Two graduate students majoring in English language education judged (a) whether each possible semantic interpretation of the target words was consistent for transparent targets and inconsistent for opaque targets based on the surrounding contexts (semantic fitness judgment), and (b) whether the amount of information conveyed by the context (i.e., informative vs. neutral) reflected the intended method design (informativeness judgment). The inter-rater agreement for the semantic fitness judgment and the informative judgment were sufficiently high (93.7% and 87.5% respectively). Then, contexts whose judgment received unintended responses by at least one rater were revised by the author; the raters would then review the revised context and their agreement was obtained.

In addition, in order to distract participants from the experimental purposes, 32 filler sentences that did not contain any target word were also constructed. Of these, 22 sentences were with yes-no comprehension questions asking about the literal meanings of the context to verify whether the participants had read the contexts for comprehension.

2.3 Procedure

The experiment was conducted individually in a silent room. First, participants were randomly assigned to one of the four presentation sets. Then, they performed the reading task. The task was administered using SuperLab 5.0 and Response Pad RB-740. The participants read the contexts word-by-word at their own pace while their reading times were recorded (moving-window). They were instructed to read to answer the comprehension questions. Each trial began with a “Ready” screen. When participants were ready, they were asked to push the “Yes” button. The next screen showed the sentence starting position with an asterisk and the word length of each word using underlines. At this time, each context was presented in one line. When participants pushed the button again, the asterisk disappeared and the first word appeared. After this, every time participants pushed the button, the subsequent word appeared and the preceding word disappeared. This meant that there was always only one word on the screen. Participants were also not allowed to read the preceding word again. When they reached the sentence-final position and pushed the button, they proceeded to the next trial. In the case of filler sentences with
comprehension questions, the question appeared on the next screen; participants were asked to answer it by pressing either the “Yes” or “No” button, and feedback was given (⭕ or ❌) after they responded. This procedure was repeated until all 64 sentences (i.e., 32 experimental and 32 filler sentences) were read. Figure 1 shows the sequence of a trial in the reading task. To familiarize participants with this procedure, they performed three practice trials before the main session.

After a short break, the participants carried out the translation task. All 32 experimental sentences in the reading task were presented again in a booklet, but the presentation order was randomized across different presentation sets. Participants were instructed to translate the entire context including the target words into Japanese. After completing the task, the participants were informed that the target words were not real English words. The entire procedure lasted for approximately 70 minutes.

Figure 1. The sequence of a single trial of the reading task.

2.4 Scoring and Analyses

Before analysis, reading times outliers from the reading task were treated. Outliers were identified using both standard deviations (SDs) from participants’ mean reading time and absolute values (Jiang, 2007). However, in this study, the reading times for target words were much longer than normal words in contexts, due to longer word lengths and novelty effects (i.e., novel words take longer to read than lexicalized words). Thus, unlike other studies, the present study used each participant’s mean reading times for target words instead of using the mean of all words in context to calculate SDs. Outliers were substituted with high and low cutoffs. The high cutoff pertained to reading times longer than 2 SDs from the means of participant’s target word reading times, while the low cutoff was 200 ms (Jiang, 2007). The reason why an absolute value was applied only for the low cutoff was that many participants’ reading times would be below zero in SD-based treatments. In sum, these treatments accounted for 7.2% of the data.
To address RQ1, a 2 (transparency: transparent vs. opaque) × 2 (context: informative vs. neutral) ANOVA was used on target words’ reading times. Again, if readers spent longer on opaque targets than on transparent targets, it suggests that readers integrated both morphological and contextual information while reading.

For the translation task, the translation protocols corresponding to target words were categorized from two perspectives: (a) the information used for interpreting the target words and (b) whether the translation fit the overall context meaning. The following four translation types were ultimately identified (the following example protocols shown in parentheses were those produced for the target word business bag). *Morphology-based interpretation* (MBI) refers to when participants simply translated the two semantic meanings of the two morphemes (e.g., 仕事用のカバン [business bag]). Although readers might have inferred the same semantic concepts only through the contexts (especially in informative contexts), this study regarded them as MBI. *Partially morphology-based interpretation* (PMI) refers to interpretations where part of the morphemes’ semantic information was deleted (e.g., ビジネス [business]), modified (e.g., 経営難 [financial difficulties]), or if some information was added (e.g., ビジネスバッグの売れ行き [sales of business bag]). This category was included because this interpretation was made based on part of the morphemes, but remained consistent with contextual meanings; as such, this interpretation functions differently from the other categories. *Context-based interpretation* (CBI) refers to translations whose meaning is only related to the contexts and no morphemic information was included (e.g., 消費増税 [increase of consumption tax rate]). *None* refers to when the target words are not translated.

As pseudo words do not have existing meanings, this study judged the appropriateness of the interpretation based on whether the interpretation fit the context. Accordingly, for transparent words, MBI, PMI, and CBI were considered appropriate although MBI meanings were more concrete than the others. For opaque words, PMI and CBI were deemed contextually appropriate interpretations. PMI was included because it was assumed that readers might have noticed a discrepancy between the morphemes’ meanings and the context, and thus made some revisions in order to generate a meaningful interpretation. The author and a graduate student categorized 30% of the data, with 90.4% inter-rater agreement. The discrepancies were resolved through discussion, and the author rated the remaining data.

### 3. Results and Discussion

#### 3.1 Comprehension Questions

The correct answer rates for the comprehension questions of all participants exceeded 80% ($M = .91$, $SD = .05$, range = .82–1.0). Thus, it was assumed that all participants had used the contexts for comprehension purposes during the reading task.
3.2 Reading Times (RQ1)

Table 2 provides the descriptive statistics of the reading times for target words in the reading task. It appears that reading times for opaque words and targets in neutral contexts were longer than transparent words and words in informative contexts, as can be seen in Figure 2.

Table 2
Descriptive Statistics of Target Words Reading Times (milliseconds)

<table>
<thead>
<tr>
<th></th>
<th>Informative context</th>
<th>Neutral context</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>95% CI</td>
</tr>
<tr>
<td>Transparent</td>
<td>1271.94</td>
<td>[1124.58, 1419.30]</td>
</tr>
<tr>
<td>Opaque</td>
<td>1471.18</td>
<td>[1266.13, 1636.51]</td>
</tr>
</tbody>
</table>

*Note. CI = confidence interval.*

A 2 × 2 ANOVA demonstrated the main effects of Transparency and Context, where $F(1, 40) = 30.55, p < .001, \eta^2_p = .43$, $F(1, 40) = 13.82, p = .001, \eta^2_p = .26$. However, the Transparency × Context interaction was not significant, $F(1, 40) = .48 p = .491, \eta^2_p = .01$. These results demonstrate that opaque targets took significantly more time to be read than transparent words, suggesting that the participants were able to integrate both morphological and contextual information while reading regardless of the contextual information. Thus, readers are sensitive to the relationship between the two semantic sources even if their goal is to read for comprehension.

However, readers’ ability to integrate the two information sources for words in neutral contexts was surprising because this did not occur in L1 experiments (Brusnighan & Folk, 2012). One may argue that the neutral contexts provided ample information about the target words and thus behaved like informative contexts. However, the main effect of Context suggests that both transparent and opaque targets in neutral contexts received longer reading times than those in informative contexts; this observation was also found in the case of unknown monomorphemic words (Hamada, 2013). Thus, it is unlikely that neutral contexts were behaving informatively.

A possible explanation would be related to the target compounds’ characteristics. In Brusnighan and Folk (2012), the semantic relations between the original existing compounds and target compounds were somewhat similar but were not identical. For example, an existing word milkshake was replaced with drinkblend, whose meaning is more unclear than the existing word.
In contrast, the target words’ literal translations in this study were almost identical as the existing words, and their constituents consisted of high-frequency words. As a result, the participants could activate concrete mental images or equivalents of the target words by referring to the lexical representation of the existing words in their L1 or L2 lexicon. This clear mental image of the target words made the semantic relation between morphemes and context salient to the readers; consequently, abstract concepts inferred from a neutral context would be enough for readers to aware and integrate the semantic relation of the two sources. In sum, this ease of constructing meaning from the target words’ morphemes possibly contributed to readers’ integrative process even in neutral contexts.

So far, the success of on-line integration means that readers could recognize that opaque words did not match the context; however, it remains unclear how they interpreted target words. Therefore, the next section focuses on their interpretation after the integration process.

### 3.3 Interpretation Tendency in Each Context Condition (RQ2)

Table 3 shows the proportion of interpretation type in each condition. Transparent and opaque target words appear to have their own similar distributions in interpretation irrespective of context informativeness.

As for transparent targets, the participants uniformly made MBIs (about 90%) regardless of context. This result is in line with the previous studies employing the multiple-choice format (Hamada, 2014). When the morphemes of novel words converge with contextual meanings, readers try to use the words’ morphological information as it conveys more concrete semantics than the context.

Table 3  
**Relative Proportions of Interpretation Types in the Translations Task**

<table>
<thead>
<tr>
<th>Informative context</th>
<th>Neutral context</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transparent</td>
</tr>
<tr>
<td>MBI</td>
<td>PMI</td>
</tr>
<tr>
<td>.932 (.10)</td>
<td>.030 (.06)</td>
</tr>
<tr>
<td>.006 (.03)</td>
<td>.074 (.10)</td>
</tr>
<tr>
<td>.878 (.12)</td>
<td>.024 (.06)</td>
</tr>
<tr>
<td></td>
<td>Opaque</td>
</tr>
<tr>
<td>MBI</td>
<td>PMI</td>
</tr>
<tr>
<td>.484 (.28)</td>
<td>.277 (.17)</td>
</tr>
<tr>
<td>.018 (.04)</td>
<td>.323 (.19)</td>
</tr>
<tr>
<td>.523 (.27)</td>
<td>.323 (.19)</td>
</tr>
<tr>
<td>.015 (.05)</td>
<td>.018 (.05)</td>
</tr>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. Standard deviations are in parentheses.*

As Figure 3 graphically shows, there are more variances in the interpretation of opaque words than in transparent words. However, MBI was the most preferred interpretation type.
irrespective of context (about 50%) even when this interpretation did not fit the context semantically. The second and third were PMIs and CBIs in both context conditions.

To examine if there were any differences in interpretation trends based on Context, a t-test compared the proportion of each interpretation category for opaque targets. The results showed that only CBI was significantly more common in informative contexts (21.2%) than in neutral contexts (12.8%), \( t(40) = 3.32, p = .002, d = 0.64 \), and there were no significance for the remaining three categories \( (ps > .05) \).

![Figure 3. Interpretation type frequency for opaque target words (%). Error bars represent standard errors.](image)

This CBI proportion can be explained in terms of the amount of information constructed from the context for target words. In informative contexts, readers can activate concrete semantic concepts of the upcoming words (Hamada, 2013); thus, they were more likely to suppress the morphemic information contradicting their prediction, and prioritize contextual information. In contrast, when reading neutral contexts, readers did not have specific meaning for target words; therefore, they generated their interpretations using word morphemes (i.e., MBI or PMI), even though they might have noticed the conflicting meanings conveyed by the two sources. Thus, it can be argued that concrete information constructed from context allowed readers to make interpretations free from morphological information.

Still, it is noteworthy that participants generally tried to include morphological information in their interpretation (i.e., MBI, PMI) for opaque targets, resulting in over 70% cases (informative context: 70.9%; neutral context: 83.6%). This would reflect readers’ perception that they have to use known morphemic information, even if the word as a whole is unfamiliar to them. Although these tendencies are mostly identical with less-skilled learners’ behavior in lexical inferencing studies using multiple-choice formats (Hamada, 2014; Mori & Nagy, 1999), it is worthwhile to note that the same trend was confirmed in the written format.
3.4 The Relationship Between On-line Integration and Interpretation (RQ3)

The final analysis explored the correlation between the integrative process and interpretation, that is, whether integration of morphological and contextual information is advantageous in interpreting novel compounds. These analyses focused only on opaque targets where variability in their interpretations was found (cf. Oakhill et al., 2016).

Correlation analysis was conducted with participants’ integration level and interpretation accuracy score. The integration level refers to how well participants integrated the two sources; this was calculated by subtracting the participants’ mean reading times for opaque targets from those for transparent targets in each context condition from the reading task. Interpretation accuracy score is the number of participants’ accurate interpretation for opaque targets in the translation task (i.e., PMI and CBI), and their sums were also calculated (i.e., PMI + CBI).

The descriptive statistics of the correlation analysis are shown in Table 4. The results showed that significant correlation was not found regardless of context and interpretation types. That is, on-line processing in the reading task presented no particular interpretational advantage.

Table 4

| Interpretation type | Informative context | | Neutral context |
|---------------------|---------------------|----------------|
| PMI                 | .04                 | .799           | .5353 |
| CBI                 | .19                 | .237           | .884 |
| PMI + CBI           | .16                 | .325           | .583 |

These results contradict with an L1 idiom study (Oakhill et al., 2016), which showed moderate correlation between increased reading times and accurate interpretation for novel figurative expressions. Therefore, the following discussion focuses on the difference in the lexical properties between the two studies. Oakhill et al. compared the interpretation of idiomatic phrases with literal and novel figurative meanings when the context was constrained to figurative meanings. As a result, the semantic relationship between the two meanings is relatively small. For example, the phrase ‘to be in the same boat’ has different literal (“to be in the same boat”) and figurative meanings (“to be in the same situation”). However, the two meanings would have a shared core concept “to be in a particular object or space.” Therefore, it can be inferred that the literal meanings could be somewhat helpful for readers to reach novel figurative interpretations only if they noticed that the literal interpretation was not appropriate.

On the other hand, in this study, the meanings of the opaque target words were irrelevant, and sometimes contradicted with contextual meanings. Accordingly, to make a successful interpretation, readers were required to suppress the literal translation (i.e., MBI) and generate an appropriate interpretation, in addition to detecting the inconsistency between the two sources. In
can be concluded that difficulty in understanding novel compounds lies more in the flexible semantic selection of morphological and contextual information in a given context rather than in appreciating the inconsistency of the two sources.

4. Conclusion

The present study examined how EFL readers understand novel compounds with a special focus on on-line integration of morphological and contextual information during reading. The three RQs addressed in this study focus on on-line integration of morphemes and contexts, sources of information used for interpretation, and the relationship between on-line integration and accurate interpretation.

The findings are summarized as follows. First, EFL readers integrate morphological and contextual information during normal reading regardless of contextual information (RQ1). Second, readers make morphology-based interpretations when the two sources are consistent (transparent compounds). In contrast, for opaque words, they make interpretations solely based on morphological information about half the time. In this point, informative context can somewhat assist participants suppress word-based interpretations (RQ2). Third, on-line integration does not correlate with accurate interpretations of opaque compounds due to the difficulty of flexible interpretation after the initial integrative process (RQ3).

From these findings, some pedagogical implications can be derived in terms of improving accurate EFL learners’ understanding of compounds. First, the interpretations for opaque words in the translation task reflected readers’ perception that morphemic information must be included in their interpretation. Therefore, it would be important to explicitly explain to students that the constituents of some words are not related to each entire word’s meaning. In doing so, presenting known opaque words whose constituents are also familiar to learners as an example would be helpful for them to understand the fact. Together with this, teachers should provide students with opportunities to apply this explicit knowledge through practical training. One example is to ask students to judge if the word morphemes are related to contextual meanings, and interpret the word’s meaning based on their judgments. Teachers can focus on semantic selection process because learners can appreciate the relationship between the sources by themselves, as seen in the reading task. At first, using informative context is helpful because learners can make interpretations easily with concrete semantic information by relying on either morphemes or contexts. However, many natural contexts do not always reveal the exact meanings of certain words; training students’ interpretive abilities through neutral contexts is thus imperative. Especially for opaque words, teachers should have students make abstract interpretations based on
cumulative contextual meanings by emphasizing that the main purpose of reading is to construct a coherent text representation and to understand its ideas (rather than exactly understanding each individual word). This kind of explanation can help students who are impatient about abstract understanding instead of word-by-word interpretation. This strategy can also reduce wrong word-based interpretation, which can be detrimental to coherent mental representation at the local level (e.g., sentence-level), and limit text comprehension as a whole. Through these instructions and training, learners will be able to gradually adopt these strategies to their independent reading.

This paper concludes with some methodological limitations and suggestions for further research. First, the main question of this study was whether EFL readers could integrate morphological and contextual information on-line; therefore, this study used reading time data to reveal the binary proposition, and the answer was yes. The subsequent research question should examine how readers make interpretations based on certain sources after noticing conflicts between the two sources. This provides important insight on what cognitive processes lead to successful or unsuccessful interpretations. In this regard, using think-aloud tasks or eye-movement tracking may reveal more poignant findings. Second, the participants took the translation task after completing the reading task. As a result, their interpretations in the translation task may be somewhat different from what they generated while reading. Although the participants did not engage in solely inferring the target words by translating context as a whole rather than target alone, there was a possibility that the task directed more attention to target than in normal reading. One possible solution is to incorporate other on-line tasks, such as priming tasks as they can tap into the semantic information readers activate while reading (although care should be taken to prepare reliable stimulus and targets). Finally, this study only addressed transparent and opaque compounds with straightforward interpretations. However, there are other factors that affect readers’ integration process even within compounds themselves. As other lexical inference study noted, semi-transparent words are more suitable for investigating integrated interpretation of morphemes and contexts, as integration is needed for accurate interpretation (Hamada, 2014; Mori & Nagy, 1999). In addition, another characteristic of the compounds relates to their multiple interpretations. For example, monkey medicine could be interpreted as “medicine for monkey,” “medicine designed by monkeys,” or “medicine made out of monkeys” (Pollatsek, Bertram, & Hyönä, 2011). These complex meanings would trigger different cognitive processes both in integrative process and interpretations. Overall, these findings will shed light on how we address novel words, and also what is necessary to successfully process and interpret them.

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