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Research Article

INTEGRATION OF VERBAL AND CONSTRUCTIONAL INFORMATION IN THE SECOND LANGUAGE PROCESSING OF ENGLISH DATIVE CONSTRUCTIONS

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Abstract
This study investigated the effects of construction types on Korean-L1 English-L2 learners' verb–construction integration in online processing by presenting the ditransitive and prepositional dative constructions and manipulating the verb's association strength within these constructions. Results of a self-paced reading experiment showed that the L2 group spent longer times in the verb–construction integration in the postverbal complement region when processing the ditransitive construction, which is less canonical and highly avoided in the learners' L1, than when processing the prepositional dative construction, which is more canonical and shares similar structural features with the L1 counterpart. In the following spillover region, L2 learners showed faster reading times as proficiency increased when the verb was strongly associated with the prepositional dative construction. Our findings expand the scope of current models on L2 sentence processing by suggesting that construction types and L2 proficiency may affect the L2 integration of verbal and constructional information.

INTRODUCTION

In sentence comprehension, readers use diverse linguistic devices to construct representations for construing a sentence's meaning (e.g., Swets et al., 2008; Traxler & Pickering, 1996). As one of the contributors to sentence meaning, recent studies have

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focused on an argument structure construction (Bencini & Goldberg, 2000; Goldberg, 1995, 2006), which is defined as a form–meaning pairing that denotes a sentence's meaning independent of its individual lexical items (Goldberg, 1995). An increasingly influential view of the role of an argument structure construction challenges the traditional verb-centered perspective that a verb mainly determines the overall sentence meaning (e.g., Chomsky, 1982; Healy & Miller, 1970; Pinker, 1989). Instead of relying exclusively on the verb's role, the constructional view proposes that a language user derives a sentence's meaning by integrating lexico-semantic information provided by a verb with constructional information (Goldberg, 1995, 2013; Goldberg et al., 2004). Previous studies have provided ample evidence in support of the constructional approach by demonstrating that English speakers exploit constructional information to induce semantic likeness among sentences (e.g., Bencini & Goldberg, 2000) or to infer meanings of sentences that include a novel verb (e.g., Ahrens, 1995; Ambridge et al., 2008).

Motivated by research on the first language (L1) development of constructional knowledge, several studies have investigated second language (L2) learners' use of constructional information for sentence production (e.g., Crossley et al., 2016; Ellis & Ferreira-Junior, 2009; Ellis & Larsen-Freeman, 2009; Kyle & Crossley, 2017). These studies corroborate that L2 learners evince an increased ability to capitalize on constructional information for constructing sentence meaning as their target language proficiency increases. Increasing proficiency also allows learners to employ verbs that are less strongly associated with target constructions in production (Ellis & Ferreira-Junior, 2009; Kim et al., 2017; Kim & Rah, 2016; Kyle & Crossley, 2017). More proficient learners tend to employ various types of verbs in the same constructions, including those that are less likely to appear in the target constructions (e.g., a ditransitive use of *drop* as in *John dropped me a letter*). L2 learners' ability to integrate a construction with a verb as a function of proficiency may indicate their linguistic competence to express an event meaning using abstract formal patterns without overrelying on lexico-semantic aspects of a verb, mirroring the close link between language experience and the development of abstract knowledge of constructions in monolingual acquisition (Ambridge et al., 2015; Tomasello, 2003).

Despite prolific research on the L2 integration of a verb and a construction in production, few studies have investigated how L2 learners conflate information between a verb and a construction during online sentence processing. Specifically, we are not aware of any studies that address the extent to which L2 learners retrieve a verb's lexical information and integrate it with a constructional meaning to derive an overall sentence meaning during incremental processing. In addition, how the verb–construction integration during L2 sentence processing interacts with other factors is less well understood. Sentence processing in an L2 may be modulated by several factors, such as proficiency, L2 lexical retrieval, and the learner's experience with the target construction. It is well attested that L2 learners show facilitated reading times in online comprehension with increasing proficiency, more stable and accurate retrieval of lexical information, and/or more experience with the target sentences (e.g., Hopp, 2018; Kaan, 2014; Prior et al., 2017). It remains less clear, however, how these factors modulate an L2 integration between a verb and a construction.

To address these gaps, we investigated Korean-speaking learners' processing of the English dative constructions. In a self-paced reading task, learners were presented with the target constructions containing verbs with different association strength such that half

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of the sentences were paired with verbs less strongly associated with the target constructions and half with verbs of stronger association strength. The strongly associated verb condition included verbs that appear in the target constructions more frequently than other verbs appearing in these constructions. Conversely, the weakly associated verb condition included verbs appearing less frequently in the target constructions compared to the frequency of other verbs in the same sentences. Thus, presenting verbs with different association strengths is expected to cause different degrees of difficulty associated with lexical retrieval and integration with constructional information for L2 learners. Furthermore, to test the modulating effect of learners' experience, the target constructions were presented in two types: the ditransitive (e.g., *Tom gave Mary a book*) and the prepositional dative (e.g., *Tom gave a book to Mary*) constructions. As will be reviewed in this article, Korean-speaking learners of English, the main population of this study, may have experienced each construction to different degrees. For instance, the English prepositional dative construction is regarded as more canonical than the ditransitive counterpart. In addition, Korean-speaking learners may be more familiar with the prepositional dative than the ditransitive construction in English because of cross-linguistic influence or L1 transfer. Contrary to the case in English, the Korean dative construction is realized as the type most closely translated into the English prepositional dative construction whereas the ditransitive type is strongly avoided. If different degrees of experience with the target constructions influence the learner's verb–construction integration, we should observe more processing difficulty with the integration when a verb is paired with the ditransitive, which is less canonical and dispreferred in Korean, than the case when a verb appears in the prepositional dative construction, the more canonical and potential equivalent of the Korean dative counterpart. Finally, to explore the effect of L2 proficiency, we recruited L2 participants at various proficiency levels.

DEVELOPMENT OF CONSTRUCTIONAL KNOWLEDGE IN L1 AND L2 ACQUISITION

Constructionist approaches define a construction as an independent unit of form–meaning correspondence (Goldberg, 1995). Among various scopes of constructions, an argument structure construction (see Table 1) expresses basic human experience in a consistent and formulaic linguistic frame through a clause (Fillmore & Kay, 1999; Goldberg, 1995).

TABLE 1. Argument structure constructions in English

Construction	Form	Meaning	Example
Intransitive-motion	Subj V $Obl_{path/location}$	X moves $Y_{path/location}$	The fly buzzed into the room.
Transitive	Subj V Obj	X acts on Y	Jim pushed Paul.
Caused-motion	Subj V Obj $Obl_{path/location}$	X causes Y to move $Z_{path/location}$	Bill sneezed the foam off the cappuccino.
Ditransitive	Subj V Obj_1 Obj_2	X causes Y to receive Z	Tom faxed me a letter.
Resultative	Subj V Obj RP	X causes Y to become Z_{state}	Sam painted the wall red.

Note. Obj = Object; Obl = Oblique; RP = Resultative phrase; Subj = Subject; V = Verb.

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One of the features driving the acquisition and development of argument structure constructions is the role of prototypicality encoded in a verb. Researchers have found that children strongly rely on so-called light verbs, or highly frequent, prototypical verbs with general purposes and less semantic content, in their early stages of constructional development (Akhtar, 1999; Tomasello, 2003). Children's deployment of light verbs in early acquisition may stem from the verbs' high-frequency and semantic compatibility with constructional meanings. For example, Goldberg et al. (2004) found a strong correlation between the meanings of the most frequent light verbs and their corresponding constructions in the speech of children and their mothers (e.g., *go* in the intransitive-motion, *give* in the ditransitive, *put* in the caused-motion construction). Similarly, Ninio (1999) observed that light verbs such as *do*, *make*, *take*, *give*, and *get*, which are highly frequent in input and have close semantic associations with the constructions in which they appear, were preferentially adopted by young children long before they used semantically heavy verbs in the same constructions. These results suggest that the properties of light verbs that allow for a biunique correspondence with constructional meanings make it possible for children to detect regular patterns among individual language tokens and develop abstract knowledge of constructions.

The role of verb prototypicality attested in L1 acquisition is also known to affect L2 learners' integration of verb and construction during production. For example, Kyle and Crossley (2017) found a strong correlation between verb–construction association strength and holistic scores of L2 writing quality. In their analyses of written essays produced by adult L2 learners, the researchers determined that essays using verbs with less association strength with a construction tended to receive higher scores. These findings were interpreted as supporting the roles of the semantic heaviness of a verb and its association with a construction, which may have different degrees of impacts on L2 learners' conflation of verb and construction, depending on their level of proficiency.

Taken together, the results of previous studies suggest that a speaker's integration of verbal information with a constructional meaning constitutes an important component in sentence production ability. However, the verb–construction integration has not been properly tested in the domain of L2 sentence comprehension. One particularly relevant issue to the verb–construction integration during comprehension is the extent to which L2 learners retrieve the verb's lexical information. The successful integration of verbal and constructional information may depend on how accurately and consistently the learner retrieves the lexical information of the verb to be fused with the constructional information. A theoretical model that helps address this issue is Hopp's (2018) lexical bottleneck hypothesis, which proposes that L2 learners have a limited ability to access and retrieve lexical information due to "weak or unstable lexical representations" (p. 11). This hypothesis predicts that inefficiency or reduced automaticity in L2 lexical access can impose great processing burdens on L2 learners, hampering their targetlike processing. Extending this hypothesis to the L2 integration of verbal and constructional information, one may expect L2 learners to experience greater difficulties processing a target sentence when the sentence includes a low-frequency verb that has a weaker association strength than when it includes a highly frequent verb with a stronger association. We tested this prediction by presenting learners with verbs that have different association strengths with the target constructions.

DATIVE CONSTRUCTIONS IN ENGLISH AND KOREAN

In constructionist approaches, the two English dative constructions, the ditransitive construction (DI; e.g., *Tom gave Mary a book*) and the prepositional dative construction (PD; e.g., *Tom gave a book to Mary*), are considered separate constructions distinct in terms of both forms and meanings (Goldberg, 1995, 2006). According to the constructional perspectives, the DI construction is specified as projecting three constructional roles of an agent, a recipient, and a patient with the central meaning of "X CAUSES Y to RECEIVE Z." However, the PD construction, often regarded as an instance of the caused-motion construction (e.g., Goldberg, 1995, 2006; Goldberg & Jackendoff, 2004), delivers the meaning of "X CAUSES Y to MOVE Z" and contains constructional roles of an agent (a causer), a theme, and a goal.

The two constructions may also differ in their canonical status. Previous studies suggest that the English PD structure is considered more canonical than the DI structure. For instance, Brown et al. (2012) noted that the PD construction is more coherent with the basic, canonical word order of SVO and instantiates higher type frequency than the DI construction. Although their study focused on the effect of information structure (i.e., given-before-new vs. new-before-given) on speakers' processing of the two constructions, it also investigated whether the effect of information structure emerges to different degrees depending on the different canonical status between the two constructions. The authors predicted that speakers would show greater sensitivity to information structure in the DI than the PD construction based on the general tendency that noncanonical word order places more restrictions on the range of possible syntactic realizations (Birner & Ward, 2009). Consistent with this prediction, Brown et al. (2012) found a reliable effect of information structure (indicated by significantly shorter reading times on given-before-new than new-before-given word order) in only the DI construction, not the PD construction. These findings suggest that the DI construction is noncanonical and thus likely to require a more specific discourse context, such as the relative ordering of postverbal elements according to information structure.

In addition to the different canonical status of the PD and DI constructions, learners' experience with the dative constructions through transfer from their L1 may also affect their processing of each construction. For Korean-speaking learners of English, for example, the cross-linguistic association may be formed more strongly between the PD construction and the Korean counterpart than between the DI construction and the Korean counterpart because the correspondent of the English PD construction is more preferred than the counterpart of the English DI construction. Korean, a SOV language, has relatively less rigid word order due to its case-marking system, thereby allowing the case-marked preverbal elements in the dative construction to freely scramble within the clause as long as the construction preserves the meaning of transfer (Sohn, 1999). For instance, the noun phrases bearing the recipient and theme roles can switch their positions, as in (1a) and (1b) (Yoon, 2015). As the recipient is consistently marked by the dative marker *-eykey*, which roughly translates into the English preposition *to*, the Korean dative sentences in (1) are most closely associated with the English PD construction. Although the relative ordering of the recipient and theme in these sentences are predominantly determined by pragmatic conditions such as information structure, the propositional meaning of the two constructions is basically identical: the agent (i.e., *Peter*) caused the recipient (i.e., *Jane*) to receive the theme (i.e., *chak*, "the book"). In addition, the two

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dative patterns are highly frequent in input, constituting approximately 99% of the variants of dative constructions in Korean (Choi, 2009).

(1) a. Korean dative construction: *dative–accusative*

Peter-ka	Jane-eykey	chak-ul	ponay-cwu-ess-ta.
Peter-NOM	Jane-DAT	book-ACC	send-give-PST-DECL[1]

"Peter sent a book to Jane."

b. Korean dative construction: *accusative–dative*

Peter-ka	chak-ul	Jane-eykey	ponay-cwu-ess-ta.
Peter-NOM	book-ACC	Jane-DAT	send-give-PST-DECL

"Peter sent a book to Jane."

In contrast, the ditransitive pattern is highly dispreferred in Korean. Although it is possible for the recipient to be modified by the accusative marker -(*l*)*ul*, as in (2), it can only occur with verbs containing the benefactive suffix -*cwu*- (literally meaning "to give"; e.g., *kennay-cwu*-, "to hand"; Jung & Miyagawa, 2004). Moreover, this pattern is extremely rare in input, as attested by a corpus analysis conducted based on a 0.8-million-sentence Korean written corpus, where the accusative–accusative pattern was found in only 12 out of 2,864 dative instances (Shin & Park, 2019). The infrequency of the accusative–accusative pattern also leads to Korean speakers' low acceptance rates for this type compared to the dative–accusative or accusative–dative pattern (Cho & Jeon, 2015).

(2) Korean dative construction: *accusative–accusative*

?Peter-ka	Jane-ul	chak-ul	ponay-cwu-ess-ta.
Peter-NOM	Jane-ACC	book-ACC	send-give-PST-DECL

"Peter sent Jane a book."

It is assumed that the English PD construction most closely corresponds to the Korean dative–accusative and accusative–dative structures, and the English DI construction corresponds to the Korean accusative–accusative structure based on their parallel functional level structures and argument order (Shin & Christianson, 2009). Previous studies have shown that speakers of a language that disprefers a double accusative form, such as Korean, have more difficulty accepting the English DI structure (e.g., Park, 2014; Whong-Barr & Schwartz, 2002), suggesting that the frequency distribution of the dative constructions in learners' L1 may have significant influence on their comprehension of the target constructions in English.

In sum, the English DI and PD constructions are distinguished in several aspects. Crucial to our main focus, the PD construction is realized in a more canonical syntactic configuration than the DI construction. In addition, the Korean dative constructions instantiate the dative–accusative or accusative–dative patterns, which correspond most closely to the English PD construction. Given the canonical aspect of the English PD construction and its structural proximity to the Korean counterpart, we can expect Korean speakers to have increased experience with the English PD structure and thus more easily process it than the English DI construction. An important question here is whether such varying experience with the target constructions would affect the Korean speakers' verb–construction integration process during the online processing of English dative constructions and how this processing pattern is modulated by L2 proficiency.

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PRESENT STUDY

This study investigated the interacting effects of L2 proficiency, the L2 lexical retrieval of a verb, and learners' experience with the target constructions on the L2 integration of verbal and constructional information during real-time sentence processing. To this end, we conducted a self-paced reading task with native speakers and Korean-speaking learners of English. We also administered an acceptability judgment task to test learners' general understanding of the target constructions used in the self-paced reading task.

METHODS

PARTICIPANTS

A total of 48 native speakers of English (NS group) and 64 Korean-speaking learners of English (NNS group) participated in the study. Participants in the NS control group consisted of self-identified English speakers (18 females, mean age = 33 years, *SD* = 7.8) who were recruited using Amazon's Mechanical Turk. Half of them completed the acceptability judgment task only, and the other half completed the self-paced reading task only, each constituting a reference group in the respective tasks.

The NNS group comprised native Korean speakers (18 females, mean age = 22 years, *SD* = 3.9) who started learning English as a foreign language in a classroom setting around the age of 8. L2 participants' English proficiency was assessed using a written cloze test (Brown, 1980). Participants' performance on the test showed scores ranging from 9 to 48 out of 50 (mean = 29, *SD* = 8.7), representing a wide spectrum of proficiency levels.[2] By virtue of the variability in the learners' proficiency—and, more importantly, because of the gradient nature of proficiency in capturing L2 processing patterns (Van Hell & Tanner, 2012)—we opted to include the cloze test scores as an interactive continuous variable in the regression model rather than grouping L2 participants according to categories of proficiency levels.

MATERIALS

The materials for the self-paced reading task included 24 English sentences in four conditions (six tokens per condition) generated by crossing two construction types (DI, PD) with verbs of different association strength with the target construction (stronger, weaker), as illustrated in Table 2. Sentences across each condition contained identical words, except for the verb and the ordering of postverbal complements in the matrix clause. The matrix clause was presented in either the [subject]-[verb]-[object]-[object] (DI) or the [subject]-[verb]-[object]-[prepositional phrase] (PD) order. The postverbal complements for each construction type were concurrently presented in the same frame during the task so that participants could identify the construction in this region. This region also corresponded to the earliest segment where verb–construction integration could potentially take place, thereby constituting the critical region of the study. In the DI construction, the postverbal complements included animate (e.g., *his professor*) and inanimate noun phrases (e.g., *the homework*) as the direct and indirect objects appearing side-by-side. In the PD construction, the object complements consisted of an inanimate noun phrase (e.g., *the homework*) followed by a prepositional phrase that carried an

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TABLE 2. Example stimuli for the self-paced reading task

	Region						
Condition	1	2	3	4	5	6	7
A	The student	sent	his professor the homework	after	he	was	finally finished.
B		emailed					
C		sent	the homework to his professor				
D		emailed					

Note. Condition A: DI with a strongly associated verb; B: DI with a weakly associated verb; C: PD with a strongly associated verb; D: PD with a weakly associated verb.

animate noun phrase (e.g., *to his professor*).[3] The frequency of the noun phrases was closely matched across the items. Following the matrix clause, four additional regions were inserted, with each presented separately on a region-by-region basis, serving as a buffer to capture any spillover delays induced by "button-press rhythm" during the task (e.g., Koornneef & Van Berkum, 2006). These four regions were created to continue the previous clause as plausibly as possible and constituted either a subordinate clause or an adverbial phrase.

For the manipulation of the relative association strength between a verb and a target construction, we first selected eight high-frequency verbs (with each verb used two to four times in different sentences) that occur most frequently in the target constructions based on previous corpus findings (e.g., Ellis & Ferreira-Junior, 2009; Ellis & Larsen-Freeman, 2009; Gries & Stefanowitsch, 2004; Levin, 1993) and labeled them as *strongly associated verbs*. These verbs were then paired with the semantically relevant but less frequent counterparts, or *weakly associated verbs*. Note that the association strength of the verbs in each condition was determined by their frequency in relation to the target constructions rather than the overall raw frequency of individual verbs. For example, the strongly associated verb *send* is highly preferred in DI and PD constructions and, hence, is one of the early verbs that children employ in their production of dative constructions (Campbell & Tomasello, 2001). In contrast, the weakly associated verb *e-mail* is less likely to appear in a dative construction, requiring readers to rely on constructional information more than on the verb semantics to arrive at a correct interpretation of the sentence.

To ensure that each pair of strongly and weakly associated verbs is clearly distinguished from each other in terms of the association strength with the target construction, we conducted a distinctive collexeme analysis for each experimental sentence based on Gries and Stefanowitsch (2004). Distinct collexeme analyses measure the likelihood that a verb appears in a given construction relative to when it occurs in other constructions. This analysis employs a Fisher exact test that yields a Delta-P score, a unidirectional statistic measure for association strength that estimates the degree to which a verb co-occurs with a construction and vice versa (e.g., Gries, 2013).

To examine whether the association strength was significantly different between the strongly and weakly associated verbs, we compared the Delta-P scores between the two verb conditions for each construction. Results showed that the mean Delta-P score was significantly smaller in the strongly associated verb condition than in the weakly associated verb condition, both for the DI ($t(46) = 2.077$, $p = .043$) and for the PD construction

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($t(46) = 2.136$, $p = .038$), indicating that the two verb types were parceled out into two distinctive categories with stronger and weaker association strength for each construction type.

To estimate how often the experimental items are translated into DI or PD in Korean, we asked five Korean-English bilinguals, who did not participate in the main experiments, to translate the English items into Korean. All the items were exclusively translated into either the dative–accusative (1a) or the accusative–dative form (1b), both of which are closely associated with the English PD construction.

The experimental sentences were counterbalanced across four lists, and each participant saw only one version of each item. These sentences were interleaved with 40 distractor items containing a variety of argument structure constructions and structural types. Appendix A contains the list of experimental items used in the self-paced reading task.

The same sentences from the self-paced reading task were used as stimuli for the acceptability judgment task, but without the spillover portion of the sentence (e.g., *The student sent the homework to his professor*). For the distractor items, some were retrieved from the fillers used in the self-paced reading task while the others were newly constructed as unnatural sentences with either semantic or grammatical violations.

PROCEDURE

Each participant first completed a language background questionnaire. For the main tasks, half of the NS group completed the self-paced reading task only, and the other half completed the acceptability judgment task only. The NNS group completed the self-paced reading task, written cloze test, and the acceptability judgment task. The whole experiment took approximately 20 minutes for the NS and 50 minutes for the NNS group. All participants received monetary compensation for their participation.

The self-paced reading task was conducted on a web-based interface provided by the Ibex Farm program (Drummond, 2013). During the task, participants read a target sentence presented in a noncumulative moving window display, processing the sentence at their own pace on a region-by-region basis. After reading the whole sentence, participants were prompted to respond to a comprehension checkup question by clicking on one of the answers provided on the screen. For example, for the sentence "The students sent the professor the e-mail after he was finally finished," the question "Did the student finish the homework?" appeared with the two options of "Yes" and "No" positioned one above the other. The position of the correct and incorrect answers was randomized. Half of the questions asked about the event denoted by the matrix clause; the other half asked about the content in the remaining part of the sentence. Prior to the task, participants received written instructions and completed five practice items.

The acceptability judgment task was carried out using a web-based survey tool provided by Google Forms. During the task, a target sentence appeared on a single page, prompting the participant to rate the naturalness of the sentence on a Likert scale from 1 (very unnatural) to 4 (very natural). We also added an option of "I don't know" for each item to prevent participants from arbitrarily answering a question about which they were uncertain. Once the task started, participants were not allowed to move back to previous items and change their answers.

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RESULTS

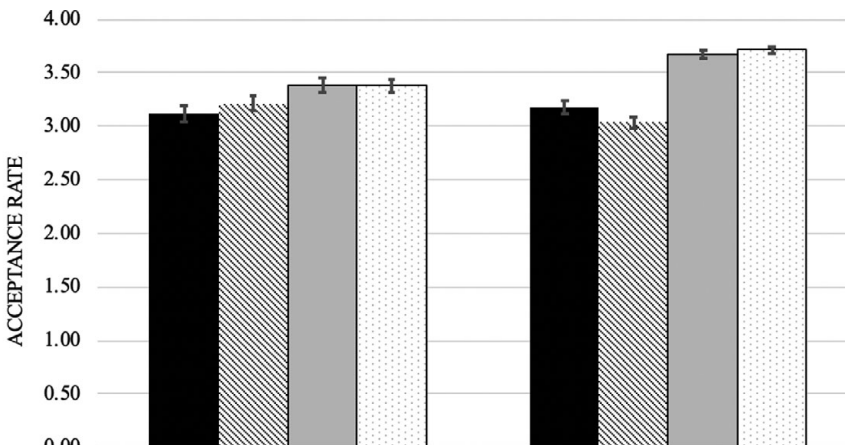
Before reporting the results from the self-paced reading task, we first present the results from the acceptability judgment task to establish whether the learners possessed sufficient knowledge to understand the target constructions.

ACCEPTABILITY JUDGMENT TASK

We first removed the "I don't know" responses (1.1%, 21 responses). The mean ratings for the ungrammatical filler items were very low for both the NS (M = 1.09, SD = 0.93) and NNS groups (M = 1.67, SD = 1.02), indicating that participants did not simply accept all sentences. Mean rates of judgment for the experimental stimuli are illustrated in Figure 1. As seen in the figure, both groups generally accepted the target constructions, with the mean rates exceeding 3 in all the conditions.

To investigate each group's judgment patterns in detail, we conducted a linear mixed-effects regression (Baayen et al., 2008) on the judgment ratings. The model included the group (NS, NNS), construction type (DI, PD), verb's association strength (stronger, weaker), and their interactions as fixed effects as well as the random effects of participant and item. All fixed effects were contrast coded and centered around the means. Based on Barr et al. (2013), we maintained a maximal random effect structure allowed by the design for the model, adding by-participant random slopes for the fixed factors of construction type and association strength as well as a by-item random slope for the group factor. All modeling was conducted in R version 3.5.2 (R Core Team, 2018).

Table 3 presents the outcomes of the model. The model showed a reliable effect of construction type, with higher acceptance rates for the PD than the DI construction. This



	NS group	NNS group
■ DI/stronger verb	3.12	3.18
▨ DI/weaker verb	3.21	3.04
▩ PD/stronger verb	3.38	3.67
□ PD/weaker verb	3.38	3.71

FIGURE 1. Results of the acceptability judgment task; error bars indicate 95% CIs.

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TABLE 3. Model outputs from the acceptability judgment task

	ß	SE	*p*
Intercept	3.37	0.05	< .001***
Group	0.12	0.10	.229
Construction type	0.48	0.06	< .001***
Verb strength	–0.03	0.04	.453
Group × Construction type	0.37	0.13	.007**
Group × Verb strength	–0.09	0.08	.244
Construction type × Verb strength	0.10	0.08	.201
Group × Construction type × Verb strength	0.28	0.18	.120

***$p < .001$; **$p < .01$.

effect was qualified by a significant interaction with group, suggesting that the discrepancy of acceptance ratings between the two constructions differed across the groups. However, in separate analyses for each group, a main effect of construction type was obtained for both groups in the same direction ($b = 0.22$, $SE = 0.06$, $p < .001$ in the NS group; $b = 0.58$, $SE = 0.08$, $p < .001$ in the NNS group), without a main effect of verb association strength or an interaction between construction type and verb association strength.

The results of the acceptability judgment task indicate that both groups were more likely to accept the PD than the DI construction, with the tendency being stronger for the NNS than the NS group. We speculate that the overall higher acceptance for the PD than the DI construction may be ascribed to the more canonical aspect of the English PD than the DI structure (Brown et al., 2012) and to the use of a full noun phrase, rather than a pronoun, as a recipient in our stimuli, which is a more preferred form in the PD than in the DI construction (Bresnan, 2007). At the same time, the finding that the NNS group accepted the PD than the DI construction to a larger extent than the NS group indicates an effect of cross-linguistic influence because Korean favors the PD over the DI structure. Another potential reason may be due to an instructional effect.[4] With more restrictions placed on the syntactic realizations of the DI than the PD (Birner & Ward, 2009), learners might have been taught that DI sentences are acceptable only with a certain types of verbs whereas PD sentences are compatible with a wide range of verbs. It is also possible that the learners might have figured out that the PD construction allows for wider sets of verbs than the DI construction after encountering numerous cases of PD examples with diverse types of verbs but only a small number of DI sentences with a limited set of verbs in textbooks (e.g., Year & Gordon, 2009). However, it is clear that participants generally accepted the sentences in all conditions, albeit to different degrees, suggesting that the learners had sufficient knowledge of the target constructions.

SELF-PACED READING TASK

Before analyzing participants' reading time (RT) data, we used the following process to conduct data trimming. First, we removed data from four participants in the NNS group who scored below 80% on the comprehension questions, leaving 60 in this group. The accuracy scores for the remaining participants were on average 90.3% ($SD = 5.7\%$) in total, with the mean accuracies of 91.5% ($SD = 6.8\%$) in the NS group

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and 89.8% (*SD* = 5.1%) in the NNS group. The two groups' mean accuracies after removing the four participants' data were not statistically different, $t(82) = 1.273$, $p = .206$, Cohen's $d = 0.288$. The high accuracy scores in both groups indicate that these participants paid close attention to the sentences' meanings during the task. Next, we removed the RTs below 100ms and above 5,000ms (1.2%) and the RTs beyond two standard deviations from the mean (5.5%).

For the remaining data, we applied log-transformation (Ratcliff, 1993). Subsequently, we residualized the log-transformed RTs to adjust for the variability in word length and individual reading speed (Trueswell et al., 1994). Figures 2 and 3 display log-transformed

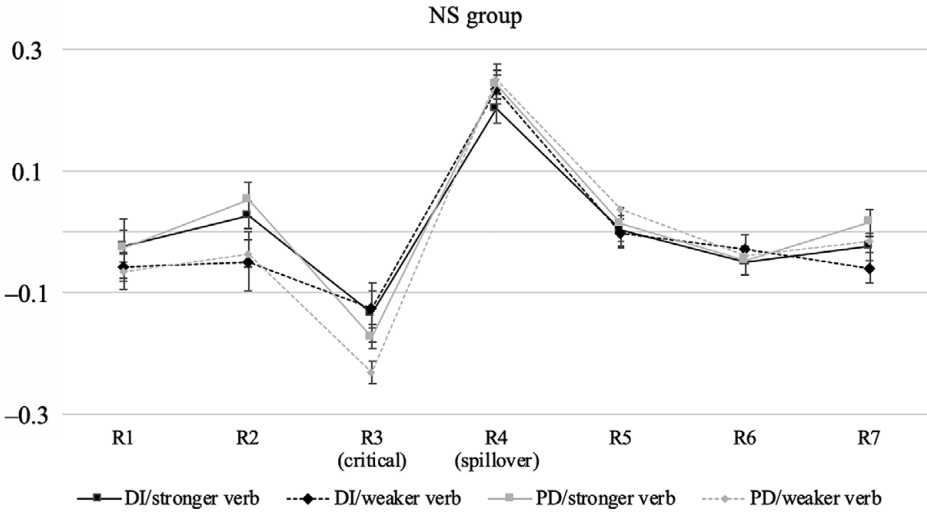

FIGURE 2. Residual RT profile for the NS group; error bars indicate 95% CIs.

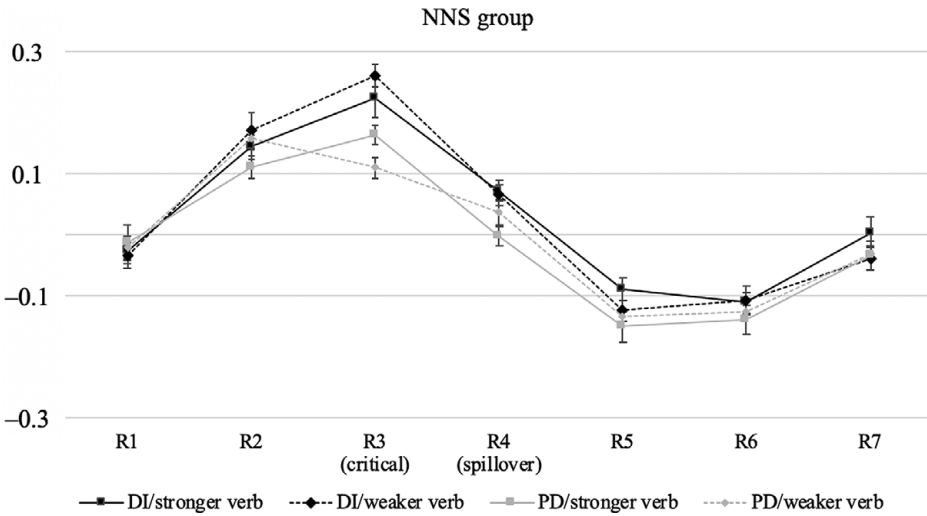

FIGURE 3. Residual RT profile for the NNS group; error bars indicate 95% CIs.

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TABLE 4. Model outputs for Regions 3 and 4 from the self-paced reading task

		ß	SE	*p*
Region 3 (critical)	Intercept	0.07	0.03	.024*
	Group	0.37	0.06	< .001***
	Construction type	–0.09	0.02	< .001***
	Verb strength	–0.02	0.03	.551
	Group × Construction type	–0.03	0.05	.547
	Group × Verb strength	0.02	0.05	.711
	Construction type × Verb strength	–0.08	0.05	.119
	Group × Construction type × Verb strength	–0.01	0.10	.924
Region 4 (spillover)	Intercept	0.10	0.02	< .001***
	Group	–0.19	0.03	< .001***
	Construction type	–0.03	0.01	.056
	Verb strength	0.02	0.02	.289
	Group × Construction type	–0.08	0.03	.012*
	Group × Verb strength	–0.003	0.03	.935
	Construction type × Verb strength	0.02	0.03	.409
	Group × Construction type × Verb strength	0.07	0.06	.284

****p* < .001; **p* < .025.

residual RT profiles for the NS and NNS groups, respectively (mean raw RTs are reported in Appendix B).

To investigate the influence of construction and verb conditions on each group's RT patterns, we fit linear mixed-effects regression models to the residual RTs in the critical region (R3) and the spillover region (R4) separately.[5] The models for each region included group (NS, NNS), construction type (DI, PD), verb's association strength (stronger, weaker), and their interactions as fixed effects (centered and contrast-coded), along with the random effects of participant and item. The random effect structure was kept maximal. As we simultaneously analyzed two regions, the alpha level was corrected for .025 (.05 divided by 2) in each analysis.

The model outputs for the two regions are summarized in Table 4. In Region 3, only two main effects were found: the effects of group and construction type. The group effect was induced by the longer RTs for the NNS than for the NS group. The effect of construction type was driven by the significantly longer RTs in the DI relative to the PD conditions, indicating that both groups spent a longer integration time with the DI than the PD construction.

Although we did not find a significant interaction between group and construction type, we decided to conduct by-group analyses to pinpoint the potential locus of the construction type effect precisely. The model for the NS group included construction type, verb association strength, and their interactions as fixed effects (centered and contrast coded) and the random effects of participant and item, along with the maximal random effects structure including by-participant random slopes for the fixed factors. The model for the NNS group was created analogously to the NS group model, but it also included proficiency measured by the cloze test scores as a fixed factor (centered). The model for the NS group did not show a main effect of construction type (b = –0.07,

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SE = 0.04, *p* = .119), a main effect of verb strength (*b* = –0.03, *SE* = 0.05, *p* = .599), or an interaction between the two factors (*b* = –0.08, *SE* = 0.10, *p* = .423), suggesting the same RTs across the conditions. The model for the NNS group revealed the main effect of construction type (*b* = –0.10, *SE* = 0.03, *p* = .002), induced by the longer RTs in the DI than in the PD construction. There was no main effect or interaction beyond the construction type effect in this group. The results of each group's RT patterns in Region 3 indicate that the NNS group experienced more difficulties integrating the verb with the target construction in the DI than in the PD construction, regardless of the verb's association strength or the learners' L2 proficiency.

Turning to the spillover region (Region 4), the global model showed a main effect of group, this time with the longer RTs in the NS group than in the NNS group. This RT pattern showed the opposite as the direction observed in the previous region, and we have no clear explanations for this result.[6] More importantly, a significant interaction was found between group and construction type. In light of this interaction, we conducted by-group analyses in the same manner as in the previous region. The model for the NS group did not show a main effect of construction type (*b* = 0.03, *SE* = 0.03, *p* = .278), a main effect of verb association strength (*b* = 0.02, *SE* = 0.03, *p* = .609), or an interaction (*b* = –0.02, *SE* = 0.05, *p* = .629). The model for the NNS group revealed a main effect of construction type (*b* = –0.05, *SE* = 0.02, *p* = .004), with longer RTs in the DI than in the PD construction. Notably, we found a significant three-way interaction among construction type, verb association strength, and proficiency (*b* = 0.01, *SE* = 0.004, *p* = .009). There were no other effects or interactions in this group.

Additional analyses breaking down this three-way interaction in the L2 model were conducted for each construction type in Region 4. We generated a separate mixed-effects regression model for the DI and PD conditions, respectively, each of which included verb association strength and proficiency (centered) as fixed effects, along with the maximal random effects structure allowed by the design. The alpha level was further adjusted to .012 (.025 divided by 2) in these subset models. In the model for the DI construction, we did not find a significant effect of proficiency (*b* = 0.01, *SE* = 0.002, *p* = .015), an effect of verb association strength (*b* = –0.01, *SE* = 0.02, *p* = .705), or an interaction (*b* = –0.003, *SE* = 0.003, *p* = .168). This result indicates that the L2 participants had the same RTs for the integration between a verb and the DI construction, not affected by the verb's association strength or the participants' proficiency. The model for the PD construction, by contrast, showed a significant interaction between verb association strength and proficiency (*b* = 0.007, *SE* = 0.003, *p* = .009) such that the RT gap between the verbs of stronger and weaker association strength decreased as L2 proficiency increased. There was no main effect of verb association strength or proficiency.

To further examine how each verb type within the PD construction interacted with L2 learners' proficiency, we conducted Pearson correlation tests, plotting RTs in the stronger and weaker verb association conditions with participants' proficiency scores. As shown in Figure 4, participants' RTs in the stronger verb association condition significantly decreased as proficiency increased (*r* = –.35, *p* = .007), whereas there was no significant correlation between RTs in the weaker verb association condition and proficiency scores. These results suggest that the primary source underlying the three-way interaction among construction type, verb association strength, and proficiency in Region 4 is that the

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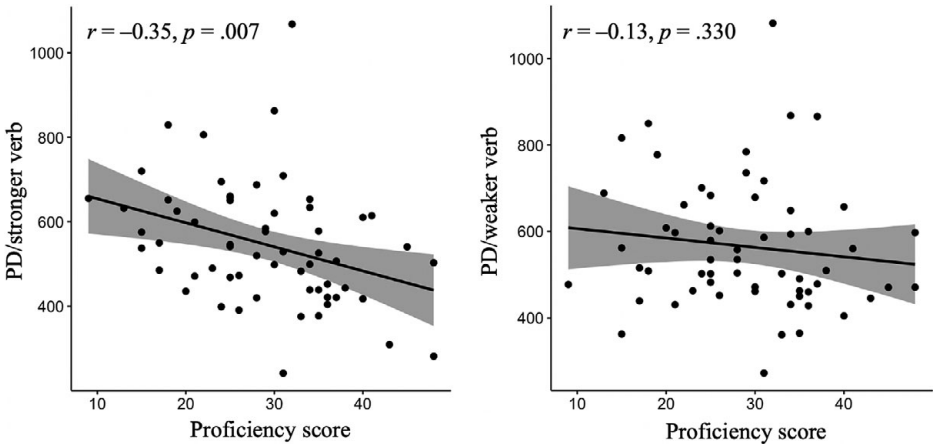

FIGURE 4. Correlation between proficiency scores and reading times for each verb type within the PD construction in Region 4.

learners were faster at integrating the verbs of stronger association strength with the PD construction as their English proficiency increased.

DISCUSSION AND CONCLUSION

In this study, we investigated how proficiency, the degree of learners' lexical retrieval, and experience with target constructions influence the integration of a verb and a construction during L2 sentence processing. Our results showed that the L2 participants spent significantly longer times on the DI than the PD construction in the critical region, regardless of L2 proficiency and the verb's association strength. The effect of construction type further interacted with L2 proficiency and the verb's association strength in the spillover region, as indicated by diminished RTs for the integration as proficiency increased only in the PD but not in the DI construction.

The learners' increased RTs in the DI relative to the PD construction in the critical region indicate that they experienced different degrees of integration difficulties with the two constructions. This finding confirms our prediction that the learners would have greater processing difficulty with the DI than the PD construction due to the difference in the relative degree of the learners' experience with each construction. The facilitated processing of the more canonical PD construction is consistent with the findings from Brown et al.'s (2012) self-paced reading study, in which English speakers spent less time reading PD than DI sentences, regardless of the manipulation of the information structure. Similarly, our results demonstrated that the L2 learners found it easier to process the canonical PD than the noncanonical DI construction, yet at the same time, we further showed that the canonical aspect of the PD structure affected the learners' integration of the verb and construction. The different canonical statuses of the PD and DI constructions may have likely affected the native speakers' processing as well, although it appears that they were more able than the L2 learners to integrate their constructional knowledge with the verbal information, as reflected by their consistent RTs taken for the verb–construction integration, regardless of the construction type.

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The learners' faster integration for the PD than the DI construction may also indicate some evidence of cross-linguistic influence as the learners had greater integration difficulty with the DI construction, the less preferred form in Korean, than with the PD construction. Some caveat is warranted, however, in attributing the faster integration in the PD construction convincingly to its structural similarity to the Korean counterpart, as we investigated processing patterns from only one group of L2 learners. As a reviewer suggested, to argue for the role of learners' L1 in the processing of target constructions, the study should compare processing patterns between two L2 groups with distinct language backgrounds. Because this study involved a single L2 group, it is not straightforward whether the faster integration with the PD than the DI construction observed in our L2 participants is an effect of the cross-linguistic interaction between the Korean and English dative constructions, or simply a reflection of general processing patterns of nonnative speakers. The lack of a comparison L2 group in our study remains an obvious limitation, which calls upon future research exploring whether the Korean speakers' processing pattern differs from that of another group of learners with an L1 instantiating dative constructions in a similar way as English. Only when the distinct processing patterns between the English DI and PD constructions are found to be exclusive to Korean-speaking learners can we confidently argue for the contribution of cross-linguistic influence in the process of L2 verb–construction integration. We leave such exploration for future studies.

It is noteworthy that the facilitated integration for the PD versus DI construction emerged in the critical region, regardless of the verb's association strength with the target constructions. We initially predicted that the learners' difficulty with the verb–construction integration would be alleviated when the verb was strongly associated with the target construction. However, the results in the critical region suggest that the learners had the same degree of integration difficulty for both strongly and weakly associated verbs. The absence of the effect of the verb's association strength in this region may be related to the learner's limited access to lexical information, even for the strongly associated verbs. These findings may be accounted for by Hopp's (2018) lexical bottleneck hypothesis, which claims that L2 learners have a reduced ability to access and retrieve lexical information. In line with this hypothesis, it appears that our L2 learners had processing difficulties associated with the access and retrieval of the verb information. In particular, the learners may have experienced much greater burdens as they were required to integrate the retrieved lexical information with the constructional meaning. Such cognitive endeavors may have prevented the learners from complete verbal and constructional integration in this region, leading to the null effect of the verb's association strength.

The assumption that the L2 learners had inefficient lexical retrieval garnered further support from the distinct reading patterns between the native and nonnative participants in the verbal region (Region 2). Note that the verbs of stronger association strength are mostly high-frequency verbs whereas the frequency of the verbs with weaker association strength is relatively lower. As illustrated in Figure 2, the native speaker group showed sensitivity to the manipulation of verb frequency, spending more RTs on the less frequent than the more frequent verbs. The L2 learners, in contrast, failed to exhibit different RTs between the two verb conditions (see Figure 3). The group difference in this region was statistically supported by the analysis of the mixed-effects regression model, which showed a significant interaction between group and verb association strength ($b = 0.12$,

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SE = 0.04, *p* = .002). Post-hoc analyses revealed a reliable effect of verb association strength in only the native speaker group (*b* = –0.01, *SE* = 0.002, *p* = .002), but not the L2 learner group (*b* = 0.04, *SE* = 0.02, *p* = .076). In addition, no interaction occurred between proficiency scores and verb association strength in the L2 data. These results indicate that the learners had difficulty fully retrieving the verbal information as soon as they had processed the verb; this pattern remained the same, regardless of learner proficiency. One potential reason for the null effect of proficiency in the L2 learners' processing patterns may be due to the fact that, despite our efforts to include learners at various proficiency levels, these learners were far from having reached the end state in their proficiency. As the lexical bottleneck hypothesis predicts more efficient lexical retrieval with increasing proficiency (Hopp, 2018), it remains to be seen whether the effect of verb frequency would emerge in the early regions for L2 learners deemed to have achieved near-nativelike proficiency.

Our second finding was the three-way interaction among construction type, verb association strength, and L2 proficiency in the spillover region (Region 4). These results suggest that the integration of a verb and a construction was facilitated for the L2 learners with higher proficiency when the verb was strongly associated with the target construction, and this facilitation occurred only in the PD construction. Several reasons may underlie this result. For example, given that the expected verb association strength effect did not emerge in the critical region but in the spillover region, it is possible that the learners' sensitivity to the verb's association strength conditioned on the construction type may have spilled over from the critical region into the spillover region. If this is the case, the emerging effect of the interaction of verb association strength and construction type may be indicative of L2 learners' delayed integration of a verb and a construction. This finding suggests that the L2 learners—at least those with higher proficiency—were sensitive to the verb's association strength, but their lexical retrieval of a verb with stronger association strength was not fast enough to enable them to engage in the integration of the verb and construction as early as in the critical region. The results simultaneously suggest that the learners still had persistent difficulties with the verb–construction integration when the verb was less strongly associated with the construction. As previously mentioned, we assume that the learners' inefficient access to the verb may be the underlying cause of the delayed integration of a construction and a verb with stronger association strength. If this is the case, the lexical bottleneck hypothesis (Hopp, 2018) can be extended to suggest that L2 lexical retrieval not only affects the processing of a single grammatical point but also modulates the process of a verb–construction integration. Thus, future studies developing this model should consider verb–construction integration as an additional area of difficulty that may be affected by inefficient L2 lexical retrieval.

The delayed verb–construction integration in the L2 compared to the L1 speakers may also be discussed in light of the role of predictive processing in L2 (Grüter et al., 2017; Kaan, 2014). One specific hypothesis as to how L2 learners engage in predictive processing has been proposed by Grüter et al. (2017), who suggested that L2 learners have a reduced ability to trigger predictions based on incoming language input. Supporting evidence of this hypothesis comes from studies showing L2 learners' delayed use of linguistic information, such as grammatical gender (e.g., Dussias et al., 2013), grammatical aspect (e.g., Grüter et al., 2017), and causality information encoded in verb semantics

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(e.g., Cheng & Almor, 2017). Consistent with findings from these previous studies, our L2 participants showed the reduced ability to preactivate the verb's semantic information to integrate it with the target construction at the critical region. At the same time, the finding that the effect of verb–construction integration found at the spillover region in the L2 group increased with L2 proficiency suggests that achieving higher proficiency might facilitate L2 predictive processing. In our study, the L2 participants learned English in an instructional setting, which indicates that they may be far from having reached the end state on their English proficiency. Based on Kaan's (2014) prediction that L2ers' engagement in predictive processing increases with higher proficiency, we expect highly advanced L2 learners, such as those who learned English in an immersive context, to show predictive behavior comparable to the native speakers. This remains a promising avenue of future research.

Another possible explanation for the three-way interaction in the spillover region is that the L2 participants might have been more sensitive to the probability of the construction given the verb than the association between the verb and the construction. As a reviewer pointed out, our participants had read the verb before they identified the construction type during the task. By the time the learners encountered the postverbal complements, the parser should have computed the probability of occurrence of each type of complements (i.e., PD or DI) for the verb that had been processed. Such probabilistic inferences may have been accomplished relatively easily by native speakers, who showed no sign of processing difficulties, but may have been taxing for the L2 learners given their relatively less practice in the L2 than in the L1. Yet these inferential difficulties could be alleviated with more experience with the target language, as shown by the learners' facilitated RTs with increasing proficiency and experience with the construction. Further work is needed to investigate how L2 learners' sensitivity to the probability of the construction given the verb relates to their verb–construction integration ability.

In sum, the online RT patterns among the L2 learners showed that the facilitated verb–construction integration occurred in the spillover region only when the learners' proficiency was higher, the verb was strongly associated with the construction, and the target construction was canonical and analogous to the learners' L1 counterpart (i.e., the PD construction). These findings suggest that the verb–construction integration may be delayed in L2 learners, presumably due to slow access to lexical information (cf. Hopp, 2018), and that learners' experience with target constructions can have significant impacts on L2 readers' conflation between the verb and construction information during online processing. Further research is required to examine other potential factors, such as working memory and L2 learning environment (e.g., natural or classroom exposure), in the L2 integration of a verb and a construction during sentence processing.

NOTES

[1]Abbreviations used throughout this paper: ACC = accusative case marker; DAT = dative marker; DECL = declarative marker; NOM = nominative case marker; PST = past tense marker.

[2]To more precisely estimate the proficiency levels of our participants, we referred to a previous study (Grüter et al., 2017) that used the same proficiency test, along with other proficiency measures, with Korean- and Japanese-speaking learners of English. Grüter et al. (2017) categorized learners in their study as independent users (B1, B2) or advanced basic users (A2) of English based on the alignment of their Versant English test

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scores with the level descriptions of the Council of Europe framework. Considering that these learners' cloze test scores ranged from 12 to 40, the score range of our participants (9–48) indicates that one of them was lower-intermediate (lower than 12) and five were highly advanced (higher than 40) learners, while most others were classified as intermediate to advanced English learners (between 12 and 40, $n = 58$).

[3]The stimuli in the PD construction consisted of sentences with the recipient argument modified by either "to" or "for." Although the two types of sentences have different surface forms, we categorized both types into the same construction following Goldberg (2006), who focused on their consistency in syntactic and semantic structures. Notably, the Korean correspondent of the English PD construction consistently involves the postposition *-eykey* "to" following the recipient argument, creating more potential for Korean speakers to conceive the "to" and "for" structures in English as the same construction if they associate them with the Korean counterpart.

[4]We thank an anonymous reviewer for bringing up this point.

[5]Analyses of the models for Regions 6, 7, and 8 did not show any effects or interactions, except the effect of group in Regions 6 and 7, all driven by longer RTs for the NS than the NNS group.

[6]One conceivable speculation is that the spillover effect may have been larger for the NS than the NNS group. As native speakers are generally faster readers compared to nonnative speakers, the task-induced button-pressing action may also have been performed more quickly by the native than the nonnative participants, presumably making the NS group more susceptible to the rapid reading of the previous critical region. Thus, the processing difficulty associated with the integration of a verb and a construction in Region 3 may have been more likely to spill over to the following region in the NS than the NNS group.

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APPENDICES

APPENDIX A. Experimental items used in the self-paced reading task (DI: Ditransitive construction; PD: Prepositional dative construction)

DI: The student sent/e-mailed his professor the homework after he was finally finished.
PD: The student sent/e-mailed the homework to his professor after….

DI: The lady made/baked her son the cake because it was his favorite food.
PD: The lady made/baked the cake for her son because….

DI: The businessman gave/offered his girlfriend the laptop because hers was broken.
PD: The businessman gave/offered the laptop to his girlfriend because….

DI: The engineer got/offered his coworker the lamp because her room was dark.
PD: The engineer got/offered the lamp to his coworker because….

DI: The woman made/cooked her husband the pasta because he worked so hard.
PD: The woman made/cooked the pasta for her husband because….

DI: The guest handed/presented the host the gift before she left in the evening.
PD: The guest handed/presented the gift to the host before….

DI: The secretary sent/texted the president the schedule after work on Tuesday.
PD: The secretary sent/texted the schedule to the president after….

DI: The lawyer passed/faxed the intern the file as she left the office.
PD: The lawyer passed/faxed the file to the intern as….

DI: The CEO gave/assigned the analyst the office after consulting his partner.
PD: The CEO gave/assigned the office to the analyst after….

DI: The scientist showed/displayed his assistant the notebook as he explained his latest project.
PD: The scientist showed/displayed the notebook to his assistant as….

DI: The secretary bought/booked her boss the flight ticket early in the morning.
PD: The secretary bought/booked the flight ticket for her boss early….

DI: The musician brought/knitted his teacher the scarf because of her help with music theory.
PD: The musician brought/knitted the scarf for his teacher because of….

DI: The student wrote/forwarded her professor the letter after the completion of her project.
PD: The student wrote/forwarded the letter to her professor after….

DI: The doctor bought/served the nurse dinner after a romantic date at the beach.
PD: The doctor bought/served dinner for the nurse after….

DI: The editor bought/saved the typist the cookies because she had not eaten.
PD: The editor bought/saved the cookies for the typist because….

DI: The bartender handed/offered the dancer the beer because she looked lonely.
PD: The bartender handed/offered the beer to the dancer because….

DI: The waiter took/delivered the customer the pizza after he served the appetizer.
PD: The waiter took/delivered the pizza to the customer after….

DI: The librarian brought/presented the student the novel because she was eager to read it.
PD: The librarian brought/presented the novel to the student because….

DI: The woman showed/presented the cashier the coupon to get a 15% discount for the shoes.
PD: The woman showed/presented the coupon to the cashier to get….

DI: The banker bought/fetched his coworker the stapler because he asked to use it.
PD: The banker bought/fetched the stapler for his coworker because….

DI: The boy passed/delivered his friend the note during class on Monday morning.
PD: The boy passed/delivered the note to his friend during….

APPENDIX A. Continued

DI: The gentleman threw/pitched the beggar the coin because he asked for it.
PD: The gentleman threw/pitched the coin to the beggar because….

DI: The player threw/pitched his coach the ball because he asked to see it.
PD: The player threw/pitched the ball to his coach because….

DI: The professor wrote/prepared the student the letter because she was at the top of her class.
PD: The professor wrote/prepared the letter for the student because….

APPENDIX B. Raw RT (standard deviations) by region in the self-paced reading task

Group	Condition	R1	R2	R3 (critical)	R4 (spillover)	R5	R6	R7
NS	DI/strong	504 (202)	417 (151)	780 (477)	516 (202)	405 (190)	384 (122)	505 (198)
	DI/weak	488 (193)	425 (168)	777 (497)	541 (227)	395 (128)	397 (146)	501 (214)
	PD/strong	507 (225)	436 (213)	838 (471)	547 (239)	406 (163)	388 (126)	540 (262)
	PD/weak	476 (154)	427 (161)	762 (416)	550 (243)	413 (167)	386 (105)	516 (207)
NNS	DI/strong	663 (361)	627 (311)	1193 (469)	582 (247)	482 (274)	478 (238)	704 (385)
	DI/weak	665 (352)	698 (360)	1234 (477)	580 (266)	464 (250)	485 (252)	665 (361)
	PD/strong	667 (352)	607 (331)	1295 (484)	547 (247)	448 (229)	461 (213)	680 (379)
	PD/weak	676 (371)	707 (391)	1195 (469)	565 (242)	458 (239)	471 (245)	679 (360)

Note. DI = Ditransitive construction; PD = Prepositional dative construction; R = region.

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