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Effects of Structure, Salience, and Working Memory on L2 Processing of English Past Participles by L1 Thai Learners

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Article information	
Abstract	This study examined the effects of working memory (WM), structure, and salience on the processing of English relative clauses (RCs) and participial reduced relative clauses (PRRCs) by L1 Thai learners. Salience in this research is the phonological alterations required for irregular verbs to inflect into the past participial form. The study included two types of irregulars with different salience levels. Seventy advanced L1 Thai learners took a reading span task and a self-paced reading task to assess their WM level and processing of past participial forms. The hypotheses proposed that WM, structure, and salience would influence online processing (reading times) and offline processing (comprehension accuracy). However, the findings showed differences between the higher and lower WM groups in only their online processing. The asymmetrical WM effects may be due to different levels of resource demands of the two processing tasks. Effects of structure and salience were observed on the learners' processing. The learners read the PRRCs faster than the RCs due to greater processing resources required for considering grammatical issues in the latter. Additionally, the participants processed the less salient irregulars faster because of greater phonological similarities between their past tense and past participial forms. Future research could explore either different classes of past

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	participles in the salience hierarchy or how WM and salience affect the PRRC processing among learners with diverse L1 backgrounds.
Keywords	second language processing, working memory, participial reduced relative clause, relative clause, salience
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1. Introduction

Two cognitive factors found to affect how L2 learners acquire L2 syntactic structures are working memory (WM) and salience. Higher WM is associated with better attention regulation and cognitive task performance (Unsworth et al., 2004). Salience refers to the prominence of an item compared to its neighbors. Bordalo et al. (2012) explain that stimuli with higher salience are more likely to be perceived than those with lower prominence.

One aspect which may involve both concepts is the processing of English participial reduced relative clauses (PRRCs) and relative clauses (RCs). PRRCs are reduced forms of RCs where the relative pronoun and verb *be* are omitted (Azar, 1999). So far, WM research has focused on native English speakers' processing of the PRRCs with regular verbs concerning how the natives resolved main verb/reduced relative ambiguity or the phenomenon where a regular verb with the *-ed* suffix can be interpreted as either the past tense or the past participle (PP) form of the verb (e.g., Eastwick & Phillips, 1999; MacDonald et al., 1992). No studies have explored WM effects on L2 learners' processing of PRRCs and RCs (e.g., Rah & Adone, 2010; Yang & Shih, 2013), and little attention has been given to irregular verbs (IVs) appearing in the two constructions. Furthermore, L2 learners' processing of PRRCs and RCs with IVs might be affected by salience of the PP form of the verbs. However, salience has never been studied as a factor to analyze L2 processing of the structures. Thus, this paper examined WM effects on L1 Thai learners' processing of English PRRCs and RCs with IVs.

2. Literature Review

2.1 Working Memory

Working memory (WM) is a limited capacity system which stores and manipulates information. It works as the site for carrying out processes and keeping the output of the processes simultaneously (Baddeley & Hitch, 1974). Hofmann et al. (2008) claim that people's WM includes their storage capacity and ability to exploit attention and exclude distraction.

WM differences are associated with distinctions between individuals concerning how well they can employ attention for doing cognitive tasks. That is, the higher WM people can control their attention better than the lower WM ones, which makes the former more likely to successfully tackle complex tasks (Unsworth et al., 2004).

2.2 Salience and English Regular and Irregular Verbs

An item's salience is the characteristic which makes it more outstanding than its neighbors. The more salient stimuli are more apt to be perceived than the less prominent ones (Bordalo et al., 2012). Salience has been shown to affect L2 learners' processing of many linguistic components, including the past tense forms of English verbs.

English verbs have been classified into two groups by their inflection to the past tense (PT) and past participle (PP) forms: regular and irregular. According to Azar (1999), regular verbs inflect the PT and PP forms by attaching the –*ed* suffix to their base form. Irregular verbs (IVs) differ from the regular ones in two ways. The first difference is that IVs have three main ways of inflection: transforming their vowel (e.g., *stick-stuck*), fastening a suffix to the verb (e.g., *learn-learnt*), or both (e.g., *bring-brought*) (Young, 1984). Secondly, while the PT and PP forms of all regular verbs are identical, the degree of similarities between the two forms of IVs varies. The two forms of some IVs are the same (e.g., *fought* and *hit*) whereas those of others are not (e.g., *awoke-awaken*). The past tense and past participle inflections of the two types of verbs are different in two aspects: formal dissimilarity degree, i.e., the extent to which the inflected form of a word differs from its base form, and non-productivity degree, namely the degree to which morphological irregularity is confined to a limited set of words (Kortmann, 2020). Regular verbs have a lower formal dissimilarity level than irregular verbs because the past tense and past participial forms of the former are the same whereas those of the latter are not. Moreover, the regular -*ed* suffix applies to a greater range of

verbs, so the degree of non-productivity of the regular suffix is lower than that of the irregular suffixes (Nicoladis et al., 2007).

Several studies have examined the relationship between salience and English IVs concerning past tense marking. In those studies, salience is how the PT form of a verb phonologically differs from its present tense form. As Minow (2010) has stated, the stronger the phonological distinction between the two forms of a verb is, the more prominent the PT form of the verb tends to be. L2 learners have been found to mark PT for the more salient verbs rather than the less salient ones. For instance, *think* requires three changes in becoming *thought*: (a) altering the vowel /ɪ/ to /ɔ/, (b) deleting the final segment /ŋk/, and (c) adding the segment /t/. In contrast, *sing* changes only its vowel in becoming *sang*. Therefore, *thought* is more prominent than *sang*, so the former tends to be past-tense inflected rather than the latter.

A much-cited study is Bayley's (1994) research exploring L1 Mandarin learners' English PT marking. Bayley first classified English verbs into nine types by salience level of their PT form: (1) suppletives or the verbs whose past and present tense forms have no phonetic segment in common, e.g., *go-went*; (2) verbs changing their vowel and final sound to /t/ or /d/, e.g., *leave-left*; (3) verbs changing their vowel, deleting the final segment(s), and affixing t/d to their end, e.g., *bring-brought*; (4) verbs changing their vowel, e.g., *come-came*; (5) copulas except the first person singular, e.g., *is-was*; (6) verbs whose past and present tense forms differ in the voicing quality of the final consonant, e.g., *send-sent*; (7) regular syllabics, e.g., *want-wanted*; (8) regular non-syllabics, e.g., *talk-talked*; and (9) the modals *can-could*, *will-would*. The participants marked PT for the verb types in the following frequency order: (1) > (2) > (4) > (5) > (8) > (6) > (7) > (9), supporting Bayley's hierarchy.

2.3 Relative Clauses and Participial Reduced Relative Clauses in English and Thai

English relative clauses (RCs) are subordinate clauses that give information about a noun phrase (NP) (Azar, 1999). RCs usually follow the NP they modify and begin with a relative pronoun, e.g., *who*, *which*, and *that*.

(1) a. The food *that was prepared* by the new catering service is very good.

(DeCapua, 2017, p. 332)

b. The portrait *which was painted* by my brother was lovely.

(Foley & Hall, 2004, p. 149)

c. The young man *who was dancing* all night lives next door to me.

(DeCapua, 2017, p. 331)

d. The man *who lives* upstairs is very noisy.

(Foley & Hall, 2004, p. 149)

In (1), the NPs *The food*, *The portrait*, *The young man*, and *The man* are modified by the RCs *that was prepared*, *which was painted*, *who was dancing*, and *who lives*, respectively.

English participial reduced relative clauses (PRRCs) are a shortened form of RCs. Lee (2007) refers to PRRCs as non-finite clauses with a participle, i.e., a kind of non-finite verbs or verbs which do not alter their forms according to their subjects. English includes two participial types: present participle (verb + *-ing*) and past participle (PP) (mostly verb + *-ed*). PRRCs are RCs where relative pronouns and the verb *be* are deleted (Azar, 1999). To illustrate, the RCs in (1a) and (1b) include the PPs *prepared* and *painted*, so the NPs *The food* and *The portrait* receive the actions *preparing* and *painting*, respectively. In contrast, in (1c) and (1d), *dancing* and *lives* modify *The young man* and *The man*, which perform the actions *dancing* and *living*. The RCs in (1) are shortened by deleting *that*, *which*, *who*, and *be*, as in (2).

(2) a. The food *prepared* by the new catering service is very good.
b. The portrait *painted* by my brother was lovely.
c. The young man *dancing* all night lives next door to me.
d. The man *living* upstairs is very noisy.

The meanings of PRRCs and RCs are the same since the former are derived from the latter. Consequently, (1a), (1b), (1c), and (1d) resemble (2a), (2b), (2c), and (2d) in terms of meaning.

Thai has both RCs and reduced RCs. Iwasaki and Ingkaphirom (2005) explain that the Thai RCs, like the English ones, follow a head noun and a relativizer, such as */thîi/* and */sǔŋ/*. However, English PRRCs have no Thai counterpart. The closest Thai construction is reduced RC or the RC which lacks a relative pronoun. This might be due to two Thai-English differences.

The first distinction involves the contexts allowing the relative pronoun omission. The English relative pronouns are mostly optional while those in Thai can be deleted in two cases.

Firstly, Thai RCs are reducible when describing general information concerning the head NP (Iwasaki & Ingkaphirom, 2005).

(3) *èk* *pen* *dèk* [(*thîi*) *rian* *kèŋ*]
(name) COP[1] child (SBR[2]) study well
'Ek is a child who studies well.'
(Iwasaki & Ingkaphirom, 2005, p. 250)

[1] COP = Copula (Iwasaki & Ingkaphirom, 2005, p. xxv)

[2] SBR = Subordinator (Iwasaki & Ingkaphirom, 2005, p. xxv)

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In (3), the RC */rian kèŋ/* 'studying well' shows a general characteristic of the NP */dèk/* 'child;' consequently, the relativizer is optional here.

Secondly, an RC can be shortened when the head NP is a specific category of people, as in (4):

(4) *tɛ̀ŋ* *kàp* *khon* [(*thîi*) *tham* *ɛɛ*]
marry with person (SBR) do/make air conditioner
'(She) is married to a man who repairs air conditioning system.'
(Iwasaki & Ingkaphirom, 2005, p. 251)

/thîi/ in (4) is omissible since the NP */khon tham ɛɛ/* "a person who repairs air conditioning system" is a person with a specific role, i.e., an air conditioner technician.

Secondly, English and Thai differ in the existence of inflectional suffixes, referring to suffixes which serve a purely grammatical purpose by indicating grammatical categories, such as tense, number, and case (Fromkin et al., 2017). English possesses the suffixes *–ing* and *–ed* for conveying active and passive meanings, respectively. In contrast, Thai lacks inflectional suffixes and uses lexical words, i.e., */kamlaŋ/* "currently" for the continuous aspect and */thùuk/*, */doon/* or */dây-ráp/* for the passive meaning (Iwasaki & Ingkaphirom, 2005).

2.4 Previous Studies on Working Memory's Effects on L2 Sentence Processing and English PRRC Processing

Numerous studies have examined the influence of WM on how L2 learners process various structures, and the results pertaining to WM impact have been inconsistent.

Several studies have substantiated the effects of WM on L2 learners' sentence processing. For example, Dussias and Piñar (2010) explored the

relationship between L1 Chinese learners' WM and their use of plausibility cues in processing English long-distance *wh*-extractions. The employed task included plausibility (plausible and implausible) and extractions (subject and object extractions) as the variables. The native English speakers and higher WM learners spent longer reading times (RTs) on the regions following the verbs in the plausible conditions, suggesting both groups successfully used plausibility information to recover from initial misanalysis. In contrast, the lower span group had more difficulty processing the verbs in the implausible conditions. Thus, WM differences could affect L2 sentence processing, and the higher span individuals were more likely than their lower span counterparts to employ semantic information during their L2 processing.

Kim and Christianson (2017) conducted two self-paced reading experiments to explore WM effects on advanced L1 Korean learners' processing of ambiguous RCs in English and Korean. They investigated the influence of the modified noun's position in sentences, focusing on the subject (SRC), e.g., *The agent of the star who met me at the party last night was poor,* and object (ORC), e.g., *The police arrested the agent of the star who met me at the party last night* (Kim & Christianson, 2017, p. 370). The researchers expected that the subject-verb integration distance, namely the number of words between the subject and the finite verb, would affect the processing of SRCs and ORCs differently in English and Korean. In English, SRCs had the subject and finite verb separated by an RC, while in ORCs, they were adjacent. In contrast, Korean SRCs had the subject and finite verb close to each other, whereas those in ORCs were interrupted by several intervening words. Consequently, in English, SRCs had a higher integration cost and greater processing difficulties than ORCs, while in Korean, the reverse was predicted. The researchers suggested that the higher WM participants had more cognitive resources, making them more sensitive to structural complexities. Thus, they tended to experience greater difficulties processing RCs with a higher integration cost, reflected in their longer RTs. The findings confirmed that the higher WM learners encountered more difficulties processing English SRCs and

Korean ORCs, whereas those with lower WM did not show significant differences in reading times for both RC types.

Rattanasak et al. (2022) explored how WM and distance-based complexity influence L1 Thai learners' utilization of morphosyntactic information when processing long-distance subject-verb number agreement dependencies in English RCs. The study involved 40 L1 Thai learners and 40 native English speakers as research participants. They took three tasks: a Lexical Decision Task (LexTALE) for assessing their English proficiency, a Reading Span Task (RST) for measuring their WM, and an SPRT for exploring their processing of number agreement violations. The SPRT included two groups of test items categorized based on the distance between subjects and verbs: short-distance subject-extracted RCs, e.g., *The guys that know the driver want(s) to buy a new car* and long-distance object-extracted RCs, e.g., *The guys that the driver knows want(s) to buy a new car* (Rattanasak et al., 2022, p. 21). The results suggested that the natives were sensitive to agreement violations in both short- and long-distance RCs, while the learners showed reduced sensitivity to long-distance RCs, potentially due to interference from L1 co-activation and limited cognitive resources for handling complicated structures. Additionally, the learners with higher WM demonstrated greater sensitivity to agreement violations than those with lower WM, indicating a connection between their processing styles and cognitive capacity.

In addition, previous research has suggested that effects of WM vary depending on the used tasks. The influence of WM is more likely to be evident in certain tasks compared to others. For example, Zhou et al. (2017) employed two tasks, i.e., a grammaticality judgment task (GJT) and a translation task, to investigate the processing of English *wh*-extractions by L1 Chinese learners. WM effects on the participants' offline processing were observed only in the translation task, which was therefore more demanding than the GJT. In the GJT, the accuracy scores of the L1 Chinese learners with varying WM levels did not exhibit significant differences.

Hopp (2015) looked into the correlation between the processing of English subject-object ambiguities and WM of L1 German advanced learners. The learners took an RST and a reading comprehension task which examined their processing of subject-object ambiguities, e.g., *When the girl was playing the piano made some funny noises* (Hopp, 2015, p. 135). The participants with different WM levels took similar RTs on the items, suggesting WM did not affect their RTs. Hopp additionally proposed that notable impacts of WM could be observed when the participants engaged in a task that required more cognitive resources, such as target stimuli where the distance between the subject and the finite verb in the main clause was increased.

The PRRC processing has been addressed in several studies. MacDonald et al. (1992) explored native English speakers' resolution of main verb/reduced relative (MV/RR) ambiguities, namely the phenomenon where a regular verb with the *-ed* suffix could be interpreted as either the PT or the PP form of the verb. The two forms depicted different semantic functions assigned to the modified nouns: agent (performer of an action) for PT and theme (recipient of an action) for PP. For example, *asked* in *The students asked me* serves as the PT form of *ask*, and the subject *The students* performed the action of asking, taking the thematic role of agent. However, *asked* in *The students asked to answer her* worked as the PP form, namely the subject received the action of asking, thus having the role of theme. In terms of compositionality, MacDonald and colleagues created four groups of stimuli by manipulating interpretation (MV-RR) and ambiguity (ambiguous-unambiguous). After each sentence, the participants answered a yes-no question regarding which interpretation they related to the ambiguous verb. Examples of the four sentence patterns and questions are illustrated below.

(5) a. MV-Unambiguous: The experienced soldiers spoke about the dangers before the midnight raid.

b. MV-Ambiguous: The experienced soldiers warned about the dangers before the midnight raid.

Question: Did someone tell the soldiers about dangers?

c. RR-Unambiguous: The experienced soldiers who were told about the dangers conducted the midnight raid.

d. RR-Ambiguous: The experienced soldiers warned about the dangers conducted the midnight raid.

Question: Did the soldiers speak about dangers?

(MacDonald et al., 1992, p. 61)

Since the simpler RCs should be less capacity-taxing than the PRRCs, the higher and lower WM groups should spend similar RTs on the RCs. However, the higher WM participants would spend more time reading the PRRCs compared to the RCs due to the cognitive load of retaining both MV and RR interpretations. Simply put, they would spend more time reading the PRRCs than the lower WM ones. In contrast, the lower WM participants were expected to spend similar RTs on both constructions as they tended to carry only the less demanding interpretation. In terms of comprehension errors, the lower WM participants were predicted to make more errors on the PRRCs than those with higher WM. The results revealed that the higher WM participants spent more time reading the disambiguating region or finite verb, indicating their longer maintenance of multiple interpretations than their lower WM counterparts'.

Eastwick and Phillips (1999) examined the influence of syntactic complexity on native English speakers' use of animacy information in processing PRRCs. The participants took a self-paced reading task (SPRT) comprising embedded and non-embedded sentences. The more complex embedded sentences contained a subordinate clause, e.g., *The judge knew that the evidence examined by the witness was unreliable* (Eastwick & Phillips, 1999, p. 12). WM effects were observed only when the readers tackled the less complex items. Only the higher WM subjects employed semantic cues when they read the non-embedded items.

Thus far, there have been scant studies on L2 learners' processing of English PRRCs, all of which did not incorporate WM in explaining the participants' processing. For instance, Rah and Adone (2010) conducted a study on how native English speakers and L1 German learners processed MV/RR ambiguities. The participants were categorized by their English proficiency levels as intermediate or advanced. An SPRT and a GJT were employed to examine the participants' online and offline processing. The SPRT focused on the ambiguity level of PRRCs and post-ambiguity cues. Three types of sentences were presented: unambiguous, ambiguous with a good cue, and ambiguous with a poor cue. Samples of the three sentence types are presented in (6).

(6) a. Unambiguous – No post-ambiguity cue: The brown sparrow seen by the hungry cat pecked at an insect.
b. Ambiguous – Good post-ambiguity cue: The brown sparrow noticed on an upper branch pecked at an insect.
c. Ambiguous – Poor post-ambiguity cue: The brown sparrow noticed almost every day pecked at an insect.

(Rah & Adone, 2010, p. 90)

The L2 learners exhibited longer reading times for ambiguous sentences, attributed to L1-L2 differences, while the native speakers did not show such distinctions. The GJT revealed no significant differences in grammatical knowledge between the two groups. Also, the advanced learners recovered from misanalyses faster than the intermediate ones, suggesting effects of the learners' proficiency level on their processing patterns.

Yang and Shih (2013) investigated the processing of PRRCs and RCs among native English speakers and L1 Taiwanese learners with varying English proficiency levels. Using a GJT and an SPRT, the study manipulated three factors: reduction, animacy, and ambiguity, in target sentences, as exemplified in (7).

(7) a. Ambiguous animate reduced: The boy kissed by the girl was cute.
b. Unreduced: The boy who was kissed by the girl was cute.
c. Inanimate reduced: The apple kissed by the girl was cute.
d. Unreduced: The apple that was kissed by the girl was cute.
e. Unambiguous inanimate reduced: The apple seen by the girl was cute.
f. Unreduced: The apple that was seen by the girl was cute.

(Yang & Shih, 2013, p. 1120)

The natives demonstrated sensitivity to both thematic information from noun animacy cues and syntactic information from the preposition “by”. In contrast, the learners’ resolution of ambiguities varied with proficiency levels, with the advanced learners showing more precise PRRC interpretation, the intermediate learners relying on both thematic and syntactic cues, and the elementary learners being influenced by the reduction effect, particularly with inanimate nouns.

To the best of our knowledge, there has been a lack of research investigating the influence of WM on the processing of PRRCs and RCs among L2 learners. Moreover, the impact of the salience of the PP form of irregular verbs (IVs) on L2 learners’ processing of the two constructions has remained unexplored. Therefore, this paper investigated the effects of WM on the processing of English PRRCs and RCs with IVs among L1 Thai learners.

3. The Present Study

This paper asked two questions: (1) How do L1 Thai learners with different WM degrees, i.e., higher and lower WM, differ in their RTs and comprehension accuracy levels? and (2) How do structure and salience affect the processing of PRRCs and RCs among L1 Thai learners? It was hypothesized that (1) the higher WM learners would spend similar amounts of time for RCs as their lower WM counterparts, take a longer time reading PRRCs, and have higher accuracy than

the lower WM participants, and that (2) the L1 Thai learners would take more RTs for the PRRCs than for the RCs, and spend more time reading the S4 verbs than reading the S2 ones.

4. Methodology

4.1 Research Instruments

The participants took two computerized tasks, a reading span task (RST) and a self-paced reading task (SPRT), via the SuperLab program.

Phinitkit's (2015) RST was used to divide the L1 Thai participants by WM level: higher and lower WM. The RST comprised 75 Thai sentences divided into 15 sets. The number of sentences in each set went up from a three-sentence condition to a seven-sentence condition. The participants read sentences, judged if they were plausible, and memorized a Thai letter after each sentence. Before the actual experiment, they took five two-sentence trials to ensure they understood the procedure.

The SPRT investigated how the participants processed the PP forms of IVs in PRRCs and RCs. Based on Bayley (1994), processing PRRCs involves distinguishing between the PT and PP forms of the verbs. Thus, the success in processing the structure could be influenced by the salience of PPs, i.e., how the PP and PT forms of IVs phonologically differ. The greater the difference between the two forms is, the more likely L2 learners are to successfully identify the given form. The PP forms of IVs had never been categorized by salience level, so an investigation of phonological distinctions between the PT and PP forms of IVs was conducted. This led to the identification of seven classes of PPs with different salience degrees, ranging from S1 (most salient, and easiest to identify the given form) to S7 (least salient, and most difficult to identify the given form). The seven classes were validated for their salience level, namely whether the classes were appropriate to their position in the salience hierarchy. The seven classes of PP inflections are revealed in Table 1.

Table 1

Classification of English Irregular Verbs by Salience Level of Past Participial Forms

Salience degree	Alteration types	Examples
S1	Suppletive	*was-been*
S2	vowel change plus syllabic [ən] morpheme addition	*wrote-written*
S3	syllabic [ən] morpheme addition	*broke-broken*
S4	vowel change plus *n*-affixation	*saw-seen*
S5	vowel change	*sang-sung*
S6	*n*-affixation	*swore-sworn*
S7	identical form	*found-found*

This study included two PP types: S2 and S4.[3] The test items involved four target conditions resulting from combinations of structures (PRRCs-RCs) and PP types (S2-S4): PRRC/S2, PRRC/S4, RC/S2, and RC/S4. Each target sentence had different versions which were identical except for the words related to the examined factors. Specifically, structure was manipulated for target sentences by incorporating different structures and maintaining the other words in the sentences, e.g., *The student* [*known/ who was known*] *for her brilliance kissed her boyfriend*. However, the manipulation excluded salience because it was difficult to change a PP in an item without changing other words. Thus, each test item had two versions of different structures: PRRC and RC. Each version had 16 sentences, leading to 32 test items.

[3] The PPs included in the experiment must sound possible when modifying animate NPs. This was associated with the aim of this study, which was to investigate if the participants could identify the given forms in PRRCs and RCs: the PT and PP forms of IVs. The two forms convey different semantic roles of the modified nouns: agent (the doer of an action) and theme (the recipient of an action). Therefore, the NPs in the target sentences must be able to perform both roles to explore if the participants could identify the given forms. Because animate nouns can either perform or receive an action (Trueswell et al., 1994), all the modified nouns in this study were animate, and the selected PPs could be used with animate nouns. Since several members in S2 (e.g., *taken* and *shaken*) and S4 (e.g., *seen* and *known*) met the criterion, these two groups were selected.

For the PRRC sentences, each target item comprised nine words. The sentences were cut into five segments: *Subject*, *Past Participle* (*PP*), *Modifier of the PP* (*MOP*), *Main Verb* (*MV*), and *Object*. To avoid length effects, the number of words in a particular region was identical across all items.

The region *Subject* contained a two-word NP. The first and second words were the article *The* and a disyllabic, animate, countable, and singular noun, respectively.

As for the region *PP*, this study encompassed PPs in S2 and S4. Four PPs from each group were used, leading to eight target PPs. The eight forms were taken from the most frequent PP list from the Corpus of Contemporary American English, ensuring that the target words should be familiar to L2 learners. Thus, the participants' long RTs on the target words would not result from their ignorance of the words. The selected PPs from each salience group had two characteristics: having transitive meaning and having the same syllabic number. The S2 PPs and S4 ones were disyllabic (i.e., *given*, *taken*, *eaten*, and *shaken*) and monosyllabic (namely *known*, *seen*, *drawn*, and *blown*), respectively.

The region *MOP* comprised a three-word prepositional phrase. The first word was a monosyllabic preposition, except *by* which might cause a bias in favor of PRRC interpretations. The second and third words were a monosyllabic determiner and disyllabic noun, respectively. This region contained definite and singular nouns. The region *MV* comprised a monosyllabic regular verb in its past tense form. The region *Object* embraced two words making the object of the finite verb. The first and second words were a monosyllabic determiner or article and a monosyllabic or disyllabic singular noun, respectively.

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An example of the PRRCs and how they were split into regions is shown in (8).

(8) The baby / given / to that couple / loved / the toy.

A yes-no question followed each target sentence to ensure the participants read it. The 32 questions were divided into two groups of 16. The questions in the first group asked whether the noun received the action in the PRRC, and had "yes" as the answer (e.g., *Did someone take the dancer to this clinic?*). The questions in the second group asked if the noun performed the action, having "no" as the answer (e.g., *Did the baker shake something?*).

The RC sentences were similar to their PRRC counterpart, except the noun in the *Subject* region preceded the phrase *who was* or *which was*. The questions for the RCs resembled those for the PRRCs. An RC example is shown below.

(9) The builder who was / blown / off the ladder / sprained / his elbow.

Twelve native English speakers were asked to rate plausibility of the items on a rating scale from 1 ("Not very plausible") to 5 ("Very much plausible"). The experiment included the items which sounded plausible when written in both the PRRC and RC constructions, i.e., scoring 2.55 or more than 2.55,[4] so that long RTs on the sentences would not be attributed to their low plausibility level.

There were two presentation lists of sentences: A and B. The two versions of each item were presented across the two lists. A stimulus presented in its PRRC form in List A was shown in the RC form in List B, and vice versa. The items were

[4] The rounding approach called *round-to-even* was used for the norming study. According to this method, the target digit is rounded up only when an odd number is the last digit (e.g., 2.55 is rounded up to 3). Therefore, this approach can prevent the tendency for all half-integers to be rounded up (Blackstone, 2016).

pseudo-randomized and distributed across the two lists in the Latin Square design for two purposes: 1) each participant read one version of each sentence, and 2) two sentences of the same structure did not immediately follow each other. In each list, the 32 target sentences were mixed up with 96 distractors. Each distractor was divided into five regions and preceded a question.

The 128 sentences were presented on a computer screen, with each region appearing from left to right. In reading each sentence, the participants clicked a mouse when they were ready to read each region. The participants were asked to read the sentences as fast as possible and answer questions about them by pressing the letter “y” (yes) or “n” (no) on the keyboard. Before the test session, the participants took five practice items to ensure their familiarity with the test-taking procedure.

4.2 Research Participants

This study included three participant groups: a native control group and two L1 Thai learner groups with different WM levels. The control group, which comprised ten native English speakers living in Thailand, provided baseline data about the processing of PRRCs and RCs. Moreover, 70 L1 Thai learners were recruited and classified into two groups by WM span: higher and lower WM. To minimize the influence of distinct English proficiency levels, this study incorporated only advanced-level learners whose proficiency was determined via their scores on the TOEFL iBT, IELTS, or Chulalongkorn University Test of English Proficiency (CU-TEP).

4.3 Data Collection and Data Analysis

The researchers administered only the SPRT to the native controls while the L1 Thai participants completed the RST followed by the SPRT. Due to the COVID-19 crisis, the experiments were conducted online via Zoom Cloud Meetings. Each participant spent approximately one hour completing the tasks.

Concerning the data analyses for the RST, one Thai letter correctly recalled in serial order equaled one point. A participant's WM span was identified by counting the total number of correctly recalled letters. The task contained 75 letters, so the maximum score was 75.

Regarding the SPRT, data in relation to comprehension accuracy of the answers to the questions and RTs on the target sentences were analyzed. Two non-parametric statistical tests, Kruskal-Wallis and Friedman, were used with the offline task, i.e., answering the questions, because the offline data were abnormally distributed. The RT data were submitted to a three-way ANOVA, with "group" as a between-group variable, and "salience" and "structure" as within-group variables. The analyses looked into two issues: effects of WM, structure, and salience on the RTs for the two structures, i.e., PRRC and RC, and those for the PPs with different salience levels: S2 and S4. The two issues were separately analyzed by grouping the regions *PP*, *MOP*, *MV*, and *Object*, in two ways. To investigate the PRRCs and RCs, the RTs on the *PP* and *MOP* regions were combined as critical regions because they were related as a participial phrase. The analyses also included the *MV* and *Object* regions as spillover regions to examine the delayed effects of the variables on the following regions. In exploring the S2 and S4 PPs, the regions *PP* and *MOP* were included as the critical and spillover regions, respectively. The two regions were separated to investigate the processing of the PPs and the influence of the forms on processing the following prepositional phrases.

5. Results

5.1 Reading Span Task

The RST score range was 29-75. The L1 Thai participants were divided into two groups by WM level: higher and lower WM, via the median split of the scores at 60. The participants scoring 60 or less were assigned to the lower WM group whereas those scoring higher than 60 were assigned to the higher span group. The mean scores among the higher WM and lower WM groups were 68.78 (SD = 3.70)

and 50 (SD = 8.62), respectively. An independent t-test yielded a significant difference between the mean scores of the two groups (t(68) = -11.569, p<.05).

5.2 Self-paced Reading Task

5.2.1 Comprehension Accuracy

Data trimming was first conducted by excluding the participants who scored lower than 80%. Eighteen L1 Thai learners were excluded, leading to a total of 52 participants. The native control data were not trimmed. Then, the mean accuracy scores for the four conditions among the participant groups were calculated. The scores are presented in Table 2.

Table 2

Mean Comprehension Accuracy Scores of the Participant Groups

Test condition	Participants					
	L1THH		L1THL		L1EN	
	Mean (ratio)	SD	Mean (ratio)	SD	Mean (ratio)	SD
PRRC/S2	95.19%	0.70	93.27%	0.71	85.00%	0.79
RC/S2	94.71%	0.76	91.35%	0.84	91.25%	0.67
PRRC/S4	87.02%	0.82	84.62%	1.03	91.25%	1.06
RC/S4	89.90%	1.02	86.06%	1.11	95.00%	0.70

The Kruskal-Wallis test showed no significant difference between the two L1 Thai groups, indicating no impact of WM on their offline processing. However, the Friedman test revealed significant differences among the higher WM learners (df = 3, W = 0.225, $\chi 2$ = 15.733**, p<.01) and the lower WM ones (df = 3, W = 0.278, $\chi 2$ = 11.145*, p<.05). A Nemenyi post-hoc test showed significant differences among the higher WM participants by the PRRC/S2 vs RC/S2 pair (p<.05), suggesting a structure effect. Among the lower WM participants, the differences between their mean scores in the same pair were barely significant (.065).

5.2.2 Reading Times

Before further analyses, data trimming was carried out in two steps. Firstly, the RT data from the items for which the participants incorrectly answered the questions were removed. Secondly, outliers were excluded via an outlier removal method called interquartile range. The removal deleted 10.35% and 11.44% of the data about *Structure* and *Salience*, respectively. Table 3 and Figure 1, and Table 4 and Figure 2 present the mean RTs the three participant groups took for processing the critical and spillover regions concerning *Structure* and *Salience*, respectively.

Table 3

Mean Reading Times for the Target Conditions of the Participant Groups Concerning Structure

Test condition		Participants					
		L1THH		L1THL		L1EN	
		Mean (ms)	SD	Mean (ms)	SD	Mean (ms)	SD
PRRC/S2	Critical	1665.59	375.33	1814.64	426.55	1465.42	306.42
	Spillover	1975.47	484.78	1819.26	379.28	2229.60	609.91
RC/S2	Critical	1601.31	357.42	1789.08	426.44	1389.03	153.43
	Spillover	1828.70	483.39	1750.63	390.55	1908.71	351.97
PRRC/S4	Critical	1598.00	430.69	1687.63	426.68	1318.73	223.89
	Spillover	1768.61	430.85	1955.61	445.49	1797.61	398.39
RC/S4	Critical	1664.08	349.27	1831.88	409.50	1552.63	329.95
	Spillover	1814.04	460.58	1717.94	319.70	2012.80	436.79

Table 4

Mean Reading Times for the Target Conditions of the Participant Groups Concerning Salience

Test condition		Participants					
		L1THH		L1THL		L1EN	
		Mean (ms)	SD	Mean (ms)	SD	Mean (ms)	SD
PRRC/S2	Critical	638.27	155.24	694.95	174.26	595.84	107.82
	Spillover	948.41	204.11	1047.52	243.08	828.28	206.26
RC/S2	Critical	666.79	173.35	680.02	114.76	605.44	63.77
	Spillover	877.57	210.52	1016.77	297.40	770.26	108.60
PRRC/S4	Critical	633.78	189.17	616.08	135.36	560.35	86.17
	Spillover	945.76	240.20	1021.47	303.33	725.17	176.48
RC/S4	Critical	667.01	150.46	702.95	149.24	604.54	94.64
	Spillover	950.65	248.46	1075.18	278.03	867.56	229.76

Figures 1 and 2 show comparisons between the RTs of the participant groups in connection with *Structure* and *Salience*, respectively.

Figure 1

Reading Times (Structure) of the Participant Groups by Test Conditions at the Critical Regions (Left) and Spillover Regions (Right)

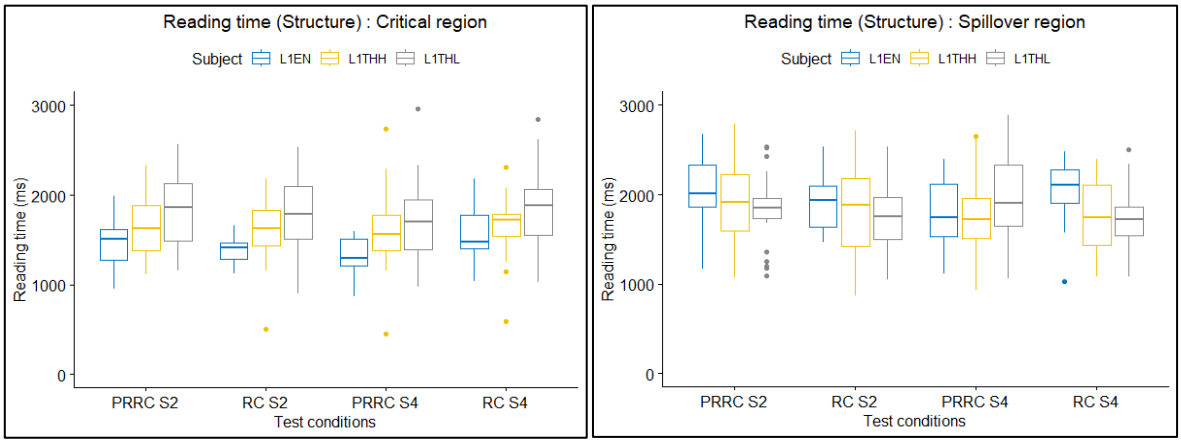
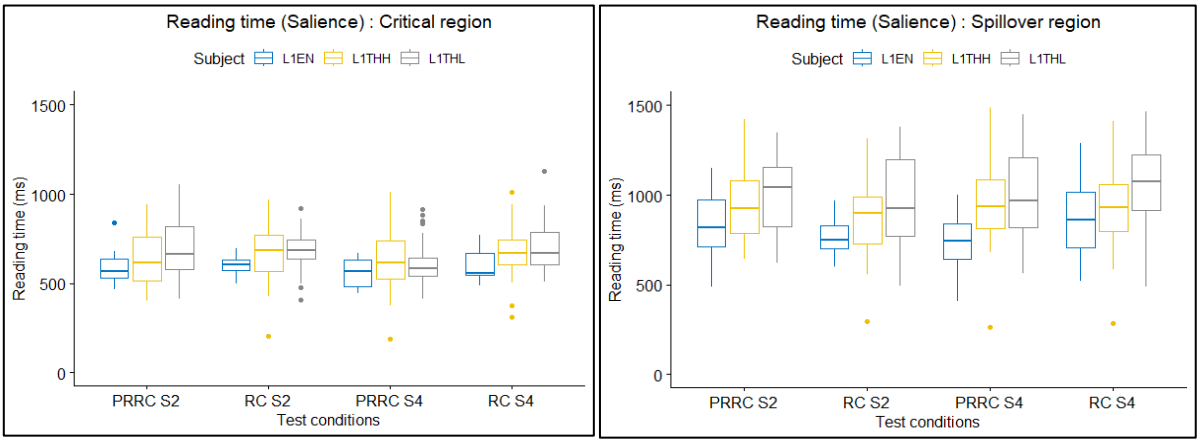


Figure 2

Reading Times (Salience) of the Participant Groups by Test Conditions at the Critical Regions (Left) and Spillover Regions (Right)



Pertaining to the critical region of the *Structure* data, a three-way ANOVA yielded a main effect of group, $F(2,59) = 4.214$, $p<.05$, $\eta^2 = .096$, and a significant interaction between structure and salience, $F(1,59) = 7.283$, $p<.01$, $\eta^2 = .015$. With respect to the group effect, a significant difference between the native controls and the lower span learners was found at the critical region of the RC/S2 condition ($p < .05$). Also, the differences between the two groups for the conditions PRRC/S2 (.0567) and PRRC/S4 (.0515) were marginally significant. The natives were faster than the learners for all the conditions. Concerning the interaction between structure and salience, a one-way ANOVA post-hoc test showed that structure had a main effect on the RTs of the native controls ($p<.05$) and the lower span learners ($p<.05$). Regarding the spillover region, the ANOVA yielded significant main effects of salience, $F(1,59) = 5.408$, $p<.05$, $\eta^2 = .006$.

In respect of *Salience*, a significant effect of structure was found at the critical region, $F(1,59) = 7.615$, $p<.01$, $\eta^2 = .009$. Concerning the spillover region, a main effect of group was observed, $F(2,59) = 5.506$, $p<.01$, $\eta^2 = .112$. Also, there was a significant interaction between salience and structure, $F(1,59) = 5.664$, $p<.05$, $\eta^2 = .013$. As regards the group effect, the native controls read the *MOP* regions faster than the lower span learners for the following conditions: RC/S2

($p<.05$), PRRC/S2 ($p<.05$), and PRRC/S4 ($p<.05$). Moreover, a one-way ANOVA yielded a structure effect on the lower WM learners.

6. Discussion

6.1 Offline Processing

The two L1 Thai groups' scores did not significantly differ, suggesting WM had no impact on their offline processing. The finding possibly resulted from the low level of resource demands of the task in this study. Just and Carpenter (1992) explain that individuals' WM tends to affect their processing when the cognitive demands of the given task exceed their available resources. In the present study, the SPRT tested if the participants understood the modified nouns' thematic role, which imposed low cognitive burdens on them. The low demands coupled with the learners' high English proficiency might have accounted for the lack of WM impact on their accuracy. This aligns with the conclusions drawn in numerous prior studies (e.g., Havik et al., 2009; Hopp, 2015; Zhou et al., 2017).

Furthermore, structure influenced the L1 Thai learners' accuracy for the S2 PPs. They were more accurate when reading PRRCs than when reading RCs. The result was attributed to two reasons. The first account involves PRRCs' occurrence in English written texts. PRRCs have been reported to frequently appear in many writing genres, including textbooks, articles, and narratives (e.g., Biber et al., 2011; Hundt et al., 2012; Rafajlovičová, 2012). It could thus be assumed that the L1 Thai participants had been highly exposed to PRRCs and that they might get used to it, leading the learners to achieve higher accuracy for PRRCs than for RCs. This is consistent with the findings of Thiamtawan and Pongpairoj (2013). Exploring L1 Thai intermediate learners' production of English PRRCs and RCs, the researchers anticipated that the participants would generate more RCs than PRRCs due to the absence of the latter structure in their L1, namely Thai. Contrary to their expectations, the participants employed a higher number of PRRCs than RCs. The L2 learners' production of the PRRCs was linked to their familiarity with the reduced clauses, which was attributed to the construction's frequent appearance

in English texts. Another reason is that RCs might consume more cognitive resources than PRRCs. L2 learners may have had to consider two issues when processing RCs: subject-verb agreement, namely determining if subjects and finite verbs in RCs agreed with each other in person and number, and tenses of RCs. In contrast, processing PRRCs might have consumed fewer resources due to their simpler form. Compared to RCs, PRRCs comprise fewer elements: an NP and a PP. As a result, the learners did not have to consider the two issues while processing PRRCs, leaving them adequate capacity to successfully tackle the questions.

Conversely, salience exerted no effects on their accuracy. Two similarities between the PPs from the two salience groups could justify the findings. The first resemblance is the syllabic number of the PPs. The current study included monosyllabic and disyllabic PPs. All the PPs were also alike in that they indicated passive meaning. The similarities tended to make the processing burden degrees of the target sentences similar.

6.2 Online Processing

The RT data are discussed in relation to two aspects: differences between the participant groups and effects of structure and salience on their RTs.

6.2.1 Differences between the Participant Groups' RTs

The findings in both the *Structure* and *Salience* sections are discussed together since they were similar, showing that the native controls spent shorter RTs than the lower WM learners. In terms of the *Structure* data, significant differences between the two groups were found at the critical region (*PP* + *MOP*) of the RC/S2 condition ($p<.05$). Also, their differences for the conditions PRRC/S2 (.0567) and PRRC/S4 (.0515) were marginally significant. Concerning the *Salience* section, the natives significantly differed from the lower span learners at the spillover region (*MOP*) for the following conditions: RC/S2 ($p<.05$), PRRC/S2 ($p<.05$), and PRRC/S4 ($p<.05$).

The findings could be supported by L1 transfer and a lower automaticity degree of L2 processing. The first account was related to the *Structure* data, whereas the second reason supported the results in both the *Structure* and *Salience* sections.

First of all, L1 transfer might underlie the lower span learners' longer RTs than the natives' at the critical region (*PP + MOP*) of the *Structure* data. The learners tended to encounter negative transfer since RC and PRRC in English and their L1, i.e., Thai, are different.

RCs in Thai and English differ in usage of relative pronouns regarding the concord between the relative pronouns and animacy of the nouns. As claimed by Endley (2010), English relative pronouns are selected according to animacy of the head nouns: *who* for humans, *which* for animate or inanimate nouns, and *that* for human, animate or inanimate antecedents. However, according to Sornhiran (1978), the main Thai relativizers, i.e., /*thîi*/, /*sûŋ*/, and /*ʔan*/, are interchangeably employed with a particular noun in many occasions. That is, the relative pronoun selection in English is more dependent on animacy of the nouns than that in Thai. Moreover, there are two English-Thai differences concerning PRRC. Firstly, PRRC is non-existent in Thai. The nearest Thai structure is reduced RC or the RC which does not have a relativizer (Rungrojsuwan, 2015). Thai also lacks inflectional morphemes, including past participles, a main element of English PRRCs. Therefore, L1 Thai learners are likely to have problems processing the PPs. Secondly, the RC reduction in Thai differs from that in English pertaining to the contexts where relative pronouns can be deleted. The English relative pronouns are optional in most cases, whereas Thai RCs can be reduced when they describe general information about a noun or when the NP is a specific category of people (Iwasaki & Ingkaphirom, 2005).

The second reason for the native controls' shorter RTs compared to the L2 learners' is the higher automaticity of L1 processing. This could be linked to non-

native speakers' limited processing resources, including memory span, access to lexical items, and processing speed (McDonald, 2006). Such resources are needed for capabilities which could lead to efficient language processing: accessing L2 words, combining them with the preceding structure, and anticipating upcoming information. The automaticity notion explains the significant differences between the natives and the lower WM learners in both the *Structure* and *Salience* sections, specifically in the *PP* and *MOP* regions. The natives, with their sufficient cognitive resources, were faster in integrating the participle into the relativizer-copula string and recognizing a passive RC. In the case of PRRCs, the natives could identify the PP form immediately after the subject more quickly than the learners. Their quicker identification enabled the natives to make faster predictions about subsequent grammatical elements, resulting in shorter RTs for the *PP* and *MOP* regions compared to the learners.

Moreover, the findings about the native controls and lower WM learners indicated one interesting aspect about the higher span learners. Although the higher WM learners read the critical and spillover regions in both the *Structure* and *Salience* sections more slowly than the natives, they were insignificantly different. The fact that the natives significantly differed from only the lower WM learners suggested that the cognitive capacity of the L1 Thai groups played a role in their processing in that the learners with higher WM performed more similarly to the native speakers than those with lower WM. This was in line with some previous studies showing a positive correlation between readers' cognitive capacity and their processing speed (Suda, 2015; Zhou et al., 2017). Simply put, the higher a reader's WM is, the faster they read and process target stimuli.

6.2.2 Effects of Structure and Salience

6.2.2.1 Structure

For the critical region of the *Structure* data, structure had a main effect on the RTs of the native controls and the lower span learners. When the two groups

read the sentences with the S4 PPs, they processed the critical regions in the PRRCs significantly faster than those in the RCs.

The finding was attributed to the distinction between processing loads of the S2 irregulars and the S4 forms. The processing burdens were associated with their salience degrees. Salience in this study refers to how the PT and PP forms of English IVs phonologically differ from each other. The more marked the alterations of a verb are, the more prominent it should be. The syllable-related alterations have been assumed to be more salient than the segment-related changes (Bayley, 1994). Therefore, the S2 irregulars should be more salient than the S4 verbs. The PPs' salience level could affect L2 learners' processing in that distinguishing the PT and PP forms of the more salient irregulars should consume the learners' less cognitive capacity than differentiating those of the less prominent verbs. Thus, the participants should find the S2 irregulars less difficult to process than the S4 ones.

The results, however, suggested salience effects in a different direction because significant differences between the RTs for the PRRCs and RCs were found only when the two participant groups processed the S4 irregulars. It was possible that the higher level of phonological similarities between the PT and PP forms of the S4 irregulars made it easier for the participants to identify the PT form related to the PP form. This allowed them to allocate cognitive resources to consider the complexity degrees of the two constructions and caused significantly different RTs for the PRRCs and RCs. In contrast, the PT and PP forms of the S2 irregulars had more noticeable differences, requiring more cognitive capacity to identify the PP forms. The participants thus had fewer cognitive resources available to consider information about the two structures, leading to insignificant differences in RTs between the PRRCs and RCs in the S2 sentences. The finding implied that the level of phonological similarities between the PT and PP forms of irregulars influenced the amount of cognitive capacity required to identify the forms, which affected the participants' tendency to consider cues about structural complexity degrees of PRRC and RC.

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With respect to the RTs for the two constructions in the S4 sentences, the native controls and the lower span learners read the critical regions in the RCs more slowly than when reading those in the PRRCs. Their extended RTs for the RCs were ascribed to RC's higher number of words which preceded the PP, namely four words (e.g., *The merchant who was* seen) compared to two words (e.g., *The merchant* seen) in PRRC. This might add cognitive burdens, i.e., processing the subject-verb agreement, tense, and relative pronoun in the phrase "who was" or "which was." The burdens could cause a slowdown in the participants' processing of the following critical regions. On the contrary, the PRRCs did not impose additional burdens; accordingly, the PRRC processing could leave the participants sufficient cognitive resources, allowing them to read the critical regions in the construction faster than those in the RCs.

Concerning the spillover region, a main effect of salience was observed among the natives and the higher WM learners. They took significantly different RTs for the S2 forms and S4 forms only when the processed sentences included the reduced RCs; however, the differences between the RTs for the verbs from the two salience groups did not reach significance when the given sentences contained the full RCs.

Consistent with the finding about the critical region, the absence of different RTs for the RC sentences could be supported by the account of processing burdens of the construction. A lot of cognitive resources were required to take into account the S-V agreement, tense, relative pronoun in the RCs, and a greater number of words relative to that in the PRRCs. The processing of these additional burdens might leave them inadequate resources, which made them unable to differentiate the more salient irregulars from the less salient ones. On the contrary, the PRRC processing necessitated less cognitive capacity and left the participants adequate resources for distinguishing the S2 PPs from the S4 ones. When it comes to the participles from the two groups, the PT and PP forms of the S4 irregulars shared

more phonological similarities. The participants might therefore need few processing resources for identifying the given forms and have sufficient cognitive capacity, allowing them to read the following spillover regions in the S4 sentences faster than those in the S2 sentences.

6.2.2.2 Salience

Concerning the critical region or the region *PP*, structure had a main effect on the RTs of the lower span learners. When given the sentences with the S4 PPs, they processed the PPs in the PRRCs faster than those in the RCs.

Again, the finding was related to different amounts of cognitive capacity required for identifying the given forms from the two salience groups. The L2 learners may require more cognitive resources to differentiate between the PT and PP forms in S2, which were more distinct. Accordingly, the learners may have insufficient cognitive capacity, and they failed to exploit structural information in their processing. In contrast, the forms in S4, which were more phonologically similar, may allow the learners to have enough resources to consider information about the two structures. When dealing with the S4 irregulars, the lower WM learners took longer RTs for the PPs in the RCs, possibly because the structure required more cognitive capacity to process S-V agreement, tense, and relative pronouns in the subordinate clauses.

In connection with the spillover region, namely *MOP*, salience had a main effect on the lower span learners. The differences between the RTs they took for the S2 and S4 forms were significant when the given sentences included a PRRC. In contrast, for the RC sentences, the differences between the RTs did not reach significance.

Similar to the RTs for the two constructions in the critical region of the *Structure* data, the significant differences between the RTs for the participles from the two salience groups in only the PRRC sentences could be caused by the PRRC-

RC distinction regarding the number of the words preceding the spillover regions in the two constructions. This added cognitive burdens related to S-V agreement, tense, and relative pronouns in the subordinate clauses. Therefore, the learners may have insufficient cognitive resources to consider the salience level of the PPs and fail to distinguish between the S2 and S4 forms. On the contrary, in the PRRCs, the spillover regions were preceded by three words: a definite article, a noun phrase, and PP. This eliminated the additional burdens imposed by the RCs, allowing the participants to have adequate capacity for processing the irregulars from both salience groups.

Furthermore, the lower WM learners read the *MOP* regions in the S4 sentences significantly faster than those in the S2 sentences. This finding can be attributed to a higher level of phonological similarities between the PT and PP forms of the S4 PPs. The identification of the S4 forms may require few processing resources, leaving adequate cognitive capacity for reading the *MOP* regions in the S4 sentences. This helps explain why they were faster when processing the prepositional phrases following the S4 participles.

7. Limitations and Future Research

The present study has two limitations. First, it concentrated on two past participle types in the salience hierarchy: vowel change plus syllabic [ən] morpheme addition and vowel change plus *n*-affixation. Further research should examine PPs from other classes of the salience hierarchy to obtain a broader picture of salience effects. Second, the study focused on L1 Thai learners, whose native language has PRRCs that differ syntactically from English. Future studies should investigate the influence of WM and salience on the processing of PRRCs and RCs among participants from various L1 backgrounds differing in the degree of similarity between the reduced RCs in the languages and that in English.

8. General Discussion and Conclusion

This study examined how WM, structure, and salience influenced L1 Thai learners' processing of English PRRCs and RCs. Two hypotheses were formulated. First, the higher WM learners would spend similar amounts of time for RCs as their lower WM counterparts, take longer time reading PRRCs, and have higher accuracy than the lower WM participants. The findings, however, showed that the higher span learners read the two constructions faster than the lower span ones and that the two groups' accuracy did not significantly differ. Therefore, this hypothesis was rejected. The second hypothesis stated that the L1 Thai learners would take more RTs to process the PRRCs compared to the RCs and spend more time reading the S4 verbs than reading the S2 ones. However, the lower WM learners read the PRRCs faster than the RCs. Furthermore, both L1 Thai groups processed the less salient IVs faster. The results contradicted the second hypothesis.

Two main findings regarding WM effects are discussed. Firstly, the impact of WM was observed only in the participants' online processing, possibly due to distinct cognitive burden levels of different task types. WM effects tend to occur more prominently in tasks with higher cognitive demands (Just & Carpenter, 1992). In this study, the online task, which involved quick sentence reading, was more demanding than the offline task of answering yes-no questions. Therefore, WM influence was more noticeable in the former task. Secondly, the higher WM learners read sentences faster than the lower WM ones, and their RTs were more similar to those of the native controls. The finding could result from unequal cognitive resources of the two L1 Thai groups. The higher WM readers could combine upcoming and preceding information more quickly, causing their shorter RTs than the lower WM group's.

In terms of the structure effect, the lower WM learners took longer to read the RCs compared to the PRRCs. This could be due to the RCs' greater number of words, which included a relative pronoun and copula, requiring the readers to process the agreement between the relative pronouns and the head nouns, the

correlation between the subjects and copulas, and tense of the clauses. Consequently, the RCs placed a heavier cognitive burden on the readers than the PRRCs. The difference in word count between RCs and PRRCs affected both L1 Thai groups, resulting in significantly different RTs for the two structures. Regarding the salience effect, the two L1 Thai groups took longer to read the S2 participles compared to the S4 ones. This finding was attributable to the differences in phonological alterations between the two salience groups. The S2 participles had more prominent alterations, making them more salient than the S4 verbs. The more marked differences between the two forms of the S2 irregulars gave rise to increased processing difficulties for the learners, resulting in their greater amount of RT on the S2 PPs.

In conclusion, this study contributes to L2 processing studies by attesting to the influence of structure and salience on L2 learners' processing. It also has theoretical implications for psycholinguistics and SLA. The findings imply that adequate cognitive capacity could raise the possibility that L2 learners would show similar online processing to native speakers. Additionally, the research reveals that L2 processing could be involved with structure and salience. Lastly, WM effects on L2 processing might be connected with the cognitive demand of a task.

9. About the Authors

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