Contextual Effects and Locality Preferences in Relative Clause Attachment in Thai

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Abstract

Since the early 1990s, there has been a debate on the universality of locality in sentence processing (i.e., the preference to associate a word or phrase to the closest possible word). Studies across various languages have investigated ambiguous relative clauses that can be attached to either of two nouns to determine the types of languages in which locality is violated. We report a corpus count and a questionnaire in Thai indicating that intra-sentential contexts can obscure locality. Two reading experiments controlling for context are also reported in support of locality in Thai. The finding that context distorted locality raises the possibility that previous reports of locality violations in various languages may be reduced to contextual effects.

Keywords: relative clause attachment; locality; intra-sentential context; Thai

Introduction

As sentences are read word by word, there is a preference to attach a new word (or phrase) to the closet possible word (*locality*, for short; Gibson, 1998, for a summary). For example, in (1) the relative clause (RC) can be attached to either the non-local noun (N1, *friend*) or the local noun (the noun closest to the RC, i.e., N2, *teacher*), and English readers favor N2.

(1) John met the friend of the teacher who was in Germany (Cuetos & Mitchell, 1988).

Prima facie evidence against locality comes from reports suggesting that N1 is favored in the equivalent of (1) in various languages (e.g., Dutch, French, Greek, Italian, Japanese, Spanish; see Grillo & Costa, 2014, for a summary).

One problem with previous studies is that they often discussed RC attachment as a purely syntactic phenomenon. However, the surrounding context can affect the intended meaning of the RC as readers expect clauses to be coherent and thus prefer attaching the RC to N1 if it provides a reason or justification for the statement in the matrix clause (Rohde, Levy, & Kehler, 2011).

Text coherence may be achieved in other ways. Even when surrounding context does not require a causal explanation or justification, it may still affect RC attachment. For example, based on world knowledge, the RC is likely to be attached to N1 (*friend*) in *there was a wake for the friend of the teacher who died yesterday*.

In this paper, we suggest that locality preferences can be obscured by contextual factors. Therefore, we report results factoring out preferences stemming from the intended meaning of the context surrounding the RC. A corpus count and a questionnaire provide evidence for contextual effects in RC attachment in Thai. Moreover, two reading experiments support the claim that locality is obeyed in Thai when contextual effects are kept under control.

Thai and its Previous Results

Thai is an SVO (subject-verb-object) language. The word order of the target construction is *N1 of N2 RC*. There are no plural markers or morphological agreement, thus ambiguity resolution is often based on plausibility.

Although previous results in Thai provided support for a non-local N1 attachment preference (Siriwittayakorn, Miyamoto, Ratitamkul, & Cho, 2014), there were some potential confounds. The first, which is the main concern of the present paper, was that the complex NP came after the matrix verb (in object position) in the items of a self-paced reading experiment. This may have led readers to attach the RC to N1 to make it coherent with the matrix clause (Rohde, Levy, & Kehler, 2011). Another concern was that sentential complements (e.g., literally: "decision of committee that will extend deadline") were incorrectly classified as RC instances, often as N1 attachment, in a corpus count (see Kullavanijaya, 2010, for ways to differentiate RCs and sentential complements in Thai).

Corpus Count

Since coherence is important in writing (Trabasso, Suh, & Payton, 1995), it would not be surprising if RCs are produced and attached according to the surrounding context. Moreover, saliency as dictated by the animacy and concreteness of N1 and N2, has been claimed to affect attachment (Desmet, De Baecke, Drieghe, Brysbaert, & Vonk, 2006) and may interact with coherence (e.g., more salient nouns may lead to stronger coherence requirements).

Thus, we report a corpus count investigating effects of context, animacy and concreteness on RC attachment.

Method

A total of 4,800 instances of *khŏŋ* "of" followed by *thî*: "that" with up to three intervening words were randomly selected (Siriwittyakorn et al., 2014, for details) from the six writing genres of the Thai National Corpus (approximately 32 million words; genres: fiction, newspaper, academic text, non-academic text, law and miscellanea; Aroonmanakun, Tansiri, & Nittayanuparp, 2009). Irrelevant instances were eliminated (e.g., 145 were sentential complements following Kullavanijaya, 2010).

There were 2,109 instances of the target construction (*N1 of N2 RC*). Instances were further eliminated if RC attachment was ambiguous (353 instances, 16.74%); if one of the head nouns was a pronoun, a proper name or a biasing noun (e.g., *khōn* 'person', *sìŋ* 'thing'; 769 instances, 36.46%); or if they were repetitions (14 instances, 0.66%).

We report the results for the remaining 973 instances coded according to attachment (N1 or N2) and lexical features of N1 and N2 (animacy: animate or inanimate; and concreteness: concrete or abstract; e.g., animate-concrete: *man*, animate-abstract: *government*, inanimate-concrete: *house*, inanimate-abstract: *goodness*).

More crucially, because we were interested in the influence of the surrounding context, instances were also classified according to *disambiguating point*. If attachment was resolved within the complex NP (i.e., *N1 of N2 RC*), it was coded as *internally-disambiguated* (e.g., "voice of man that was uttered"). If context surrounding the complex NP was needed to determine attachment, it was coded as *externally-disambiguated* (e.g., in "The writer used only words that have beautiful sound to create rhyme of word that arouses listeners' emotion," "rhyme" is more likely to be associated with the "beautiful sound" mentioned in the matrix clause, making it more likely to arouse listeners' emotion and, hence, more likely to be modified by the RC).

Externally-disambiguated instances only involved intra-sentential contexts (the matrix clause, subordinate clauses; inclusion of the 4 instances where an adjacent sentence determined attachment, 0.41%, did not change the trends reported; see Desmet, De Baecke, & Brysbaert, 2002, on inter- and intra-sentential contexts in RC-attachment).

Two native Thai speakers coded all instances independently. Disagreements (5.33%) were settled after discussion with a third native Thai speaker.

Results

Overall (i.e., for internally- and externally- disambiguated instances), there was no reliable difference in attachment (N1 attachment: 460, 47.28%; N2 attachment: 513, 52.72%; where clear, only numbers for N1 are reported from here on). However, when restricted to internally-disambiguated instances (i.e., when attachment did not depend on the surrounding context), the bias towards N2 attachment was reliable (N1: 45.11%; $\chi 2$ (1) = 8.12, p = .004; see Table 1).

For the externally-disambiguated instances, N1 attachment was more frequent than N2 attachment (N1: 67 instances, 67.00%; $\chi 2$ (1) = 10.9, p = .001). The interaction between attachment (N1 or N2) and point of disambiguation (internal or external) was also reliable ($\chi 2$ (1) = 16.37, p < .001).

For animacy and concreteness, results are reported for the internally-disambiguated instances (trends are the same when externally-disambiguated instances are included; there was no interaction between animacy-concreteness and context; all ps >.10). The trends in Table 1 replicate the effects of animacy and concreteness in Dutch (Desmet et al., 2006). For example, animate N1 attracted RCs when both nouns were animate-abstract (N1: 92.11%, p < .001). Concrete nouns also attracted RCs (e.g., RCs were more frequently attached to N1 when it was inanimate-concrete and N2 was animate-abstract; N1: 77.78%, p = .006).

Moreover, like in Dutch, there were few instances when both nouns were animate-concrete (for Thai, N1: 9; N2: 12). However, numerical trends were in the opposite direction in Dutch (out of 1,065 instances, N1: 19; N2: 10), but a direct comparison with our results is difficult, since the Dutch counts did not differentiate between internally- and externally-disambiguated RCs.

Discussion

Context was found to be a factor that can obscure the N2-

Table 1: Attachment distribution in internally-disambiguated tokens (each cell indicates the number of N1 and the number of N2 attachments; *: p < .05; +: p < .10 according to exact binomial tests)

Type of N1		Type of N2				Total
		animate		inanimate		
		concrete	abstract	concrete	abstract	
animate	concrete	9-12	11-11	4-4	0-1	24-28
	abstract	1-5	35-3*	0-2	0-0	36-10*
inanimate	concrete	41-46	21-6*	27-47*	9-3	98-102
	abstract	76-100+	64-46	49-122*	45-69*	234-337*
Total		127-163*	131-66*	80-175*	54-73	392-477*

bias, which was significant only when surrounding-context effects were excluded. The fact that context often favored N1 (67% of externally-disambiguated instances) is not surprising. To increase text coherence, writers may prefer N1 attachment as it is the head of the complex NP and is part of the outer clause (e.g., the matrix clause).

In comprehension, readers have been shown to prefer texts to be coherent using clausal relations such as causality and justification (Rohde, Levy, & Kehler, 2011). In the Thai corpus, however, the clausal relations often involved world knowledge. Whether such relations are enough to affect comprehension even though they do not involve causal relations was tested in the following questionnaire.

Experiment 1: Questionnaire

A questionnaire study is reported providing evidence that intra-sentential contexts not involving causal relations can affect RC attachment preferences during comprehension.

Method

Participants Sixteen Native Thai speakers aged between 20-30 volunteered to participate. One of them was a graduate student in linguistics who was unaware of the purpose of the study. All participants signed consent forms.

Stimuli To investigate the influence of context, 12 corpus fragments (N1 of N2 RC), not involving causality or justification relations, were shown in isolation or with intra-sentential context (i.e., the entire corpus sentence). An example translated into English is shown in (2).

(2) a. In isolation: "Rhyme of word that arouses listeners' emotion"
b. With context: "The writer used only words that have beautiful sound to create rhyme of word that arouses listeners' emotion."

The native Thai speakers who coded the corpus sentences (see previous section) agreed that N2 ("word") would be favored in (2a), but N1 ("rhyme") should be favored in (2b) as "rhyme" is more closely related with "beautiful sound."

The twelve corpus segments for which reversals were most consistent according to a pre-test were included in the questionnaire (e.g., (2)). According to the pre-test, four items had a bias for N1-attachment when read in isolation, and a bias for N2-attachment when context was included (i.e., N1-N2 items). In the remaining eight items, the trend was in the opposite direction (i.e., N2-N1 items).

Procedure and Analyses Participants were asked to choose between two paraphrases for the two possible attachments (e.g., "rhyme arouses listeners' emotion" and "word arouses listeners' emotion"). Order of the paraphrases was included as a factor together with context (with context or in isolation). The 12 test sentences were distributed into four lists following a Latin Square design. Each participant saw one list with 66 fillers.

Six fillers had one correct paraphrase. Since all participants answered these items correctly, results reported include all participants' data. Analyses were conducted on R version 3.0.2 (R Core Team, 2013) using logit mixed-effect models (see Jaeger, 2008, and references therein).

In two items, a portion of the RC was incorrectly shown as part of the matrix clause; and in two items, there were more than two possible host sites. Therefore, only the results for the remaining eight items are reported (trends including all 12 items were similar to those reported).

All means reported are averages over participants.

Results and Discussion

As predicted there was a main effect of context as the preferred attachment site in isolation (77.08%) was less preferred when context was provided (16.67%; $p < .001$).

The effect of context was qualified by an interaction with type of item (N1-N2, or N2-N1: $p = .013$) but this is not of interest as it only indicates that the effect was stronger in the N1-N2 items ($p < .001$, according to Bonferroni-adjusted pairwise comparisons with least-square means, function *lsmeans*; Lenth, 2013) than in the N2-N1 items ($p = .005$).

The change in preferences indicates that context can affect RC-attachment during comprehension. To achieve coherence, readers do not expect only causality and justification. They also used their world knowledge to relate the meaning of the RC to that of the matrix clause.

In this paper, we are not directly addressing the relation between frequency in corpora and preferences in comprehension, but some of the data used to support such a frequentist explanation should be reexamined. For example, although in a completion questionnaire using corpus fragments (Desmet, Brysbaert, & De Baecke, 2002), the distribution in corpora matched native speakers' continuations; the similar distributions may have been a result of the surrounding contexts constraining RC attachment in corpora and in the completion task.

In short, studies investigating RC attachment should take the influence of context into consideration. This is true for work using corpora, given the rich contexts that often precede the target construction. But it is also true for experiments showing individual sentences in isolation given that intra-sentential context can be a crucial factor affecting attachment (see also Rohde, Levy, & Kehler, 2011).

Although the N2 preference observed in the internally-disambiguated instances of the corpus is compatible with locality, lexical factors other than animacy and concreteness may have contributed to the N2 preference. To provide clearer evidence for locality in Thai, we conducted reading experiments controlling for contextual and lexical factors, and report them as Experiments 2 and 3.

Experiment 2

An off-line task (i.e., overall preferences after the sentence was read) was used to determine whether readers prefer N1 as the attachment site of the RC when the RC and the matrix clause are unrelated.

Method

Participants Eighteen native Thai speakers volunteered to participate in the experiment. Three of them had taken an introductory course in linguistics. All participants in this and the subsequent experiment and in the norming questionnaires were undergraduate students at Chulalongkorn University. They all signed a consent form.

Stimuli Twenty-four ambiguous sentences in which an RC can be attached to either of the two nouns were created. To avoid animacy and concreteness confounds, and to make the results comparable to previous reports for other languages, the two nouns (N1 and N2) were common human nouns. An example is given in (3).

(3) khó:t khɔ̌:ŋ nák wîŋ thî: wâ:t rû:p sŭaj
coach of runner that draw picture beautifully
kāmlāŋ-càʔ ʔɔ̀:k bùat
FUTURE become-a-monk
"The coach of the runner that is good at drawing is going to become a monk."

Matrix clauses unrelated to the RCs were created (e.g., in (3), there is no relation between being good at drawing and becoming a monk). Five native Thai speakers confirmed that they could not find a relation between the topics in the RC and the matrix clause. None of the five speakers participated in any of the experiments reported here.

The two interpretations (e.g., "coach is good at drawing," and "runner is good at drawing") were equally natural according to a norming questionnaire in which a new group of 30 native Thai speakers rated the plausibility of the two interpretations on a five-point scale (Wilcoxon: all *p*s > .10).

Procedure and Analyses Test items were shown in a fixed random order interspersed with 60 fillers so that at least one filler intervened between two test items.

In order to obscure the purpose of the experiment, 28 fillers were ambiguous sentences, some of which contained the word *thî:* as an RC marker of an unambiguous RC, a complementizer or a preposition. For 46 fillers, the question had only one possible answer to verify that participants were paying attention (all participants scored over 95%).

Sentences were shown individually without line breaks on a computer monitor. After each sentence, a question was displayed on a new screen. This procedure was adopted to prevent participants from consulting previous items or rereading the sentence when answering the question and thus, noticing the ambiguity. Each question was followed by two alternatives with the order counterbalanced across items. For the test items, the question was about attachment (e.g., "Who is good at drawing?").

How often each participant chose N1 attachment was included as the dependent variable. Both by-subject and by-item analyses were conducted on R version 3.0.2 (R Core Team, 2013) using Wilcoxon signed rank test (function wilcox.test in the package stats; R Core Team, 2013).

Results and Discussion

Overall, the rate of N1 attachment (33.1%; i.e., a 66.9% preference for N2) was different from chance (Wilcoxon by subjects: $V_1 = 23.5$, $p = .013$; by items: $V_2 = 6$, $p < .001$) suggesting that participants favored N2 attachment.

However, it is conceivable that this is not evidence for a locality preference but an unintended effect of the matrix clauses used. Readers may avoid attaching the RC to N1 when it is unrelated to the matrix clause so as to avoid two unrelated clauses referring to the same entity. To address this possibility an on-line experiment was conducted.

Experiment 3

An on-line experiment was conducted to show that there is an N2 preference before readers can determine whether the clauses are coherent (i.e., before the matrix clause is read).

Method

Participants A new group of 42 native Thai speakers volunteered to participate in the experiment. Thirteen of them had taken an introductory course in linguistics.

Stimuli In the 24 pairs of test items used (see (4) for an example), the RC modified the subject so that the matrix clause would not contaminate the reading times to the RC.

(4)

a. N1 attachment
lă:nchā:j | khɔ̌:ŋ | khūnjĭŋ | thî: | phɔ̂:ŋ jà: |
nephew of duchess that just divorce
kàp ʔànōŋ | mîa ʔā:thít thî:lɛ́:w | chɔ̂:p pāj
with Anong(f) when week past like go
thîaw | thî: chīaŋmàj
travel at Chiang Mai
"The nephew of the duchess that got divorced from Anong(f) last week likes traveling to Chiang Mai."

b. N2 attachment
lă:nchā:j | khɔ̌:ŋ | khūnjĭŋ | thî: | phɔ̂:ŋ jà: |
nephew of duchess that just divorce
kàp jōŋjút | mîa ʔā:thít thî:lɛ́:w | chɔ̂:p pāj
with Yongyut(m) when week past like go
thîaw | thî: chīaŋmàj
travel at Chiang Mai
"The nephew of the duchess that got divorced from Yongyut(m) last week likes traveling to Chiang Mai."

All crucial nouns (N1 and N2) were common human nouns. Disambiguation was based on plausibility (e.g., involving gender stereotypes; "f" and "m" in the glosses in (4) indicate the gender of the preceding noun; e.g., in (4a), the RC modifies the nephew as only a man and a woman can get divorced according to current Thai laws).

To confirm the plausibility biases for each RC, a norming questionnaire was conducted with a new group of 47 native Thai speakers. The results indicated that the two plausible interpretations (e.g., for the nephew and Anong (f) to get

divorced, and for the duchess and Yongyut (m) to get divorced) were equally natural, and the two implausible interpretations (e.g., for the nephew and Yongyut (m) to get divorced, and for the duchess and Anong (f) to get divorced) were equally implausible (all *p*s > .10).

Word and bigram frequencies for the disambiguating words (e.g., "Anong" in (4a), "Yongyut" in (4b)) obtained from the Thai National Corpus (Aroonmanakun, Tansiri, & Nittayanuparp, 2009) did not differ (Wilcoxon: all *p*s > .20).

Procedure and Analyses The 24 pairs of test sentences and 60 fillers were distributed into two lists according to a Latin Square Design. Sentences were divided into nine regions as indicated by the vertical bars in (4). The critical region where the attachment ambiguity was resolved, was always the sixth region (i.e., the underlined region).

Participants read sentences one region at a time by pressing the space bar. After each sentence, a comprehension question was shown on a new screen. The question did not query about attachment to avoid drawing participants' attention to the point of the experiment. To fit the width of the screen, sentences were broken into two lines. For the test items, the nouns and the RC were always shown together on the first line (to avoid an N1-attachment bias; see the *implicit prosody hypothesis*; Fodor, 1998).

Analyses were performed on R 3.0.2 (R Core Team, 2013) using mixed-effects models (package lme4.0; Baayen, Davidson, & Bates, 2008, and references therein). The p-values were calculated by using Wald chi-square (function Anova in the package car; Fox & Weisberg, 2011).

For all regions, attachment, Latin-Square list and their interaction were set as fixed factors. Since the disambiguating words differed (e.g., "Anong" in (4a) and "Yongyut" in (4b)), their lengths, log frequencies (word and bigram), and scores from the norming questionnaire were included as additional fixed factors for the critical region. Random intercepts were included for participants and items. Because of convergence limitations, only attachment was included as by-participant random slope, and attachment, Latin-Square list and their interaction as by-item random slopes. Outliers beyond three standard deviations were removed (Baayen, 2008) affecting less than 1% of the data.

Results

Comprehension Accuracy Overall (including test items and fillers) question-response accuracy was 99.04%. None of the participants scored less than 94%.

Accuracy for both conditions was high, but N1 attachment (99.80%) was marginally higher than N2 attachment (98.81%) (The results for both by-subjects and by-items are the same: Wilcoxon *V*s = 24, *p*s = .073; by-subject medians for both N1 and N2 attachment: 12; by-item medians for both attachments: 21). Attaching to N1 may reactivate the representation of this noun, thus making it easier for participants to answer the questions, which always included N1 and the matrix predicate.

Reading Times In the critical region, N2 attachment was read faster than N1 attachment (β = -37.74, p = .049) and attachment did not interact with any of the other factors. In the remaining regions, there was no reliable effect of attachment or interaction with list (main effects of list are not of theoretical interest and are not reported).

Discussion

The reading-time results confirmed that with animate nouns, N2 was the preferred attachment site. The results are compatible with those of the off-line task in Experiment 2, confirming the locality preference in attachment in Thai. Because the preference was observed before the matrix predicate was read, we can be confident that the present result was not affected by readers trying to make attachment coherent with the matrix clause.

General Discussion

The corpus count and Experiment 1 indicate that context affected attachment both in production and in comprehension. With intra-sentential contexts factored out, the N2 preference in the corpus count was compatible with locality. The effect of locality was further confirmed by off-line and on-line tasks (Experiments 2 and 3).

Previous results were primarily concerned with causality and justifications between clauses in comprehension (Rohde, Levy, & Kehler, 2011). Our results extend the types of clausal relations involved and indicate that context can also affect corpus frequencies, thus obscuring local-attachment trends in production.

We emphasized coherence but there are many ways that context may affect preferences as sentences are read (Spivey, Anderson, & Farmer, 2013, for a summary of contextual effects in various constructions).

Further studies are needed but if previously-reported N1 attachment preferences in various languages can be ascribed to context, then a local attachment preference can be held as a universal principle, without the need for cross-linguistic parameterizations in the way people process sentences.

In a recent proposal, Grillo and Costa (2014) arrived at a similar conclusion suggesting that N1 attachment is only favored when the matrix clause can give rise to an alternative interpretation (*pseudo relative small clauses*, or *pseudo RCs*) in which the events in the two clauses are simultaneous and only the N1 interpretation is possible. However, the availability of pseudo RCs cannot explain the present results. For example, in Experiment 1, since none of the RCs could be interpreted as pseudo RCs, the preference reversal are unexpected if pseudo RCs are the only (or the main) factor leading to N1 preferences.

Similarly, the items of some studies reporting a non-local attachment preference could not be interpreted as pseudo RCs (e.g., in Japanese: Kamide & Mitchell, 1997; Yamada, Arai, & Hirose, 2014). More interestingly, these studies in Japanese reported an initial preference for the local noun and a late reversal favoring the non-local noun as the matrix clause was read. This is compatible with the assumption that

locality is observed initially but is overridden by text coherence later as the matrix clause is read.

The results that pseudo-RCs have been claimed to explain, may be reduced to contextual effects where text coherence favors attaching the RC to N1 to make its time reference overlap with the time of the matrix clause.

Conclusion

We examined contextual effects in RC attachment in Thai. A corpus count and a questionnaire indicated that context affected attachment. In the corpus results and two reading experiments, there was an N2-attachment preference when contextual effects were excluded. This is compatible with the assumption that locality is a universal parsing principle, which is modulated by context and lexical features such as animacy and concreteness.

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References

Aroonmanakun, W., Tansiri, K., & Nittayanuparp, P. (2009). Thai National Corpus: A progress report. *Proceedings of the 7th workshop on asian language resources, ACL-IJCNLP 2009* (pp. 153-160). Suntec, Singapore.

Baayen, R. H. (2008). *Analyzing linguistic data: A practical introduction to statistics using R*. Cambridge University Press.

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language, 59*, 390–412.

Cuetos, F., & Mitchell, D. C. (1988). Cross-linguistic differences in parsing: Restriction on the use of the Late Closure strategy in Spanish. *Cognition, 30*, 73-105.

Desmet, T., Brysbaert, M., & De Baecke, C. (2002). The correspondence between sentence production and corpus frequencies in modifier attachment. *Quarterly Journal of Experimental Psychology, 55A*, 879-896.

Desmet, T., De Baecke, C., & Brysbaert, M. (2002). The influence of referential discourse context on modifier attachment in Dutch. *Memory & Cognition, 30*, 150-157.

Desmet, T., De Baecke, C., Drieghe, D., Brysbaert, M., & Vonk, W. (2006). Relative clause attachment in Dutch: On-line comprehension corresponds to corpus frequencies when lexical variables are taken into account. *Language and Cognitve Processes, 21*, 453-485.

Fodor, J. D. (1998). Learning to parse? *Journal of Psycholinguistic Research, 27*, 285-317.

Fox, J. & Weisberg, S. (2011). *An R companion to applied regression* (2nd ed.). Thousand Oaks, CA: Sage.

Gibson, E. (1998). Linguistic complexity: Locality of syntactic dependencies. *Cognition, 68*, 1-76.

Grillo, N., & Costa, J. (2014). A novel argument for the universality of parsing principles. *Cognition, 133*, 156-187.

Jaeger, T. F. (2008). Categorical data analysis: away from ANOVAs (transformation or not) and towards logit mixed models. *Journal of Memory and Language*, *59*, 434-446.

Kamide, Y., & Mitchell, D. C. (1997). Relative clause attachment: Nondeterminism in Japanese parsing. *Journal of Psycholinguistics Research, 26*, 247-254.

Kullavanijaya, P. (2010). อนุประโยคขยายนาม :คุณานุประโยคและอนุประโยคเติมเต็มนาม [Clauses modifying nouns: Relative clauses and complement clauses] .In A. Prasithrathsint (Ed.), *Controversial constructions in Thai grammar: Relative clause constructions, complement clause constructions, serial verb constructions, and passive constructions*. Bangkok: Chulalongkorn University Press.

Lenth, R. V. (2013). lsmeans: Least-squares means (1.10-2). R package.

R Core Team (2013). R: A language and environment for statistical computing. Vienna, Austria: R foundation for statistical computing.

Rohde, H., Levy, R., & Kehler, A. (2011). Anticipating explanations in relative clause processing. *Cognition, 118*, 339-358.

Siriwittayakorn, T., Miyamoto, E. T., Ratitamkul, T., & Cho, H. (2014). A non-local attachment preference in the production and comprehension of Thai relative clauses. *Proceedings of the 28th Pacific Asia conference on language, information and computation* (pp. 575-584). Bangkok, Thailand: Chulalongkorn University.

Spivey, M. J., Anderson, S. E., & Farmer, T. A. (2013). Putting syntax in context. In R. P. G. V. Gompel (Ed.), *Sentence Processing*. New York, NY: Psychology Press.

Trabasso, T., Suh, S., & Payton, P. (1995). Explanatory coherence in understanding and talking about events. In M. A. Gernsbacher & T. Givón (Eds.), *Coherence in spontaneous speech*. Amsterdam: John Benjamins Publishing Co.

Yamada, T., Arai, M., & Hirose, Y. (2014, March). Unforced revision in the processing of relative clause association ambiguity in Japanese. Paper presented at the 27th annual CUNY conference on human sentence processing, Columbus, OH.