Extraction from Coordinate Structures: Evidence from Language Processing*

Jesse A. Harris
University of Massachusetts, Amherst

1 Introduction

Decades of psycholinguistic research have witnessed a sustained interest in whether syntactic island constraints are active during online processing (Stowe 1986; Bourdages 1992; Frazier & Clifton 1989; Goodluck & Rochemont 1992b; Wagers & Phillips 2009). Initiated by Ross (1967), the study of syntactic islands seeks to identify environments in which filler-gap dependencies are banned. But to these generalizations, there are, of course, exceptions. One of the more resilient island constraints is Ross's (1967) Coordinate Structure Constraint (CSC), although it, too, admits systematic counterexamples. The focus of this paper is on one such counterexample to the CSC – extraction from so-called 'pseudo-coordination' structures – and its treatment in online processing.

At the center of this paper is the following long-recognized puzzle: why is the filler-gap dependency licensed in the pseudo-coordination structure (1a), but not the seemingly identical structure (1b)?

(1) a. What did John go and buy __?
b. * What did John drive and buy __?

Many different solutions have already been proposed. In some of these solutions, pseudo-coordination structures are said to be not genuine conjunctions (Ross 1967) or idiomatic constructions (Na & Huck 1992). In others, the validity of the CSC is denied. Extraction, they claim, is governed not by syntactic principles, but rather by how the coordinated event descriptions frame discourse level priorities (Erteschik-Shir & Lappin 1979; Lakoff 1986; Deane 1991; Na & Huck 1992; Kehler 2002).

In one sense, the answer I defend differs substantially from those above: the syntactic structures in (1) are not as similar as they might first appear (see also de Vos (2005)). Pseudo-coordination conjoins its conjuncts low in the clause, whereas ordinary coordination (1b), contrary to appearances, conjoins its conjuncts high. However, these different *syntactic* structures are driven by *semantic* factors: low coordination reflects Non-Boolean conjunction to create complex predicates of events, but high coordination reflects Boolean conjunction, coordinating two distinct event descriptions. Since only Boolean conjunction requires that the filler be distributed across both conjuncts, extraction from only one conjunct, as in (1b), is prohibited only in this structure.

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In another sense, my proposal coheres with the observations of previous work, but grants them a weaker status in the exposition. That is, the way that events are organized in discourse is indeed a factor in the licensing of extraction, but only *indirectly* so. Rather, different event descriptions are composed by different semantic configurations, which in turn present different syntactic structures.

The remainder of this paper proceeds as follows. Section 2 provides the relevant background on the CSC and pseudo-coordination structures. Section 3 introduces Non-Boolean coordination and outlines how the syntactic and semantic structures of pseudo-coordination reveal the composition of event descriptions. Lastly, section 4 presents two experimental studies that offer initial support of these claims.

2 Extraction from coordinate structures

Ross's (1967) Coordinate Structure Constraint (CSC) prohibits movement of a conjunct, or "any conjunct contained in a conjunct, . . . out of that conjunct." The CSC is remarkably robust, and successfully captures a wide range of cases (2–3).

(2) a. * What did John play __ and sing madrigals?
b. * Here's the lute that John plays __ and sings madrigals

(3) a. *What did John play the lute and __?
b. *What madrigal did John play the lute and sing __?

However, Ross (1967) soon observed two kinds of exception to the CSC. One kind of exception is Across-the-Board (ATB) movement, a configuration in which parallel gaps, both seemingly controlled by the same antecedent, appear in both conjuncts (4). Thus, if it is implausible that the same object could fill both gaps at once, the entire extraction becomes implausible (4b).

(4) a. What did John brew __ and Mary drink __ ?
b. # What did John eat __ and Mary drink __?

A second kind of exception to the CSC is known as 'pseudo-coordination' – the coordination of a light verb of motion (*go, come, run, etc.*) with a lexical verb hosting the gap site. Pseudo-coordination permits asymmetric extraction, i.e., extraction from the second conjunct and not the first (5). In contrast, asymmetric extraction is markedly worse in a minimally contrasting question coordinating two lexical verbs (ordinary coordination):

(5) a. What did John go and eat __ ? (Pseudo-coordination)
b. * What did John drive and eat __ ? (Ordinary Coordination)

Crucially, the events described by the verbs in pseudo-coordination *cannot* be construed as a description of multiple events. That is, pseudo-coordinations like *go and buy* describe a single event, despite being composed of multiple verbs. This fact is illustrated by the infelicity that results when adverbial *both* modifies a pseudo-coordination construction (Carlson 1987; Johannessen 1998; de Vos 2005):

(6) a. # John both went and took his medication
b. John both called his mother and took his medication

Assuming that adverbial *both* requires that the coordination describes multiple events, as in (6b), then (6a) is semantically anomalous precisely because the pseudo-coordinated verbs together describe a single event. A similar argument holds for related adverbs like *simultaneously, alternately, etc.*

Already, an interesting correspondence has started to develop. Coordination structures that are interpreted as single events license extraction, whereas those that describe multiple events do not. In his investigation of extraction from adjunct islands, Truswell (2006) noticed a similar correspondence. He codified the relationship *directly* into a constraint on extraction:

(7) Wh-questions carry a presupposition that the minimal constituent containing the head and the foot of the chain describes a single event. Wh-movement is permitted only if the denotation of that minimal constituent can be construed accordingly.

In condition (7), the relationship between event-construal and extraction is constitutive; extraction is licensed only if the events coherently describe a single extended event.

A third kind of coordination structure seems to support condition (7). Ambiguous coordination conjoins a light verb of motion with a prepositional phrase and a lexical verb (8). Interestingly, this structure is ambiguous between single and multiple event interpretations. Given condition (7), we would expect that the multiple event interpretation would not license asymmetric extraction. Indeed, extraction is licensed only when the coordination is construed as a single event (8b), an interpretation precluded by adverbial *both* in (8c).

(8) John went to the store and bought some whiskey. (Ambiguous coordination)
   a. John both went to the store and bought some whiskey. (Multiple event)
   b. What did John go to the store and buy __ ? (Single event)
   c. * What did John both go to the store and buy __?

Thus, the contrast between pseudo-coordination and other coordinate structures provides an excellent way to test the relationship between event-construal and extraction. In particular, I contrast the following two perspectives on this relationship:

(9) I. **Direct Approach:** A single event requirement is encoded *directly* into a constraint on extraction. Wh-extraction presupposes that its domain spans a structure which may be construed as a single event (Truswell 2006).

II. **Indirect Approach:** The correlation is derived as an *indirect* consequence of independent factors, operating on the same domain. In the case of pseudo-coordination, the relevant factors are (i) the structural properties of distinct conjunction operators, and (ii) a syntax-semantics constraint on how events are encoded into syntactic structures.

The direct account suffers from several empirical difficulties. First, it incorrectly predicts that ATB-movement (4) is infelicitous: the conjuncts denote two separate events, yet extraction is grammatical. Second, there is no ready explanation for the central puzzle in (1); why shouldn't *drive and buy* be pragmatically construed as a

single event, thereby licensing extraction? Requiring that the events overlap in time, as Truswell (2006) does, doesn't make matters any clearer, as asymmetric extraction from contemporaneous events like *drive and call* are just as bad. And yet, there is something intriguing and insightful about the purported correlation between a single event interpretation and extraction, at least for pseudo-coordination cases.

In the next section, I further outline and defend the *indirect approach* by illustrating two independent factors in pseudo-coordination structures that together give rise to the correlation between event-construal and extraction. For the first factor (i), I propose that two different conjunction operators are at work. These different operators are shown to behave differently with respect to asymmetric extraction. For the second factor (ii), I posit the Aspect Constraint, which delimits how event descriptions are composed in the syntax. The Aspect Constraint is further argued to localize the syntactic position of the different conjunction operators.

3 Coordination and structure

3.1 Two kinds of coordination

The conjunction operator is often treated as Boolean conjunction, defined below (Partee & Rooth 1983):

(10) a. **t-conjoinable types**
   i. t is a t-conjoinable type
   ii. if τ is a t-conjoinable type, then for all σ, $\langle\sigma,\tau\rangle$ is a t-conjoinable type.

b. **Recursive definition of Boolean conjunction**
   i. if α,β are of type t, then $\alpha \wedge \beta$ as usual.
   ii. if α,β are of a t-conjoinable type $\langle\sigma,\tau\rangle$,
   then $\alpha \wedge \beta = \lambda\chi_\sigma.[\alpha(\chi) \wedge \beta(\chi)]$, where χ is free in α and β.

In other words, Boolean conjunction takes two conjuncts of identical t-conjoinable type, i.e., truth-values or sets of objects, and asserts that both conjuncts hold. If the conjuncts are sets of objects α and β, it forms a new set from the intersection of those sets – those objects χ which are in both α and β. Thus, the argument χ to α and β in Boolean conjunction distributes across conjuncts (10b.ii)

Distributing the argument, however, does not always preserve the original meaning of the expression. For instance, distributing the conjoined individuals in (11) fails to capture the intended meaning (Krifka 1990).

(11) Barbara and Mats wrote an article together ↮
Barbara wrote an article together and Mats wrote an article together

In other words, the predicate *wrote an article together* holds not of the respective individuals, Barbara and Mats, but rather of their collective sum: Barbara⊕Mats, the sum individual consisting of Barbara and Mats (cf. Winter 2002 and Heycock & Zamparelli 2005).

The Boolean analysis similarly fails for pseudo-coordination. In (12), a Boolean operator returns the set of events which is both a *going* and an *eating of cake*. Pre-

sumably, there is no such event, and the coordination would simply fail to denote any event at all:

(12) a. John will go and eat the cake
b. # ⟦ go and eat the cake ⟧ = $\lambda e.go(e) \wedge eat(e)(\iota x.cake(x))$

Instead, as argued by Krifka (1990) and others, the conjunction operator sometimes expresses a Non-Boolean relationship between its conjuncts; a simplified version restricted to predicates of events is provided below:

(13) ⟦ and_{NB} ⟧ = $\lambda\alpha.\lambda\beta.\lambda e''.\exists e, e'[e'' = e \oplus e' \wedge [\beta(e) \wedge \alpha(e')]]$

To return to a familiar example, the conjunction of two predicates of events, such as *go and eat*, no longer returns the empty set. It is perfectly easy to find an event that satisfies the requisite description: simply find a going event and an eating event and take their plural sum.

(14) ⟦ go and_{NB} eat ⟧ = $\lambda e''.\exists e, e'[e'' = e \oplus e' \wedge [go(e) \wedge eat(e')]]$ =
the set of events e'' for which there are two subevents e, e' that partition e'' such that e is a going and e' is an eating.

However, there is already a fly in the ointment. Given that the plural sum can be taken for any two events, Non-Boolean conjunction severely overgenerates, predicting that any verbs coordinated together could describe a single event.

(15) ⟦ drive and_{NB} eat ⟧ = $\lambda e''.\exists e, e'[e'' = e \oplus e' \wedge [walk(e) \wedge eat(e')]]$ =
the set of events e'' for which there are two subevents e, e' that partition e'' such that e is a driving and e' is an eating.

There are at least two ways to block (15): either constrain the sum operator itself or impose an additional grammatical constraint that limits its distribution. Since the more constrained version appears to be dependent on context, e.g., it applies within the verbal domain, and not the DP domain, in the next section I pursue the second option and propose a grammatical constraint on event encoding imposed by Viewpoint Aspect (Smith 1991).

In addition, a brief word is required about the lexical differences between a light verb of motion like *go* and a manner of motion verb like *drive*. For simplicity, I assume that light verbs of motion semantically contribute paths, but are lexically unspecified for an endpoint. Thus, they contribute no lexicalized boundary. Manner of motion verbs, in contrast, are specified for both the manner in which the path is traversed and a natural boundary at which that path ends. As we will see, if light verbs possess no boundaries, they may form a complex event with a continuous running time when combined with a lexical verb under Non-Boolean conjunction. Although far more could (and should) be said about what light verbs contribute to the semantics of pseudo-coordination constructions, such remarks must be left for another occasion.

3.2 Constraining Non-Boolean conjunction

I assume a syntactic model in which Tense projections dominate Aspect projections (see de Swart & Verkuyl (1999) for introduction). In turn, Aspect dominates the

Voice projection (Kratzer 1996; 1998) which introduces the *agent* relation to the semantics of the verb, which itself denotes a set of events.

For illustration, I show the compositional derivation of (16a). First, the object DP *the cake* combines with the lexical verb *eat*, the result of which is a set of eating-the-cake events (16b).

(16) a. John ate the cake.
b. $[\![$ eat the cake $]\!] = \lambda e.eat(e)(\iota x.cake(x))$

Next, the VP composes with the Voice head, which adds an agent to the set of cake-eating-events by the composition principle Event Identification (Kratzer 1996).

(17) $[\![$ Voice^0 $]\!] = \lambda x.\lambda e.agent(x)(e)$ (*Set of agentive events*)

(18) **Event Identification:** Given a function $f_{\langle e,\langle s,t\rangle\rangle}$ and a function $g_{\langle s,t\rangle}$ Event Identification produces a function $h_{\langle e,\langle s,t\rangle\rangle}$:

$$\begin{array}{ccc} f & g & h \\ \langle e,\langle s,t\rangle\rangle & \langle s,t\rangle & \langle e,\langle s,t\rangle\rangle \\ \lambda x_e.\lambda e_s.f(x)(e) & \lambda e_s.g(e) & \lambda x_e.\lambda e_s[f(x)(e) \wedge g(e)] \end{array} \quad \Rightarrow$$

The result is again a set of events, but this time with an argument for agent incorporated into the semantics (19a), filled by *John* in the specifier of VoiceP (19b).

(19) a. $[\![$ Voice^0 eat the cake $]\!] = \lambda x.\lambda e.agent(x)(e) \wedge eat(e)(\iota x.cake(x))$
b. $[\![$ John Voice^0 eat the cake $]\!] = \lambda e.agent(j)(e) \wedge eat(e)(\iota x.cake(x))$
(*Set of events where John eats the cake)*

Example (19) has yielded a set of events e, in which John eats a cake. Yet, something is still missing. We have only given the basic relationships between participants in the event, but haven't yet described the duration of the event, and haven't yet located it in time. To do so, the event is mapped into an interval of time, which specifies its *running time*. Following Kratzer (2002), this occurs at Aspect. Letting τ be the function which maps each event onto its running time, Kratzer's (1998) semantics for Perfective Aspect is as follows:

(20) $T([\text{Perfective}]) = \lambda P_{\langle s,t\rangle}.\lambda t_i.\exists e[P(e) \wedge \tau(e) \subseteq t]$

Thus, Perfective Aspect maps "a property of events into a property of times that is true of a time t just in case t includes the running time of a P-event" (Kratzer 2002).

The constraint I propose is one placed on the running time function τ. The basic intuition is that a singular event e has a continuous running time, i.e., the same event cannot reappear once it has ended.[1] Thus, the constraint demands that a continuous running time τ must be defined for each event, complex or otherwise. A first, and perhaps overly restrictive, attempt is stated in (21).

[1]This assumption raises a question which I do not address here, namely how to treat semelfactives that appear in pseudo-coordination– e.g., *the light went and blinked for an hour*.

(21) **Aspect constraint:** For any event e, and process P that holds of e: if there are times $t, t' \in \tau(e)$ and $P(e)$ holds at t and t', there is no $t'' \in \tau(e)$, such that $t < t'' < t$ for which $P(e)$ fails to hold at t''.

In other words, the running time τ of the complex event is gapless. Since light verbs, by hypothesis, are not specified with lexicalized boundaries in their semantic representation, they may be conjoined with lexical verbs and still maintain a continuous running time. Defining what a boundary is may be a deeply problematic task (Varzi 2008), but our purposes permit a simplified understanding of the concept. A boundary is simply the part of the object that separates outside from in.

As mentioned, adopting the Aspect constraint allows us to localize Non-Boolean conjunction beneath Viewpoint Aspect. Following Kratzer (2002), Viewpoint Aspect represents those Aspectual heads which "mark a switch of perspective from events to reference times." As such, Viewpoint Aspect closes off the event description for further modification, and therefore the two event descriptions must be summed into a complex event description before the entire event is existentially closed. For simplicity, I assume that Non-Boolean coordination takes verb or verb phrases as its conjuncts (de Vos 2005).

In contrast, since our cases of Boolean conjunction, by hypothesis, must describe two distinct events, each conjunct should at least contain its own Viewpoint Aspect projection. More evidence is required to localize the syntactic position of Boolean conjunction with any precision. I will call the conjuncts of Boolean coordination 'clausal' with this caveat in mind.

The basic proposal is summarized in Table 1. Pseudo-coordination structures license Non-Boolean conjunction, low (verbal) coordination, and asymmetric extraction. Ordinary coordination structures license Boolean conjunction, high (clausal) coordination, but not asymmetric extraction. Ambiguous coordinations may instantiate either type.

		Conjunction		
	Events	**Type**	**Height**	**Extraction?**
Pseudo-coordination	1	Non-Boolean	Low	✓
Ordinary coordination	2	Boolean	High	*

Table 1: Pseudo-coordination *vs.* Ordinary coordination

In the next section, I present experimental work that tests the syntactic differences between the different kinds of coordination.

4 Experimental work

The results from two experiments are presented below. They provide initial evidence that extraction out of pseudo-coordination is easier to interpret and process than extraction out of ordinary coordination counterparts.

4.1 Questionnaire

In order to verify that pseudo-coordination and ordinary coordination structures do indeed differ with respect to extraction, I compared the two kinds of coordination in an offline acceptability judgment task.

4.1.1 Materials

The central materials consisted of 20 triplets of the kind in (22A – C). All three sentences involved matrix *wh*-questions extracting an argument gap from the second conjunct in a coordination. The experiment manipulated the first conjunct of the coordination with different types of verbs or verb phrases. In some conditions, the initial conjunct contained a light verb with a directional prepositional phrase (LightPP) or without (Light). Otherwise, the initial conjunct contained a lexical verb of motion with the same directional prepositional phrase in the LightPP conditions. Only lexical verbs of motion with intuitively strong intransitive senses were selected. An additional condition (22D) consisting of extraction from a purpose clause was added for comparison and counter-balancing (LexPurp). This condition consisted of the same lexical verb of motion and PP as the LexPP condition, but contained a gap located not in the second conjunct but rather in a purpose clause.[2]

(22) What did the electrician ...

A. go and repair after his afternoon coffee? (Light)

B. go in the attic and repair after his afternoon coffee? (LightPP)

C. crawl in the attic and repair after his afternoon coffee? (LexPP)

D. crawl in the attic to repair after his afternoon coffee? (LexPurp)

4.1.2 Participants and method

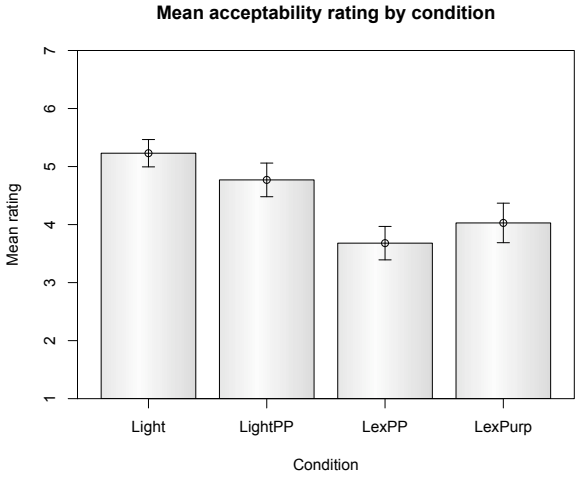
Twenty participants completed the offline questionnaire. All materials were divided into four counterbalanced lists in a Latin Square design, so that no participant saw sentences from the same quartet and all participants saw the same number of items. The materials were randomly ordered with respect to experimental items from an unrelated experiment and genuine filler items. Participants were instructed to rate the items on a scale from 1 to 7, with 7 as the most acceptable and 1 as the least. Participants were instructed to base their ratings on colloquial English.

4.1.3 Results

Responses were averaged and subjected to a one-way Analysis of Variance (ANOVA), which showed significant differences between the conditions both by subjects, $F_1(3, 19) = 18.272, p < 0.001$, and by items, $F_2(3, 19) = 13.488, p < 0.001$. Post hoc pairwise comparisons of the data revealed that responses to the questionnaire patterned as expected; participants rated sentences containing extraction out of Light pseudo-coordination constructions ($M = 5.23, SD = 1.05$) higher than out of the LexPP condition ($M = 3.68, SD = 1.29$), $p < 0.001$. The data also confirmed that extraction from LightPP constructions ($M = 4.77, SD = 1.30$) were rated as more acceptable than their LexPP counterparts, $p < 0.01$, though they were also marginally degraded with respect to the Light condition, $p < 0.06$. The pattern of the means is displayed in Figure 1 (standard deviations are in parentheses).

Interestingly, however, the LexPurp condition ($M = 4.03, SD = 1.50$) was rated on par with the other LexPP condition, $p = 0.1$, and was rated significantly less acceptable than both the Light, $p < 0.01$, and LightPP, $p < 0.05$, conditions. At

[2] All materials are available from the author upon request.



Condition	Rating	(SD)
Light	5.23	(1.05)
LightPP	4.77	(1.30)
LexPP	3.68	(1.29)
LexPurp	4.03	(1.50)

Figure 1: Mean ratings for the questionnaire

this point, it is unclear why extraction from purpose clauses should have been rated lower than pseudo-coordination.

4.1.4 Discussion

The results lend experimental support to the pattern of grammaticality judgments as they are reported in the literature. Extraction from pseudo-coordination structures was judged to be significantly more acceptable than extraction from ordinary coordination structures. Still, these results are consistent with multiple accounts of extraction, including some versions of the direct account (9I). In order to determine whether pseudo-coordination and ordinary coordination could have different semantic compositions, the next study probes how gaps are assigned to the respective structures in online processing.

4.2 Self-paced reading

This second study was designed to test how the filler-gap dependency was resolved in various coordinate structures during online processing. I assume a model of the language parser which builds syntactic structures incrementally as soon as it finds enough evidence to do so, adopting the most parsimonious structure available at that processing stage, as in e.g. Frazier (1987). I assume a version of the Active Filler Strategy, in which the parser assigns a filler to the first possible gap location (Frazier & Clifton 1989).

These assumptions, along with others enumerated above, make the following predictions: in structures parsed with Boolean conjunctions, the parser will assign a gap immediately after the first conjunct. That is, Boolean conjunction ensures that the filler distributes across both conjuncts, and thus the language processor considers the first conjunct to be a likely gap location. As soon as the semantics of the verb-argument combination is computed, the structure is subject to plausibility effects, in which the processor evaluates the plausibility of filler-gap combinations. Coordinate structures analyzed as Non-Boolean conjunction, in contrast, need not

tempt the parser to assign the filler after the first conjunct. As a result, pseudo-coordination structures should avoid processing penalties arising from implausible gap assignments, and are consequently expected to be processed with less difficulty than their ordinary coordination counterparts.

4.2.1 Participants and method

Sixty native English speakers from the University of Massachusetts, Amherst participated in the self-paced reading experiment for cash or course credit. Participants were seated in front of a computer monitor and given both written and verbal instructions. Participants read sentences divided into moving time windows. Responses were recorded with a button box, which participants used to view the next window and to respond to comprehension questions. Participants were instructed to read naturally for comprehension, and were given practice trials before beginning the experiment. Participants read 24 experimental items within a Latin-Square design. Items were presented in random order and were embedded with several other sub-experiments with constructions of varying type and complexity.

4.2.2 Materials

Materials were composed of two sentences as in (23). The first sentence (Region 1) was displayed in a single window on a separate line above the second sentence, and served to introduce the necessary discourse referents. The second sentence was presented in 6 distinct windows. The first of these regions (Region 2) invariably contained an 'it-cleft' containing a pronoun that was anaphorically linked to the object of the preceding sentence. The second window (Region 3) contained the head of a subject-headed relative clause with a gendered pronoun anaphorically linked to the subject of the preceding sentence.

The next window (Region 4) was the only region that varied across sentence forms, manipulating verb type (Light vs Lexical) by preposition (no preposition vs preposition). The verbs in the light verb conditions were evenly split between *come* and *go*. All lexical verbs were verbs of motion with a prominent intransitive sense. There were 24 quadruplets in all.

The regions that followed were again identical within a quartet. Region 5 contained the coordinator *and* and a transitive verb whose semantics made for a plausible gap location. Regions 6 and 7 divided a single adjunct clause into natural prosodic units. Region 6 provided a spill-over region for effects posited to appear on the previous region. Region 7 constituted the final region, where well-known sentence final wrap-up effects occur (Just & Carpenter 1980; Rayner *et al.* 2000).

(23) /$_1$ John found an old bottle of whiskey./$_2$ It was the one /$_3$ that he /$_4$

A. went (Light)
B. went to the park (LightPP)
C. drove (Lex)
D. drove to the park (LexPP)

/$_5$ and drank __ /$_6$ after his girlfriend /$_7$ broke up with him./

The lexical verbs of motion included in the study were both longer and less frequent than light verbs. Thus, the lexical verbs could elicit longer reading times in comparison to the light verbs, without necessarily reflecting sentence integration effects. However, the experiment was designed to avoid this confound by primarily examining the effects of verb-type and preposition on the following two regions, where such lexical effects should have been neutralized.

4.2.3 Results

Prior to analyses, scores exceeding 3 standard deviations from the mean of each region were discarded, resulting in no more than a 2% data loss per condition. Figure 2 displays the mean reading times by condition in each region of interest.

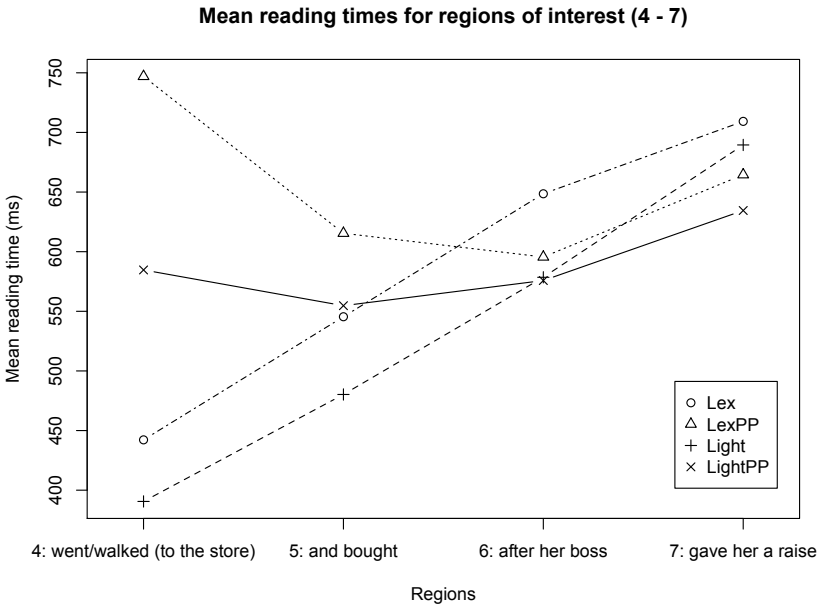


Figure 2: Mean reading times of regions of interest by condition.

Data from each region was subjected to various linear mixed effect regression models with participants and items as random effects. There were two primary reasons for selecting this statistical method. First, there was some significant loss of data, which would not have been treated as well by the more traditional ANOVA. Second, visual inspection showed potential effects of trial order. This method can incorporate such unplanned predictors into a model and test for goodness of fit against other models with different predictors. Models were selected by top-down model fitting, in which a loaded model (a model with all potential explanatory variables included) was tested against less saturated models and compared by a χ^2 test (see Crawley (2007) for examples). Of these, (24) best fit the data for all regions of interest:

(24) $\texttt{rt} = \texttt{verb} * \texttt{prep} + (1 \mid \texttt{participant}) + (1 \mid \texttt{items})$

Estimates, Standard Error and t-values were computed for each region; Table 2 summarizes the results.

	Predictor	Estimate	Std.Error	t-value	
Region 4	(Intercept)	446.66	26.07	17.13	***
	verblight	-50.035	21.45	-2.33	*
	preppp	309.78	21.75	14.24	***
	verblight:preppp	-116.41	30.60	-3.80	***
Region 5	(Intercept)	547.61	16.20	33.80	***
	verblight	-64.65	15.93	-4.06	***
	preppp	72.01	15.92	4.52	***
	verblight:preppp	3.61	22.54	0.16	
Region 6	(Intercept)	652.19	21.20	30.77	***
	verblight	-69.53	18.77	-3.70	***
	preppp	-50.77	18.74	-2.71	**
	verblight:preppp	45.92	26.44	1.74	.
Region 7	(Intercept)	714.15	23.19	30.79	***
	verblight	-20.89	21.05	-0.99	
	preppp	-43.69	21.02	-2.08	*
	verblight:preppp	-8.37	29.81	-0.28	

Table 2: Details of analysis. Linear mixed effects models with `participants` and `items` as random effects. '***' $p < 0.001$; '**' $p < 0.01$; '*' $p < 0.05$; '.' $p < 0.07$. Shaded rows display significant effects of theoretical import.

No significant differences were observed prior to Region 4. Due to lexical level confounds frequency and length in Region 4, the statistical analysis on that region is presented with caution. Region 4 showed evidence of main effects, in addition to a robust interaction. Light verbs were read significantly faster than lexical verbs, $p < 0.5$, and verbs followed by a PP were read significantly slower than those without, $p < 0.001$. While these main effects may be attributed to differences in frequency and length, the interaction between conditions, $p < 0.001$, is potentially revealing. As seen in Figure 2, the effect of adding a PP resulted in a much longer slowdown for lexical verbs as compared to light verbs. Pairwise comparisons revealed that each condition was significantly different from all others, $p's < 0.05$.

Region 5 displayed two main effects: structures containing a light verb maintained a significant advantage over those without, $p < 0.001$, and constructions containing a PP elicited significantly longer reading times over those without, $p < 0.001$. Pairwise comparisons revealed significant differences between all conditions, except the Lex and LightPP. In general, the Light condition was read fastest on Region 5, followed by the LightPP and Lex conditions. The LexPP condition elicited the slowest reading times, which may be interpreted as spill-over effect from the previous region, or as a continued disruption due to having to assign the filler to an implausible gap site.

In Region 6, significant main effects of verb and PP were again observed: items from the Light condition and the PP condition were read faster than their competitors. Additionally, there was evidence for a marginally significant interaction, $p = .06$, between the conditions, an effect which may have been driven by the long reading times for the Lex condition. Indeed, pairwise comparisons found significant differences between Lex and both Light, $p < 0.01$, and LightPP, $p < 0.01$, conditions. A marginal difference was also observed between the Lex and LexPP conditions,

$p = 0.05$. All other pairwise comparisons showed no signs of difference.

4.2.4 Discussion

Though not yet conclusive, the results from the self-paced reading study are consistent with the claim that pseudo-coordination and ordinary coordination structures are manifested with different conjunction operators. Provided that the Aspect Constraint is obeyed, both pseudo-coordination structures – Light and LightPP – are composed with Non-Boolean conjunction, whereas the multiple event structures – Lex and LexPP – are composed with Boolean conjunction. Since Boolean conjunction requires that the filler distributes across both conjuncts, the parser should have tried to fill the gap after the first conjunct as soon as possible (Wagers & Phillips 2009). If the parser posited a gap after the lexical verb of motion in Lex and LexPP conditions, the resulting ATB interpretation would be implausible. In (23c–d), for instance, distributing the filler across both conjuncts yields an interpretation in which John drives the *bottle of whiskey*, in addition to buying it.

Difficulty in interpreting Lex and LexPP conditions appeared at different points in processing. While the penalty for LexPP items appeared immediately on the region containing the first conjunct (Region 4), Lex items elicited slower reading times in later time windows (Regions 5–6). One interpretation of this pattern is that the presence of the PP dissuades the parser from looking for a better alternative gap site downstream – when it encounters the PP, it realizes that it probably will not be able to interpret the gap site elsewhere (see Bourdages (1992) for a related result), Thus, the LexPP condition activates an early plausibility violation (Pickering *et al.* 1994). If so, the plausibility violation in the Lex condition would occur on later regions, when it becomes clear that there will be no other plausible gap sites with which to associate the filler. Indeed, although verbs from the Lex and LexPP conditions were intended to be interpreted in their intransitive sense, there is evidence that the parser automatically assigns a gap after the verb if it lists a transitive use (Staub 2007).

4.3 Conclusion

This paper consisted of a detailed investigation of pseudo-coordination constructions in English. It concentrated on the relation between the fact that such constructions are construed as describing a single event and the fact that extraction is permitted out of the second conjunct in violation of the Coordinate Structure Constraint (Ross 1967). The investigation reached some suggestive conclusions. First, I argued that the semantics of the coordinator *and* in pseudo-coordinations was best analyzed as a case of Non-Boolean conjunction, which builds a complex event description from the events described by its conjuncts. To block over-application of Non-Boolean conjunction, a constraint requiring that single events have continuous running times was posited to hold in Viewpoint Aspect. Thus, Boolean and Non-Boolean conjunction were argued to appear in different locations in the parse tree, giving rise to very different syntactic structures.

If the indirect relationship I proposed here is correct, then the lexical properties of the conjunction operator plays a central role in licensing extraction. I presented two experiments to test this hypothesis. The first, an offline questionnaire, confirmed the intuition that coordinate structures for which the conjuncts could be construed

as a single event permit extraction from the second conjunct, whereas those that describe multiple events do not. Pseudo-coordination structures, with or without an intervening PP, were rated as more acceptable than ordinary coordination structures, which must describe multiple events.

Since the results of the offline questionnaire were also broadly compatible with accounts in which extraction is licensed, either in whole or in part, by how events are pragmatically construed, I tested extraction from coordination structures in an online self-paced reading task. Assuming that the language processor aggressively seeks to assign the wh-filler to potential gap locations, I predicted that *only* structures analyzed as Boolean coordination would show processing penalties reflecting that the parser assigned an implausible gap after the verb in the first conjunct. The results from the two studies are consistent with this interpretation.

While these data still admit multiple alternative interpretations, the experimental results are consistent with an indirect relationship between events and extraction. That is, structures supporting single event interpretations *do indeed* license extraction, but for altogether independent reasons. Rather, semantic and other structural factors that reflect how event descriptions are composed in syntactic structure provide the locus of extraction patterns in pseudo-coordination data. As this was the first study, to the best my knowledge, to explicitly test extraction from pseudo-coordination structures against other kinds of coordination, far more research on the topic is required to conclude with confidence that the model I have presented here is correct.

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