Interpreting conjunctions

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The interpretation generated from a sentence of the form $P$ and $Q$ can often be different to that generated by $Q$ and $P$, despite the fact that $and$ has a symmetric truth-conditional meaning. We experimentally investigated to what extent this difference in meaning is due to the connective $and$ and to what extent it is due to order of mention of the events in the sentence. In three experiments, we collected interpretations of sentences in which we varied the presence of the conjunction, the order of mention of the events, and the type of relation holding between the events (temporally vs. causally related events). The results indicated that the effect of using a conjunction was dependent on the discourse relation between the events. Our findings contradict a narrative marker theory of $and$, but provide partial support for a single-unit theory derived from Carston (2002). The results are discussed in terms of conjunction processing and implicatures of temporal order.

**Keywords:**

- Combining events with the connective $and$ can communicate a large range of different interpretations in addition to its logical, truth-functional meaning. For example, in the sentence *He took off his boots and he got into bed*, a temporal sequencing relation appears to hold between the two events; witness the incongruity that occurs if the events are reversed, as in *He got into bed and he took off his boots*. Such a difference between the two sentences contrasts with their logical counterparts, $P$ & $Q$ and $Q$ & $P$, which are truth-conditionally identical. This discrepancy between what $and$ communicates and its minimal, logical operator meaning has generated
a large amount of research in philosophy and linguistics on how these additional senses arise and their implications for the semantics/pragmatics distinction (e.g., Bar-Lev & Palacas, 1980; Blakemore, 1987; Carston, 2002; Grice, 1981; Levinson, 2000; Recanati, 1994; Strawson, 1952). In order to shed light on this debate from a psycholinguistic point of view, we present three experiments that investigate what the conjunction communicates.

The case for a pragmatic explanation of the different interpretations was first put forward by Grice (1981). Grice suggested that at the level of what is said, the utterances *He took off his boots and got into bed* and *He got into bed and took off his boots* are truth-conditionally identical, just as their logical counterparts, P & Q and Q & P are identical. Additional meanings, like the temporal sequencing interpretation, are generated by conversational implicatures (this is also the view of many neo-Griceans such as Levinson, 2000). For example, for the utterance, *He took off his boots and he got into bed*, the listener is entitled to assume that the character took off his boots before getting into bed because speakers usually describe events in the order in which they occur, and the speaker did not indicate otherwise. This assumption is sometimes called the *iconicity principle*. This account implies that these additional meanings should not be restricted to cases of conjunction, because it is simply the order of mention of the events that drives the temporal sequencing interpretation. This is indeed the case, as can be seen by comparing the above example with *and* as a connector to the same clauses separated by a period:

1a. John got into bed. He took off his boots.

1b. John got into bed and he took off his boots.

In both cases, we feel some semantic anomaly about John getting into bed and then taking off his boots, suggesting that the temporal sequencing implicature applies just as much when events are juxtaposed as when they are conjoined by *and*. If such implicatures occur with juxtaposed sentences, what differences in understanding arise between events connected with *and* and those presented individually?

**Effects of *and* on temporal order**

Carston (2002) presents examples like the following as evidence that there are effects of a conjunction that are not present otherwise (see Bar-Lev & Palacas, 1980, for a detailed discussion of such examples):

2a. Greg skipped the seminar. He was sick.

2b. Greg skipped the seminar and he was sick.

In (2a), the information communicated in the second sentence can be understood as providing an explanation for the events in the first sentence. The fact that Greg was sick, though presented second, is understood to have preceded and caused Greg to skip the seminar. This “backward” order interpretation does not seem to be available in (2b) however, where we understand the events to occur in the normal, forward interpretation where Greg skipped the seminar and was sick as a (no doubt deserved) consequence.

Such clear differences between the interpretations of (2a) and (2b) suggest that the semantics of *and* includes some feature that blocks the backward order interpretation. Indeed, Bar-Lev and Palacas (1980, p. 141) argue that the meaning of *and* specifies that the “second conjunct (S₂) is not prior to the first (S₁) (chronologically or causally)”. This feature, when combined with pragmatic maxims, captures the effects of *and* across a large range of circumstances. However, this account appears overly restrictive of the range of allowable conjunction interpretations. For example, *He went to college in New York and he went to high school in Boston* (adapted from Carston, 2002) communicates a statement in which the event in the second conjunct occurs prior to the first, contradicting Bar-Lev and Palacas’s semantic feature. Further evidence against a strict semantic account of conjunction processing comes from the defeasibility of temporal order within *and* sentences, such as *He had a drink and he went to the*
cinema, but not in that order. These, and other arguments against a semantic explanation, led Carston (2002) to suggest a pragmatic account of conjunction processing within the framework of Sperber and Wilson’s (1986) relevance theory.

Carston (2002, building on Blakemore, 1987) argued that when events are combined with and, it is the resulting complex proposition that becomes the cognitively important unit and not the constituent propositions. If the hearer is required to go to the effort of processing the lexical and syntactic structure involved in conjunction, the hearer is entitled to presume that there is more relevant information contained in that conjunction than would follow if the events were produced individually. For example, in (2b), the speaker is communicating that Greg’s sickness and his skipping the seminar are not just independent events, important in their own right, but their joint occurrence is also being drawn to the hearer’s attention. Thus, in (2b), the events are processed as a single complex unit, and knowledge structures are updated on the basis of this conjunction, whereas in (2a), the two events are represented as separate units for analysis.

Carston (2002) argues that the blocking effect of and falls naturally out of this analysis. In her examples, the backward order interpretation arises when the second event acts as an explanation, or a cause, of the first. For example, in Greg skipped the seminar. He was sick, the fact that Greg was sick acts as an explanation for why Greg skipped the seminar. She suggests that after encountering a new fact, people have a natural tendency to seek out an explanation for the new information. Linguistically, this translates as asking an implicit Why? or How? question after hearing factual statements, and to expect the next statement to be an answer to that question. For example, after hearing Greg skipped the seminar, the hearer generates an implicit question asking why Greg skipped the seminar and further assumes that the next statement, He was sick, is an answer to that question. If the two events are combined to form a single unit of analysis however, as in Greg skipped the seminar and he was sick, either the implicit Why? question does not arise after the first event (perhaps because implicatures generally arise at the end of sentences) or, if it does, the listener cannot extract the second event as the answer. According to Carston, the individual events are not accessible in a conjunction to act as question and answer.

Carston’s (2002) explanation is interesting and appears to explain a wide range of data. One issue, however, is that it is not clear to us when the implicit question is predicted to occur, nor its role in communication. Carston (2002) argues that the question is generated because of natural tendencies to seek explanations. This suggests that the implicit question facilitates processing of causality information, perhaps by creating an expectation that subsequent sentences will be causally related. And, under some circumstances, implicit questions appear plausible. For example, saying John crashed his car abruptly to a colleague is likely to generate an implicit (or even an explicit) How?/Why? question. But is a question generated after all statements? Presumably not, since there are many contexts in which the subsequent statements would not provide answers to explanatory questions (a sequence of events in a narrative is one such context), and the question would serve no purpose. But if the implicit question is

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1 Interestingly, although the ordering of the events is defeasible in this manner, much of the inferential information that would have been drawn if the information was presented in the preferred order is lost. For example, He skipped the seminar and he was sick, but not in that order does not appear to generate the same causal inference relating the two events as He was sick and he skipped the seminar. Thus, the second conjunct of the defeased version cannot function as an explanation of the first, as it does in (2a). The blocking component of the conjunction may not, therefore, be defeasible.

2 It is a bit unclearly exactly what the units (i.e., the conjuncts) are in the explanation. At various times, Carston (2002) refers to facts, propositions, utterances, events, and (most prominently) processing units. However, it is not clear that we need to know exactly what the unit formed by the conjunction is—the critical claim is that its components are not available to serve as statement and explanation, as they do in (2a). That is, Greg skipped the seminar and he was sick is being conceptualized as a single event (or single something), and so its parts are not easily decomposable.
generated only in discourse contexts that suggest causal explanations will be forthcoming, it is difficult to understand why the question is being generated at all. The processing benefits of causal expectations could be linked to recognition of the discourse context, without the necessity to generate an implicit question.

Despite the uncertainty about when the implicit question arises, we can nonetheless generate predictions that would separate Carston’s (2002) single-unit theory from other plausible accounts for the difference in interpretation between (2a) and (2b). One such alternative is based on the role of the conjunction in maintaining narrative coherence. If two events are presented as separate sentences, they could be seen as two separate occurrences that are not closely connected. If they are presented as a conjunction, however, this could act as a signal that the events are part of the same narrative unit (consider the periodic and used to connect events in loosely told stories) and that the resulting discourse should be coherent. Since temporal order is important for establishing discourse coherence (e.g., Kehler, 2000, 2004, argues that temporal order helps determine the type of the discourse relation that holds between propositions), the conjunction should signal a greater importance of that order. One way to think about this is that and as a sentential connective implicates and then in sentences like (2b). The conjunction therefore prevents the fact–explanation interpretation by emphasizing the narrative order, which is inconsistent with the fact–explanation interpretation. We refer to this as the narrative order account because it suggests that the use of the conjunction encourages a greater reliance on the order in which the events occur in the narrative.

Both the single-unit account and the narrative order account explain why the backward order interpretation is unavailable in examples like (2), where there is a potential causal relationship between the events. However, what happens when there is no causal relationship? Consider He got into bed and he took off his boots. In this example, the second conjunct is not able to function as an explanation for the first (there is no reason why taking off one’s boots should cause going to bed), but the iconic interpretation of this sentence is counter to script knowledge (normally, people take off their boots before going to bed). There is therefore an incentive to ignore the order in which the events were presented and assume that he took off his boots before he got into bed. This would be an acceptable interpretation under either conjunction account since neither prohibits a noniconic interpretation. Now consider the same sentence expressed as two separate statements, as in (1a). The narrative order hypothesis predicts that it should be easier to reverse the order of the events in this case than in the conjunction case because the conjunction encourages an interpretation based on the order in which the events were presented. Carston’s (2002) single-unit hypothesis is somewhat ambiguous about such cases. On the one hand, unifying the conjuncts into a single event might make it harder to reorder them. On the other, such reordering does not occur as a result of a question–answer interpretation, but as a general tendency to interpret events as occurring according to known scripts. Thus, we do not find a strong argument in Carston’s hypothesis concerning such items.

In summary, the narrative order explanation suggests that and works to emphasize the order of events by virtue of increasing their narrative coherence. The single-unit hypothesis argues that and serves to unify the two events into a single unit. Experiment 1 tested these accounts by presenting participants with texts with two clauses in which a strong causal relation holds between the clauses (causal items) and texts in which there was only a temporal relation (temporal items) between the clauses. Participants were asked which events within the text they understood to have occurred first. If the single-unit account is correct, the conjunction should affect backward order interpretations more for the
causal set than the temporal set, whereas the narrative order account would predict equal blocking effects across both sets of items. We explain these hypotheses in more detail below.

Another goal of this research was to investigate the interpretations of untrained speakers (rather than experts in linguistics) on a range of carefully constructed items. It is possible that idiosyncratic aspects of examples in the literature could have influenced linguistic judgements. We obtained ratings of causality and temporal ordering to ensure that our own intuitions on the normal order and causal relations of clauses were shared by the participant population.

EXPERIMENT 1

Experiment 1 was designed to assess the conditions under which the backward order interpretations were blocked by the conjunction. Participants were presented with short narratives that included a description of two events, presented either as two separate sentences (i.e., juxtaposed) or conjoined with and. For example, one group of participants saw the text He took off his boots. He went to bed, and the other saw He took off his boots and he went to bed.4 The pairs of events were constructed so that there was a normal chronological order in which they typically occurred, according to familiar scripts. Participants saw events presented in either the correct order, which is the order in which they might expect the events to occur, or in the reverse, incorrect order. Following the presentation of the text, participants answered a question concerning their interpretation of the order in which the events occurred. We expected that backward order responses would occur only for the incorrect-order items and investigated whether the conjunction would affect these interpretations.

To assess the types of relation under which backward order interpretations were blocked, we constructed two sets of items: a causal set and a temporal set. In the causal set, there was an obvious causal relationship between the two events. We chose the pairs of events so that the word because could be inserted between the putative consequence and cause in the chronological order only. For example, the sentence He crashed the car because he ran a red light is sensible, whereas He ran a red light because he crashed the car is peculiar. In contrast, the temporal set was constructed so that there was much less of a causal relation between the two events, yet a strong temporal ordering was still present. For example, when the events He posted the letter and He sealed the envelope are combined with because, as in He posted the letter because he sealed the envelope, the result is odd, even though the act of sealing the envelope invariably occurs before the act of posting the letter. We performed several tests on our items to ensure that the two sets differed primarily on the degree of causality (see “Test of materials” section below). The first test checked our intuitions about the event ordering within each item. The second test was conducted to check that the two sets differed in the degree to which a causal relation was perceived to hold between the events.

For the juxtaposed sentences, we expected participants to make some backward order interpretations for both temporal and causal incorrectly ordered items. Since there was no explicit indication of the chronological order, participants had to consider two pragmatic principles when

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4 We acknowledge that there should be a comma before and, as two independent clauses are being conjoined (Strunk & White, 1972). However, we omitted commas in the stimuli in order to minimize the length differences between the two conditions, and so we follow that practice in this article when giving examples. There is strong evidence (from their own writing) that our undergraduate participants are not very familiar with the rule requiring commas, so we do not believe it influenced the results. Another potential concern is that the stimuli would be more naturally expressed without the second pronoun, as in He took off his boots and went to bed. We decided on including the pronoun, however, to equate the number of pronouns in the two conditions. Any unnaturalness of either of these aspects of the stimuli would apply equally in the two sentence types and for the two orders and so could not explain any effects obtained.
making their judgement: first, the convention that events occur in the order in which they are presented (iconicity); and second, that events generally occur according to scripts, or world knowledge. When the events are presented in the correct order, these two principles agree, and the task is simple. When the events are presented in the incorrect order however, these principles work in different directions. It is therefore likely that some incorrect-order texts will be interpreted in line with the iconicity principle, and others will be interpreted in line with world knowledge.

The single-unit account and the narrative order account make different predictions regarding the effect of the conjunction. For the narrative order account, the predictions are straightforward: Because and signals a greater reliance on the presented order for both the temporal and the causal conditions, the conjunction should reduce the rate of backward order interpretations (compared to the nonconjoined conditions) equally for both sets of items.

For the single-unit account, the predictions for the causal items are straightforward: Since the second event can be taken as an explanation of the first, we expect a large number of reversals in the period condition. In the conjoined condition, the individual events get combined into one complex single unit, and the fact–explanation reversing gets blocked. Hence, we expect a high number of reversals in the causal–juxtaposed cases, and fewer reversals in the causal–conjoined cases. The predictions of the single-unit account for the temporal items are more complicated, because Carston (2002) is not explicit about this comparison. Given that the two temporally related events cannot be considered fact and explanation, the question–answering restructuring should not arise when the events are presented separately. However, some backward ordering might still occur, when the presented order appears bizarre relative to one’s script knowledge. If and is only predicted to block question–answer restructuring, it should not block backward order interpretation because these do not arise from question–answer restructuring. A comparable number of reversals would therefore be predicted for the temporal conjoined and temporal juxtaposed items. In short, the single-unit hypothesis as described here predicts an interaction between the type of relationship (causal vs. temporal) and the type of connective (and vs. juxtaposed).

Those predictions regarding the effects of and on the temporal items are the simplest interpretation of Carston (2002). A reasonable generalization from her account, however, is that a single-unit representation would make any form of restructuring more difficult, regardless of whether the restructuring was caused by question–answer or a disparity between presented order and script order. Interpreting the conjunction as a single unit means that the conjunction is mapped onto the schema in its entirety, with the order already specified. To change the order in which the events occurred requires decomposing the single unit, accessing the individual events, and reversing the order. If the events were separated by a period, the listener could access the individual events without having to decompose the initial unit of interpretation. This generalization of Carston’s theory would therefore predict simple effects of and on both sets of items. For the temporal items, and should reduce reversals compared to the period condition because reversing the conjoined events would involve decomposition of the single unit; for the causal items, and should reduce reversals because decomposition is also required, and the conjunction blocks question–answer restructuring. However, a greater effect of the conjunction would be expected on the causal

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5 Carston (2002) does not make explicit claims about the difference in interpretation between conjoined and juxtaposed temporal events. However, Carston (p. 251) does discuss why temporal items in the incorrect order are not reversed when they involve a conjunction (e.g., why Bill went to bed and he took off his shoes is not reversed to generate the interpretation that Bill took off his boots before he went to bed). Her explanation is that iconic interpretations of temporal items are less effortful than reversals and are therefore the preferred interpretation. This argument applies equally to juxtaposed events, in our view, but she does not make explicit comparisons between the two types of connective, so we refrain from ascribing such a view directly to her.
items than on the temporal items (an interaction) because reversal of the causal items requires overcoming both obstacles.

Method

Participants
A total of 24 students from New York University were paid or received course credit for their participation. All participants included in this article claimed to be native speakers of English.

Test of materials
We conducted two tests on our materials to assess: first, the strength of temporal sequencing of the events and, second, the strength of the causal relationship between the events. For the first test, 24 other participants were presented with two different orderings of the events and indicated which ordering was the most normal one and to what extent. We chose to use a continuous scale, as opposed to a binary scale, because the continuous scale would be sensitive to confidence or degrees of certainty. For each item, they saw a first line of the text indicating the broader context (e.g., Jane was badly hurt in a car accident), followed by a rating scale. (We included context sentences in the pretests, because they occurred in the main experiment and could have influenced the interpretation of the events’ order.) At one end of the scale, the target events were presented in what we assumed to be the correct order (e.g., She ran a red light/She had a collision), and at the other end, what we assumed to be the incorrect order (e.g., She had a collision/She ran a red light). The two events were placed one above the other on separate lines, with no periods or and. The positioning of the correct and incorrect orders with respect to the scale was counterbalanced across participants. The scale consisted of seven possible choices corresponding to seven adjacent keys on the keyboard (letters D to L). We decided to use letters because our rating scale was symmetrical, whereas use of numbers would suggest that one end of the scale indicated a greater degree of normality than the other. For each item, participants entered a letter corresponding to where on the scale, in relation to the two orderings, they believed the normal ordering occurred. For example, the participant might press “D” if she believed that running a red light and then having a collision was a very normal ordering for the events, because “D” corresponded to the marker for the far left of the scale. We converted these letters into scores in which 7 indicated an ordering that corresponded maximally with our intuitions and 1 an ordering that was the reverse of our intuitions. The scores for the causal items ranged from 5.7 to 6.7, \( M = 6.33, SD (\text{items}) = 0.29 \), and the temporal items ranged from 5.8 to 7.0, \( M = 6.63, SD = 0.30 \). Thus, both the temporal and causal items showed a very high degree of (normal) temporal sequencing.

The second test assessed the degree to which there was a causal relation between the pairs of events. A total of 30 new participants read a statement that one of the events caused the other and then rated how sensible they believed that statement to be. For each trial, they saw the context line of the narrative, followed by the two events arranged one line below each other. These were labelled Event A and Event B, respectively. Participants rated the sensicality of a statement “Event A caused Event B” on a rating scale from 1 to 7, 7 being the most sensible. For example, the participant might see the context line Jane was badly hurt in a car accident followed by Event A: She ran a red light and Event B: She had a collision followed by the causal statement Event A caused Event B. They would then hit a key corresponding to the degree they judged the causal statement to be sensible. The events were always presented in the correct order so that Event A always corresponded to the event that would normally occur chronologically prior to the other event of the pair. Thus, for the causal items, the resulting statement should be highly sensible. The results revealed that the causal items were more causally related than the temporal items were (causal \( M = 5.92, SD = 0.66 \); temporal \( M = 3.7 \) and \( SD = 0.92 \)). However, one of our temporal items had a score of 6.1, which was higher than the mean of the causal items and
over two standard deviations higher than the mean of the temporal items. We therefore removed this item from all of the analyses presented in this paper. The new temporal set, based on 19 items, had a mean of 3.5, \(SD = 0.73\).

**Materials**

We employed the 20 causal and the 19 temporal items from the pretests, each preceded by a context sentence. The full list of items can be found in the Appendix. We varied the connective (and or period) and the order of presentation of the events (correct or incorrect). We also tested 20 filler items, consisting of a context sentence followed by two events on the second line. They all used connectives like *as soon as* or *once* that indicated an unambiguous ordering. The appropriate response to the following question for these items (see below) was the opposite of the appropriate response for the correct-order experimental items so that any response bias was neutralized.

**Procedure**

Each trial started with a fixation cross, followed by the presentation of the first line of text. This line remained on the screen for 2 s, which pilot testing showed to be ample time to read the sentence. After the first line disappeared, the experimental text appeared on the line below, again for 2 s. This was replaced by the question, “How did you interpret the story that you have just read?” Below the question, there were three possible interpretations of the text corresponding to the two possible orders of the events and an “unclear” option. In each of these interpretations, the events were presented in the reverse order to which they were presented in the text. The general form of the interpretations was “[Event 2] before [Event 1]”, “[Event 2] after [Event 1]”, “It is unclear whether [Event 2] occurred before or after [Event 1]”, where Event 1 and Event 2 corresponded to the events mentioned first and second in the text, respectively. For example, if the participant had seen, *She ran a red light and she had a collision*, then the first option would be *She had a collision before she ran a red light*, the second option would be *She had a collision after she ran a red light*, and the third would be *It is unclear whether she had a collision before or after she ran a red light*. We presented the events in this order because we wanted to discourage participants from invoking a pattern-matching strategy in which they simply matched up the order of the events in the question with the order of the events in the text. Participants pressed a key corresponding to their choice of interpretation, and the next trial started.

**Results**

For items with events presented in the correct order, participants overwhelmingly maintained this order when asked for their interpretation, regardless of the relation between the events, or the choice of connective. For the causal items, the mean proportions maintaining text order were .94 versus .95 for *and* versus period, respectively, and for the temporal items, the means were .89 and .93. These results indicate that participants understood the task and performed as expected.

Figure 1 presents a breakdown of the choices for items presented in the incorrect order. The upper panel shows responses to the causal items and the lower panel responses to the temporal items. The *text order* choice indicates a decision to maintain the order of the events presented in the original statement. For example, if the participant had seen the sentence *She had a collision and she ran a red light*, the text order response would be that the participant believed the collision event occurred before the running of the light. A *switch* choice indicates a decision to switch the order of the events and interpret the events as occurring in the reverse order, so that the collision was understood to occur after the light-running. The *unclear* choice indicates that the participant was unsure which order was intended. The figure presents the proportion of responses made according to a particular interpretation for each cell in the design, and the numbers sum to one for each set of three bars.

There appears to be a difference in the pattern of responses for the two types of relations. For the causal items, participants most often
interpreted the order as switched, and this was especially true in the period condition. This is the pattern of responses that would be expected if participants were able to make the backward inference more often in the period cases than in the and cases, as suggested by Carston (2002). In contrast, responses to the temporal items were distributed more evenly across all three interpretation choices in both connectives.

We analysed this pattern by allocating each participant (and item) a score for the proportion of switch responses per condition. This is a measure of how often readers made the backward inference in interpreting the stimulus. In all of the analyses presented in this article, we included the counterbalancing factor as a between-subjects measure in our analyses of variance (ANOVAs), but for the sake of exposition, we do not report the results involving this factor because they are of no interest to the hypotheses in question. The analysis revealed that there were more switch responses to the causal items than to the temporal items, $F_{1}(1, 20) = 18.29, MSE = 0.045, p < .001$, $F_{2}(1, 37) = 19.77, MSE = 0.036, p < .001$, and that there were more switch responses in the period condition than in the and condition, $F_{1}(1, 20) = 30.13, MSE = 0.016, p < .001$, $F_{2}(1, 37) = 10.14, MSE = 0.035, p < .001$. These effects were qualified by a reliable interaction: $F_{1}(1, 20) = 7.9, MSE = 0.029, p = .01$, $F_{2}(1, 37) = 4.94, MSE = 0.035, p < .05$. Separate ANOVAs for the temporal and causal items revealed an effect of connective on causal items, such that more switch responses were made in the period condition than in the and condition, $F_{1}(1, 20) = 29.8, MSE = 0.024, p < .001$, $F_{2}(1, 19) = 11.33, MSE = 0.045, p < .01$, but connective did not influence the temporal items, $F_{1}(1, 20) = 1.14, MSE = 0.025, p = .30$, $F_{2} < 1$. Paired $t$ tests revealed that more switch responses were made in the period, causal cell than in all three of the other cells, all $t$s $> 4.8$, all $p$s $< .001$.

Finally, out of a concern that the results might reflect participants’ changing responses to these sentences over the course of the experiment (perhaps through boredom), we examined the results of the first half of the experiment alone. These results showed the same qualitative pattern as the overall analysis. In particular, and had the effect of reducing switch responses by 33% in the causal items but only by 9% in the temporal items. Thus, the critical interaction was present throughout the experiment. (Because stimulus counterbalancing was not complete in halves of the experiment, we did not carry out an ANOVA.) We also examined the first halves of the results for the remaining experiments and found no qualitative differences from the overall results reported; we will therefore not return to this issue.

Discussion

When the causal items were connected with and, we observed a lower rate of backward order interpretations than when they were separated by a period. This result is important, because it

![Figure 1. Interpretations of incorrectly ordered items as a function of item relation and connective, Experiment 1.](image-url)
demonstrates that the conjunction conveys a meaning that is different from that conveyed by the juxtaposition of its constituent propositions, as indicated by the linguistic analyses of Carston (2002) and Bar-Lev and Palacas (1980). However, we found no such effects of the conjunction in the temporal items, despite the fact that there was a high rate of backward order responses for these items in general. Thus, and blocks backward order interpretations when there is a causal relation between the statements more than it does when there is no obvious causal relation. The effects of the conjunction are therefore dependent on the discourse relation between the two text units. Our experiment adds to Carston's (2002) linguistic data by testing a range of sentences on multiple participants and by eliminating the possibility that blocked backward order interpretations were due to greater temporal expectancies in causal texts than in noncausal texts (see the “Test of materials” section).

Carston's (2002) single-unit hypothesis predicted that the conjunction would reduce the rate of backward order interpretations more for the causal items than for the temporal items, whereas the narrative order account predicted that the conjunction would reduce the rate of backward order interpretations equally for both sets of items. Since the results confirmed the former prediction, the experiment provides tentative support for her single-unit account of conjunction interpretation. In the introduction, however, we suggested that a reasonable generalization of Carston’s account would also predict that the conjunction would make reordering the temporal items more difficult, but we did not observe this effect. Experiments 2 and 3 provide further tests of this finding.

Interestingly, although there were more backward order interpretations in the period condition, about half of the responses in the and condition were also reversals. For example, 5 out of 6 participants understood She checked her email and she turned on the computer to mean that she turned on the computer first and then she checked her email, even though they saw she checked her email first in the sentence. Such a high rate is unlikely to be due to error since there were almost zero backward order responses when the events were presented in the correct order. Since the blocking characteristics of and appears defeasible, a strictly semantic account of and blocking appears unlikely (cf. Bar-Lev & Palacas, 1980). Thus, any account of and’s effect must explain it as a tendency, whether it be pragmatic, discourse based, or cognitive.

One limitation of our experiment is that it only examined interpretations concerning the order in which events were understood to occur. Perhaps readers attempted to draw some other kind of inference to interpret the incorrect-order conditions, which was blocked by and. For example, two juxtaposed events could appear less temporally proximal than two conjoined events, thereby permitting a wider range of interpretations but not necessarily affecting temporal order (e.g., John raced home. He completed his homework intuitively allows a range of activities to take place between John getting home and doing his homework, whereas John raced home and completed his homework could imply that John completed his homework immediately on getting home). Because Experiment 1 asked only about order, such inferences and their blocking would not be apparent there. To test this possibility, we conducted an experiment in which participants made sensicality judgements on the same materials as those in Experiment 1. Our reasoning was that if and blocked some inference that would make the incorrect-order sentences seem more reasonable, then participants should not consider them as sensible as sentences without and. This should be apparent in the sensicality judgements as a difference between the period and and conditions, even for the temporal sentences, contrary to what we found in Experiment 1.

EXPERIMENT 2

In Experiment 2, participants saw each line of text and judged whether it made sense. The predictions of the two accounts are similar to those of Experiment 1. The single-unit account predicts that the conjunction should prevent backward
order interpretations for the causal items, thereby leading to lower sensicality judgements for the conjoined sentences than for the period sentences when the events occur in the incorrect order. The narrative order account suggests that and will cause more of the incorrectly ordered sentences to be judged nonsensical, as and implies that the stated order is intended.

Method

Participants
A total of 36 new students from New York University were paid or received course credit for their participation.

Design and materials
We used the same experimental items as those in Experiment 1, adding a third line of text after the critical events to complete the scenario (e.g., The car was a write-off). In addition to the experimental items, we included 56 filler items that contained a nonsensical sentence on one of the three lines. The dependent measure was proportion of sensicality judgements on the second line of the critical stories.

Procedure
Participants saw a fixation cross followed by the first line of each item. The first line remained on the screen for 2 s, after which the participants made a binary sensicality judgement, the line of text disappeared, and the next line was presented immediately. This procedure continued until sensicality judgements had been collected for all three lines. The final line was followed by a comprehension question in order to make the participants pay attention to all lines of the text.

Results
Trials in which the participant answered incorrectly to the comprehension question were removed on the grounds that the participant may not have read the item sufficiently to make a sensicality judgement. This led to 146 responses being removed, or 8% of the experimental trials.

Table 1 presents the proportions of responses judged as sensible for each condition. As shown by the scores in the first and third data columns of the table, participants overwhelmingly judged the correctly ordered events as being sensible, regardless of the connective, as expected. These responses were at ceiling in all four conditions and so were not analysed. Responses to the incorrectly ordered events varied depending on the connective and the relation, as reflected in a reliable interaction between these factors: $F_1(1, 32) = 18.48$, $MSE = 0.024$, $p < .001$, $F_2(1, 38) = 6.22$, $MSE = 0.038$, $p < .02$. For the causal items, incorrectly ordered events separated by a period were judged as more sensible than those separated by and, $M = .78$ ($SD = .27$) versus $M = .58$ ($SD = .36$), $t(35) = 4.3$, $p < .01$, $t(19) = 3.3$, $p < .01$. This was presumably because the backward order interpretation was available to them. No such pattern was observed for the temporal items, where responses were virtually equal, $M = .57$ ($SD = .36$) versus $M = .56$ ($SD = .33$), $t < 1$.

(it is tempting to also make comparisons across the rows of Table 1, for example, to ask whether the .78 proportion sensible for incorrectly ordered causal items is larger than the .57 for the temporal items. However, such cross-item comparisons are not easily interpretable, because the sentences differ in many respects—as is necessary to denote different kinds of semantic relations—and so any simple differences between them may be due to any of a number of factors and not just causal versus temporal relation. Thus, we do not attempt to interpret any such differences but instead focus on the interaction of sentence type
Discussion

The results of Experiment 2 mirrored those of Experiment 1. For both sets of items, participants were less able to make sense of events presented in the incorrect order than in the correct order, but it was only for the causal items that the conjunction affected interpretations. When the causal items were conjoined, participants found it more difficult to make sense of the incorrectly ordered events than when they were presented as separate sentences, but there was no such effect for the temporal items. These results therefore confirm and broaden our conclusion from Experiment 1—namely, that the conjunction blocks interpretations only when there is a causal relationship between the events, as predicted by Carston’s (2002) single-unit account.

The narrative order account has difficulty explaining the greater proportion of blocking for the causal items than for the temporal items. If and acts to emphasize the stated order of the events, there is no obvious reason why it should do so for events that could be causally related but not those that only have a typical temporal order. One possibility is that the script bias for temporal items was stronger than that for the causal items. If so, there would have been a stronger bias to reverse the order of the events, and this bias could have overwhelmed the conjunction’s narrative function. For example, perhaps She cut open the patient and she picked up the scalpel was so incongruous with world knowledge that the conjunction was unable to preserve the text order interpretation. Such an explanation of our results would predict that reverse order interpretations would be more frequent in the temporal items than in the causal items, when no and is present. In fact, our results were completely the opposite: There were significantly more reversals in Experiment 1 for the causal items in the period condition and a trend for more reversals in the conjunction condition (see Figure 1). However, it is possible that the existence of script-based ordering in our sentences masked the narrative effect of and in some way, and so Experiment 3 used a set of items having no prior order preference. Here there should be a strong effect of iconicity, if and indeed has the effect of emphasizing narrative order.

EXPERIMENT 3

Experiment 3 used the same methodology as that of Experiment 1. Participants read short vignettes, after which they answered questions concerning the order in which events occurred in the text. There were three sets of items. The first set were the temporal items used in Experiment 1, in which the events had a typical order and an unusual order and were unlikely to be carried out simultaneously. There was no preferred order of events in the other two sets. One set, the neutral items, involved events that could occur in either order, but not simultaneously—for example, He did the dishes and he vacuumed the floor. The other set, the simultaneous items, contained events that could occur in any order or simultaneously, such as He drank a beer and he watched the barbecue (see the Appendix). Participants read the vignettes and recorded their interpretations by entering one of four response options. Three of these were the before/after/unclear options from Experiment 1, and the fourth indicated that the events occurred simultaneously. We included this fourth option because we did not wish to force participants into accepting an ordered interpretation when none was intended.

If the narrative order account is correct, participants should draw more iconic interpretations in the conjunction condition than in the period condition for both sets of unordered items (neutral and simultaneous), where there is no script order to mask and’s effect. In contrast, the single-unit account predicts that the rate of backward order responses should not differ as a function of the connective, because none of the events could act as an explanation. Participants also had the option of responding that they interpreted the events as occurring simultaneously, a response we expected for many of the simultaneous items.
The narrative account predicts that *and* should induce an order on the possibly simultaneous events and so should reduce the frequency of this interpretation relative to sentences without the connective.

**Method**

**Participants**
A total of 24 new New York University students participated for course credit or payment.

**Materials**
We employed three sets of 20 items. Each item consisted of two lines of text, and the second line described two events (as in Experiment 1). The three sets reflected different temporal ordering relationships between the events. The *temporal* set involved events that had a correct, or preferred, order and were unlikely to occur simultaneously; the *simultaneous* set involved events that did not have a preferred order, but could occur simultaneously; and the *neutral* set involved events that did not have a preferred order and were unlikely to occur simultaneously. The temporal items were identical to those used in Experiment 1 with the exception that one of the items was replaced because it was judged to contain events that were too causally related (see the “Test of materials” section of Experiment 1). The new item scored a temporal rating of 6.95 and a causal rating of 3.03 on the same test of materials. Both scores are well within the range of the other temporal items.

Four versions of each item were constructed by varying the conjunction (*and* vs. period) and the order in which the events were presented (Order 1 vs. Order 2). For the temporal items, Orders 1 and 2 referred to the correct and incorrect orders described in Experiment 1. For the simultaneous and neutral sets, one presentation order of the events in each item was arbitrarily assigned to Order 1 and the other to Order 2.

Each item set was divided into counterbalancing lists so that each participant saw each item once and an equal number of items in all conditions. Across all participants, all items were seen an equal number of times in all conditions.

**Procedure**
The procedure was identical to that of Experiment 1 with the exception that participants now had four options to choose from instead of three. The additional option was the “simultaneous” interpretation, which read, “[Event 1] at the same time as [Event 2]”. For example, *He did the dishes at the same time as he vacuumed the floor.* The four response options were presented on the screen one below each other in the order: before, after, simultaneous, and unclear.

**Results**
Responses to the temporal items presented in the correct order were much like those of Experiment 1: Participants overwhelmingly chose to maintain the text order interpretation regardless of the connective, $M = .89$ proportion text order responses with *and* as a conjunction, versus $M = .93$ with period as conjunction. Thus, our analyses focused on the more revealing conditions in which temporal items occurred in the incorrect order (see the upper panel of Figure 2). Switch responses were the most common response, $M = .65$ ($SD = .33$). Indeed, there were more switch responses than all of the other responses combined, $t_1(23) = 2.26, p < .05$, $t_2(19) = 4.78, p < .005$ (using a one-sample $t$ test comparing $M = .65$ against $M = .50$, since if a response rate is significantly greater than .5, it must be the majority response$^6$). This result is somewhat different from Experiment 1, where no single response dominated. The reason is probably the inclusion of two sets of unordered items in the present experiment, which may have enhanced the perception of temporal order in these items.

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$^6$ Because the proportions of responses must sum to 1, it is not possible to compare the proportion of one response to the sum of the others, as these values would not be independent.
as well as the addition of a new response category not available then. Under such conditions, comparisons across experiments of the absolute frequencies of one of the common responses is not very meaningful. There were almost no simultaneous responses, $M = .04$ ($SD = .072$), and remaining responses were distributed evenly across text order, $M = .18$ ($SD = .27$) and unclear order, $M = .13$ ($SD = .17$). Across connective types, however, there were no differences in response proportions, $F_s < 1$, replicating the result of Experiment 1. This is in contrast to the predictions of a narrative order explanation of and, which predicts a greater maintenance of text order interpretations in the conjunction condition than in the period condition.

Although the conjunction did not encourage an iconic interpretation for the temporal items, this may have been because the schematic representation of the order in which events generally occur was too great to allow the conjunction to have a noticeable effect. We therefore examined neutral items for which there was no preferred sequential order. Here, the effect of and should reveal itself. The response proportions to these items can be seen in the middle panel of Figure 2. The highest response rate was for the unclear order interpretation, $M = .64$ ($SD = .29$), and this option was more common than all of the other responses put together, $t_1(23) = 2.37, p < .05$, $t_2(19) = 4.88, p < .005$ (again, testing the proportion against $.5$). Participants apparently thought that sequential ordering was pragmatically unimportant if there was no schema already in place for the event ordering. The bulk of the remaining responses were text order, $M = .28$ ($SD = .27$), and there was a very low rate of switch and simultaneous responses, $M = .04$ ($SD = .07$) and $M = .05$ ($SD = .08$), respectively. The rate of switch responses in the neutral items was, not surprisingly, much lower than that of the temporal incorrect items, $M = .65$, $SD = .33$, confirming our manipulation of perceived order of events. Furthermore, we observed no differences in any response category between the two orders of the neutral items, $F_1(1, 20)s < 1.58, p > .22$, $F_2(1, 19)s < 2.32, p s > .14$, whereas there were large differences between the correct and the incorrect order of the temporal items.

Having established that the neutral items had a weak preferred ordering, we now consider whether the type of connective affected the responses. As Figure 2 illustrates, the conjunction did not encourage greater text order interpretations than the period (in fact, the trend is in the opposite direction), nor were there any differences across
connectives in any of the response categories, all Fs < 1. Thus, contrary to a narrative order view, the conjunction had no detectable effect on order interpretations, whether the schema order was strong (as it was for the temporal items) or weak (the neutral items).

A further test of the narrative order hypothesis was provided by interpretations of the simultaneous items. Here, and might overrule the tendency to interpret the events as happening simultaneously by inducing an order on them. The lower panel of Figure 2 shows the response proportions for the simultaneous items averaged across the two orders (order assignment was arbitrary for these items). The most common response was the simultaneous option, \( M = .63 \) (SE = .12), and this rate was significantly higher than the sum of all of the other response rates, \( t_1(23) = 2.96, p < .01 \), \( t_2(19) = 4.57, p < .005 \) (comparing \( M = .63 \) against \( M = .5 \)). The remaining responses were mostly the unclear order option, \( M = .27 \) (SE = .11), with very few text order or switch interpretations, \( M = .08 \) (SE = .072) and \( M = .02 \) (SE = .029), respectively. In contrast to the prediction of the narrative order hypothesis, there was a .05 higher proportion of text order responses in the period condition than in the and condition (significant only in the items analysis), \( F_1(1, 20) = 2.65, \quad MSE = 0.026, \quad p = .12 \), \( F_2(1, 19) = 4.94, \quad MSE = 0.012, \quad p < .05 \), and there was a significantly higher proportion of simultaneous responses in the and condition than in the period condition, \( M_{\text{diff}} = .12 \), \( F_1(1, 20) = 8.02, \quad MSE = 0.038, \quad p = .01 \), \( F_2(1, 19) = 5.22, \quad MSE = 0.05, \quad p < .05 \). Clearly, there was no sign that and was increasing the tendency to attend to the order of events. There were no significant differences between the connectives on other response options, \( ps > .15 \), and there were no significant effects of order of presentation (which was simply a counterbalancing variable) on any response category, \( ps > .19 \).

Discussion

Experiment 3 investigated the effects of the conjunction with items that did not have a preferred order. The results confirmed the conclusions regarding the temporal items from Experiment 1—namely, that the conjunction did not affect the rate of backward order interpretations nor the rate of text order interpretations. The same was true for events without a prior order bias, which could be interpreted as occurring simultaneously or sequentially. We therefore found no evidence to support the hypothesis that the conjunction facilitates an iconic interpretation, even in items when there was no countervailing order preference.

We also found several unexpected results. First, the most frequent response for neutral items was the unclear order interpretation, which was more prevalent than temporal or simultaneous interpretations. Given that the experiment explicitly asked about order and that the only temporal information was the order of presentation of the events, it is surprising that participants did not draw the iconic interpretation and make more text order responses—it does not seem that iconicity is a default assumption, as Grice (1975) proposed. Perhaps participants thought that if the speaker intended the order to be important for these items, he or she would have used an explicit temporal marker like after or before. This suggests that the effects of iconicity are relatively weak unless there is some script bias towards interpreting them to occur in a particular order. Indeed, it is striking that in neither this experiment nor Experiment 1 were the iconic interpretations the most common (never exceeding 30%), unless there was a countervailing script order. We discuss this further in the General Discussion.

Second, we found that when the simultaneous items were presented with a conjunction, participants were more likely to interpret the events as occurring simultaneously than when the events were separated by a period. This directly contradicts the narrative order account, whose main claim is that and increases the tendency to interpret the events as occurring in the presented order. The single-unit account, however, could accommodate these results (albeit post hoc). First, note that the simultaneous events were most often interpreted as occurring simultaneously
regardless of the connective. This suggests that it was common for these events to occur at the same time in the participants’ experience and for these events to be represented as a single unit in the appropriate schemata (assuming that repeated encountering of a set of events in the same structure leads to a single-unit representation; see, for example, Anderson & Lebiere, 1998, on chunking). By conjoining the events, the speaker was communicating that the events should be represented as a single unit and that this entire unit should be mapped onto the schema, whereas presenting the events as separate sentences communicated that they should be represented as separate propositions. Hence, the conjunction, and the resulting single-unit interpretation, reinforces the simultaneity that can be found in the schema. Events represented as a single unit are obviously susceptible to being interpreted as occurring simultaneously.

GENERAL DISCUSSION

*And* is one of the most frequent words of English, having a variety of functions. We have focused on its use as a sentential connective. If *and* has a meaning, it is most likely just the truth functional *&* (though even this is controversial, as Carston, 2002, discusses). However, since Grice (1981), a variety of different pragmatic functions have been attributed to *and*. When two clauses, A and B, appear conjoined by *and*, a number of implications may be drawn, such as concerning the order of the events or their explanatory relation. However, it is not always clear how many of these implications are due in some degree to *and* and how many are simply due to the presentation of A followed by B. Our research explicitly varied the presence of *and* in order to identify its influence on people’s interpretations of order and explanatory coherence.

Our results regarding *and* may be divided into two main parts. The first concerns the issue of temporally versus causally related clauses. As suggested by Carston’s (2002) and Blakemore’s (1987) analyses, *and* blocks one from interpreting the second clause of an utterance from acting as an explanation of the first. We found this both in questions about order (Experiment 1; given that explanations refer to events prior to the explained event) and sensicality (Experiment 2). Furthermore, the possibility that the effects are due to a stronger temporal order in the causal items than the temporal items can be ruled out because of our rating of materials. Perhaps surprisingly, *and* did not block the reversing of the stated events in order to make an utterance more consistent with prior knowledge (Experiments 1 and 3). Thus, an important conclusion of the present work is that the reordering involved in these two seemingly similar cases (causal and temporal order) must be underlyingly different. We address this difference in the next section.

The second main result concerns tests of *and* as a narrative marker. If *and* emphasizes narrative relations, and in particular the usual temporal sequence of events in a narrative, then it should have the effect of increasing iconic interpretations. This explanation could account for the blocking of explanation interpretations, because the explaining state cannot come after the to-be-explained event. However, if *and* is a narrative marker of this sort, it should apply to all kinds of events and not just those that have a possible explanatory relation. Our results consistently found that it did not have the predicted effect for other events. *And* did not reduce the number of switches in temporal sentences (Experiments 1 and 3). It also did not increase the number of iconic interpretations of schematically unordered or potentially simultaneous events (Experiment 3). It seems that there is a general expectation that events occurred in the order they were stated in, and connecting the events with *and* does nothing to increase this tendency. Indeed, the only effect we found was (slightly) in the opposite direction (Experiment 3).

In short, the results generally follow the predictions of Carston’s (2002) account and not a narrative order account. In the Introduction, however, we suggested that a reasonable generalization of Carston’s theory was that effects of the conjunction would be seen on the temporal items, in addition to the causal items. If processing the...
two clauses together should block treating the second as an explanation of the first, it should also block reordering the second as having occurred prior to the first. If the two clauses simply became a single unit (in some to-be-defined sense), then reconceiving their relation should be difficult in either case. Yet we never found such an effect of and on temporally ordered items.

To maintain the single-unit account, therefore, Carston (2002) must assume that the reordering of temporal items uses a fundamentally different mechanism from that of the reordering that takes place for the causal items. Although this is not impossible—the former is driven by a need to maintain interpretations consistent with world knowledge, while the latter is driven by a bias towards explanation—it is not clear why reordering leading to causal explanation is different from reordering leading to noncausal interpretations. For example, in He crashed the car. He ran a red light, one interpretation might be that he crashed the car as a result of running the red light, and another interpretation might be that he ran a red light and then some other event (e.g., his cell phone ringing) caused him to crash the car. In both cases the listener must reinterpret the events as occurring in the more plausible order, but in only one interpretation is there a causal relation between the events. According to the single-unit account, the reordering mechanism that led to the former interpretation is different from the reordering mechanism that led to the latter interpretation, even though they result in similar representations.

In summary, neither of the accounts we originally set out to test proved completely satisfactory. One alternative explanation is that the blocking properties of and arise not from the linking properties of the conjunction—that is, not by preventing the manipulation of the order of the events—but by the constraints that and places on the types of events that can be conjoined. It is well known that coordination is felicitous when the things being coordinated are of the same type (Hendriks, 2005) but that it is awkward or even ungrammatical to conjoin items that are syntactically diverse or conceptually different kinds of things. For example, Quirk, Greenbaum, Leech, and Svartvik (1985, p. 1473) point out that (3a) is unacceptable, because it involves conjoining clauses of different types (compare to 3b).

3a. The rain stopped and let’s go for a walk.

3b. The rain stopped and we went for a walk.

Although this constraint is somewhat loose, conjunction generally seems to be most acceptable when the units conjoined are similar.

Perhaps, then, and is having the effect of promoting the interpretation that the two conjuncts are the same type of thing. Given that the first clause described an event and that the second clause is a possible event, conjoining them encourages the interpretation that the sentence is simply a sequence of two events, because it is felicitous to conjoin two events. Interpreting the second conjunct as an explanation or elaboration of the first requires understanding it in a different way from the first.

This account successfully prohibits the fact–explanation interpretations of the conjoined sentences without predicting effects of the conjunction on the temporal items (since the events in these items can be considered the same type). Conjunctive type constraints, however, might overly restrict the range of allowable conjunction interpretations. For example, John was hit by a bus and he went to hospital seems perfectly fine, but the clauses are of (potentially) different discourse types: cause and consequent. An account proposing that and coerces the types of events to be the same would have to explain why a structure of [cause] and [consequent] is potentially allowed, but [consequent] and [cause] is not.

Constraints versus rules

We have been talking about and as if its effects were universal. However, it is clear that whatever and is doing, it is a constraint upon interpretation rather than a hard-and-fast rule. For individual
examples, Carston (2002) talks about the effect of *and* to “block” or “make unavailable” a certain interpretation (e.g., explanation). However, when taken across our items and subjects, it can be seen that “blocking” is by no means complete. In Experiment 1, participants reversed the order of the conjuncts almost half the time in the causal sentences. Clearly, the explanatory interpretation was not made unavailable all the time. However, the same is true of the iconicity effect and the schema effect. For the former, Experiment 3 shows that neutral sentences were understood to have occurred in the order stated only about 30% of the time; most of the time participants were unclear on the order. (We discuss this in detail below.) Furthermore, the iconicity effect was diminished when it conflicted with prior knowledge. By the same token, world knowledge of the order of events did have an effect (interpretations differed for the correct and incorrect orders of each experiment), but it was not universal either. People did not reverse near 100% of the temporally misordered sentences in any experiment.

All of these variables, then, exert pushes and pulls on interpretations rather than determining them. No doubt the influence of each variable depends on the presence of the other variables and the plausibility of the different interpretations that result. However, as our participants told us, sometimes the available interpretations all seem dubious, and the result is simply unclear. Because speakers occasionally intend to say things that are unexpected and unusual, sometimes they must be taken as expressing unusual messages. Thus, if iconicity and the presence of *and* lead one to think that the speaker is saying something weird, listeners may give the utterance that interpretation rather than reversing it. The detailed interaction of all these factors is a topic for future research.

Implications for the communication of temporal order

The main thrust of our experiments were concerned with *and* as a connective, but our results also have implications for how temporal order is understood from the order of mention of the events in a sentence.

Grice’s (1975) submaxim, “be orderly”, instructs us to mention events in the order in which they occur. Dowty (1986) and others make similar proposals. What is surprising about our results is how weak this maxim appears to be: Whenever there was a mismatch between world knowledge and order of presentation, the vast majority of interpretations followed the order predicted by world knowledge. Recall that there were no explicit temporal markers in these items; the implicature was cancelled purely on the grounds that what the speaker was implying did not match the knowledge of the listener. This is in stark contrast to other implicatures, such as the so-called scalar implicatures, which appear relatively difficult to cancel through world knowledge (witness the difficulty of interpreting *Some trout are fish*, Bott & Noveck, 2004, due to the clash between the implicature *not all* and world knowledge). Implicatures that disappear whenever they contradict the listener’s prior beliefs are not useful communicative devices.

Even more troubling for an order maxim is the result from our neutral items (Experiment 3). The events contained within these items were specifically designed so that they were as likely to occur in one order as the other. This is the ideal context for an order maxim to be useful, since there was no contradiction with world knowledge and no explicit temporal markers. Yet only 30% of the responses indicated that they thought that the order of the events was determined by the order of the presentation—the majority thought that the order was unclear. Why were the order implicatures cancelled or ignored in such a high proportion of responses? One possibility is that there are certain contexts in which the order maxim does not apply. According to this account, certain discourse structures could suspend the implicature regardless of the content of the sentences. Perhaps participants cancelled the order implicatures because in narrative contexts like ours, temporal order is not generally important. We have several difficulties with this proposal, however.
First, participants were explicitly asked about the order of the events in Experiments 1 and 3, and they were not asked about anything else. The experiments were not subtle investigations into the interpretation of temporal order; participants were fully aware of the information they needed to gather. If the order implicatures were cancelled because of the discourse context, it is surprising that explicit instructions to pay attention to temporal order did not reinstate the implicatures. Furthermore, in narratives describing sequences of events, order typically is quite relevant to understanding the story.

Second, such an account departs from the standard notion of Gricean implicatures. Implicatures were originally conceived of as being default interpretations that are generated unless special circumstances cancel them (see Horn, 2004; Levinson, 2000). Even when the implicature is cancelled, the listener draws the default interpretation first, then rejects it as being inappropriate. The implicature cannot be cancelled prior to establishing the truth conditions of the sentence. Experiments have found that readers cannot ignore implicatures even when instructed to do so and when drawing them hurts their performance (Glucksberg, Gildea, & Bookin, 1982; Shapiro & Murphy, 1993). The default nature of Gricean implicatures is vital for their proposed function of making communication efficient, because it allows the processor to automatically interpret the sentence without having to check the context for suitability. An order implicature that was context dependent could not, therefore, claim the processing advantages associated with Gricean implicatures.

The discussion so far has emphasized the weakness of iconicity effects in our experiments. Nonetheless, it is clear that in some circumstances the order of mention does affect the order of perceived occurrence. For example, Mary got married and had children can mean something different from Mary had children and got married, and in our experiments we found that interpretations varied depending on whether we presented events in the correct order or in the incorrect order. If these effects are not caused by an order maxim, what are they caused by? We suggest that knowledge of the events themselves sometimes triggers a search for cues to temporal order, and the order of mention is one such cue. For example, the difference between Mary having children before getting married or after getting married is seen (by some people) as an important difference, and the temporal ordering of the events is therefore communicatively important. Because the sentence does not provide any explicit information about ordering, the stated order may be taken as representing the event order. For other events, the temporal ordering is not generally important, so iconicity will not play an important role in what is communicated.

In short, perhaps order of mention is only seen as indicative of temporal order when the events themselves indicate that ordering is important. This account is different from a Gricean model because we are not proposing that there is a default interpretation that is always derived, but that order of mention is only used under circumstances determined by the events. Furthermore, our results show that the iconicity effect is weaker than one would expect from a maxim.

**CONCLUSION**

The word *and* is intuitively a very simple connective. Its effects are seemingly explained by a meaning equivalent to logical & combined with Grice’s maxim of manner. Indeed, it is used in a variety of psychological studies as the neutral connective when researchers investigate the effects of seemingly complex connectives, like because, however, or but (e.g., Caron, Micko, & Thuring, 1988; Millis & Just, 1994; Murray, 1997). Yet our research has demonstrated that the psychological processes governing conjunction interpretation are anything but simple. First, we have found that whatever constraining effects *and* has on interpretations, these effects are easily defeased. This rules out any straightforward semantic account of *and* processing (e.g., Bar-Lev & Palacas, 1980) and suggests that the effects of the conjunction are better explained in terms of
tendencies or biases rather than hard and fast rules. Second, conjoining events affects different discourse relations in different ways. The conjunction constrains the range of allowable interpretations with causally related events, but not with temporally ordered or neutral events, and it also encourages a simultaneous interpretation when events can reasonably occur at the same time. These results rule out accounts that and acts as a kind of narrative marker, encouraging greater reliance on the order in which events are mentioned.

We see our contribution to the debate on conjunction processing as narrowing down the range of possible explanations, rather than finding a definitive answer. By systematically comparing different kinds of events in both orders, we were able to obtain new evidence about the extent of and’s influence and how it depends on other variables. Our results appear best explained by an account derived from Carston (2002), suggesting that and creates a single unit for cognitive analysis, but even this account is not a complete account of the phenomena. What is clear is that and processing is not about the meaning of a single word. Rather, it involves many different linguistic factors, such as discourse coherence, implicatures of temporal order, and the content of the individual conjuncts. Understanding the processing of and means understanding how these different levels interact with one another.

REFERENCES


**APPENDIX**

**Causal items**

Lines 1 and 2 were used in Experiment 1, while all three lines and the comprehension question were in Experiment 2.

<p>| | |</p>
<table>
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| 1 | Bill walked slowly to the university.  
   | He felt very ill and he skipped the seminar.  
   | The professor was not pleased.  
   | Did Bill walk to the university? |
| 2 | Jane was badly hurt in a car accident.  
   | She ran a red light and she had a collision.  
   | The car was a write-off.  
   | Did Jane drive slowly? |
| 3 | Ann lay on the ground shivering.  
   | She slipped on a rock and she twisted her ankle.  
   | Her ankle was considerably swollen.  
   | Did Ann twist her ankle? |
| 4 | Ben had nearly finished the repair work.  
   | He unblocked the pipe and he watched the water flow.  
   | He was satisfied with the job.  
   | Did Ben unblock the drain? |
| 5 | Sheila was lying in bed for months.  
   | She fell off her horse and she broke her leg.  
   | She doesn’t want to ride again.  
   | Did Sheila fall off her horse? |
| 6 | Karen vomited into the bucket.  
   | She ate raw fish and she got food poisoning.  
   | She recovered a few days later.  
   | Did Karen get sick after eating raw chicken? |
| 7 | Dave had celebrated by going to a top restaurant.  
   | He drank too much wine and he got a hangover.  
   | He would drink less in the future.  
   | Did Dave go to a top restaurant? |

(Continued overleaf)
8 Mary decided that she wanted to look thinner. She went on a diet and she lost some weight. The diet consisted of fresh fruit and vegetables. Did Mary want to gain some weight?

9 Lewis was pleased with the interview. He was well prepared and he got the job. He is to start on Monday. Did Lewis get the job?

10 Lisa needed good marks in biology. She studied all week long and she aced the test. She made it into graduate school. Did Lisa fail the test?

11 Katie decided to go to the beach. She lay in the sun and she got bad sunstroke. She had to go to hospital for treatment. Did Katie lie in the sun?

12 Chuck was walking next to the stream. He slipped on the ice and he broke his wrist. The ambulance had trouble getting to him. Did Chuck break his leg?

13 Annabel was happy with the way the play worked out. She rehearsed a lot and she gave a good performance. The critics loved her. Did the critics like Annabel?

14 Sylvia was out of the match. She forgot to warm-up and she pulled a muscle. Her father would be unforgiving. Did Sylvia warm-up?

15 Lynn had not enjoyed the day. She walked too far and she got a large blister. It was the last time she would do this. Did Lynn get a large blister?

16 Pedro was walking home late at night. He got aggressively mugged and he went to the police. The police were sympathetic. Did Pedro walk home during the day?

17 Gareth was trying to get to the airport in rush hour. He got stuck in traffic and he missed the flight. His girlfriend was very annoyed. Did Gareth get stuck in traffic?

18 Catherine was playing hockey in Montreal. She smashed her tooth and she went to the dentist. The tooth continued to trouble her for some time. Did Catherine hurt her wrist?

19 Brett was sentenced to ten years in prison. He got a good lawyer and he was released early. The lawyer charged a thousand dollars an hour. Did Brett get released quickly?

20 Henry returned from Borneo feeling ill. He took some antibiotics and he got better quickly. The infection was not severe. Did Henry go to Brazil?

(Continued overleaf)
Temporal items

Lines 1 and 2 were used in Experiments 1 and 3, while all three lines and the comprehension question were used in Experiment 2.

1985

21 Greg walked into the forest behind his house.
He took out his axe and he cut down the tree.
The next tree to go was his favorite.
Did Greg go into a forest?

1990

22 David arrived at the supermarket.
He parked the car and he turned off the ignition.
The car park was deserted at this time of night.
Did David go to the garage?

1995

23 Brian had decided that he looked too hairy.
He took out a razor and he shaved his beard.
His chest hair was going to be much more difficult.
Did Brian shave his beard?

2000

24 Harry loved the fairytale Hansel and Gretel.
He opened the book and he read the story.
There were lots of interesting pictures.
Did Harry hate the fairytale Hansel and Gretel?

2005

25 Dorian finished his Grandmother's thank you note.
He sealed the envelope and he posted the letter.
The letter would stop his mother harassing him.
Did Dorian send a letter to his Grandmother?

2010

26 Helen just managed to get to the library before it closed.
She turned on the computer and she checked her e-mail.
There was no news from Dave.
Did Helen hear from Dave?

2015

27 Rachel was looking forward to bedtime.
She brushed her teeth and she went to bed.
Her Mom finished the story that she started yesterday.
Did Rachel brush her teeth?

2020

28 Elizabeth was exhausted after hiking for a day.
She closed her eyes and she fell asleep.
Her dreams were full of mountains and backpacks.
Did Elizabeth go swimming that day?

2025

29 Jane finished the meal at her local restaurant.
She asked for the check and she paid with cash.
Her meal had been superb.
Did Jane enjoy her meal?

2030

30 Brad just managed to get home in time for his favorite show.
He turned on the TV and he watched the broadcast.
The show was as entertaining as usual.
Did Brad turn on the Radio?

2035

31 Sonya was pleased to be going to bed.
She finished her book and she turned off the light.
She was asleep in seconds.
Did Sonya finish her book?

2040

32 Peter walked into his room.
He removed his shoes and he went to bed.
He decided he would read another chapter of his novel.
Did Peter watch TV?

(Continued overleaf)
33 Cheryl was waiting inside her house for her friend to arrive. She heard the doorbell and she opened the front door. A stranger greeted her. Did Cheryl expect a friend at the door?

34 Andrew finally caught hold of one of the wild horses. He put on the saddle and he climbed onto the horse. He rode away into the sunset. Did Andrew ride a tame horse?

35 Tony wanted to look good for his interview. He went to the hairdresser and he got a haircut. He asked for green highlights. Did Tony go to the hairdresser?

36 Sara could feel a cold coming on. She took out her hanky and she blew her nose. She decided to take the day off work. Did Sara go to work?

37 Robyn was performing a standard surgical procedure. She picked up the scalpel and she cut open the patient. She located the inflamed appendix with ease. Did Robyn make an incision?

38 Paul was asked for two hundred dollars. He opened his wallet and he took out the money. He hoped that he'd escape unharmed. Did Paul get asked for three hundred dollars?

39 Rebecca looked at her large bowl of breakfast cereal. She poured on the milk and she ate her Cheerios. They tasted of cinnamon. Did Rebecca eat Cheerios for breakfast?

40 Holly was putting up her new picture on her bedroom wall. She picked up a hammer and she hit in a nail. The picture hung perfectly. Did Holly put up the picture in her kitchen?

Neutral items

These items were used in Experiment 2 only.

41 Luke was helping his Dad do the housework. He did the dishes and he vacuumed the floor.

42 Jeff went for a stroll in the park. He walked over the hill and he went around the large pond.

43 Olivia was having a successful year. She wrote a book and she directed a documentary.

44 Laura did some work in the garden. She planted a tree and she cut the lawn.

45 Louie passed the Saturday in his usual way. He played some computer games and he read his book.

(Continued overleaf)
46 Gabrielle went to church.
   She said a prayer and she talked to her neighbor.

47 Pete was preparing for his date.
   He brushed his teeth and he combed his hair.

48 Helen passed her Saturday feeling lonely.
   She made a pie and she went to the movies.

49 Daisy picked up the newspaper.
   She read the sports section and she looked at the cartoons.

50 Erika went to the beach.
   She played volleyball and she went for a long swim.

51 Mora was loving her vacation in Hawaii.
   She surfed the waves and she sunbathed on the beach.

52 Hannah was waiting for her husband to come home.
   She bathed the child and she put dinner in the oven.

53 Lana went out one night.
   She had a drink in a bar and she went to dinner.

54 Kim worked hard that day.
   She studied her psychology notes and she went to a chemistry class.

55 Sarah needed some groceries.
   She went to the farmers’ market and she popped into the corner shop.

56 Anne spent a pleasant afternoon enjoying the summer.
   She watered the garden and she made iced tea.

57 Lynne needed to write a report about economic downturn.
   She interviewed a professor and she talked to some unemployed miners.

58 Alex did lots of sports today.
   He played basketball and he refereed a soccer game.

59 Sue had a typical weekend at home.
   She read part of a novel and she washed her car.

60 Sophie enjoyed the fair.
   She went on the big wheel and she won a goldfish.

Simultaneous items

These items were used in Experiment 2 only.

61 Annette was giving a lecture on English literature.
   She went through her slides slowly and she spoke clearly.

62 Cherry was acting as personal assistant for the day.
   She took notes and she listened to her boss.

63 Lisa had just finished dinner.
   She knitted a sweater and she watched TV.

64 Candy felt a piece of food between her teeth.
   She flossed her teeth and she looked in the mirror.

65 Mark sat down by the computer.
   He checked his e-mail and he listened to Bob Dylan.

66 Ira truly liked the Shakespeare play.
   He watched the actors take a bow and he applauded enthusiastically.

67 Fred was driving to Ohio.
   He looked at the scenery and he chatted on the phone.

(Continued overleaf)
Pedro got back late from school. He chewed bubblegum and he wrote his geography paper.

David had a relaxing day. He went running and he listened to his iPod.

Nancy stayed in her office at lunchtime. She ate her sandwich and she read her gossip magazine.

Josh was getting ready to leave. He put on his suit and he thought about the interview.

Tim was enjoying his summer party. He watched the barbecue and he drank a beer.

Chrissie was waiting for her friend. She smoked a cigarette and she talked to herself.

Andrea was expecting people for dinner. She peeled the potatoes and she rehearsed the guests’ names.

Tony woke up sleepily. He yawned widely and he stretched his arms.

Toby saw his friend down the corridor. He smiled in her direction and he waved his hand.

Daniel was due to meet his girlfriend for lunch. He spoke to her on the telephone and he looked at his watch.

Mauricio took part in a talent show. He sang and he played the piano.

Elaine was getting tired of her boyfriend. She filed her nails and she listened to him whine.

Mary sat towards the back of the church. She played with her beads and she listened to the organ.
Queries
Lewis Bott, Steven Frisson and Gregory L. Murphy

Q1 Please supply up to 5 keywords.
Q2 S’ and S’ in quote changed to S” and S’, OK?
Q3 Please label vertical axis of figure [“Clearly label each axis with both the quantity measured and the units in which the quantity is measured” (APA5: 3.81, p. 196)].
Q4 Should ?* be deleted here?
Q5 Bach (1994). Text citation?
Q6 Blakemore (2004). Text citation?
Q7 Clark (1975). Text citation?