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RUNNING HEAD: Pragmatically enriching *and*

Abstract

An utterance conjoining two propositions with *and* often conveys more information than the sum of its parts. Consider how a truth-table analysis would show that *Mary got pregnant and got married* is equivalent to *Mary got pregnant and got married*; in conversation, the order of the two conjuncts matters much more. We present three experiments that investigate both the development and on-line processing of pragmatic enrichments linked to *and* by presenting story-vignettes, each concerning a short series of events, to ten-year-olds and adults. Critical were two types of a comprehension question: One that conjoined two events in their order of appearance and one that inverted the two events. Results show that (a) children are generally more likely than adults to respond affirmatively to inverted-order questions; b) as events are made more salient in the story, children's pragmatic enrichments in response to the test-questions increase and; (c) inverted-order questions are linked with extra reading time for both children and adults, but not necessarily for the same reason. These data are taken to show that *and* sentences are initially processed among children in a minimal fashion and that developmental effects reflect how pragmatic enrichments as well as metalinguistic analyses require further effort in processing these sentences.

Children's and adults' enrichments of conjunctive sentences in context

Introduction

Consider an ordinary conjunctive sentence, as in (1a) below, and the same sentence with its conjuncts reversed, as in (1b):

(1) a. Mary got married and got pregnant.
b. Mary got pregnant and got married.

Whereas the first sentence expresses a relatively standard series of events, the second can raise eyebrows in places where the order in (1a) is traditionally observed. The implicit enrichment of both utterances, which is linked to the way the conjunction *and* is interpreted in each utterance (e.g. from *and* to *and then* or to *and thus*) make the two sentences seem rather different. This comparison highlights the contribution pragmatics makes to sentence meaning. Without such enrichments (based on the semantics of the sentences), the two utterances are equivalent. In fact, logically speaking, the two are (P&Q = Q&P).

Investigations into other pragmatic enrichments lead to the prediction that children are less inclined than adults to pragmatically enrich such conjunctive utterances. This expectation is based mostly on recent work with scalars (Noveck, 2001; Chierchia, Crain, Guasti, Gualmini, & Meroni, 2004; Papafragou & Musolino, 2003; Pouscoulous, Noveck, Politzer & Bastide, 2007): Whereas children as old as ten are likely to accept the minimal lexical meanings of terms such as *Some* (which can be glossed as *Some and possibly all*) in experimental tasks, adults are more likely to go further by enriching the sentence pragmatically (e.g. by making *Some* imply *Not All*). For example, Pouscoulous, Noveck, Politzer & Bastide (2007) show that 9-year-olds are significantly more likely than adults to respond affirmatively to statements such as *Some turtles are in the boxes* (when in fact all of the turtles in the scenario are in boxes) because adults are arguably more likely to generate *Not all turtles are in the boxes* (which justifies a "false" response).[1] Similarly, after displaying each of three horses jumping over a log, Papafragou and Musolino

[1] In a similar vein, Noveck and Posada (2003) showed that adults who answer negatively to such statements take longer than those who answer affirmatively (see also Bott & Noveck, 2004).

(2003) reported that 88% of 5-year-olds accept the statement *Some of the horses jumped over the log* whereas nearly all adults reject it.

An investigation into the pragmatic enrichment of *and* makes for an ideal complement to the studies on scalars and for two reasons. First, if one can find evidence showing that this sort of enrichment develops with age, it would show that the robust findings concerning scalars are just one example of linguistic-pragmatic development. This is important because some argue that scalar development occurs at the level of semantics and is practically a grammatical phenomenon (Chierchia et al, 2004). Evidence of general pragmatic development would strongly suggest that scalars are representative of a more general extralinguistic phenomenon.

Second, there are findings from the literature that cast doubt on the detectability of such a development. Early work on the more specific conjunctions *before* and *after* leave the impression that young children do not even fully integrate conjunctions in sentence processing. Clark (1971) reported that 3- to 5-year-old children are sensitive to the "order of mention" of conjuncts to the extent that, despite hearing a sentence like *B after A* (e.g. "The boy kicked the rock after he patted the dog"), 45% of 5-year-old children act out kicking (the first mentioned event) and then patting (the second mentioned event), even though the word *after* ought to indicate that the second mentioned event occurred first. It is as if nearly half of the 5-year-olds ignore the uttered conjunction and interpret the sentence based on the order in which the two events were mentioned. If it is the case that order of mention is paramount for young children then we should expect children to readily reject a sentence as false when it presents two events in an order that is opposite to what was just read or heard.

In fact, initial experimental indications are that enrichments of sentences containing *and* do indeed produce a developmental effect akin to scalars. An exploratory study (Noveck and Chevaux, 2002) presented seven-year-olds, ten-year-olds and adults with booklets that included a small set of four very short stories (among fillers), each followed by a conjunctive comprehension question. For two of the comprehension questions, the order of its two conjuncts respected the sequence of events in the story and for the other two the conjuncts were inverted. For example, one story described a girl, Julie, who had answered a phone call in the second sentence and accepted an invitation to a birthday party in the fifth.

Participants were then required to respond *Yes* or *No* to one of two kinds of follow-up questions:

(2) a. Julie answered the phone and accepted an invitation?
b. Julie accepted an invitation and answered the phone?

Agreeing with the utterance of (2b) indicates that the participant accepted the minimal meaning of the conjunctive sentence (that the two conjuncts are true). Rejecting 2b would indicate that the sentence was enriched, making the order of the two conjuncts relevant. Whereas the rates of agreement to (2a) were high and accurate for all participants, the authors found that 85% of seven-year olds, 63% of ten-year-olds, and 29% of the adults respond affirmatively to (2b). The adults' rates of affirmation both were lower than those produced by the children and defied chance predictions. The children were evidently less fussy than adults about the sequence of the conjuncts. That ten-year-olds respond affirmatively to questions like (2b) after having read (and while still having available) the story is impressive; it indicates that they do not readily enrich *and* sentences like the one in (2b). This effect has since been replicated (Mira Ariel, personal communication).

Competing linguistic-pragmatic accounts, which have driven the discussion on scalars, would also disagree about the way the pragmatic enrichment of *and* occurs. On the one hand, there are those who assume that specific pragmatic enrichments occur automatically or by default with the arrival of the critical spoken word, in this case *and*. For example, Levinson (1983, 2000) argues that interlocutors initially "buttress" the conjunction by privileging the sequential interpretation of *and* (see 3b below). Other interpretations become available once the buttress becomes incompatible with the context (see Levinson, 2000, pp. 122-127). Although this default mechanism for *and* is hypothesized to work in a way that is equivalent for the process in generating scalars (where, for example, *Not all* is generated by default with the onset of the word *Some*), this buttress is considered to be representative of a different class of implicatures.[2]

[2] Scalars are considered classic examples of Q-implicatures (which refer to Grice's Quantity maxim) while conjunctions are exemplary of I-implicatures (which refer to Informativeness).

On the other hand, there are those who assume that listeners start off with the minimal, linguistically-encoded meaning before pragmatically enriching it. Such Contextualist accounts are best represented by proponents of Relevance Theory (Sperber & Wilson, 1995). For example, Carston (1996, 2002) argues that the encoded meaning of *and* is akin to a minimal, truth-functional meaning and that context helps enrich it in any one of several ways. For example, consider four *and*-enrichments described by Carston (2002):

3) a. *Contrast:* It's autumn in the U.S. and it's spring in Chile.
   b. *Sequential*: She took the scalpel and made the incision.
   c. *Containment*: We spent the day in town and went to Macy's.
   d. *Causal*: She shot him in the head and he died instantly.

This approach does not privilege sequential interpretations and it supposes that a sentence could be perfectly meaningful without an enrichment to start with. Furthermore, this approach does not make a principled distinction between scalar inferences and pragmatic enrichments of *and* because both are examples of a listener's best efforts to make a speaker's utterance yield more cognitive effects.

One can better appreciate the two accounts by taking the utterance in (2b), considering it an arbitrary utterance (4), and comparing the linguistically encoded meaning (5a) and the meaning inferred by way of enrichment (5b):

(4) Julie accepted an invitation (A) and answered the phone (B).

(5) a. Julie did A and B in some order (logical interpretation).
   b. Julie first did A and then did B (pragmatic interpretation).

Note that (5a) is less informative than (5b) because the former is compatible with any one of two possible treatments of *and* in (4). That is, *Julie did A and B in some order* can be true with 2 representations (one where A comes first and another where B comes first). The interpretation represented by (5b) reduces the range of meanings of *and* (and is true only when A comes first). According to Relevance Theory, a listener starts with the interpretation that corresponds with the meaning of the words, like in (4); if a minimal reading (5a) is satisfactory to the listener, he will adopt it. However, if the listener aims to make (4) more relevant, e.g. more informative, he can enrich its

meaning, e.g. by adopting (5b). Given that (5b) arrives by way of further processing (enrichment), there is a cost involved (i.e. cognitive effort). This amounts to deeper processing but at a (perhaps small) cost.

Right now, the two approaches can account for the pragmatic-developmental effect generally and for the finding regarding *and* in our exploratory study more specifically. From the Default Inference perspective, it could be claimed that defaults, such as the one that results in buttressing, become automatic with development and that the developmental-pragmatic effect reflects such maturation. A Contextualist account would suggest that children and adults use the same comprehension mechanisms but that greater cognitive resources are available for adults, which in turn allows them to process the critical term (in this case, *and*) more deeply.

Although the work from Noveck & Chevaux (2002) is revealing, the experiments go only a short distance in describing effects of pragmatic enrichment among children. The present work aims to expand on our prior findings while refining the paradigm and addressing the theoretical debate. Refinements are fivefold. First, we present a follow-up to Noveck & Chevaux (2002) that includes cases of *before* and *after* in order to determine the extent to which conjunctions are recognized at all in these tasks (Experiment 1).[3] Second, a version of the study with *and* is presented as part of a computer-driven story-reading task in which one line is presented at a time in a self-paced manner, in order to get a more natural reaction to the comprehension question. The aim is to extract revealing response times (Experiments 2 and 3). Third, unlike in the prior work (which potentially prompted causal as well as sequential enrichments), the comprehension questions here are designed to produce enrichments that can only be sequential in nature. Fourth, we add stories (providing us with 6 stories in Experiment 1 and 9 in Experiments 2 and 3). Finally, we introduce a third conjunctive comprehension condition that is aimed to allow for an unequivocal false response. A question that ought to prompt a negative response allows us to eliminate the possibility that children favour affirmative responses.

[3] Noveck and Chevaux (2002) also showed that while 74% of seven-year-olds incorrectly respond affirmatively to Inverted-order questions that employ *and then* explicitly as a conjunction, as in *Julie accepted an invitation and then answered the phone?*, adults and ten-year-olds answered affirmatively at very low rates (8% and 0%, respectively) The present study isolates ten-year-old children because they demonstrated adult-like competence on such control questions.

Experiment 1

In the first experiment, we expand on the Noveck & Chevaux task in three ways. First, we provide two conditions (*and* vs. *before/after*). Second, we add a condition where "No" is the only correct response. With a minor change in the story, one can arrive at this third type of question. For example, if in the story above Julie were to decline the invitation, the answer to the question in (2a) would now be clearly negative. Third, we add two stories, so that participants read 6 instead of 4.

Method

Participants. Fifty-one ten-year-olds and 57 undergraduates participated. All participants were native French speakers. The participants' mean ages (range) were 10;9 (10;2 –11;11) and 18;6 (17;6 – 20;0). The participants were recruited from middle class regions in Lyon and the Université de Lyon II.

Materials. Booklets were prepared that included 14 stories, 6 of which were relevant to the present study. The remaining 8 stories formed part of another study concerning children's answers to *Yes/No* questions (including when the question was formed as a negative). Each story was made up of five lines and had its own page and there was a follow-up question after each story that appeared at the bottom of the page along with the choice of responses *Yes* and *No*. The participants were required to circle the appropriate choice. Thus, the stories remained in view as the participants answered each question. For example, consider the (translated) story in (6):

(6) Guillaume finishes eating dinner at his friend's home.
Since it is not late, he decides to walk home.
On the way, he hears a noise in a bush.
He heads to the bush and, in the branches, discovers a cat.
Guillaume takes the cat into his arms and caresses its head.

For the questions containing *and*, the follow-up came in one of three varieties: Either it presented events from the story in their proper order (e.g., 7a), in an inverted

order (7b), or with a false second conjunct. The question for this third type was identical to the one that tested for the properly-ordered conjunctive question (e.g. 7a's); however, an inconsistency was created by making a minimal modification to the original story linked with the question (for example, we changed *cat* to *bird* in the story above):

(7) a. Guillaume ate dinner at a friend's and took a cat into his arms?
b. Guillaume took a cat into his arms and ate dinner at a friend's?

We refer to these three types of question as *A&B*, *B&A*, and *A&I* (with *A* being the first even in the story, *B* being the second and *I* standing for inconsistent). We took pains to a) make each comprehension question equivalent in length and to b) choose an "A" event from an early portion of the story and "B" event from the end of the story.

To create the *before/after* condition, *and* was systematically replaced by *before* or *after* (in French, *avant* or *après*). With respect to the story above, the answer to the comprehension question that contained *before* in (8a) would be correct while (8b) would not be.

(8) a. Guillaume ate dinner at a friend's before he took a cat into his arms?
b. Guillaume took a cat into his arms before he ate dinner at a friend's?

The same can be done with *after*: Now, however, (9a) is wrong and (9b) is correct.

(9) a. Guillaume ate dinner at a friend's after he took a cat into his arms?
b. Guillaume took a cat into his arms after he ate dinner at a friend's?

For the sake of completion, we replaced *and* with *before* and *after* in the A&I condition as well, but the "correct" answer under these conditions becomes difficult to discern. For example, in the case of (8a) the test question can appear ambiguous because the semantics of *before* is partly satisfied (Guillaume did eat dinner at a friend's before doing something else). Thus, we were not certain that (children and adult) participants would say "false" consistently. Given that this was a secondary

control (to be compared to the *A&I* problems, which were controls for the *B&A* sentences) and included for the sake of completion we did not focus on these results. Nevertheless, we track these results even if they make only a limited contribution to the present study.

Design. With the exception of a single practice story, all three types of *and* question were prepared for each story. Booklets were prepared that rotated questions with respect to each story. In the case of the A&I question, the story was changed minimally as we described earlier. In this way, each participant had a unique set of materials.

Given that there were 3 sorts of test questions with *and* and 6 sorts of *before* and *after* questions (see Table 1), the stories were distributed differently according to condition. In the *and* condition, stories were paired and then linked either to *A&B, B&A* or *A&I* questions and across three kinds of booklets. For example, in one booklet, Stories 1 and 4 were presented with the test question *A&B*, Stories 2 & 5 were presented as *B&A*, and Stories 3 and 6 were linked with the test question *A&I*. Another booklet could have Stories 1 and 4 presented with the test question form B&A and in a third booklet these stories could be linked with the test question form A&I. This way all stories appeared with the three question forms.

Given the multiple ways one can arrive at story-question pairings for the *before/after* condition (in principle, each of 6 stories can be paired with 6 types of questions), we constrained the booklet preparation in the following way. Any *individual* story was linked with one of three questions (e.g. the Guillaume Story was linked with a *B after A* question, a *B before A* question and an *A before I* question), but ultimately three stories were linked with each type of question (and all six types of questions were represented). Three booklets were prepared each having the same set of experimental story-question pairs. That is, each of three booklets had a collection of six stories, each having one sort of question.

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Insert Table 1 about here

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Procedure. Booklets were prepared that included 14 stories, 6 of which were relevant to the present study. The remaining 8 stories were filler items. Each story was made up of five lines presented on a single (half-) page that included a follow-up

question at the bottom of the page along with the response options *Yes* or *No*. The participants were required to circle the appropriate choice. Thus, the stories remained in view as the participants answered each question.

Results and Discussion

First, we review participants' performance with the unequivocal control sentences before turning to participants' performance with the *B&A* sentences. This is followed by a presentation of performance on the remaining control sentences in the *before/after* condition. Following Clark (1973), we carried out analyses using both participants (represented with the index 1) and stimulus items (represented with the index 2) as random effects.

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Insert Table 2 about here

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As can be seen in Table 2, adults respond at ceiling for the two unequivocal *and* sentences (*A&B* and *A&I*) and for the four unequivocal *before/after* sentences (*A before B, B after A, B before A, A after B*). The children's performance also reveal strong competence, with rates of correct responses to all unequivocal sentences being above chance levels, with the exception of the *A after B* sentence, which prompted 69% to give a correct response (*No*). Nevertheless, the adults' performance is consistently stronger than the children's with respect to the four unequivocal *before/after* sentences ($t_1(48) = 3.55$, $p < .001$, $t_2(5) = 2.01$, $p < .10$) and the two unequivocal *and* sentences ($t_1(57) = 2.32$ $P < .05$, $t_2(5) = 2.57$, $p < .05$). Importantly, whenever the second event was mentioned first (*B after A* which is true and *B before A* which is false), children's and adults' performance was optimal, indicating that the participants were well aware of the test question's "order of mention".

Given the generally high rates of correct performance (and one where adults' rates of correct performance are consistently higher than the children's), it is striking that rates of agreement (Yes) to the *B&A* sentences are significantly higher among the children (73%) than they are among the adults (53%). Given our a priori prediction concerning the direction of this effect, we conducted a one-tailed test and found that the results largely confirm what was found in Noveck & Chevaux (2002). Children are significantly more likely than adults (marginally in an analysis by

participant) to accept *B&A* sentences as adequate interpretations of the events in the stories: $t_1(46) = 1.48$, $p = .08$; $t_2(5) = 3.67$, $p<.01$.

As we pointed out earlier, the responses to the *before* and *after* sentences that contain a false conjunct can potentially prompt children and adults to respond affirmatively. This turned out to be the case. For example, one story describes a character named Beatrice who goes scuba diving. The two conjuncts in the test question for the more standard versions (those that do not introduce a false conjunct) are "jumped off the boat" and "observed colourful fish". In order to set up the false test question for the *A&I* conditions (as well as *A before I* and *I after A*), the story about Beatrice mentions colourful plants instead of colourful fish. .It is reasonable for participants to figure that Beatrice, who is scuba diving after all, is likely to see fish and thus answer affirmatively to *Beatrice jumped off the boat before observing fish* [*Béatrice a sauté du bateau avant d'observer des poissons?*]. In fact, this story encouraged 88% of the adults and all of the children to answer affirmatively to this test question even though the story never mentioned fish (and even though the story remained visible while responding to the question). Interestingly, however, only 25% of adults and 33% of children answer this question affirmatively when the connective is *and* (i.e., most responded "No" when the test question was conjoined by *and*, as in *Beatrice jumped off the boat and observed fish*). These data indicate that the choice of conjunction has a strong effect on the way a question is evaluated. A neutral *and* encourages the participants to read the conjuncts carefully in order to see that it is true, while the conjunctions *before* and *after* appear to bias participants to accept the statement as true when a conjunct corresponds with one of the true events. Although this effect is in itself interesting (and it does not appear to be a developmental one); it is not central to our aims and we will not discuss it further.

To summarize, Experiment 1 demonstrates that children are highly sensitive to the order in which the two conjuncts are mentioned. When a test question mentions the latter (of two true events) first and the two events are conjoined by *after*, both children and adults accept these as true; when a test-question mentions the latter (of two true events) first and they are conjoined by *before*, nearly all reject these as false. Nevertheless, ten-year-olds have a strong tendency to reply affirmatively to *B&A* questions and more so than adults. Ten-year-olds' affirmative responses to *B&A* test questions can safely be taken to show that the children are less likely to enrich these sentences than their older cohorts.

Experiment 2

This experiment aims to capture on-line processing of sentences containing the conjunction *and*. In order to achieve this goal, three more 5-line-long stories are developed to be part of a self-paced task for ten-year-olds and adults. The experiment includes 9 stories (plus one example), without filler items, so as not to overburden the children. (A self-paced reading task is manifestly more difficult for children than a standard paper-based paragraph-question task.)

As in Experiment 1, each story is followed by a comprehension question that mentions two conjoined events. All conjunctions are presented as *and*. There are three conditions (*A&B, B&A,* and *A&I*). Participants are required to answer *Yes* or *No* to each question. Unlike Experiment 1, lines of text are presented and disappear after having been read. Our focus rests on responses to questions whose events are inverted; a negative evaluation to a *B&A* question would be an indication of a pragmatic enrichment while a positive evaluation would be an indication that *and* was treated with a minimal meaning. Participants are not told in advance that their response times are recorded.

Method

Participants. Twenty-nine ten-year-olds and 22 adults participated. All participants were native French speakers. The participants' mean ages (range) were 10;8 (10;2 –11;1) and 18;6 (17;3 – 20;3). The children were recruited from schools or after-school programs in middle class regions around Lyon. The adults were recruited from the Université de Lyon II.

Materials. Ten stories were prepared. One served as a practice problem. As in Experiment 1, each story was made up of five lines and concerned one person and a series of events. As indicated above, the follow-up question used the conjunction *and* and came in one of three varieties, which we refer to as *A&B, B&A,* and *A&I*, as in Experiment 1.

Design. With the exception of the practice story, all three types of question were prepared for each story. The MATLAB program that ran the study was designed to a) randomly generate one type of question per story while b) assuring that each type of question was linked to 3 trials of *A&B, B&A,* and *A&I* conditions over the course of the experiment. In this way, each participant had a unique set of materials.

Procedure. The instructions informed participants that the experiment concerned text comprehension and that it included about 10 stories. The instructions also explained how each story would be presented line-by-line, how the story could be advanced by pressing the space bar, and that the stories should be read naturally. The instructions explained that there would be a question following each story and that the participant should – throughout the task – keep one finger from each hand on the *Yes* and *No* keys (which were indicated on the *e* or *p* keys of an AZERTY keyboard). The program then presented one example.

Each left-justified line of text was presented in the middle of the screen. The start of each story was signalled by "Story (#): To continue press the space bar." The end of the story and the arrival of the question were signalled by "To make the question appear, please hit the space bar." The question was presented in a shade of white that was slightly lighter than the previous lines. The assignment of the right and left hands for *Yes* responses was counterbalanced across the experiment. The program to run the experiment was written in MATLAB using the Psychophysics Toolbox (Brainard, 1997; Pelli, 1997).

Results and Discussion

The response proportions were analyzed principally with t-tests among the participants. The reaction-time data, which included only justifiable responses that were sufficiently numerous (this excludes incorrect responses to A&B and A&I questions and adults' affirmative responses to B&A questions), were analyzed using ANOVAs or t-tests to which a log transform was applied. As before, we carried out analyses using both participants and stimulus items as random effects. The participant analysis involved summing over all stories but distinguished between the three types of questions. The item analysis separated the nine stories, summed over all participants and distinguished between the three kinds of questions. By convention, we refer to F-values obtained with participants as the random factor as F_1 (or t_1), and F-values obtained with items as the random factor as F_2 (or t_2). All p-values assume a two-tailed test unless otherwise stated.

We removed five participants (3 children and 2 adults) whose responses indicated a failure to fully appreciate the task. Four of these participants responded by hitting the same key in response to all nine of the questions and the remaining participant hit the same key to eight.

Responses to questions were considered outliers if they were beyond the mean response time ± 3 Standard Deviations for each population. This amounted to the loss of 2 data points among adults and one among children. These outliers were removed from both choice proportions and reaction time data and amount to less than 1% of the data.

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Insert Table 3 about here

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Table 3 illustrates the proportion of affirmative responses as a function of question-type. For the *A&B* sentences, 77% of the adults' responses and 75% of children's are affirmative, indicating little difference between the children and adults. Similarly, the *A&I* questions yielded low rates of affirmative responses -- 7% and 11% for adults and children, respectively. However, there is a large difference between the two populations for the B&A question to which 18% of the adults' responses and 46% of the children's are affirmative.

These observations were verified using an ANOVA with proportion affirmative as the dependent variable, Question-type as a within-subject factor and Age as a between-subject factor. The ANOVA revealed a significant interaction for Question-Type and Age, $F_1(2,90) = 4.67$, $p < .05$, $F_2(2,32) = 3.78$, $p < .01$. Further t-tests revealed that this interaction was due to the B&A question. Whereas, the B&A question among the children prompted significantly fewer affirmative responses than A&B questions, $t_1(25) = 4.89$, $p < .0001$; $t_2(8) = 3.95$, $p < .005$ and significantly more affirmative responses than the A&I question, $t_1(25) = 4.56$, $p < .0001$; $t_2(8) = 4.78$, $p < .002$, the B&A question among the adults prompted lower rates of affirmative responses than the A&B question, $t_1(19) = 6.32$, $p < .0001$; $t_2(8) = 8.91$, $p < .0001$ and rates of affirmative responses that were similar to the A&I question, $t_1(19) = 1.56$, $p > .05$; $t_2(8) = 1.99$, $p > .05$. This analysis shows that adults are enriching *and* in the B&A questions to a greater extent than children, consistent with Noveck and Chevaux (2002) and Experiment 1 above.

The participants' mean response times can also be found in Table 3. We compared children and adults using an ANOVA with reaction times to the three

questions as a repeated measure.[4] There was (not surprisingly) a developmental effect, F_1 (1,40) = 49.14, p< .0001, F_2 (1,14) = 158.74, p< .0001 and an effect for question type, F_1 (2,80) = 12.92, p< .0001, F_2 (1,14) = 3.96, p< .05. The interaction was not significant, F_1 (2,80) = .135, p> .8, F_2 (2,28) = .08, p> .9.

A series of t-tests (with significance levels appropriately reduced to .017 for each set) showed that the question type that prompted the longest response time was the negative response to the B&A question.[5] For adults, the main effect for question type is due to the difference in response times between the negative response to the B&A question and the other two (for the difference between A&I vs. negative response to B&A: $t_1(19) = 3.48$, p<.01, $t_2(7) = 1.54$, $p = .16$; and for the difference between A&B vs. the negative response to B&A, $t_1(18) = 2.63$, $p = .017$, $t_2(7) = 1.00$, p> .30). Similarly, for children, the latency effect was due primarily to the different speeds in responding to A&I and negatively to B&A questions, $t_1(23) = 4.33$, p<.005, $t_2(8) = 4.33$, p<.005 and (when based on stories) to the different speeds in responding to A&B and negatively to B&A, $t_1(23) = 1.57$, $p = .13$. $t_2(8) = 3.31$, p<.017. These findings indicate that negative responses to B&A questions were more time-consuming to arrive at than responses to the other questions, both for children and adults.

A more fine-grained analysis was conducted for the children in which the latencies of the four justifiable responses were compared in a One-Way ANOVA. Again we found a main effect for speed of justifiable response, F_1 (3,51) = 4.45, p<.01, F_2(3,21) = 4.52, p<.05, and conducted follow-up t-tests (with significance levels reduced to .008). As before, the main effect is due to the difference between the latency of the negative responses to B&A and to A&I. Children's speed of affirmative responses to the B&A question are thus comparable to the control questions.

Finally, we investigated response times to children's split response to the B&A question and, given prior findings and our a priori hypothesis, we used a one-tailed

[4] As indicated earlier, we used only the negative response latencies to the B&A question because there were only 11 affirmative responses in total among adults (3 of which were outliers that disproportionately increase the mean response times for this group).

[5] For within-subject analyses that follow, we use only participants or stories that fill both cells (i.e. there are occasionally empty cells for B&A questions). This explains why the degrees of freedom vary in the t-tests.

test. We found the expected difference, showing that children's negatives responses to B&A questions prompt significantly slower responses than positive ones (at least when stories are a random factor), $t_1(17) = 1.53$, $p = .07$, one tailed, $t_2(7) = 2.24$, $p < .05$, one-tailed.

Discussion

This on-line task presents two main confirming findings. First, we find the same pragmatic developmental effect reported in Experiment 1 with respect to children assenting to B&A questions at higher rates than adults. Second, for both age groups, the mean latency of *No* responses to B&A questions is significantly longer than those of correct responses among the control questions. This indicates that answering the B&A question requires extra effort. Meanwhile, the children's affirmative response times to B&A questions are comparable to those for the controls and faster than negative responses to this question. These findings indicate that the linguistically encoded meaning of *and* is fundamental because those children who respond affirmatively to B&A questions cannot be said to be canceling a default inference, but to be applying *and* without enrichments from the start. This depiction of the response time data is consistent with Contextualist accounts of pragmatic enrichment among adults (e.g. Bott and Noveck, 2004).

It is difficult to argue that the slow, negative responses to B&A questions are due simply to a bias linked to *No* responses because the *A&I* questions also prompt *No* responses and are not exceptionally slow. It is also hard to attribute the developmental pattern to learning because the children's *fast affirmative/ slow negative* response-time patterns to B&A questions here resonate with those found with adults in scalar studies (Noveck & Posada, 2003; Breheny, Katsos, & Williams, 2006; Bott & Noveck, 2004).

One thing that remained imperfect on this task was the rate of correct responses to the controls, and especially the responses to the *A&B* questions. We noted that even if we used a strict criterion (for example, to include those participants who got at most a single control item wrong), and thereby reduced the number of children to 16 and the number of adults to 17, the child-adult pragmatic effect for the *B&A* question remains (44% of affirmative responses among children versus 20% for adults) and the percentage of correct responses for the control problem A&B remains

in the low 80%'s. We found this last figure less than ideal and aimed to re-administer the task while improving the quality of our items.

Experiment 3

Experiment 2 confirmed that children are less likely to enrich conjunctive statements than adults when the experiment uses an on-line task. Moreover, children reveal a slower pragmatic response with respect to their semantic response. Nevertheless, the control problem (the *A&B*) condition provided rates of correct responses that were relatively low for children and adults (75% and 77%, respectively) when the text was presented one line at a time (Note that in Experiment 1, performance on control tasks was satisfactory and arguably because the entire text was available).

We thus did an inventory on the stories and identified those whose results indicated that they were problematic. We improved these and conducted a new Experiment that was identical in design to the last one. As we describe in the Method section, it appeared that the weak stories needed to make events more salient. For example, in the Guillaume story's question (Guillaume had dinner at a friend's house and caressed a cat on the head), the reference to dinner in the vignette is made almost in passing even though it is the opening line. We also noticed that higher rates of correct responses to *A&B* questions followed stories in which the events appeared prominent.

Method

Participants. 19 ten-year-olds and 26 adults participated. All participants were native French speakers. The participants' mean ages (range) were 10;1 (9;6 to 10;6) and 19;9 (18;7 – 21;5). The children were recruited from an elementary school in Romans. The adults were recruited from the Université de Lyon II.

Materials, Design & Procedure. The design of Experiment 3 was identical to that of Experiment 2. We made only minor editorial changes with the goal of making the events (to be described in the test question) more salient. For example, the story about Guillaume described in (6) referred to his having dinner at a friend's house in passing before going home and finding a cat (or bird). We thus changed the story so that the dinner is eliminated but mention of his bicycle is clear. The story now reads as:

(6') Guillaume is on his way home from a friend's on a bicycle.
He puts his bicycle down in the garden and makes his way to the door.
On the way, he hears a noise in a bush.
He heads to the bush and, in the branches, discovers a cat.
Guillaume takes the cat into his arms and caresses its head.

This led to a clearer comprehension question, referring now to an *A* event that concerns the salient bicycle :

(10) a. Guillaume put down his bicycle and took a cat into his arms? *A&B*
b. Guillaume took a cat into his arms and put down his bicycle? *B&A*

As in Experiment 2, we were very careful to make sure that question length was similar across items (range from 15-18 syllables).

Results and Discussion

Performance on the control questions was much improved compared to Experiment 2. Children scored M = 0.91 (SD = 0.24) and M = 0.90 (SD = 0.19) proportion correct on the A&B and A&I questions respectively, while adults were even more accurate, M = 0.93 (SD = 0.17) and M = 0.96 (SD = 0.14). Nonetheless, five children and two adults failed to exceed the inclusion criterion of providing more than 4 correct responses out of 6 control items and were removed from further analysis. As shown in Table 4, the correct performance to the control questions among the included children was M = 0.89 (SD = 0.16) and M = 0.94 (SD = 0.13) to *A&B* and *A&I*, respectively, and M = 0.95 (SD = 0.13) and M = 0.99 (SD = 0.07) for the adults.

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Insert Table 4 about here
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We now turn to the experimental questions, B&A. Recall that in Experiment 1, a high proportion of children (73%) accepted the reversed events as being an accurate description of the story and in Experiment 2 fewer did (44%). Interestingly, in Experiment 3 the trend was extended i.e., children were even less likely to accept the

B&A description, M = 0.28 (SD = 0.31). This proportion was significantly lower than chance (in the participant analysis), $t_1(17) = 3.06$, $p = .007$, $t_2(8) = 1.84$, p = 0.10. In contrast, the proportion of affirmative responses among the adults was higher than in previous experiments so that the adults were now equivocal, $M = 0.44$ ($SD = 0.40$). There was no significant difference between the two groups on the experimental questions however, $t_1(36) = 1.65$, $p = .11$, $t_2(16) = 1.27$, $p = .22$.

The responses by the adult participants imply that they were equivocal. This is confirmed by longer reaction times for affirmative *and* negative responses compared to the appropriate control questions. The affirmative responses to B&A were slower than the affirmative (correct) responses to A&B, $M = 6.61$ *vs.* $M = 5.17$, $t_1(16) = 2.25$, $p = .039$, $t_2(8) = 2.19$, $p = .060$, and negative responses to B&A were slower than negative (correct) responses to A&I, $M = 6.63$ *vs.* $M = 4.87$, $t_1(18) = 4.35$, $p = .020$, $t_2(8) = 2.38$, $p = .045$. Analysis of the children's response times proved inconclusive because we failed to observe significant effects between responses to the experimental questions and the control questions, nor were there any significant interactions when comparing adults to children.

In summary, we did not observe the same developmental trend in Experiment 3 as we did in our prior experiments. Instead, we failed to observe significant differences between adults and children responding to the B&A statements and the majority of children's responses were to reject the B&A statements rather than to accept them. Nevertheless, we can draw an important conclusion from these results — the effects observed previously are sensitive to the exact form of the experimental items. The crucial difference between this experiment and the previous ones is that the story-items were clarified in an attempt to improve responses to the control questions. As we achieved our goal to improve the clarity of the stories and the questions (responses to the control questions were more accurate than in Experiment 2), this methodological improvement prompted so many children to enrich the B&A question that it eliminated the developmental effect found in the two prior experiments and in Noveck and Chevaux (2002). Thus, we can conclude that children's ability to detect pragmatic anomalies depends on how easy it is for them to identify the relevant events in the discourse. When these are made easily available, as in this experiment, enrichment is more likely. We discuss the implications of these findings in more detail below.

General Discussion

This study was designed to investigate pragmatic enrichment of the conjunction *and* in utterance processing with a focus on children. Overall, it shows that pragmatic enrichment is a general phenomenon that covers more than just scalars. We summarize our main findings here and show how they fit with the rest of the developmental literature on pragmatic enrichment.

One main result concerns literate ten-year-olds who are more apt to seek out pragmatic enrichments as the task becomes clearer. Starting with Noveck & Chevaux (2002) and continuing through each of the three experiments reported here, one can see how ten-year-olds – while responding to roughly equivalent test questions – tend to enrich more as the expectations of the task as well as the stories themselves become clearer. Experiment 1's paper and pencil task, which presented stories (and filler items) that were eventually shown to be less than optimal, yielded few responses indicating conjunction enrichments (27%). Experiment 2, which removed the fillers that were present in the first Experiment and focused uniquely on 9 stories that had the same sort of test question each time, increased rates of responses indicating pragmatic enrichment (to 47%). When we improved the stories themselves while maintaining the same experimental paradigm in Experiment 3, children were more likely to enrich the "and" question; i.e., "pragmatic" responses increased further to 72%. Thus, ten-year-olds are more likely to make pragmatic enrichments as the context of the task and the stories themselves become sharper and less burdened by distractions. This shows that a pragmatic enrichment depends to a great extent on the delivery of the utterance in context. Merely stating two events in their inverse order and connecting them with *and* is not enough to encourage pragmatic enrichment.

This developmental result resonates with the findings from Pouscoulous, Noveck, Politzer & Bastide (2007), who showed how extraneous processing demands may negatively affect the computation of scalar implicatures, especially in young children. The first experiment in Pouscoulous et al. showed that 91% of nine-year-olds accept the linguistic meaning of *some* (i.e. 9% enrich) when the task uses the (relatively difficult) French quantifier *certains*, arbitrary materials, and plenty of distractor items. Experiment 2 of that paper revealed that with a set of minor changes (a non-verbal action task that uses the more frequent *quelques* and includes

no unnecessary distractors), children as young as 4 years of age can be encouraged to derive enrichments at very high rates (over 80% of 7-year-olds enrich).

The results of the three experiments in the present paper show that adults are generally less likely to accept the minimal, linguistically-encoded meaning of *and*. When one considers the data from Noveck & Chevaux (2002) and the first two experiments here, one sees that adults pragmatically enrich consistently more than children. Whereas children in Experiment 1 were likely to respond affirmatively to the B&A question, adults' responses reveal equivocality. When the task was presented as part of an on-line study in Experiment 2 and both the children and adults became more "pragmatic", the adults were more likely to respond negatively to the B&A question than the children. This demonstrates that the developmental-pragmatic effect, reported mostly for scalars, is robust (Chierchia, Guasti, Gualmini, Meroni, & Crain, in press; Noveck, 2001; Papafragou & Musolino, 2003; Pouscoulous, Noveck, Politzer & Bastide, 2007).

However, the final experiment revealed a surprising effect: Once the paradigm was clarified by having well constructed stories (along with the continued absence of distractors), the children were mostly "pragmatic" (and more than in the previous experiments). Adults — who had generally enriched the conjunctive utterances in Experiment 2 — became equivocal (as in Experiment 1). That is, the stories allowed for improved processing for adults and led them to detect that two answers to the B&A question were possible, making the process of answering this question a metalinguistic one.[6] As the reversedness of the *B&A* questions become more salient, the adults (and to a lesser extent the children), not only pragmatically enrich the meaning of *and* but also become aware of both readings.

Although this is the first time we have come across this unenriched to enriched to metalinguistic effect, it is possible that it has already been witnessed in the developmental literature. Using the *Some elephants have trunks* material used by Noveck (2001, Experiment 3), Feeney, Handley & Grafton (2004) have reported an anomalous finding showing how children and adults respond "true" to these underinformative sentences at about a 65% rate, indicating that the adults are less pragmatic than usual and that children are slightly less logical than usual (Noveck showed that children as old as ten accept these underinformative statements as true at

[6] This may account for the adults' equivocal responses in Experiment 1 as well.

rates of upwards of 80% while adults respond at rates that are at chance levels). We hypothesize that, due to the authors' instructions (which are reproduced below[7]), participants in their task (and specifically the adults) were encouraged to take a metalinguistic stance and notice that the underinformative items can lead to two justifiable responses:

> There are sixteen statements on this sheet. You have to decide whether the statement is true or false. I will read each one out individually and I want you to answer true or false. I will then mark your answer down. If you don't understand a particular word please ask.

By twice stressing that the experimenter was seeking a logical (True/False) analysis, the study might well have encouraged a metalinguistic stance (especially among the adults) that would also ultimately favor adults' providing logical responses. We suspect that the children's responses could also be affected by presenting what could appear as a logical task, but not necessarily for the same reasons as the adults. In contrast, Noveck (2001) carried out a double blind study wherein participants were simply asked to spontaneously indicate whether they agree or disagree with the provided statements (see also Guasti et al., 2005).

In conclusion, our experiments show that the developmental-pragmatic effect, which has focused mostly on so called scalar terms, is robust because our main result shows that children are generally less likely than adults to produce enrichments of *and* as they answer what we call B&A questions. More specifically, this work ultimately shows how a conjunctive sentence can be read in three ways, each one more complex than the previous one. At its most basic, a sentence containing *and* simply connects two propositions. Enrichments that provide an implied temporal order can render a conjunctive sentence more informative, but this does not come for free. Finally, participants (especially more mature ones) can become aware of both interpretations when the order of conjuncts in a question is reversed as long as the task is made clear and is easy to process. This three-step process could well be exemplary of utterance processing generally.

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[7] The authors wish to thank Aidan Feeney, who was kind enough to send these instructions to the first author.

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Table 1. The construction of Experiment 1 entailed having 3 sorts of questions with *and* and 6 sorts with *before/after*.

Conjunction	*Anticipated answer*
and	
A and B	Yes
B and A	Yes/No*
A and I	No
before/after	
A before B	Yes
B before A	No
A before I	No
A after B	No
B after A	Yes
I after A	No

Notes. *A* and *B* refers to two events that occurred in a story and in that (A then B) order. A sentence stating *Guillaume had dinner at a friend's before he took a cat into his arms* is true when the two events occurred in that order in the story. * indicates that this is the critical item for this study, where a *Yes* response is consistent with logic and *No* indicates a pragmatic response. *I* refers to an event inconsistent with the story. A sentence stating *Guillaume had dinner at a friend's and took a cat into his arms* is false when the story never mentioned a cat (but rather a bird) for this condition.

Table 2. Percentage of correct responses to questions in Experiment 1 concerning the presence of two events (A and B) in a story conjoined by either *and* or *before/after*.

And	Correct Response	10 year olds N = 27	Adults N = 32
A and B	Yes	96%	97%
B and A	Yes*	73%	53%
A and I	No	85%	95%
before/after	Correct Response	10 year olds N = 24	Adults N = 25
A before B	Yes	83%	100%
A after B	No	69%	100%
A before I	No	42%	40%
B after A	Yes	94%	100%
B before A	No	92%	96%
I after A	No	21%	60%

Note. *A* refers to the event that occurred first with respect to another event *B*. *I* refers to an event that is inconsistent with the story. * indicates that this is the critical item for this study, where a *Yes* response is consistent with logic.

Table 3. Mean latencies of (and percentage of) justifiable responses to the three types of conjunctive questions in Experiment 2.

	Question			
	A&B	B&A		A&I
	Justifiable Responses			
Group	Yes	Yes	No	No
Children	9754	9465	11769	9004
N = 26	(77%)	(44%)	(56%)	(89%)
Adults	5259	7710*	6400	4990
N = 20	(75%)	(18%*)	(82%)	(93%)

Notes. *A* and *B* refer to the order in which the events occurred in the story, where A occurred in an early part of the story and B in a later portion ("I" refers to an event inconsistent with the "B" type of event). *We include this cell for completeness sake, but it does not provide a reliable measure of response times because there were relatively few such responses (see text and especially Footnote 5).

Table 4. Mean latencies (and percentage) of justifiable responses to the three types of conjunctive questions in Experiment 3.

	Question			
	A&B	B&A		A&I
	Justifiable Responses			
Group	Yes	Yes	No	No
Children	8445	10172	8937	8114
N = 19	(89%)	(28%)	(72%)	(94%)
Adults	5173	6635	6113	4860
N = 26	(95%)	(44%)	(56%)	(99%)

Notes. See above Tables for an explanation of “A”, “B”, and “I.”